INTEGRATING SUSTAINABLE STORM WATER MANAGEMENT AND URBAN PLANNING

- A comparative case study between Sponge City in China and Climate Proof City in the Netherlands

Jing Yang

MSc. Thesis-LUP80436
Urban Environmental Management-Land Use Planning Group
Wageningen University

Illustration on the cover page: Green Initiative: China to introduce 'Sponge City' (cctvnews.cn, 2015)

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By

Jing Yang

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Dr. Ir. W.G.M. van der Knaap

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WAGENINGEN UR
For quality of life

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Wish you enjoy reading this thesis, and please do not hesitate to contact me if you have any questions.

Jing Yang

Jing.yang@wur.nl or ohyadayj@gmail.com

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Summary

Conventional storm water management, which is based on technical design and functionality such as pipes and sewers, disregarded the potential of green and blue spaces serving the ground to better manage storm runoff. On the other hand, current urban planning practices also neglect the effect of the change of land use on surface runoff volume. Paved landscape in urban areas therefore is formed, which results in increased imperviousness of urban areas and reducing cities' capacity to address storm water. Conventional storm water management based on all-grey infrastructure is unsustainable, which failed to adapt to uncertain changing conditions from climate change, ongoing urbanisation, and increasing high concentration of sealed surface.

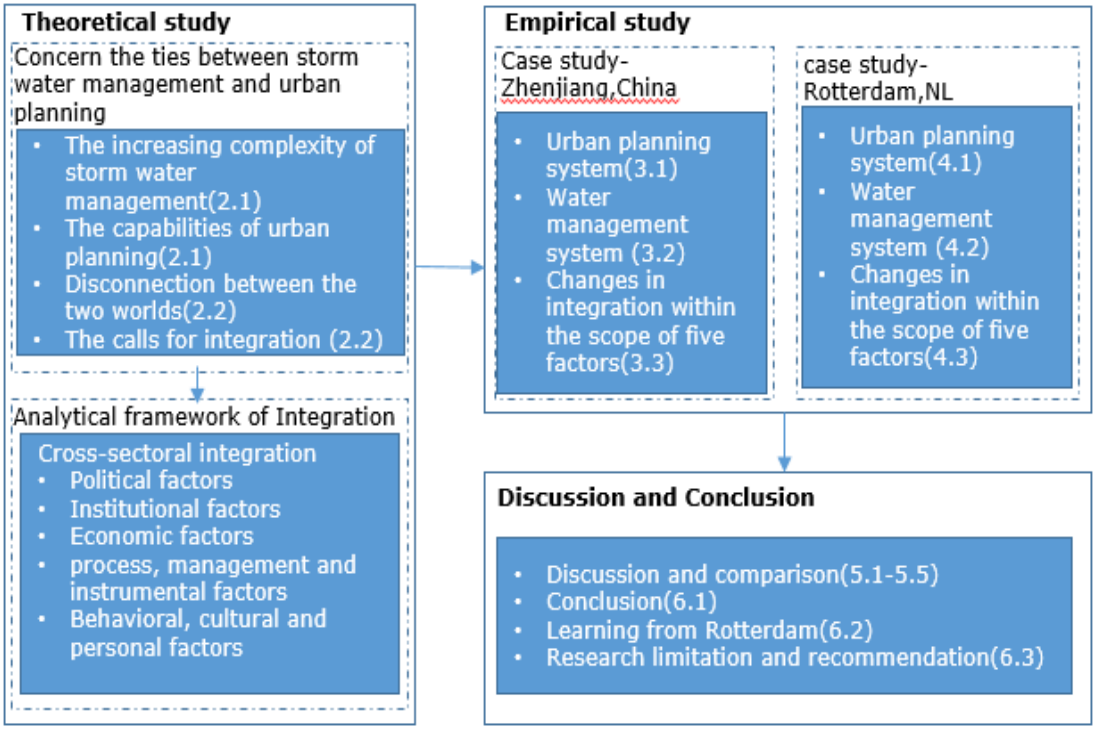
Sustainable storm water management, which values storm runoff as resource and mostly focuses on infiltration by using green and blue infrastructure such as swales, permeable street, water squares, etc., will require more space in the urban fabric rather than buried under the ground. It offers a means of integrating storm water infrastructure and urban planning to achieve multiple objective. However, there are some barriers which could hinder the implementation of sustainable storm water management identified in academic literature, especially the lack of a coordinated institutional framework. Therefore, this report pays attention to the integration between storm water management and urban planning.

The uptake of Sponge City, which focuses on the means of infiltration, storage, detention, filter, reuse and discharge, increases the acceptance of sustainable water management in China. There is a lack of literature dealing with whether and how Sponge City techniques produce the interaction between storm water management and urban planning in policy and practice. The Netherlands, which is well-known for their water management, is deemed to have more advanced experience with implementing sustainable storm water management and knowledge in the integration between water management and urban planning. Therefore, a comparative case study between China and the Netherlands was conducted to gain a more comprehensively insight into the effects of implementing sustainable storm water measures on the relationship between storm water management and urban planning. The purpose of this research was to answer the question:

What are the changes in the integration between urban planning and storm water management induced by the uptake of Sponge City in cities of China and Climate Proof City in several cities of the Netherlands?

In order to understand the integration between sustainable storm water management and spatial planning, an Analytical Framework of Integration was formed to explore factors that might influence the integration of the two worlds. After a review of academic literature which is related to policy integration and the relationship between storm water management and urban planning, the most discussed Political Factors, Institutional/Organisational Factors, Economic Factors, Process, Management and Instrumental Factors, and Behavioural, Cultural and Personal Factors were chosen for this report.

Concerning the formed Analytical Framework of Integration and Supporting by results from interviews and documents review, this research conducted case studies in Zhenjiang of China and Rotterdam of the Netherlands. The following framework provides a quick scan of the structure and logic of this research.



It was found that the integration between storm water management and urban planning has been facilitated by the uptake of sustainable storm water management both in Zhenjiang, China and Rotterdam, the Netherlands. A few details are:

Political factors: Both Zhenjiang and Rotterdam have a shared understanding of the need to implement sustainable storm water management and strengthen the relationship between the water sector and the planning sector. Zhenjiang is prevailing in

a controlling mode of government, which prefers to impose urban planning policies and regulations to affect storm water management. Rotterdam is promoting an enabling mode of governance, which attempts to enhance water-conscious of multiple sectors, especially urban planning, and facilitates cooperation between them. Water is regarded as an important vehicle to make a city attractive and prosperous, comparing to among other competing interests in urban planning. Zhenjiang or China should be aware that there are more competing interests in the urban planning and decision-making process, and storm water management is a cross-sector issue.

Institutional Factors: Compared to the Netherlands, China has a much more complex water management system and urban planning system. Especially, the water management system in China is labelled as 'the Nine Dragons who administer water'. It is recommended that China should simplify these two systems to promote interagency and interdisciplinary cooperation. It may help to enhance communication and knowledge sharing between various sectors.

Economic Factors: There was not so much information available from the interviews and literature reviews in this factor. The Dutch way of teaming up relevant actors and projects could be learned to avoid costs.

Process, Management and instrumental factors: it is found out that Zhenjiang seeks to integrate water considerations and urban planning by regulatory practices, which reflects there is a rational planning thinking in Chinese planning system. In the Netherlands, planners act as facilitator, negotiators and mediators while taking water considerations into urban planning, for example, in the process of Water Assessment. It reflects that there is a collaborative planning thinking in Dutch planning system. The uptake of sustainable storm water management, which is regarded as a cross-sectoral issue, is complex and needs more collaboration between different sectors. It is recommended that Chinese planners should rethink their role in integrating storm water management in urban planning, be regulators, or be facilitators, negotiators and mediators.

Behavioural, Cultural and Personal Factors: Urban planners and water managers in the two case study areas are confronting the challenge of different thinking, which differs in socio-economic or technical orientation. Dutch experiences told us that a communicative and consensus-seeking attitude will help to mitigate tensions. a constructive working relation, trust and cultural awareness and willingness of cooperation are also important.

In conclusion, this report reflected five changes that are accompanied with sustainable storm water management resulting in a closer connection with urban planning in China and the Netherlands. It is found that there are main changes in policy discourse, the applied government or governance system, the institutional changes, economic resource and investment arrangement, the role of planners as regulators or facilitators, negotiators and mediators, the integration of knowledge between different sectors. They are all relevant and important to the integration between sustainable storm water management and urban planning.

1. Introduction

1.1 Introduction

In recent years, we have been increasingly aware of the impacts that climate change brings to our cities, where people and assets are concentrated. Climate-related risks, such as frequency and intensity of extreme weather events, are already affecting the environment and our livelihoods, such as alteration of ecosystems, damage to infrastructure and settlements, consequences for mental health and well-being, etc. (IPCC, 2014). The impacts of climate change are becoming progressively harder to ignore, we therefore need to take action to adapt unavoidable climate change (Matthews et al, 2015; Francesch-Huidobro, 2015).

In storm water management, it is worldwide well accepted that conventional urban water infrastructure failed to address current and future uncertainties in urban storm water issues in a changing climate (Wong and Brown, 2008; Burns et al, 2012; Marlow et al, 2013). The increasing high concentration of sealed surface, the intensive urbanisation, the impact of climate change all call the need for innovative solutions in storm water infrastructure (Burns et al, 2012; Marlow et al, 2013; Albers and Deppisch, 2013). There were worldwide responses to improve urban storm water management in the context of climate change, for example, Low–Impact Development (LID) in the USA and Canada, Sustainable Urban Drainage System (SUDS) in the UK, the Water Sensitive Urban Design(WSUD) in Australia and Climate Proof City in the Netherlands, and Sponge City in China (Fletcher et al, 2014). Although the world responses in regard to storm water issues are named differently, they are all trying to achieve a sustainable urban storm water management with the common theme of replacing conventional storm water management which is regarded as unsustainable (Marlow et al, 2013). In addition, they mostly focus on incorporating natural elements, such as green and blue infrastructure in urban infrastructure, which shows an ecological turn in storm water management (Childers et al,2015).

However, barriers exist in the shift from conventional urban storm water management to sustainable storm water management (Brown and Farrelly, 2009). After reviewing 53 studies, Brown and Farrelly (2009) concluded that these barriers are socio-institutional rather than technological, and the most commonly identified barrier was the lack of a coordinated institutional framework. It is important to

address those barriers to advance sustainable storm water management. In addition, there is an ongoing academic discussion on the relationship between water management and spatial planning. Hartmann and Spit (2014) argued that traditional institutional division between water management (relies on engineering and technical solutions) and spatial planning (mediates competing interests) is unsuitable with the changing environmental constraints. They proposed a new governance scheme for integrated land and water resources management. Porse (2013) stated that the shift towards sustainable storm water infrastructure combining hard (structural conveyance) and soft (infiltration) infrastructure will bring changes to storm water management. He (2013, p48) claimed that cities should '*diversify employee skill sets and develop mechanisms to promote cross-department or cross-agency collaboration amongst engineering, environmental, financial and urban planning professionals*'.

Those barriers, that hinder the implementation of sustainable storm water management, are largely socio-institutional, especially the lack of a coordinated institutional framework. In addition, there is a growing discussion on the relationship between water management and spatial planning. This report hereby pays attention to the interagency and interdisciplinary integration between storm water management and spatial planning. It will study and compare the integration between storm water management and spatial planning where the uptake of sustainable storm water management has a significant effect on. In addition, this report will focus on two different contexts, which both have made efforts on transforming to sustainable storm water management. Concerning the ability of the researcher to speak Chinese and English, and the researcher is studying in the Netherlands, this study will focus on China and the Netherlands.

1.2 Contexts

1.2.1 Sponge City in China

In China, urban flood frequency has dramatically increased in recent years (Ran,2012; Liu and Guan, 2013). According to the first national pluvial (rain-related) flood report for 351 cities in 2010, 62% cities suffered from flooding on streets due to intensive rainfalls (Lv and Zhao,2013). On the 21st of July in 2012 in Beijing, 78 citizens died in a catastrophic flood event because of heavy rain, which was the triggering event that has heightened awareness of storm water management issues (Lv and Zhao, 2013).

Liu and Guan (2013) identified that the main causes of urban flood in China are climate change, urbanisation, the lagging drainage system development and inadequate urban planning. The current and conventional approach to storm water management is to treat rainwater as wastewater which should be quickly discharged into the sewage system by grey infrastructure (Liu and Guan, 2013). The current storm water drainage system in China is designed to historical precipitation data and the time for rainfall runoff to reach the drainage system is designed around 10-15 minutes. It is noted that this approach does not consider the changes of rainfall and storm water characteristics as consequences of climate change (Liu and Guan, 2013).

In addition, attempts have been made to deal with current storm water management dilemmas. For example, replacing a combined sewer system with a separated sewer system is regarded as an alternative. However, it mostly fails to fulfil the goal to address urban street flood. One of the most famous failure cases is the sewer separation project in Nanjing from 2010 to 2014. 10 billion RMB (1.46 billion euros) had been invested in this project, which has planned to invest to 18.7 billion RMB (2.7 billion euros), but the outcome is not effective so far (Hu and Li, 2015).

Furthermore, local governments, that have failed to pay sufficient attention to drainage systems, also play a significant role in causing the increasing flood frequency in a large number of Chinese cities (Ran, 2012; Li, 2014). It has been a common problem that the leaders of local governments attempt to maximise their achievement in urban development and economic growth during their four-year term. Because it is regarded as one of the most important requirements for their performance assessment, and it largely relates to their future promotion. It ends up with seeking economic GDP growth as a priority (Ran, 2012; Li, 2014, Francesch-Huidobro et al, 2015). They intend to demonstrate their 'political achievement' (Zhengji Gongcheng) through emphasising short-term and ambitious goals. Therefore, visible and above ground large projects are paid more attention in order to achieve local leaders' political aspiration. On the contrary, the underground infrastructure development is less important in their perspectives. The leaders of local government only take responsibility for the cities' development for their four-year term, which makes them neglect to improve buried drainage system that has long-term effects on cities. The local leaders exert influence over the planning and decision-making process (Ran, 2012; Li, 2014).

Sponge City Development Guidance was issued by the Ministry of Housing and Urban-Rural Development (MHURD) in 2014 to guide an alternative approach of urban storm water management (MHURD, 2014). In 2015, 16 cities were chosen for a three-year Sponge City Demonstration Programme (Table 1). It is expected that China will widely implement the concept of Sponge City in city development in the coming years.

Table 1 Sponge City Demonstration Project (Calid.cn, 2015)

Policy	Sponge City Development Guideline
Main concept	● Infiltrate, storage, clean, detention, filtration, reuse and discharge urban storm water runoff ● 20 square kilometres of the areas in demonstration cities should reach the goal of controlling 70% annual volume rainwater runoff
Pilot project	The first batch of the 16 sponge cities are Wuhan, Chongqing, Xiamen, Zhenjiang, Qian'an, Chizhou, Pingxiang, Jinan, Hebi, Changde, Nanning, Suining, Guian new district, Xixian new district
Time frame	2015-2017
Finance	● Every Sponge City can gain fund vary from 400 to 600 million RMB(58-87 million euros) per year ● Implementation via public-private partnership

The measures of Sponge City are similar with other sustainable water management practices, such as Water Sensitive Urban Design, Climate Proof City, Low Impact Development (LID) Sustainable Urban Drainage System, which all mostly focus on infiltration and attempt to use green and blue infrastructure to address excessive rainfall. Sponge City promotes natural storm water management techniques that minimise runoff and help prevent pollutants from getting into the runoff (MHURD, 2014). Those practices all have a focus on urban storm water management, intend to promote the use of green and blue infrastructure installed on the surface, and seek to integrate storm water infrastructure into urban planning and design. The similarities of those approaches are in recognising defects of traditional methods of collecting rainwater into a sewer system as fast as possible, and promoting sponge-like cities which use urban planning and design approaches to soaking and reusing storm water runoff. As such, Sponge City measures refer to green and blue infrastructure including green roofs, rain gardens, street trees, vegetated parks, permeable pavement, wetlands, bio-filtration swales, etc., which are varied and

mostly focuses on infiltration. In this report, Sponge City is framed with two points: firstly, it is about a process turning natural and ecological concerns in storm water infrastructure by using a range of means of infiltration, storage, detention, filter, reuse and discharge (Appendix 1). Secondly, Sponge City, seen as a multi-functional and cross-sector solution to storm water management, is about coordination and integration. It leads to a closer relationship between water management and urban planning.

China is at a starting stage towards sustainable storm water management. There is a lack of academic literature dealing with how to integrate storm water management and urban planning and how to promote this integration in China. Firstly, it needs to identify how the changing storm water management techniques combining hard and soft infrastructure will affect storm water management. Secondly, it remains unclear that whether and how Sponge City development produces the interaction between water management and urban planning in policy and practice. This research is conducted to contribute to these two areas, in order to facilitate the development of Sponge City in China and address the knowledge gap.

1.2.2 Climate Proof City in the Netherlands

China is not the only country that has been hit by flooding in the face of climate change and advocating alternative storm water infrastructure. The Netherlands, as a low-laying country, is worldwide acknowledged that it has large experience and long history with water issues. The Netherlands with this unique geography is vulnerable to flood risk, therefore, the Netherlands has a long tradition of flood protection (OECD, 2014). In the OECD report (OECD, 2014, P53), it states 'safety against flooding and the management of excess rain have long been the foundation of water management in the Netherlands'.

The Netherlands has made efforts to make Climate Proof City over recent years, which is associated with sustainable water management. For example, the national initiative 'Space for Rivers' in 2007 and other similar practices, such as 'Building with Nature', provide insight into a unique combination of land, nature and water management. It shows that the shift in thinking from just increasing the height and size of dykes to give the river more room to be able to manage higher water levels (Ruimtevoorderivier, 2016). Conventional approaches including dredging and dyke are single-purpose, which hardly provides co-benefits and new possibilities (Swart et al, 2013) Verkerk and van Buuren (2013) argued that Space for Rivers not only presents a shift in the content of measures, but also in a more interactive and

collaborative water management style. Building with Nature, refers to a design process aiming to 'utilize natural processes and provide opportunities for nature as part of the infrastructure development process', which shows a paradigm shift from building in nature to build with nature (De Vriend and Van Koningsveld, 2012). Water retention in urban areas, such as practices of water squares in Rotterdam, aims to cope with heavy rain events with a short period by using a little room for water buffers in urban areas (Gemeente Rotterdam, 2007).

Those strategies show a new paradigm from against water to live and accommodate water in the Netherlands. They facilitate the integration between water management and urban planning. In addition, there is an increasing awareness of strengthening the integration between water management and urban planning in the Netherlands in the policy field. For example, in the National Water Plan 2016-2021, Melanie Schultz van Haegen, the Minister for Infrastructure and the Environment, wrote a small chapter 'Water-conscious when it comes to spatial planning tasks', which argued that it is important and imperative to integrate water-related tasks and other spatial planning tasks whenever possible (I&M, 2016). In 2014, the Organisation for Economic Cooperation and Development (OECD) qualified Dutch water management as a 'global reference' and praised that the Netherlands has a robust and adjustable institutional and policy framework (OECD, 2014).

It is deemed that the Netherlands has advanced experience with building climate proof cities and understanding on the inclusion of water issues in urban planning. Dutch innovative approaches are worth learning for the Chinese context. Therefore, a comparative case study between China and the Netherlands can be useful to gain a more comprehensively insight into effects of implementing sustainable storm water techniques on the integration between storm water management and urban planning, and to inspire China to improve the connection between the two worlds.

1.3 Research Objectives and Questions

1.3.1 Research Objective

Sustainable storm water management, including Sponge City in China and Climate Proof City in the Netherlands, is understood as a process which facilitates the cooperated development and management of land and water, in order to include natural and ecological concerns into the storm water management approach.

Furthermore, it aims to contribute to climate adaptation strategies and achieve social, economic and environmental sustainability. It implies that the fast urbanisation, increasing urban population, and climate change effects raise questions on the limitation of conventional piped drainage systems for storm water. Storm water management with a closer connection to urban planning procedures and decision-making process is needed to respond to future challenges and sustainability calls.

This study intends to explore the changes in the integration between urban planning and storm water management as a result of the uptake of sustainable storm water techniques in China and the Netherlands, along with possible approaches that China could learn from the Netherlands to overcome the gaps between the two worlds, by:

1) Developing an Analytical Framework of Integration by reviewing and synthesising literature to explore factors and elements relating to the relationship between storm water management and urban planning;
2) Applying the Analytical Framework of Integration in China and Dutch case studies to explore how cities cooperating sustainable storm water infrastructure affects the integration between urban planning and storm water management;
3) Finding out which approaches are developed by the Netherlands with relevant mature and advanced experiences with regard to the integration between sustainable water management and urban planning, that could be useful to China.

1.3.1.1 Scientific relevance

It was identified that the most common barrier of the shift from conventional storm water management to sustainable storm water management is a lack of a coordinated institutional framework. It implies that the integration between storm water management and urban planning is worth to being investigated to advance sustainable storm water management. This report is not the first study to discuss the topic about integrating storm water management into urban planning. However, it is found that there is a lack of literature dealing with how to integrate storm water management and urban planning and what should be concerned with this integration in China. This report specifically focuses on China context, which recently proposed an adaptive strategy -Sponge City, and Dutch context, which has a long history of water management and shows a shift from fighting against water to accommodating water. From a scientific point of view, it is value-added to investigate factors that might influence the integration between sustainable storm water management and urban planning in the two countries. In addition, a

comparative case study between China and the Netherlands may help to gain a more comprehensively insight into the integration between storm water management and urban planning. Chan could benefit from it.

1.3.1.2 Societal relevance

It is expected that this report can contribute to the enhancement of the awareness of the integration between sustainable storm water management and urban planning, and the uptake of sustainable storm water measures to prevent urban flooding and improve the quality of life.

1.3.2 Research Question

The main question of this research is:

What are the changes in the integration between urban planning and storm water management induced by the uptake of Sponge City in cities of China and Climate Proof City in several cities of the Netherlands?

The sub-questions of this research are:

- What are factors and elements relating to the integration between storm water management and urban planning identified in literature?
- What is the urban planning system in China and the Netherlands?
- What is the urban water management system in China and the Netherlands?
- What are factors in the scope of a formed Analytical Framework of Integration that might influence the integration between storm water management and urban planning in Chinese and Dutch case studies?
- What are innovative approaches with respect to the integration between sustainable water management and urban planning practiced in the Dutch situation that could be profitable for Chinese cities?

1.4 Research Methodology

1.4.1 Research Process

As mentioned before, this study stresses the significance and necessity of taking account of storm water management issues into that urban planning process. With the aims to analyse and bridge the disciplines of storm water management and urban planning, this research will be developed in 3 phases. The focus of the first phase is to form an Analytical Framework of Integration, which will be used to explore factors that might influence an integration of ecological-based storm water management and urban planning in case study areas. The generation of the

framework will be based on identified elements and factors in current academic literature, through a literature review and synthesis.

The second phase aims to explore and to analyse factors that might influence the integration of storm water management and urban planning in China and the Netherlands based on the Analytical Framework. The research will be based on a qualitative case study approach.

The selection of case study concerns the experiences of cases with sustainable storm water management, because it helps the researcher to explore information about storm water-urban planning integration using interviews and literature review. Therefore, case areas should be representative and with sufficient data.

Before China officially promoted the concept of Sponge City, there were some efforts related to the implementation of the ecological-based storm water management. The first round of demonstration projects in 16 cities is used to further introduce, test and promote sustainable storm water infrastructure approaches. The Chinses case study will be chosen from the 16 cities.

In the third phase, it is recognised the importance of learning from other countries with mature experiences and practices of ecological-based management, in order to promote the success of Sponge City development in China. Dutch cities' innovative approaches to the integration between urban planning and urban storm water management will be explored and analysed.

1.4.2 Research approach

For this report, information is mainly gathered through the following two qualitative research methods:

- Desk studies
- Semi-structured interviews

1.4.1 Study Design and Data Collection

1.4.1.1 Desk Studies

The aim of the desk study is firstly to portray the reasons and significance of integration between storm water management and urban planning, and understand the integration within Chinese and Dutch case study cities.

Secondly, literature review is used in the formulation of a theoretical framework of integration, which is navigated by the two questions: 1) Why should we concern in the integration between storm water management and urban planning? 2) What are elements and factors that might influence interagency and interdisciplinary integration?

Thirdly, information associated with the current Chinese and Dutch urban planning system, storm water management and approaches to the integration is expected to be revealed via desk study. Information will be gathered from academic articles, reports, news, web pages, water and planning laws and regulations, national, regional and local storm water and development plans, and articles related to the practice of integration.

1.4.1.2 Interviews

The aim of the interviews is to investigate how sustainable storm water management practitioners (mainly urban planners and water managers) perceive and value the integration of storm water management and urban planning in the case study cities, and what are factors that influence the interagency and interdisciplinary integration. In order to obtain the perception of water managers and urban planners in the case study cities, a list of research questions for water managers and urban planners will be generated (Appendix 2). The research questions are derived from the Framework of Integration. The researcher is well aware that conducting more interviews lead to a wider perspective. At least, two water managers and two urban planners will be interviewed in each case study city. However, bias cannot be avoided. Firstly, it is impossible to reach all water managers and urban planners involved in Sponge City development. Secondly, it is expected that interviewees as water managers and urban planners working in governments may prefer to give positive answers rather than negative answers. Thirdly, the interpretation of the results is subjective. Furthermore, interviews for Chinese case study will be conducted by using video-conferencing, telephone or email, because of this study will be conducted in the Netherlands. On the other hand, face-to-face interviews for Dutch case study will be largely conducted.

Chapter 2 Literature Review

2.1 Storm Water Management and Urban Planning-Why Concern the Ties?

2.1.1 Increasing Complexity of Storm Water Management

Urbanisation, climate change, and environmental degradation all challenge the effectiveness of conventional storm water management which is a network of buried pipes and often separated from urban planning. Various authors suggested conventional approach is no longer appropriate (Pahl-Wostl, 2002; Ashley et al, 2003; Milly et al,2008; Pearson et al, 2011; Brown et al, 2011, cited by Marlow et al, 2013; Howe and Mitchell, 2012). Conventional piped drainage systems are considered less sustainable than ecological-based storm water management (Cettner et al, 2013; Burns et al, 2012).

The concept of sustainable urban storm water management is emerging and developed for a number of years, however, its meaning is not precisely defined (Marlow et al, 2013). Thus, it is regarded as an alternative that differs from the conventional approach in its core features: the relationship and synergies between urban planning and design; the type of infrastructure; sustain a site's pre-development hydrologic regime, manage rainfall at the source. In this study, Water Sensitive Urban Design(WSUD), Sponge City, Climate Proof City, Low Impact Development (LID), etc. are regarded as a synonymous concept of sustainable or alternative urban storm water management. So the literature related to those sustainable storm water management will be used to support the analyses of Sponge City in China and Climate Proof City in the Netherlands.

The nature of storm water management is becoming more integrated and sophisticated over time. Historically, urban storm water management has focused on a range of other objectives such as protecting against flooding and so on. The main storm water infrastructure is made of concrete, metal or plastic. In a sustainable storm water management approach, storm water is regarded as a resource that helps to deliver a range of desirable outcomes instead of only wastewater that should be discharged through a drainage system as fast as possible. The infrastructure can also be green (nature and ecology) and blue(water) that works with and mimics nature. Alternative storm water management concerns flood

mitigation, recreation and aesthetics, water quality, flow regime restoration, ecology of receiving water, storm water as a resource, resilience and microclimate (Fletcher et al, 2014)(Figure 1).

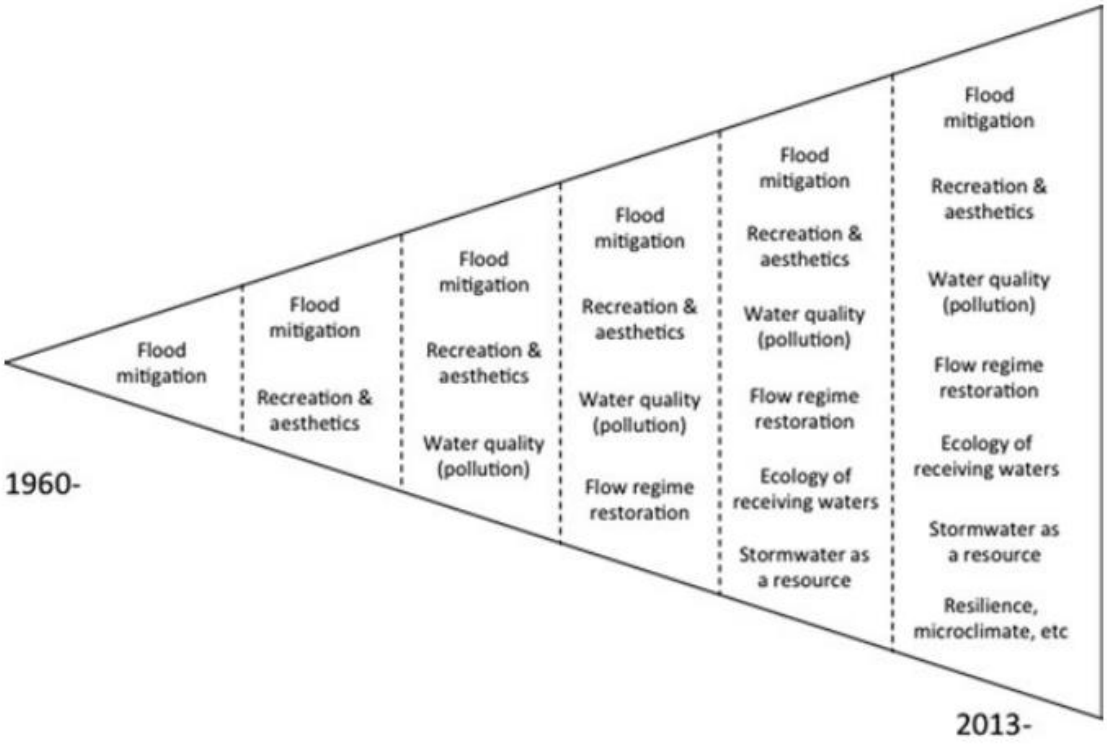


Figure 1 Increasing integration and sophistication of urban drainage management over time (Fletcher et al, 2014, p10)

In addition, there are some scholars who identified the future challenges in water management. Niemczynowicz (1999, p12) argued that future challenge in urban water management is to '*organize cross sectorial cooperation between several actors in order to introduce innovative water technologies, management systems and institutional arrangements which are able to meet the multiple objectives of equity, environmental integrity and economic efficiency, simultaneously maintaining or/and providing high level of water services for urban residents*'. Porse(2013, P31) suggested that '*technologies and approaches to manage water effectively in the coming century already exist, but promoting cooperation in water management among participants is a continual challenge*'. The multiple goals and responsibilities of sustainable storm water management are dispersed among different disciplines and sectors. The practitioners of sustainable storm water management should recognise the increasing complexity and multi-disciplinary on storm water management in nature. More cooperation in storm water management is needed.

2.1.2 Urban Planning

The literature about the conceptual definition of planning is numerous. The European Regional/Spatial Planning Charter of 1983 gave one of the earliest definitions of spatial planning:

> *Regional/spatial planning gives geographical expression to the economic, social, cultural and ecological policies of society. It is at the same time a scientific discipline, an administrative technique and a policy developed as an interdisciplinary and comprehensive approach directed towards a balanced regional development and the physical organisation of space according to an overall strategy*. (committee of ministers to member states on the European regional/spatial planning charter, 1983, recommendation 84(2), cited by Kidd et al, 2011, p47)

Healey defined urban planning as '*a self-conscious collective effort to re-imagine a city, urban region or wider territory and to translate the results into priorities for area investment, conservation measures, strategic infrastructure investments and principles of land use regulation*' (Healey, 2004, p.45, cited by Kidd, 2007, p167). It reflects that the first focus of urban planning is on guiding the spatial organisation of particular territory to achieve expected economic, social, cultural and ecological goals. The second focus is that urban planning relates to a concern to achieve policy coherence and support for planning interventions among the variety of authorities and stakeholders that influence spatial development and the built environment. In this study, urban planning is regarded as an integrative mechanism to guide the spatial expressions of a range of other sectoral policies in cities, which play an important role in urban built environmental, economic, and social development. For the purpose of this study, a precise distinction between spatial planning and urban planning is not of great importance.

Hurlimann and March (2012, p477) argued that urban planning as a critical mechanism can facilitate climate change adaptation. They identified six capacities of urban planning, as follows:

> *act on matters of collective concern; manage competing interests; cut across scales; reduce and act on uncertainty; act as a knowledge repository; and be oriented to the future while integrating a range of diverse systems*

With these capacities, urban planning plays a role in addressing climate change.

Matthews (2011) argued that planning is 'internationally utilised, multi-disciplinary, collaborative and forward-thinking'. The planning tool, which includes plan-making, development management and urban design, helps to address complex and challenging climate change issues.

Voogd and Woltjer (2009, p127) argued that 'urban development is often motivated by the presence of water or restricted by its lack', therefore, water management and urban planning are inherently connected. Integrating sustainable storm water management in spatial planning helps to reduce the impacts of urbanisation on the natural environment, and to protect the ecosystem. Thus, ecological-based water management should be given more consideration in planning (Woltjer and Al, 2007). In addition, cities are important sites for engaging with environmental issues. The evidence gathered from academic literature proved that it is widely acknowledged that urban planning has an important role in climate change adaptation (Wilson and Piper, 2010; Matthews, 2011; Hurlimann and March,2012; Davidse et al, 2015).

Stead and Meijers (2004) said that greater policy integration across different sectors and disciplines is important for sustainable development. Sustainable storm water management reflects a new paradigm in the planning and design of urban environmental management that gives more concerns to storm water management. They are no longer undertaken in isolation one from the other. On the one hand, storm water and its management are now beginning to be seen as an opportunity since the rainwater is seen as a valuable resource. It brings social, economic and environmental benefits (Danler and Langellotto-Rhodaback, 2015). On the other hand, it also gives the uncertainties inherent in understanding how climate change may affect rainfall. It helps to build climate resilient cities and delivers improved environmental outcomes for today and the future.

2.2 Integration

2.2.1 The Disconnection

Potter et al (2010, p239) argued that '*the sheer complexity of the issues surrounding water management and the impacts upon spatial planning mean that partnership working is essential to achieve an integrated approach'*. They think that it is important to understand the differences in culture and context of water management and urban planning before seeking partnership working. Historically, water managers including engineers and hydrologists focus on a technical viewpoint within a closed policy domain of water management. Urban planners give more consideration into shaping the place above the ground to meet development needs and the pressures of population growth. As mentioned earlier that water management and spatial planning are inherently connected, there is a more or less stable alliance between water managers and planners, although they have different

focuses. However, institutionalised mind-sets and ideologies create 'mechanisms of path dependency' and result in 'significant barriers and frustrating attempts to innovate' in integrated water management' (Potter et al, 2010, P243).

In addition, water managers and urban planners have different views and language on water-related issues. Water managers have a more quantitative view on space, such as kilometres, volumes and cubic meters. They concern strength and height of dams, peak discharges, construction cost and so on. Water managers have solutions for water issues by increasing the reliability and confidence of infrastructure design. And water managers' fundamental focus is water. Planners, on the other hand, have a more qualitative view on space. Urban planners with awareness of water issues have solutions for water issues by linking other spatial functions and planning objectives, such as green space conservation, housing, recreation, climate change adaptation and mitigation. However, although planners have an increased awareness of the importance of a more integrated approach to water issues, it does not mean planners will think water has exclusive priority above other planning needs. There are other competing interests, such as housing development, heritage conservation, and economic development (Potter et al, 2010).

Table 2 safety and flood risks, according to water managers and spatial planners (Source: Wiering and Immink, 2006, p432)

Issue	Water managers	Spatial planners
Flood risk (ontological discourse)	Flood risks are measurable cause–effect relations within water systems. Probabilities and effects can be translated into universal norms and comprehensive models.	Flood risks are context dependent, being part of a complex of interrelations between social, physical, and spatial features of a particular place, as well as depending on human risk perception.
Perspective on safety (normative discourse)	'Safety first' is the leading policy principle. River management must be focused on making room for the riverbed itself to reduce the probabilities of risk.	Safety is one of the more strategic principles underlying a sustainable, resilient, and attractive spatial and landscape planning in river basins.
Policy strategy and measures (strategic discourse)	Modeling of probabilities and effects translated in spatial claims for dike relocation and other water system related measures.	Flood risks can be reduced by incorporating the specific features of the region and facilitating collaborative planning to create strategic and creative perspectives on regional spatial development.

Therefore, water is not a fundamental focus that planners have, but one of many competing issues to trade off. Table 2 shows the differences between water managers and spatial planners in term of flood risk, perspective on safety and policy strategy and measures, which give the example of how they think differently. The differences in culture, approaches and context of water management and spatial planning lead to different policies and priorities. (Potter et al, 2010).

2.2.2 The Call for Integration

> *'There are increasing calls for greater policy integration from a number of areas, one of the most prominent being environmental policy-making where integration is frequently recognised as being crucial for sustainable development. A wide variety of sectoral policies turn out to have unexpected and often unwanted environmental consequences (or externalities) that were not taken into account in the process of policy-making. Calls have been made to avoid such fragmented decision-making by integrating different, but interrelated policies.'*
>
> *Meijers and Stead, 2004,p1*

In this thesis, the most important argument is that an interagency/ interdisciplinary and integrated partnership working between water and urban planning, which vary in responsibilities, approaches, focus, and views, contributes to a more effective and wider delivery of sustainable storm water measures. The argument is formed because it is widely acknowledged that water management and urban planning are inherently connected, and some literature highlights the multidisciplinary and cross-sectoral in nature, and calls for the integration between water management and urban planning, for example:

- The integration of water quality management and land use planning can promote protecting the biotic quality and habitat health and preventing pollution from happening, which serves the purpose of protecting water quality and maintaining ecologically and economically healthy land development (Wang, 2001, p. 34)

- In the Dutch case, water management tasks conventional belong to engineers, who operate within well-established water agencies…..However, climate change and calls for greater coordination within Europe have caused Dutch water managers and planners alike to seek ways to connect water management and spatial planning(Woltjer and Al, 2007, P212).

- Planning is therefore an ideal mechanism through which water considerations can be integrated at an early stage into the development of policies guiding the spatial expression of various sectors impacting on the water environment (Carter, 2007, p. 336).

The theory of integration forms the backbone of the theoretical analysis framework in this research. It is still unclear which aspects of integration might be expected to deal with and which factors might affect integration, while there are growing academic researches that discuss the topic of integration. In the following context, the dimension and influential factors of integration will be reviewed to improve the understanding of integration, therefore, to form an Analytical Framework of Integration to explore and analyse factors that influence the integration between storm water management and urban planning.

2.2.3 The Dimension of Integration

Kidd and Shaw (2007) explored a framework of integration to analyse the challenges of institutional integration in Integrated Water Resource Management(IWRM) and spatial planning in the UK (Table 3). They summarised the dimensions of IWRM. It takes into account the human system (decides the resource use, waste production and pollution of the resources, and also sets the development priorities), and is based on a similarity of thinking of various authors. Based on the summary, they identified that the dimensions of integration in three integration classes with seven separate aspects: sectoral integration, territorial integration and cooperation/organisational integration.

Table 3 Kidd and Shaw's framework of integration in spatial planning(Kidd and Shaw, 2007, p322)

Human system	Sectoral	Cross-sectoral integration	Integration of water resource management with different public policy domains
		Inter-agency integration	Integration of public, private and voluntary sector activity related to water resource management
	Territorial	Vertical integration	Integration between different spatial scales of water resource management
		Horizontal integration	Integration of water resource management between areas that form part of the same natural system
	Organisational	Strategic integration	Integration of water resource management with other strategies, programmes and initiatives
		Operational integration	Integration of water resource management with the delivery mechanisms in all relevant agencies
		Disciplinary/stakeholder integration	Integration of different disciplines and stakeholders related to water resource management

Vigar (2009) argued various notions of integration that underpin spatial planning. He analyses policy integration in the Scottish territory by two forms of integration: vertical integration (vertical processes of integration and the way in which coalition and network of actors link between spatial scales) and horizontal integration (how coalitions are built and maintained).

Healey (2006, cited by van Straalen, 2012) presented four main forms of integration: co-ordination, framing, linking policy and action, and linking multiple actors (Table 4). It focuses on specific actions to be taken to integrate policies in planning practices (van Straalen, 2012).

Table 4 Healey's framework of integration in spatial planning (Healey, 2006, cited by van Straalen, 2012, p4)

		Type of integration	*Meaning of integration*
A		*Co-ordination*	
	A1	Aligning	Fitting in to other policies and strategies
	A2	Co-aligning	Mutual adjustment among diverse strategies
	A3	Multilevel co-aligning	Mutual adjustment both vertically and horizontally
B		*Framing*	
	B1	Widening a policy frame	Extending an existing frame to encompass a new dimension
	B2	Creating a new frame or vision	Developing a new policy focus and discourse
	B3	Creating a place-focused policy frame	Focus specifically on place qualities and spatial organisation
C		*Linking policy and action*	
	C1	Policy and delivery	Connecting policy assertions to specific delivery mechanisms
	C2	Regulation and investment	Linking principles governing land use regulation to those governing development investment
D		*Linking multiple actors*	
	D1	Involving	Drawing the community and key stakeholders into plan-making processes
	D2	Sharing knowledge and ideas	Drawing on and developing knowledge with stakeholders
	D3	Sharing ownership	Developing a shared commitment to the content and legitimacy of a plan/strategy

Kidd and Shaw, Vigar, and Healey, all take a different perspective on integration in spatial planning, but their frameworks to some extent overlap. For example, vertical and horizontal integration appeared in all reviewed literature. Vertical integration refers to the hierarchy of plans including the national plan, the regional plan and the local plan. Horizontal integration refers to cross-sectoral and interagency integration, which will be the main focus of this study emphasising on the interagency and interdisciplinary integration between storm water management and urban planning.

2.2.3 Factors that Influence Integration

A helpful starting point for understanding influential factors that facilitate or inhibit interagency and interdisciplinary is a paper written by Stead and Meijers (2009). They draw on several academic sources to elaborate the facilitators and inhibitors of sectoral policy integration. The review of facilitators and inhibitors of policy integration for spatial planning makes it clear that achieving more integrated policies is dependent on a multitude of different types of factors that include: a) political, b) institutional/organisational, c) economic/financial, d) process, management and instrumental and e) behavioural, cultural and personal factors.

Political factors are facilitators when there is a convergent problem definition, professional ideologies, interests and approaches, and political leaders who are able to convey the bigger picture and identify partners to pursue cross-cutting objectives. And they are inhibitors when there are a divergent problem definition resulting from a lack of consensus on nature of the problems and solutions, fear of conflict over domain, lack of political commitment and leadership.
Institutional/organisational factors are facilitators when there are standardised procedures but inhibitors when it is excessively bureaucratic which causes increased communication costs, fragmented communication and results in low level of internal communication and low motivation to inter-organisation network. ***Economic/financial factors*** are facilitators when there are corresponding actual needs, common benefits and scarce resources (time, money, information, raw material, legitimacy, status). And economic/financial factors become negative when the costs of coordination may outweigh benefits. ***Process, management and instrumental factors*** are facilitators when there are group-central approaches to problem solving, but the factors could be inhibitors when there are infrequent or inadequate communication, lack of dialogue between sectors, fear of delay as a consequence of coordination problems, complex relationships and lines of accountability and lack of management mechanisms.
Behavioural, cultural and personal factors are facilitators when there is a positive attitude and organisational culture towards working with other organisations in a joint vision based on good historical relations. Specifically, individuals in the organisation are able to understand their own and others' possible benefits of coordination, and have the willingness to cooperate along with expertise and culture of trust. On the contrary, behavioural, cultural and personal factors are inhibitors when there are poor historical relations, vested interests, lack of shared understanding of issues as a consequence of different specialist approached and language, low openness to cooperation(Stead and Meijers, 2009).

Eggenberger and Partidario (2005, p204) argued that '*whenever there are two professionals with different backgrounds looking at the same problem with similar objectives they are integrating. Whenever there are two different topics that need to be tackled together, there is integration*". They identified that one of the challenges of urban planning is the integration of different sector policies with respect to sustainable development. In order to identify integration issues, they classify the forms of policy integration in five aspects: substantive, methodological, procedural, institutional, and policy. Bolposta (2012) adapted the five forms of integration in his paper. The main objective of Bolposta's paper is to determine the impediments and reduce the gap between urban planning and water management, which is similar to this study (Table 5). The adapted five forms of integration are helpful for creating an Analytical Framework of Integration for the purposes of this study.

Table 5 The adapted five forms of integration for Turkish case study(Bolposta, p46).

Dimension of Integration	Sub-type of Integration
Substantive	The significance of water issues in spatial /land use planning
	The integration of sustainable water resources management with spatial/land use planning
Methodological	The integration of assessment approaches and techniques
	The integration of the different applications, and experiences with the use of particular tools
Procedural	The integration of informational requirements of water management in land use decision making
	The integration of procedural requirements of water management in land use decision making
	Horizontal plan consistency
	Consensus building
Institutional	The definition of leading and participating agencies
	Interagency coordination and Clear delineation of actor roles and responsibilities for each two sectors
	Human capacity
Policy	The integration of sector regulations
	The integration of sector strategies

Howe et al (2013) identified that institutional challenges to water sensitive urban design in Australia limit the ability of organisations to cooperate with each other, and to restrict the attempts to an innovative new system that facilitates the uptake of green infrastructure and resource recovery. There are five major institutional challenges and their underlying causes that hinder the transition towards water sensitive city.

-**legislation and regulations** that are prescriptive, overlapping and inconsistent
-**economic and financial systems** that are restrictive and traditional
-**planning** that is uncoordinated and non-collaborative
-**organisational and professional cultures** that are siloed and inflexible
-**citizen engagement** that is uncoordinated, technical and uninspiring

Van der Knaap and Pijnappels(2010) stated that implementation of environmental directives including Water Framework Directive(WFD) is challenging tasks for the responsible organisations in the Netherlands. More actors are required to make efforts in WFD implementation process, while it is difficult for involved actors with their own objectives to cooperate with each other. They argued that the effectiveness of local cooperation between water managers and spatial planners is affected by:

Language (discipline related jargon) (forming a collective and shared language between different disciplines and between policy makers, administrators and spatial projects)

Contracts (an aspect to maintain or stimulate co-operation, such as the continuation of involved person, the coherence between contracts, financial issues and trust)
Trust (trust between officials, different administrative levels and different spatial project; trust exists in an open and transparent process, where expectations, interests and apprehensions are exchanged)
Personal competence (refers to someone's status, power and position; it is an important element to make progress)
Policy tuning and policy instruments (measures to improve cooperation)
Innovation-institutional, infrastructure and mental (innovation helps to stimulate cooperation; institutional innovation-disciplinary, strategic and operational integration; instrumental innovation-the use of instruments to stimulate cooperation, such as computer-based innovation helps to share and transfer knowledge, mental innovation-thinking out of the box) (Van der Knaap and Pijnappels,2010)

Table 6 offers a review of those factors. They are identified by Stead and Meijers, GWP, Howe et al and van der Knaap and Pijnappels, and play an important role in the success of interagency and interdisciplinary integration. Although those authors have different terminology and approach to discussing influential factors, to some extent, there is a similarity of thinking among them.

Table 6 Identifying the factors that influence the success of interagency and interdisciplinary integration

Stead and Meijers(2009)	**Bolposta (2012)**	**Howe et al(2013)**	**Van der Knaap and Pijnappels(2010)**
Political factors(eg. an understanding of other organisation's need; convergent or divergent problem definition, ideologies and approaches)	Substantive(the significance of water issues in land use planning; the integration) Policy(regulations; strategies)	Legislation and regulation (e.g. consistency in laws, policies; enabling regulatory framework; agreed unifying vision)	Language (a collective and shared language between policy makers and administrators) Personal competence
Institutional/organisational factors(bureaucratisation, high communication costs, fragmented communication; large institutional and	Institutional(leading and participating agencies, actor roles and responsibilities, human capacity	Planning and collaboration fragmented/soiled planning exercises; flexibilities; funding for integrated planning, roles and responsibility)	Language(collective and shared language between different disciplines) institutional innovation

organisational differences)			
Economic factors(whether perceived gain in resources-money, information, status; allocation of budgets to cross-cutting issues or to sectors)		Economic and financial systems(funding for green infrastructure, funding for integrated process)	Contracts(maintain or stimulate co-operation; financial issues and trust)
Process, management, and instrumental factors(e.g. mechanisms to solve conflicts early in the process; systematic inter-sector dialogue)	Procedural (informational/procedural requirements of water management in land use decision-making; consensus building) Methodological(assessment approaches and techniques; experience with the use of particular tools)	Organisational and professional culture (system thinking and integration, conservation; organisational inertia; incentives)	Language Trust (open and transparent process) policy tuning and policy instruments(measures to improve cooperation) mental innovation instrumental innovation
Behavioural, cultural and personal factors(organisational culture towards working with other organisations; good historical relations; understanding and willingness)			Trust (open and transparent process; joined-up working) Personal competence(someone uses his/her status, power and position to make progress)
		Citizen engagement(coordinated methods and processes for data collection, information sharing and messaging)	

Based on the review and synthesis of those influential factors of policy integration which were discussed by Stead and Meijers(2009), Bolposta (2012), Howe et al(2013) and Van der Knaap and Pijnappels(2010), it is found that political factors, institutional/organisational factors, economic factors, process, management and instrumental factors and behavioural, cultural and personal factors are most discussed. Only Howe et al discussed citizen engagement factors as influential factors in interdisciplinary integration. It is agreed that sustainable storm water management has multi-goals and multi-disciplinary in nature. If cities seek to cooperate more sustainable storm water infrastructure, citizens should be brought in and play an important role. However, this thesis is expected to be written in a period of 6 months. In order to avoid delaying, the research considers to choose the similarity among the 4 papers. Therefore, even though it is value-added to investigate citizen engagement factors, it will be excluded in this study.

Figure 2 shows factors that influence the interagency and interdisciplinary integration between water authorities and planning authorities, and between water managers and planners, that will be taken into consideration in this study.

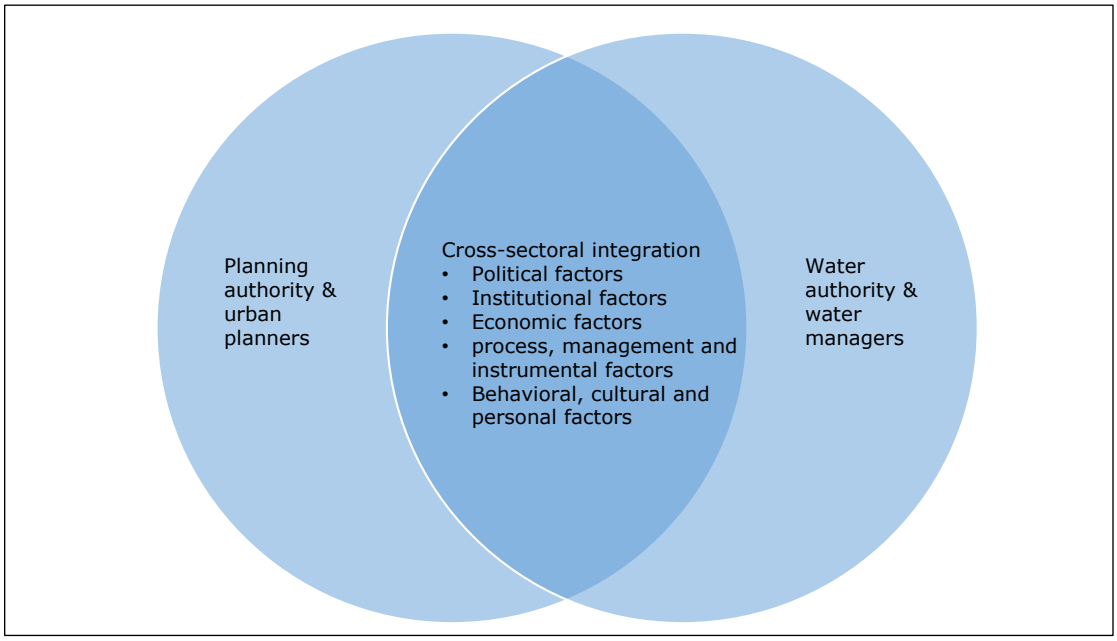


Figure 2 the factors used for this study

Sub-factors of the five main factors are chosen based on the similarity among the 4 papers. Table 7 shows the established Analytical Framework of Integration for the purpose of this research to analyse the interagency/interdisciplinary integration between urban planning and storm water management.

Table 7 Analytical Framework of Integration

Influential factors	Explanation
Political factors	● shared understanding of the policy issues and objectives ● the legislation, regulations and strategies that enable and facilitate cross-sector integration shared understanding of the policy issues and objectives
Institutional/ organisational factors	● the delineation of actor roles and responsibilities for the two sectors ● Internal communication and inter-organisational network -bureaucratisation or flexibility to policy integration -fragmented or integrated communication
Economic factors	● funding for integrated process ● Financial supports that enable and facilitate the achievement of integration
Process, management and instrumental factors	● communication channels between two sectors -Easy or complex interaction and communication -Inter-sectoral dialogue ● mechanisms/instruments to anticipate, detect and resolve policy conflicts between two sectors -reconcile and identify or avoid conflicting priorities
Behaviour, cultural and personal factors	● the relationship between water authorities and planning authorities and between water managers and planners -previous cooperation -existing level of trust -willingness and openness to cooperation with other organisation -information sharing, collective approaches and language

Chapter 3 Urban Planning and Storm Water Management in China

3.1 Urban Planning in China

In order to gain insight into the integration between storm water management and urban planning, it is important to understand the administrative system, the urban planning system and the water management system first. Urban planning in China has undergone several transitions due to governance and economic changes. After 1949, China went to a modern method of urban planning and development. Between 1949 and 1978, the state and central-planned economy from the former Soviet Union practised total administration of the urban economy and society (Yu, 2014).

The central-planned economy overwhelmingly exerted influence over the establishment of the Chinese hierarchical and top-down administrative system. The land was administratively allocated free, therefore, there was no land market. The organisational form of State Work Unit[1] under Maoist socialism underpinned the Chinese political, economic and social system (Yu, 2014; Zhang, 2004).

After 1978, the introduction of the socialist market economy under the globalised market triggered the diminishing influence of a centrally-planned economy. This transition led to an incremental devolution of decision-making and financial power from the central to local governments, which resulted in unprecedented power and responsibility are gained by local government (Ng and Xu, 2000). In addition, the transition is also influenced by western planning theories and practices. In the late 1980s, the statutory urban planning system was established, such as City Planning Act 1989 and land Administrative Act 1986(Yu, 2014).

At present, the Chinese Urban planning system consists of the socio-economic development five-year plans, the land use plans, and the urban and rural plans at the national, provincial, municipal and country level. The three plans jointly shape the urban and rural spatial development. There is a hierarchy among these three plans. It is clearly stated in the Urban and Rural Planning Act of 2008 that '*preparation of a city master plan and town master plan, rural plan and township plan should be in according with the national economic and social development plan (five-year plan) and be linked up with land use plan'* (cited by Li,2004, p140).

[1] Work Unit (Danwei): a form of enclosed live-work community, often with complete educational, health and recreational services (Ng and Xu, 2000)

3.1.1 the Socio-Economic Five-Year Plans

At the national level, the Development and Reform Commission (DRC), which played an important role in the period of the central-planned economy, is responsible for preparing the Social-economic Five-Year Plans. Those plans should be prepared every five years, which affect social and economic development in the whole country. The DRC also plays an important role in environmental policy making under the challenges of climate change and global warming. The DRC structured their agencies vertically distributed over the central, provincial and municipal and county levels. The provincial and local Socio-Economic Five-Year Plans also should be prepared under the guidance of the National Five-Year Plan. 2016 to 2020 is the period of the thirteenth Five-Year Plan.

3.1.2 the Land-use plans

At the national level, the Ministry of Land and Resource(MLR) is the major policy-maker for planning, managing, protecting and monitoring the use of land, mineral and marine resources. The two tasks of the MLR significantly influence urban and rural development: 1) to make policies and regulations for 'assignment, lease, evaluation, transfer, transaction and purchase land use right on behalf of the state'. 2) to make policies and regulations to protect agricultural land. Each provincial and local department of Land and Resource shares with the MLR to fulfil the two tasks. The planning period of Land Use Plan is 15 years (Yin, 2014 and Yu, 2014).

3.1.3 the Urban and Rural plans

The City Planning Act 1989 is a milestone in the planning system history in China, which regulated the statutory status of urban planning for the first time and empowered local authorities to enforce urban development control. The law was last revised in 2008 and named as the Urban and Rural Planning Act. The urban planning system in China is characterised by a top-down approach. China has an administrative system with five tiers including authorities at the national, district, provincial, municipal and county government, and township level. Each administrative tier is responsible for preparing, implementing and controlling its planning documents. The Ministry of Housing and Urban-Rural Development (MHURD) overseen by the State Council is the governmental agency responsible for making a National Urban System Plan and its implementation. At the provincial level,

the Department of Housing and Urban-Rural Development overseen by the provincial government is responsible for preparing a Provincial Urban System Plan.

At the city level, the urban planning authority or the department of housing and urban-rural development overseen by municipal government is responsible for a two-tier statutory planning. The upper tier is the urban master plan and the lower tier is the detailed plan. The Urban and Rural Planning Act 2008 marks that the power of planning to rural areas is extended and more consideration is given to natural environmental protection. It formalised the current statutory planning system that consists of an urban system plan, the urban plan (including a comprehensive plan and the detailed plan), the town plan, the country plan and the village plan (UPCQSMC, 2011). (Figure 3)

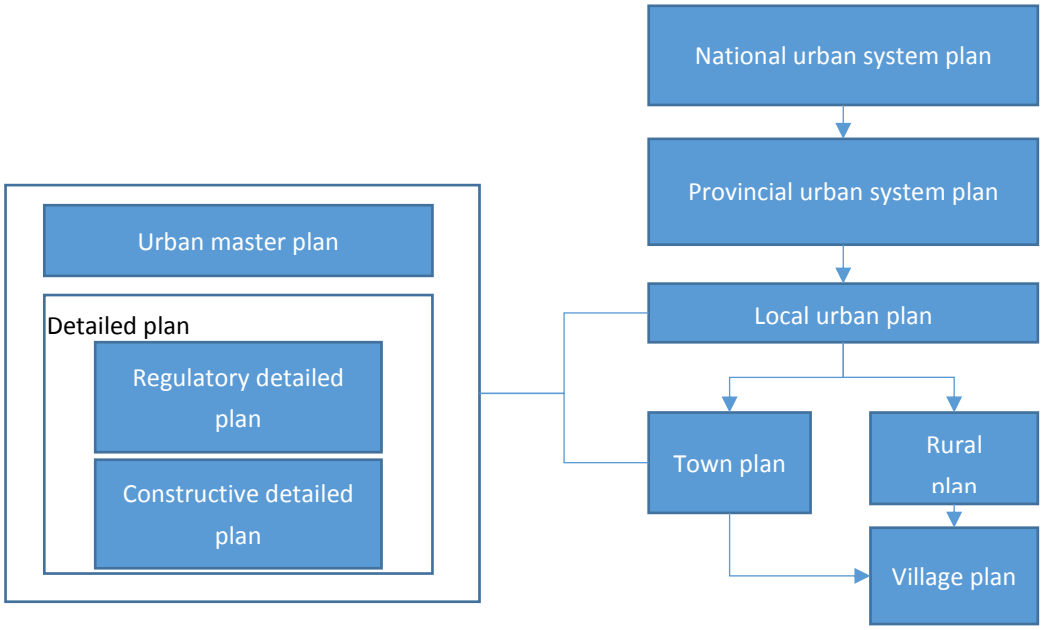


Figure 3 Urban and rural planning of China (translated from UPCQSMC,2011)

The city master plan (zongti guihua) at the top tier is a comprehensive plan for guiding urban development, which includes development objectives, size, scales, and the principles of spatial organisation and so on. In addition, the city master plan is supplemented by various sectoral plans (zhuanxiang guihua), such as transportation, infrastructure, environmental protection, lake and river system, green space system, heritage conservation plan, etc. The city master plan is prepared by the local government and needed to be examined and approved by the State Council. The planning period of the Urban Master Plan is 20 years. The detailed plan (xiangxi guihua) including a regulatory detailed plan (kongzhixing xiangxi guihua) and a constructive detailed plan (xiujianxing xiangxi guihua) is more

specific for each site. The detailed plan is prepared by local government as well. The constructive detailed plan is prepared by the private developers, and needs to be examined and approved by local development.

The Chinses government administrative structure, a legacy of the central-planned economy, influences the planning system. Three ministries have different responsibilities and their own plans for urban and rural development, while there are some conflicts and overlaps. Yu (2014) argued that the appropriate coordination mechanisms among different sectoral governments are important to avoid conflicts and overlaps. The three ministries structured their agencies vertically distributed over central, provincial and local levels. Each administrative tier is responsible for preparing, implementing and controlling its planning documents. The documents must be approved by the higher administrative tier in order to enter into force (Yu, 2014). The urban planning system in China is a top-down system, therefore, the central, provincial and local government have a common interest. Figure 4 shows the urban planning system in china.

Policy Area / Authority / Administrative Divisions	Socioeconomic development Plans	National spatial Plans (Land use Plans)	Urban and Rural Plans
	National Development and Reform Commission	Ministry of Land and Resources	Ministry of Housing and Urban-Rural Development
National Level	The Five-Year Plan for National Economic and Social Development National Core function area Plan	National Spatial Plan Overall Land Use Plan	National Urban System Plan
Areas Level		Priority Areas Spatial Plan	
Province Level	The Five-Year Plan for Provincial Economic and Social Development Provincial Core function area Plan	Provincial Spatial Plan Provincial Land Use Plan	Provincial Urban System Plan Provincial Urban and Rural Plan
Prefecture County Level	The Five-Year Plan for prefectural Economic and Social Development	Prefectural Spatial Plan Prefectural Land Use Plan	Prefectural Urban System Plan Prefectural Urban and Rural Plans

Figure 4 the Planning System in China (Mlit, 2016a)

3.1.4 the Development Control System

Local authorities are responsible for determining individual planning applications. For each individual development plot, a planning application for a Site Selection Recommendation Report, a Land Use Planning Permit and a Building Construction Permit planning permit are required to make sure the development is allowed (Figure 5).

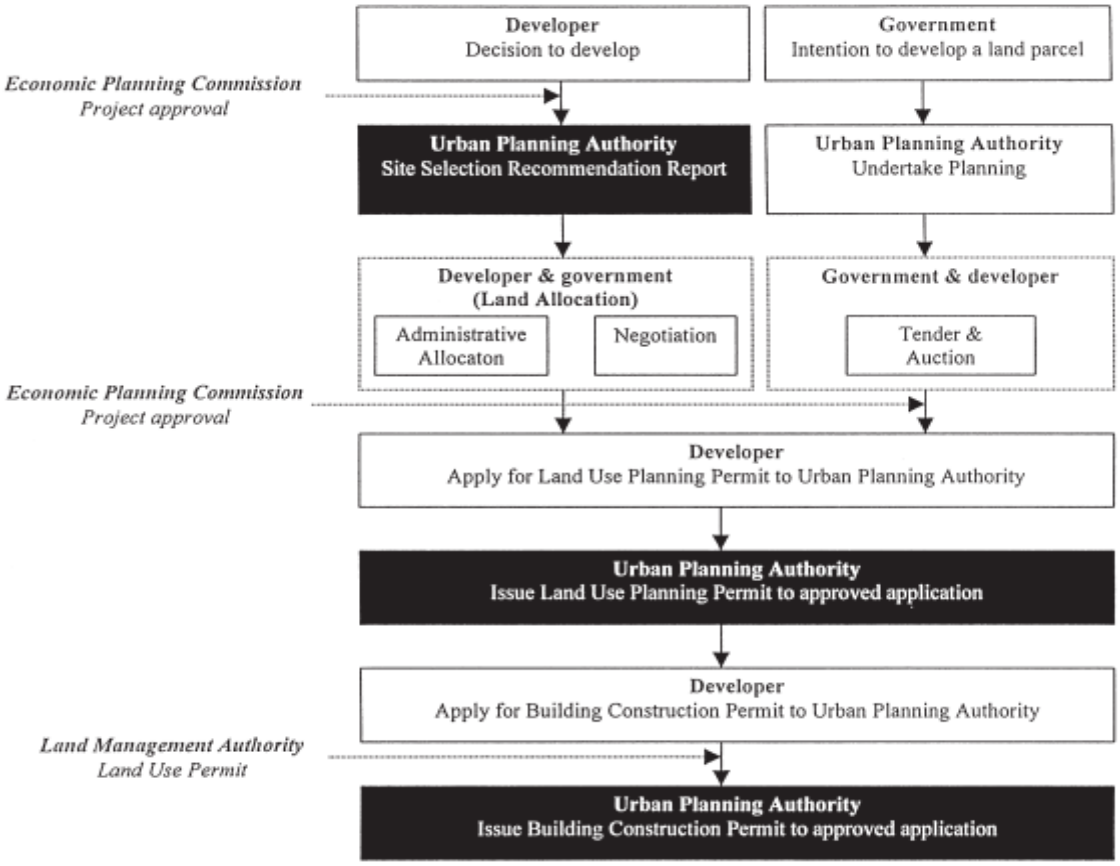


Figure 5 Development control in China: the 'one report and two permits' system (Ng and Xu, 2000, p412)

3.1.5 Planning Policies Related to Storm Water Management

Sponge City-integrating urban storm water management into urban planning system

In practice, urban planning and storm water management have different and separate approaches and administrative structures to dealling with the management of storm water. On the one hand, urban planning pays more attention to urban land use planning and disregards storm water management. On the other hand, urban water management pays more attention on building and managing underground water infrastructure such as sewers to satisfy urban demand by engineering techniques (Du, 2010). Du argued that 'there has been a gap between the two fields in considering the spatial needs for the water itself'. The development of Sponge City indicates the realisation of the importance of the application of ecological-based storm water management and the integration of storm water management and urban planning. The Technical Guidance for Sponge City Development released in October 2014 by the MHURD shows the transition to integrate Sponge City into an urban planning system in practice. According to the guidance, storm water management related to the principles of Sponge City should be considered at the early and every stage of the planning process (Figure 6) (MHURD, 2014).

On the 2nd of April in 2015, the MHURD, the Ministry of Water Resource (MWR) and the Ministry of Finance (MOF) started a Sponge City demonstration programme in China. 16 cities were selected. In September 2015, the MHURD created a Sponge City Development Committee which consisted of 37 experts from a range of fields, such as water supply and drainage, urban planning, landscape architecture, environmental management, transportation, etc. The Committee takes the responsibility to provide technical guidance and consultation, summary the best practices of Sponge City measures, and track the development of Sponge City Demonstration Projects (MHURD, 2015).

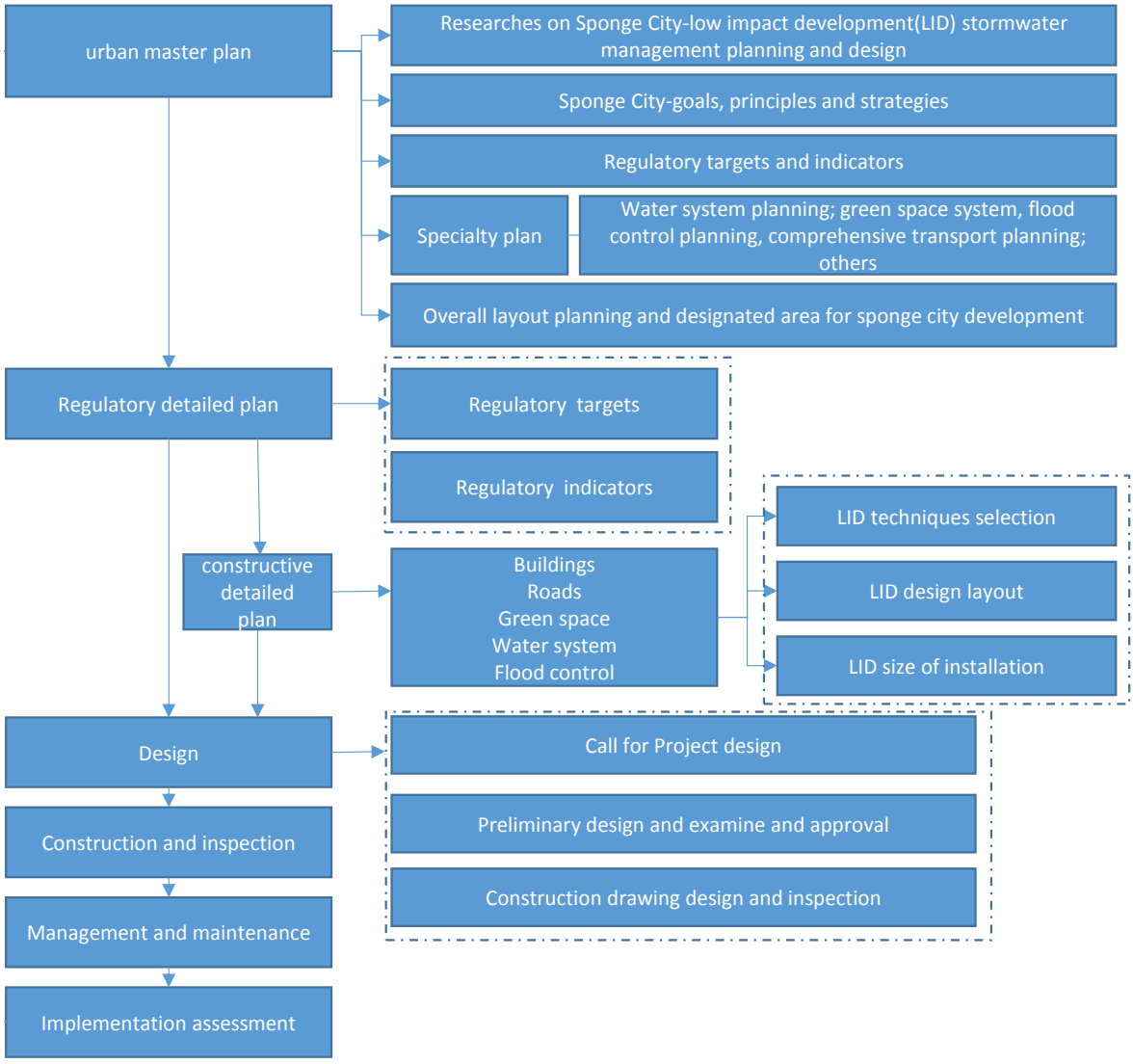


Figure 6 the Sponge City planning system (translated from MHURD, 2014, p7)

Urban storm water drainage and flood control sectoral plan

Increased pluvial flood frequency draws high attention from the central to the local government. In total, 642 cities were asked to prepare Water Drainage and Flood Control Plans in 1996 by the central government. While it was reported that 170 out of total 642 cities have not completed their flood control plans until 2006. In 2013, MHURD issued a technical guideline for the formulation of a comprehensive urban storm water drainage and flood control sectoral plan. More than 600 cities and 1000 counties are required to develop the new version of a storm water management and flood control plan according to the technical guideline. The plan as a sectoral plan supplements the urban master plan. It shows increased awareness of integrating storm water management into urban planning system (Xie and Wang, 2014).

3.2 Water Management in China

3.2.1 the Water Management System

China has developed a series of water-related laws and regulations since the 1980s, including the Water Law (1988, revised in 2002), the Prevention and Control of Water Pollution Law (1984, revised in 1996 and 2008), the Regulations for River Administration (1988), the Environmental Protection Law (1989), the Water and Soil Conservation Law (1991), and the Flood Control Law (1998). The Water Law (1988, revised in 2002) is the key legal instrument laying out the general principle of how to manage water resources in China. The Water Law alongs with other water-related laws and regulations supports China's institutional water management system (Lee, 2006; Chinawaterrisk.org, 2016).

Similar with the urban planning process, the water management system in China is characterised by a strong hierarchical structure and a top-down administrative model. At the national level, China's water regulation and policy are overseen by the Ministry of Water Resources (MWR) under the State Council. The Ministry of Water Resources manages the overall administration of water resources in China alongside the seven River Basin Commissions (RBCs). In details, the MWR is responsible for formulating water-related policies, water resource protection and conservation, flood control and drought relief, and so on.

In addition to the MWR, the responsibility for the regulation of water at the national level is split to eight more national agencies. The Ministry of Environment Protection (MEP), established in 2008, shares most responsibilities for water scarcity-related issues with the MWR. The Ministry of Housing and Urban-rural Development (MHURD) is responsible for planning, construction and management of water supply, drainage and sewage projects. The Ministry of Land and Resources (MLR) is responsible for the monitoring and prevention of groundwater contamination as well as over-extraction. The other agencies are the Ministry of Agriculture(MA) and the Ministry of Health (MOH), the Ministry of Transport (MOT), the State Forest Administration (SFA) and Ministry of Finance (MOF). This complex system has been labelled as 'the nine dragons who administer water' (Lee, 2006). Cheng and Hu (2011) commented the current institutional system of water resources management involves multiple agencies which are entrusted with administrative power relate to water, and the responsibility and task division among them are not clearly defined and there are some overlaps. For examples, the WMR, the MHURD

and the MEP all have responsibilities with regard to urban water supply, water recycling, drainage and sewers. As a consequence, the efficiency of water resource management is impeded because of inconsistent policies and conflicting interests on water caused by poor clarity on issues of responsibility, and low cooperation and interaction level among different agencies (Cheng and Hu, 2011; Carmody, 2010).

The water affairs management agencies (Nine Dragons) have structured their agencies vertically distributed over central, provincial and municipal levels (Du, 2010). Figure 7 shows the responsibilities of the MWR, the MHURD and the SEPA and their subordinated departments at the provincial and local level. It is clear that the management of water affairs such as urban water supply, urban wastewater drainage, flood control, pollution control, etc. are managed by separate agencies. The organisational complexity in water management results in a lack of institutional cooperation, since it is difficult to be facilitated. Therefore, water management needs an immediate paradigm shift (Du, 2010).

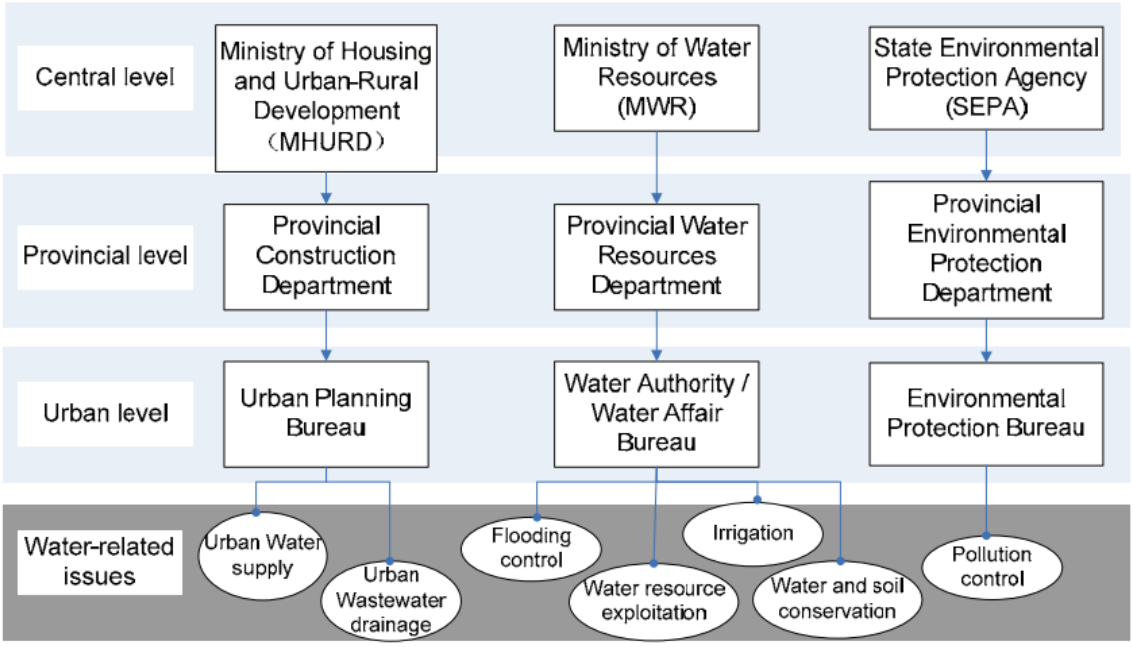


Figure 7 the Institutional structure of water management in China (Du, 2010, p61)

3.2.2 Water Policies

The Decree No. 321 of Ministry of Water Resource delivery its instructional suggestions on Sponge City development to all of the subordinate provincial and local water management authorities. Firstly, it states the importance of recognising the crucial role of the water sector in Sponge City development. Secondly, it sets out the general considerations on the water sector's role in promoting Sponge City

development. It emphasises the importance of integrating water resource management measures and requirements in an urban master plan, and strengthening the consistency with other relevant sectoral plans, such as comprehensive river basin sectoral plan and water drainage and flood control sectoral plan. Thirdly, it sets out the main responsibility and tasks for the water authority in Sponge City Development. Under the unifies leadership of the local municipality, the water authority should cooperate with the Department of Finance and Department of Housing and Urban-Rural Development to build Sponge City (MWR, 2015).

3.3 Case Study: Zhenjiang

In Chinese, Zhenjiang refers to the Garrison of the River. It is located in Jiangsu province and on the intersection between Yangtze River and Beijing-Hangzhou Grand Canal (Figure 8). Water resource is a major natural resource and it includes more than 60 rivers/canals with a total length of 700 km. The average annual precipitation is about 1063 millimetres. The average annual rain day is 119 days. Most of them fall in July, August and September (UWDFCSP,2013). At present, Zhenjiang is facing the water issues including increasing flood frequency, water quality deterioration and shrinking water bodies (Wang, 2011). In 2007, Zhenjiang already started to exploring the implementation of sustainable storm water management by learning from Low Impact Development in the USA and Sustainable Urban Drainage System in the UK. In 2012, Zhenjiang already had a Low-impact development design, construction and management guideline for Guantang new district(sina.com, 2015).

The Work Plan for Sponge City in Zhenjiang described a vision that 22 square kilometres of the designed areas (Figure 8) will reach the goal of controlling 70% annual volume rainwater runoff, preparing for the 30-year storm events, reducing 60% of the surface runoff pollution in the end of 2017(jsj.zhenjiang.gov.cn, 2015).

It was mentioned in 1.4.1 that the selection of case areas should concern weather the cities are representative and have sufficient data related sustainable storm water management. Zhenjiang started the practices of sustainable storm water management earlier than most of other chinses cities. It is selected in the first round of Sponge City demonstrate programme. There are more participators who are willing to attend the interviews for this thesis in Zhenjiang, compared to Xixian New District, Wuhan and Changde (in demonstration programme). Therefore, Zhenjiang is proper to be selected for Chinese case study.

Figure 8 The location of Zhenjiang and the designed area for sponge city development(in red line) (Zhao, 2015)

3.3.1 Political Factors

The Jiangsu Development and Reform Commission published the Thirteen Socio-Economic Five-Year plan in March of 2016, which set out a goal to improve cities' resilience to climate change and natural hazard, and to implement Sponge City measures. Especially, the five-year plan mentioned to support the Sponge City development in Zhenjiang (JSDPC, 2016).

In 2013, the Division of Urban Drainage Management(DUDM), which is subordinated by the Department of Housing and Urban-Rural Development, cooperated with the Zhenjiang Urban Planning and Design Research Institute(ZJUPDRI), the Shanghai Urban Construction and Design Research Institute and the Tsinghua Holdings Human Settlements Environment Institute to prepare Urban (rainwater) Water Drainage and Flood Control Sectoral Plan for the period between 2013 and 2020. The Zhenjiang Construction Commission, the Department of Housing and Urban-rural Development, the Planning Authority, the Water Resource Authority and other planning and design companies helped to arrive the accomplishment of this Sectoral Plan. The Sectoral Plan recorded the fluvial floods caused by intensive rainfall in every year in Zhenjiang (Appendix 3).

The storm water record shows an increasing flood frequency in Zhenjiang, and the failure of the water drainage system. The Sectoral Plan requires to implement the principles of Low Impact Development: 1) the post-development runoff should not exceed the pre-development condition. 2) Using 'storage, filtration, detention, clean, reuse and discharge' approaches to maintaining runoff rate and duration. And

permeable area of a new development area should not be lower than 40%. The Sectoral Plan sets out regulations and standards for the Regulatory Detailed Plans at new and existing development area as the precondition for land use (DUDM, 2013).

The Planning and Design Guidance for Zhenjiang Sponge City Development (trial) prepared by ZJUPDRI went to the public in July of 2015(ZJUPDI, 2015)[2]. It regulates that the principles, procedures and criteria of Sponge City should be integrated into the urban master plan, the sectoral plans, and the detailed plans. In the course of Sponge City planning and designing-making, the interdisciplinary cooperation and understanding among the parks, architecture, roads, water supply and drainage, economy, etc. should be achieved so that a sustainable design proposal could be realised.

3.3.2 Institutional/Organisational Factors

In 2014, the municipality of Zhenjiang released a Notice to organise a Flood Defence Headquarter in the Decree No. 49. The headquarter is responsible for the planning, administration and monitoring of urban water drainage and flood control, and for supervising and coordinating the aligned members. The director of the department of housing and urban-rural development is in charge of the Headquarter. Apart from the department of housing and urban-rural development, the water resource authority, the planning authority, the department of land and resource, the department of transportation, environment protection authority, the reform and development commission, the weather authorities, the health authority and the education authority are involved in this Headquarter (Zhenjiang.gov, 2014).

All municipalities which are involved in Sponge City Demonstration Programme, including the municipality of Zhenjiang, are required by the national government to set up a sponge city special working team. It should be consisted of officials from the public work, environment, transportation, planning, water etc. authorities to promote interagency and interdisciplinary cooperation and take responsibility for Sponge City development and supervision.

A close cooperation between the different competent authorities is important for successfully implementing the principles of Sponge City in practice (UPC2. interview). In 2015, the municipality of Zhenjiang organised a Special Working

[2] Zhenjiang Urban Planning and Design Research Institute (ZJUPDRI) is a quasi-government organisation. The local government usually entrusts an urban planning institute to form a planning group to produce relevant plans.

Team for Sponge City development and released the Decree No. 140 to identify the competent authorities and their responsibilities and tasks on Sponge City Development. The deputy mayor is the director of the Special Working Team. The urban planning authority is responsible for preparing relevant policies, regulations, and plans based on its statutory function and duty. *The Urban Planning Authority* should integrate the principles, procedures and criteria of Sponge City approach into the two-tier of plans including the urban master plan and detailed plans. In addition, the Urban Planning Authority should use the planning approach of development control, including of the 'one report and two permits', to make sure the principles of Sponge City approaches are implemented. *The Department of Housing and Urban-Rural Development* takes the responsibility of the policy- and regulation-making based on its statutory function and duty, and the examination and inspection of building construction permit, projects management, and education and training for relevant workers with regard to Sponge City project design, construction and supervision. *The Department of Land and Resource* is responsible for making policies and regulations based on its statutory function and duty. The Land and Resource Department should cooperate the principles and standards of Sponge City in land use rights consideration and permission. *The Water Authority* is responsible for implementing the policies, development criteria and regulations made by the superior government, and preparing relevant policies, regulations, and plans based on its statutory function and duty. The water authority should implement the principles of Sponge City in its sector work, such as urban flood control plans, water conservancy projects, and water resource management and so on. *The Finance Authority* is responsible for the supervision and allocation of Sponge City budget gained form the national government. Furthermore, the Municipal Propaganda Department, the Municipal Development and Reform Commission, the Transportation Department, the Parks and Greening department, the Environmental Protection Department, etc. share responsibilities to shift Zhenjiang to a Sponge City (Zhenjiang.gov, 2015).

There are various organisations in Zhenjiang municipality that are involved in Sponge City development, such as the municipal Development and Reform Commission, the Department of Housing and Urban-Rural Development, the Planning Authority, the Department of Land and Resource, etc.. All Chinese interviewees stated that it is important to promote interagency cooperation within these relevant organisations, and the Zhenjiang Special Working Team for Sponge City is set up as a steering team which is able to contribute interagency cooperation.

3.3.3 Economic Factors

There is no direct financial support that enables and facilitates the achievement of integration in Zhenjiang. The municipality of Zhenjiang is the receiver of Sponge City budget from the national government. While the budget is far from enough, a Private-Public Partnership approach is expected to be exerted to bring relevant authorities and experts together in every Sponge City project (UPC1, interview).

3.3.4 Process, Management and Instrumental Factors

Urban planning guidance, policy and legislation in Zhenjiang are evolving to integrate the Sponge City development principles. Especially, in the process of planning preparation and development control. The planning authority has a responsibility to ensure that the principles of Sponge City approaches have to be considered in planning preparation including the urban master plan, the sectoral plans and the detailed plans.

For example, in the Urban (rainwater) Water Drainage and Flood Control Sectoral Plan for the period between 2013 and 2020, it is regulated that the new development area should reach to a storm runoff volume control at 82.5%, and the existing areas should reach to a runoff volume control at 60%. The storm runoff volume control should be achieved through the uptake of low impact development approaches (Table 8).

In the planning preparation and development control process, a series of consultations must be taken with competent authorities which have the responsibility for storm water issues, such as the water authority, the environment authority, the public-private sewerage and water companies, the transportation authority and so on. Those stakeholders, which are joining hands with planning authority, exert influence over planning policy preparation and development control concerning storm water issues (UPC2, UPC3, interview).

Table 8 The low impact development requirement in detailed regulatory plan(DUDM, 2013, P48)

Project type	Control object	Low impact development technologies	Control parameters
New residential community project	Gross floor area⩾ 100,000 m^2	Green roof; permeable paving; swales; rain garden;	Green area ratio⩾40%, rain water utilisation ⩾ 30%, permeable paving ⩾50%
Public, commercial, and industrial buildings	Roof area of a single building		Green area ratio⩾20%, rain water utilisation ⩾ 30%, permeable paving ⩾50%
New and redevelopment plaza and car parking	Built-up area ⩾ 10,000 m^2	Permeable paving; water retention	Permeable paving⩾50%; available retention area ⩾ 50%; retention depth ⩾ 0.3m; parking area should be permeable
New and redevelopment road	all	Swales; rain garden; low elevation greenbelt	The sunken greenbelt along the road ⩾ 70%
Park	all	Swales, rain water utilisation	70% of the green area in the park should be as sunken green space

When interviewees were asked about how to integrate the standards and requirements of Sponge City into the current Zhenjiang Master Plan 2002 to 2020, its supplementary sectoral plans and Detailed plans, one urban planner replied that it is impossible to make big changes with every plan in a short time. Therefore, they put the principles and requirements of Sponge City in relevant plans as an appendix (UPC3, interview).

Jiang'er residential area, the first demonstration area in Zhenjiang, shows how sustainable storm water measures are applied in practice. It was built in the 1980s. The area contains 9 residential buildings in an area of 19,000 square meters. The area faces the challenge of ageing water infrastructure, and floods when meet 1-year storm events. In 2015, it planned to transform impervious surface between

the nine buildings into sponge surface by applying rain gardens[3] and permeable paving in a period of 120 days(zgjssw.gov.cn, 2015). Figure 9 shows the planned rain gardens in Jiang'er area. Rain gardens cover an area of 4,056 square meters, which accounts for 21 percent of total area of Jiang'er and 60 percent of the areas between buildings (Zhao, 2015).

Figure 9 the rain garden plan for Jiang'er residential area (areas marked with black number are for rain gardens) (Zhao,2015)

One interviewee (WMC1) criticised that Zhenjiang should not have designed such big rain garden areas to reach the experimental goal of meeting the standard of a 30-year flood event. He said it will be enough with 6 percent of sponge areas to meet the standard of a 1-year storm event. And for a 30-year storm event, grey

[3] Rain gardens are form of 'bio-retention' system, which help to harvest and infiltrate rainfalls from walkways and roofs(Zhao, 2015).

infrastructure, urban watercourses and green and wetland areas should be incorporated rather than only relying on green measures. In addition, there are resistances from residents. Figure 10 shows that one resident pushed a tree down, because he/she thinks that the tree will block the sunshine to his/her apartment. Residents also complained that there is too much public space used for rain gardens, they therefore take the consequence of the lack of space for bicycle and motorcycle, and recreation (Figure 10).

Figure 10 images of rain gardens in Jiang'er residential area (Zhao, 2015)
(*The first images show a resident pushed one tree down because he/she think it will block sunshine to his/her apartment. The second image shows that there is no enough space for bicycle and motorcycle parking. The third image shows that there is less space left for recreation*)

3.3.5 Behaviour, Cultural and Personal Factors

Sponge City is a new approach to urban planning and development under the challenges of frequent and intensive rainfalls and street flood. There is a lack of human capacity in the field of ecological-based storm water management including green and blue infrastructure. The shift of thinking from conventional water management (structural conveyance) to sustainable storm water management(infiltration) is a challenging task for all water managers and urban planners. For example, urban planners historically regard green and blue spaces are nice to have which could be subordinated to other competing land use development, such as encroach green spaces for housing development. With the implementation of sustainable storm water management, those spaces serving ground to implement green and blue infrastructure is a necessity that we must have (UPC2, interview).

Urban planners in the planning authority and water managers in the water authority work with their own views and language, and used to work separately. The decision-makers and experts in the field of water drainage used to work with a narrow, engineering-oriented thinking. The goal of the management of rainwater was to move the water out of sight as soon as possible by using an underground

water drainage network. The design of the drainage network was at the late stage in the city master plan. Specifically, the design of the drainage network was based on the road system, for example, the diameter of drainage pipes was based on the hierarchy of road. There was a lack of pre-development research for development areas, such as research for topography and perception. (WMC2, interview).

Sponge City, which deals with storm water as a cross-cutting issue, requires to promote the interagency and interdisciplinary cooperation. Every interviewee acknowledged the importance of the cooperation between water managers, urban planner and other relevant experts in Sponge City Development.

A water manager stated that the storm water management based on the principles of Sponge City involves both grey (hard) infrastructure and green and blue (soft) infrastructure. With the requirement of implementing green infrastructure, more space at the surface is needed, especially at the build-up areas where waterlogging disasters happen most. While the competition for space in urban area, especially city centre, is high, it is a challenge for water managers and urban planners to work together to redesign the vulnerable and valuable land in existing development area into the areas that allow the storm water to slowly soak into the ground or be used by plants(WMC2).

Chapter 4 Learn from Others: Urban Planning and Storm Water Management in the Netherlands

Cities can learn from each other and actively exchange best practices, which significantly help to transform cities that are resilient to extreme rainfalls due to climate change. The Netherlands is a small and a highly populated country. It has a long history of fighting with floods since it lies largely below sea level.

4.1 the Urban Planning System in the Netherlands

For decades the Dutch spatial planning system was built on a hierarchical model of planning. Therefore, the national government was to set the key planning decisions, and the lower governments including provincial and municipal governments were to make structural plans abided by the national planning decisions. In 2008, a new Dutch Planning Act came into force which changed the powers and responsibilities of the various tiers of government. The spatial planning in the Netherlands is shifting towards using fewer rules, less central control possible and an implementation-oriented approach.

According to the new Spatial Planning Act, the structural vision replaces the national key planning decision at the national level, the regional plan at the regional level, and the municipal structure plan at the local level. The structural visions, which is characterised by a strategic and indicative policy, show that the emphasis has shifted to the vision of the desired urban development for a particular area. In addition, the structural visions are mandatory policy documents without any legally binding elements, so each tier of government lays out its own structural vision that binds itself. If the national and provincial interests are at stake, they can make an Integration Plan, which has the same status as a land use zoning scheme at the municipal level (Figure 11).

The Ministry of Infrastructure and the Environment(I&M) has the responsibility to compile a National Strategy Vision. The Ministry made the National Policy Strategy for Infrastructure and Spatial Planning (abbreviated as SVIR in Dutch) in 2011, which provides a comprehensive view of central government policy on spatial planning and mobility up to 2040. It replaces the National Spatial Strategy, the

Randstad 2040 Structural Vision, and the Policy Document on Mobility, ect.. It seeks to remove excessive layers of government, simplify and integrate spatial planning regulations, and delegate more to local and provincial authorities. The SVIR sets out the ambitions of the Netherlands by 2040, which are making the Netherlands competitive, accessible, liveable and safe. Especially, the ambition related to liveability and safety sets the aim to provide its residents with a healthy and safe living environment with good environmental quality, and make sure the Netherlands is permanently protected from the impacts of extreme weather and the threat of flooding as a consequence of climate change. It stresses the importance that the short and long-term water management requirement should be complied by spatial plans including plan for urban and brownfield development (I&M, 2011, Van der Brugge and de Graaf, 2006).

The 12 provinces have the responsibility to prepare the structural visions, which are self-binding and not binding for the lower level governments. Since more power is delegated to the lower level government, the municipalities not only can adopt structural visions for the main issues of the municipal intended development, but also should prepare land use zoning scheme for the entire territory of the municipality which is legally binding. The plan should be updated once every ten years to ensure that it keeps up-to-date. The Land Use Zoning Scheme needs to show which land use is allowed on which place, and the word 'land' in the new planning Act refers to areas both above ground and underground. The Land Use Zoning Plan also serves as the basis to grant building permits (Lelie, 2011; I&M,2011; I&M, 2016a; Mlit, 2016b).

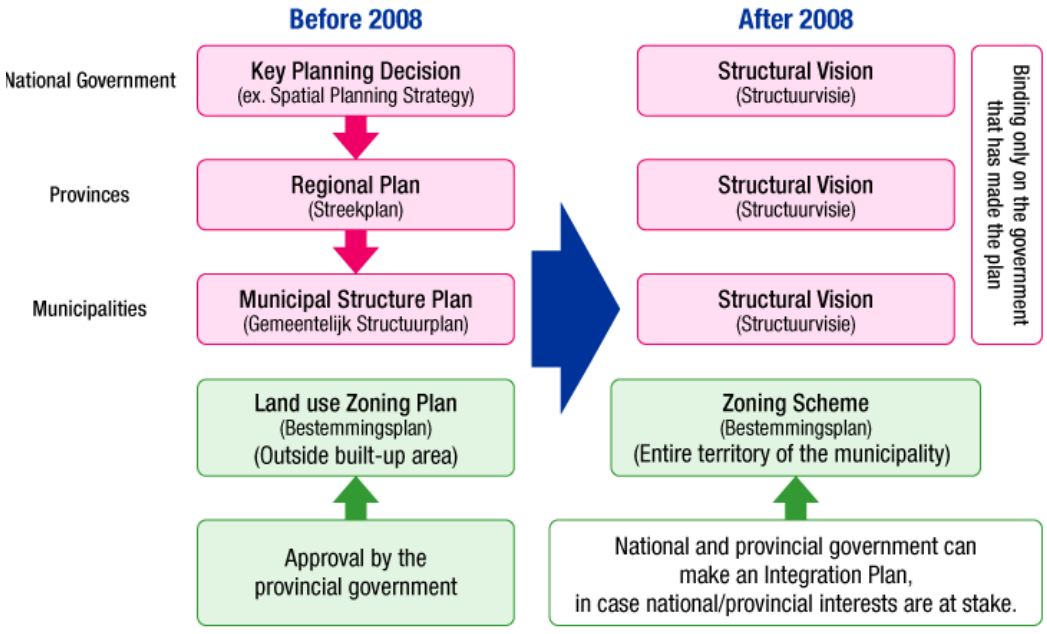


Figure 11 Dutch spatial planning system (Mlit, 2016b)

4.2 Water management in the Netherlands

European and national level

Water management in the Netherlands has undergone three phases: Local and regional water management from 1200 to 1798; central guided water management from 1798 to 2000; EU-directed water management from 2000 to present (van Leussen and Lulofs, 2009, p.174). Water management in the Netherlands is characterised by a multi-level governance system from the European Union to the local level. It has been built on a relatively high degree of decentralised model with the motto 'decentralised whenever possible, centralised whenever necessary' (I&M, 2009).

The European Water Framework Directive came into force in 2000, which has strong influence on Dutch water management (van Leussen and Lulofs, 2009). The Directive stresses the importance of an integrated approach to managing water quality on a river basin basis. It requires the integration of water management with other sectors, especially spatial planning. The implementation of the Water Framework Directive in the Netherlands keeps '*the exciting legal, financial and institutional framework intact as much as possible* (Juner and Mostert, 2012, p8)'. The OECD also concluded that the organisational structure in water management is functioning effectively. There is no need to change administrative or organisational settings in water management. (OECD, 2014)

The new Water Act was published in 2009, which is based on the integration of eight older acts[4] (van Rijswick, 2009). According to the Water Act 2009, the central government, provinces, municipalities and the water boards have the joint responsibility for water management. In 2010, the Ministry of Housing, Spatial Planning and the Environment and the Ministry of Transport, Public Works and Water Management was merged to form the new Ministry of Infrastructure and the Environment. The establishment of the Ministry of Infrastructure and the Environment reflects that the responsibility for water management and spatial planning is united within one ministry (Watertoets, 2016). The Ministry of Infrastructure and the Environment is responsible for the national water policy and the agreement making with other policy areas connected with water such as spatial planning, environment, economic development (OECD, 2014). Using and evaluating

[4] The new Water Act 2009 combined and integrated the Water Management Act, Pollution of Surface Water Act, Pollution of Sea Water Act, Groundwater Act, Land Reclamation and Dykes Act, Flood Defence Act, Public Works Act, and Water Management Act 1900(van Rijswick, 2009).

the water Assessment (more information in section 4.3.4) is part of this agreement. Water management and spatial planning are brought together at the national, regional and local level under this agreement. The national water authority (Rijkswaterstaat) is the executing agency of the ministry, which is in charge of the operation and maintenance of the main national water system (OECD, 2014).

According to Dutch Water Act, a National Water Plan(NWP) should be made for the main elements of national water policy and the associated aspects of national spatial policy. The preparation of the National Water Plan should be based on joint consultation with representatives of all provinces, water boards and the municipal councils as well as other competent authorities (Water Act, Art.4.1 and 4.3). The latest National Water Plan for the 2016-2021 with a preview towards 2050, as the successor to the National Water Plan 2009-2015, sets down the ambition to create a robust and future-oriented design of the water management system. It promotes to effectively protect against floods, prevent pluvial flooding and drought, and achieve good quality and a healthy ecosystem. The new Plan states that a better connection between water and space is essential to achieve the goals of NWP (I&M, 2016b).

> '*It is important to connect water and space more effectively. … In this regard, the Cabinet is also striving for comprehensive combinations, in which the spatial organisation plays an important role in resolving the water challenges. Conversely, when addressing the spatial challenges, it is important to take account often water challenges and the resilience of water systems at an early stage. The more effective connection which is desired between water and space applies to all challenges in the area of flood risk management, freshwater and water quality'*.
>
> I&M, national water plan, 2016b, p59

Regional level

There are two relevant actors for water management at a regional level. Firstly, the 12 provincial water authorities are responsible for setting provincial water policies and regulations, and supervise the water boards.

Thee water boards, the first democratic authorities specialised in water in the Netherlands, have a self-supporting financial system (levy their own taxes) and three legal tasks including flood protection, water quantity and water quality management. The water boards have their own water management plans, which should be approved by the provinces. From a hierarchical point of view, a water board has the same status with a municipality (OECD,2014).

Local level

Municipalities have responsibility for the sewerage collection system, urban drainage and rain water collection and disposal at local level. It is regulated that dealing with rainwater shall include at least the following measures: '*storage, transport, effective use or recharge, whether or not after treatment, on or into the ground or into the surface water of collected rainwater as well as its transportation to a treatment plant*' (Water Act, Art.3.5). Figure 12 shows the water management system in the Netherlands in European, national, provincial and municipal level.

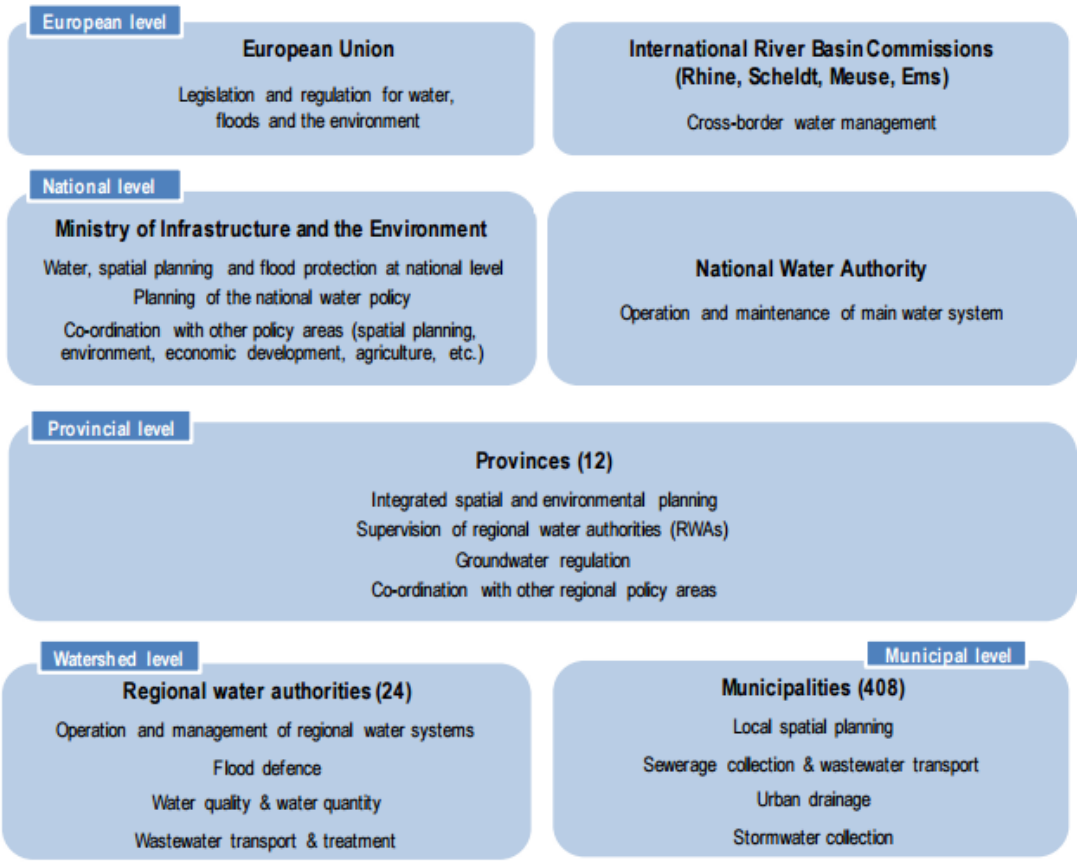


Figure 12 water management system in the Netherlands (OECD,2014, P31)
(The Regional Water Authorities in figure means the Water Boards. As of 2016, there are 23 water boards.)

4.3 Case Study: Rotterdam

Rotterdam, the heart of the Dutch delta, is located in the delta of the rivers Rhine and Meuse. The city is largely below sea level. It is protected from the sea by a complex and extensive system of dykes, closure dams and storm surge barriers. It is predicted that Rotterdam will experience more extreme weather conditions, such as heavier rainstorms, longer periods of draught and more heat waves. Since

Rotterdam is a low-laying delta city, it is especially vulnerable to these consequences and climate change. Water management is of major importance in the Netherlands, especially Rotterdam. Dutch flood protection standards are currently the highest in the world. Most of the protection systems around Rotterdam are designed to withstand a storm estimated to occur once in every 10,000 years. There is still a risk that the current sewerage system may not be able to treat and drain the surplus of water(Francesch-Huidobro, 2015).

In addition, Rotterdam is a test ground for developing climate resilient city. For example, Rotterdam has been participating in the 100 Resilient Cities network in 2014. Rotterdam joined in the C40 Cities Climate Leadership Group, a prominent global organisation aiming to reduce greenhouse gas emissions and climate risks. And it is involved in the Connecting Delta Cities which aims to develop a network of delta cities to exchange knowledge on climate adaptation and share best practices for making climate-proof cities (deltacities, 2016).

According to the OECD, Dutch water management is qualified as a 'global reference' (OECD, 2014). Rotterdam, in the Netherlands, is well-known for its climate adaptation programme, and is an international test ground for developing climate resilient city. Therefore, Rotterdam is enough representative. In addition, there are a lot of websites, documents and news about Rotterdam's Climate Proof City strategy in English, which could provide sufficient data for this report. So Rotterdam is selected for Dutch case study.

4.3.1 Political Factors

'Although Rotterdam is one of the safest delta cities in the world, it is vulnerable because of its location in the Dutch delta…we do not regard climate change as a threat, but rather as an opportunity to make the city more resilient, appealing and economically stronger.'

Ahmed Aboutaleb (mayor of Rotterdam)(RCI, 2014)

There is a shared understanding of the need to make a climate-proof Rotterdam among the municipality and the Water Boards. The Stadsvisie Rotterdam (Rotterdam Urban Vision) describes the broad vision for the spatial planning and economic development of the city until 2030. The mission is laid down in the Urban Vision: 'work at a strong economy and attractive residential city'. (City of Rotterdam, 2007) In addition, the Rotterdam City Vision 2030 takes consideration into building an attractive city by linking living with water into planning concerns (Lu, 2014).

In line with the city's aims stated in the Urban Vision, the Rotterdam Climate Change Adaptation Strategy in 2013 sets the city's wish to be a 100% climate-proof city by 2025. Adaptation to climate change in the city of Rotterdam is understood as '*a process whereby society reduces its vulnerability to climate change or whereby it profits from the opportunities provided by a changing climate*'. (RCI, 2013, p5) The core strategies are maintaining and optimising the existing robust system, taking adaptive measures throughout the whole urban environment, cooperating with others, and taking advantage of the opportunities connected with the adaptation measures. It states that the problem of heavy downpours in Rotterdam will not only become more frequent but also more intensive. More frequent and intensive rainfall will challenge the robust system, and lead to an increase in flood-related problems. In order to cope with the challenges of extreme rainfall, the Climate-Proof City measures of Rotterdam should be robust and resilient. Rotterdam should continue to maintain and optimise the existing system of storm surge barriers, canals and sewers, etc., and develop adaptation measures in all aspects of the urban environment that make the city more water resilient, such as water squares and green roofs. The Strategy stresses the importance of intensive cooperation between the water boards, urban developers, and the City of Rotterdam and Spatial administrators to achieve a water-proof Rotterdam (Gemeente Rotterdam, 2007).

The Rotterdam Water City 2035(in Dutch: Rotterdam Waterstad 2035), jointly prepared by the City of Rotterdam, the Hollandse Delta Water Board, and the Schieland and Krimpenerwaard District Water Board, received the Architecture Biennale Real Estate Award in 2005. It is stated that' an excellent and now well-known example of this synergy (water and spatial development) is our entry for the second International Architecture Biennale: Rotterdam Water City 2035'. (Gemeente Rotterdam, 2007, p7&23).

Water plan 2 Rotterdam was prepared jointly by the Municipality of Rotterdam, the Schieland and Krimpenerwaard Water Board, the Hallandse Delta Water Authority and the Delfland Water Control Board in 2007. In line with the Urban Vision, it lays out framework, vision and an elaborated programme of measures for dealing with all the excessive water until 2030. Rotterdam should confront the challenges of water as an opportunity rather than a problem. The water issues related to excessive water must be given priority. Space must be created to detain and store water, in order to withstand the peaks in precipitation due to climate change. The implementation programme includes a number of innovative measures, such as water plazas and vegetation roofs, which not only solve the requirements of water storage, but also improve the spatial quality. Water Plan 2 reemphasises the

interrelated relationship between water and spatial development. Water managers and planning experts should join hands to boost water storage measures (Gemeente Rotterdam , 2007).

4.3.2 Institutional/Organisational Factors

According to an interview with an urban planner (UPNL1, Interview) of the City of Rotterdam's Urban Planning Department, their current work related to storm water management are:

- responsible for the climate adaptive strategies for the flood prone areas of Rotterdam;
- The implementation of the Rotterdam Climate Change Adaptation Strategy and Climate Change adaptation in the Rotterdam Resilience Strategy.

For both the implementation and the development of the Rotterdam Resilience Strategy, they are currently working on developing long-term strategies for implementing local storm water management measures into urban planning and development.

There is a program in Rotterdam, which aims at stimulating small-scale storm water management measures (e.g. green roofs, on-site water retention or public rain gardens). There is a cooperation between the city and the three water boards in Rotterdam. In addition, there are some combined or multifunctional storm water retentions have been built, which are integrated into the design of a parking garage or public plaza.

Moving towards small-scale integrated water retention solutions also requires the cooperation between urban designers, infrastructure managers and public stakeholders such as real estate owners and community organisations. There are not so many issues concerning the responsibilities but more around questions around the distribution of costs and benefits, maintenance and long-term sustainability of small scale retention. For example, the development of green roofs is stimulated through an incentive program of the city's water management department and the water boards. However, it remains unclear if the storm water retention capacity is sufficient to reduce storm water flooding on street and property level and it is uncertain whether these green roofs will remain (homeowners may decide to change the use of the roof) and well managed on the long-term. Consequently, the water retaining capacity is not included in the storm water modelling and, as such, not regarded as a functional solution. These issues between

legal, or formal position of these local measures and the functional value of flood retention remains a major issue. (UP1, interview)

The possibility of changing precipitation patterns due to climate change has altered how urban planners and water managers do their storm water related job. An interviewee from the department of city maintenance in the team of water stated that they used to mainly work on underground sewer system management, but nowadays the municipality of Rotterdam and three water boards work together to manage the city water in total (WMNL2, interview).

The Storm Flood of 1953 helps Rotterdam to arrive at a common vision that all private developers, municipal organisations and the water boards should work together to build a water resilient city. The disaster made more people become more aware of the problems they are facing. The municipality and the water boards cannot do it on their own. Even if the municipality and the water boards work together, they cannot solve the problems as well. People need to know if they are living in a low-laying area, and there can be a problem of high water level in a certain period of time. Therefore, they began to use some instrument, such as Delta City Rotterdam App, to involve more people in the actions to adapt climate change and work in a bottom-up way (WMNL1 and WMNL3, interview). In addition, Rotterdam works well in interagency and interdisciplinary cooperation between distinctive actors for sustainable storm water management as a cross-cutting issue (WMNL3, interview).

4.3.3 Economic Factors

It is clearly stated in Waterplan2 that the Water Boards pay for the interventions that contribute to water quality and water quantity targets, and the city of Rotterdam pays for wastewater collections interventions and is responsible for interventions within open spaces. Therefore, once the objectives of intervention are identified, then it becomes clearly to allocate the costs. While a water manager said,

'The regional water authorities like the projects we do on water, but when you start to build a green roof or water plaza then water boards have to give financial supports. Then they start to think do we really need it. Some of our projects are too ambitious without thinking the issue of lacking fund. '(WMNL2, interview)

With the challenges around financial issues like cost distribution, a water manager working in a water board revealed solutions. Due to economic crisis, a water board mainly focus on its own business, and also subsidies the municipalities to encourage

their habitants to take measure to climate change adaptation, such as buying rainwater storage. An interviewee said,

'*We do have money to realise our own tasks. While what we are trying to do is to team up within us in order to avoid to do our projects and the projects of municipalities, provinces and state separately. Bringing all the money together with different actors involved, we are trying to reach more different goals rather than a single goal we have. The amount of money is limited, but we are trying to make big difference as much as possible*' (WMNL1, interview).

In addition, one interviewee argued that there is no direct financial incentive that stimulates cooperation. But Dutch municipalities have a long tradition of cooperation between several levels of authority (e.g. water boards, national authorities), which help them to cooperatively invest in climate proof city measures(WMNL3, interview).

4.3.4 Process, Management and Instrumental Factors

Instrument 1: Water assessment test

There are some planning instruments, which are meant to ensure cooperation between urban planners and water managers. Since 2001, a Water Assessment test is required to assess each land use proposal. This Water Assessment test is a process of interaction between water management and urban planning to ensure that water aspects are integrated into urban planning process from the earliest stages. The spatial planning authority and the water authority are the two formal actors in the process of Water Assessment. It is not a test on water aspects of a completed spatial plan as its name may suggest (Watertoets, 2016).

Water Assessment is fully integrated into existing spatial planning process rather than a new procedure. There are three phases in Water Assessment (Figure 13). Firstly, the spatial planning authority should contact the water authority as soon as the first ideas about the plan initiated. Hereby the water authority informs the spatial planning authority about the water system, relevant policies, criteria and priorities in water management. Then they jointly make an agreement on the assessment criteria and process. Secondly, the planning authority and the water authority work interactively on the design of the draft spatial plan. The result of this phase is that the water authority checks whether the agreed water criteria are met and then gives a Water Recommendation about their findings or recommendations for adjustments to the planning authority. Thirdly, the planning authority modifies

the plan based on the Water Recommendation. A Water Paragraph, which should be included in the plan, clarifies how water issues have been taken account as a result of Water Assessment process. If the plan is contrary to the recommendation of the water authority, reasons and compensatory measures must be described. Finally, there was a procedure that asking an approval from a higher authority. Since the new Planning Act came into force, this step is not required. (Watertoets, 2016)

Water Assessment as a planning instrument helps to ensure water managers to make their objectives and needs clear to urban planner at the early stage, then to prevent negative effects of the spatial plan on the water system (Voogd and Woltjer, 2009; Watertoets, 2016).

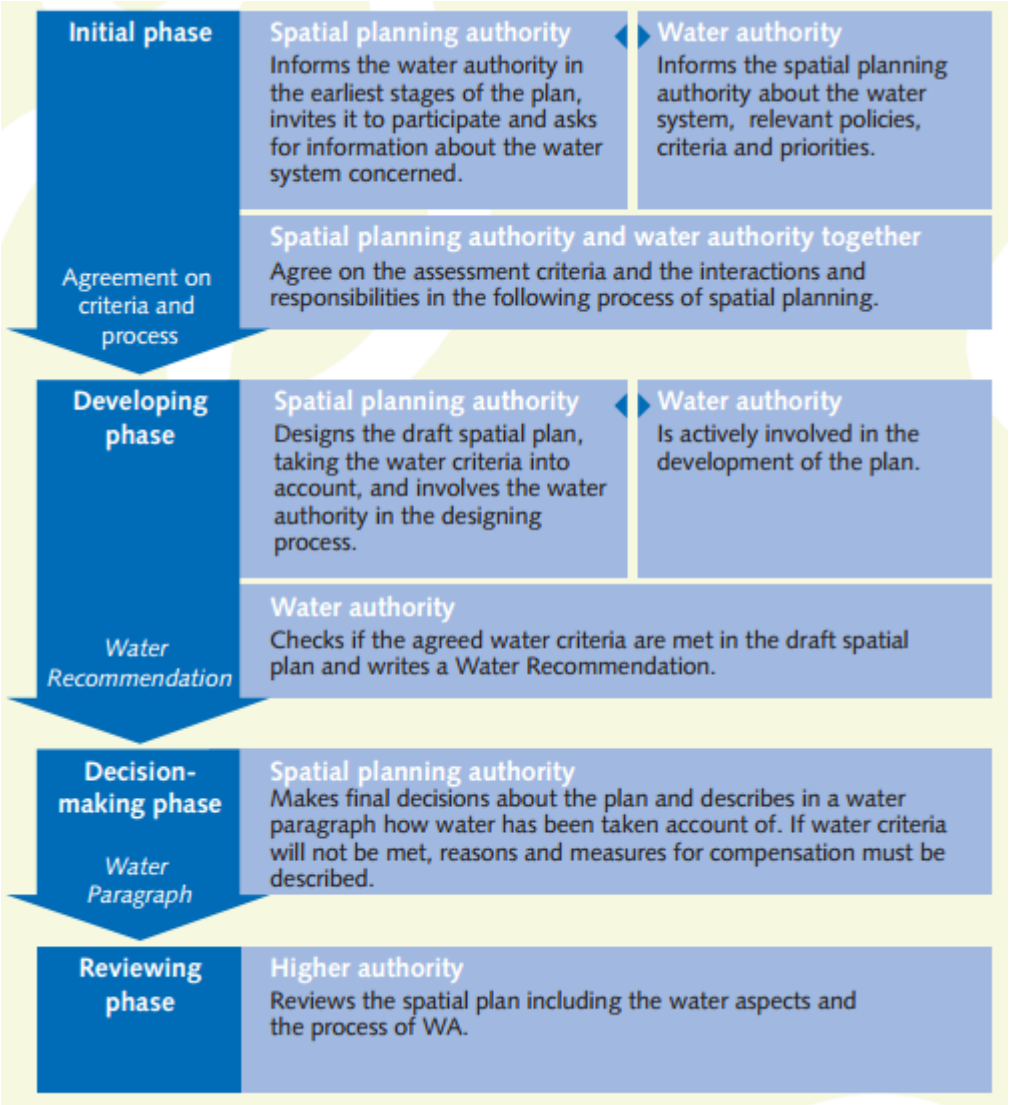


Figure 13 The water assessment in the Netherlands (Watertoets, 2016)

In order to lead the urban developers as well planners take into account the conditions and principles included in the Water Plan2, the Water Boards assess the proposed plans by using water assessment test. The Water Plan2 mentions the important aspects that should be included in the assessment test, as follows:

1. Include the water prerequisites into the checklists for urban development and into the checklists for open spaces;
2. Verify the water section in the zoning plans with the vision contained in this Water Plan
3. Investigate whether it is possible to include conditions in the construction permits and development planning that are essential for achieving the Water Plan's objectives. (Gemeente Rotterdam, 2007, p126)

Water assessment test is available to planners and water managers to strengthen the link between spatial planning and water issues. The Delfland Water Board uses the Water Test approach for every development and redevelopment projects. Once the planning authority receives a planning application from individual developers, the authority should let the water board involve in and go through the Water Test procedure (WMNL1, interview).

Instrument 2: Water opportunity map

The water opportunity map, which aims to affect spatial policymaking, reflects the attitudes of water boards shift from traditionally technical-oriented water management to proactive approach with respect to land use planning (Voogd and Woltjer, 2009). The most notable fact of Water Opportunity Map is visualisation. It plays an information and communication instrument by visualising 'water system conditions and preconditions for land use' (Voogd, 2006, p54). The Water Opportunity Map, which is drawn by water authorities, have an effect on planning and decision-making on land use from a water perspective.

Instrument 3 Helpdesk Water

Helpdesk Water is primarily designed to answer questions from people who are (professionally) involved in water policy, water management and water-safety issues in The Netherlands. Helpdesk Water was created through a collaboration between the Dutch government, provinces, municipalities and the local water board's union. Helpdesk Water is an online information instrument that not only provides an information base for people working with water but also facilitates to integrate the worlds of spatial planning and water management by exchanging knowledge (helpdeskwater.nl, 2016).

4.3.5 Behaviour, Cultural and Personal Factors

It is acknowledged that water managers and urban planners have distinctive professional cultures. Water managers consisted of engineers and hydrologists work from a technical viewpoint. On the other hand, planners have more political and economic visions. When asking an urban planner in Rotterdam about the experience of different professional culture between water managers and urban planners in the course of working on storm water issues, a comment from an urban planner of City of Rotterdam is as follows:

'Indeed, there is always some tension between engineered focus of water managers and the more holistic and systematic focus of planners. However, considering the long tradition of working together on flood risk and storm water management, water managers and urban planners share a common vision and build up a common language. Of course, there are issues but these are solved through communication and a consensus-seeking attitude. I realise that this condition is rather unique, even in the Netherlands'. [UP1, Interview]

On the other hand, water managers in Rotterdam also have a consensus-seeking attitude and try to adapt themselves under the challenges of climate change. A water manager working in the department of city maintenance said *'for me as a water engineer, it is hard not to think hard measures. I like technically shaped sewer systems. But I started to learn the advantages of green and soft measures. It took time, but I can get used to it. For green measures if they are really less expensive than technical hard measures, now I don't think so, but there are more benefits to it. It improves the liveability of the city. A house owner likes his house more when he looks at green trees than looks at a grey street*.' (WMNL2, interview).

A water manager with the urban planning study background working in the Hoogheemraadschap van Delfland Water Board was interviewed in this research. She used to be an urban planning related-policy maker working in a municipality, now she is on other side of the table working on water plans in a water board to make sure there is enough spatial relevancy in water plans which actually can be drawn on a map and then be able to integrate it with other spatial plans. She works as a mediator who not only knows the language and vocabulary of technical-oriented water engineers but also the language of design and planning (WMNL1, interview).

In addition, trust and communication play an important role in it. It will take longer to start a project because different actors have to talk to each other and find a common ground. But once the common ground is reached, then the following process could go smoothly due to the fully support is gained from the aligned group (WMNL3, interview).

One interviewee (WMNL1, interview) stated that it is important to be open enough with the information sharing for both sides. The water boards shall make efforts to identify the weaknesses, strengths and opportunities of the water system and to frequently contact with municipalities. For instance, the water board has regular meetings with relevant municipal officials to discuss the Water Assessment Test (more info in 4.3.4) in each two or four weeks. They will discuss the ongoing development projects concerning water quality and quantity, and come up with solutions that work for both of them. Negotiation is important if conflicts happen and that hinder the cooperation (WMNL1, interview).

One interviewee argued that the cultural awareness of cooperation is important. It helps to facilitate the cooperation and communication between urban planners and water managers. Dutch municipalities have a long tradition of cooperation between several levels of authority (e.g. water boards, national authorities) for water management and a constructive working relation between these authorities that build on the strong cultural awareness of cooperation in flood risk management in the Netherlands. (UPNL1 and WMNL2, interview)

Chapter 5 Discussion

In this section, the results from the analyses of the case studies in China and the Netherlands will be discussed. The aim of this discussion is to analyse and compare the interagency and interdisciplinary integration between urban planning and water management in the two countries. The discussion will follow the structure and content of the Analytical Framework of Integration which is generated in Chapter 2. Therefore, *the political factors, institutional and organisational factors, economic factors, process, management and instrumental factors and behavioural, cultural and personal factors,* that exert influence over the integration between urban planning and water management in Chinese and Dutch case studies will be analysed in this chapter.

5.1 Political Factors

Law, regulations, policies and strategies for water management and urban planning, play a vital role in investigating the level of integration and cooperation between those two disciplines. In China, the Technical Guidance for Sponge City Development released in October 2014 by the MHURD shows the transition towards integrating Sponge City into the urban planning system. According to the guidance, storm water management practising the principles of Sponge City should be considered at the early and each stage of the planning process. In 2013, MHURD issued a technical guideline for the formulation of a comprehensive urban storm water drainage and flood control sectoral plan. The plan acts as a sectoral plan supplements of the urban master plan. It shows an increased awareness of integrating storm water management into the urban planning system. The Decree No. 321 of Ministry of Water Resource delivers its instructional suggestions on Sponge City development to all of the subordinated provincial and local water management authorities. It emphasises the importance of integrating water resource management measures and requirements into the urban master plans, and strengthening the consistency with other relevant sectoral plans, such as a comprehensive river basin sectoral plan and a water drainage and flood control sectoral plan.

Following the guidance of National plans and policies, Zhenjiang prepared the Urban (rainwater) Water Drainage and Flood Control Sectoral Plan and the Planning and Design Guidance for Zhenjiang Sponge City Development (trial). Zhenjiang is also trying to integrate Sponge City principles in existing plans. Those plans stressed the important role of urban planning in facilitating the practice of storm water

management with the principles of Sponge City or Low Impact Development. Water managers and urban planners made efforts to establish a new connection between storm water management and urban planning towards a regulatory planning style, such as the implementation of regulations and standards. As a result, the water aspects are integrated into the urban planning and decision-making process, since the Municipality of Zhenjiang uses a Regulatory Detailed Plan in planning management to implement the principles and standards of Sponge City on every new development and redevelopment plan. In the Netherlands, the Ministry of Infrastructure and the Environment prepared the National Policy Strategy for Infrastructure and Spatial Planning (abbreviated as SVIR in Dutch) in 2011, which sets a comprehensive view of the central government policy on spatial planning up to 2040. It emphasises the importance that the short and long-term water management requirements should be complied by spatial plans such as plans for urban and brownfield development. Influenced by the European Water Framework Directive, the integration between water management with other sectors, especially spatial planning, is enhancing. According to the Dutch Water Act, a National Water Plan (NWP) should be prepared every 6 years. The latest National Water Plan 2016-2021 states that a better connection between water and space is essential.

In Rotterdam, there is a shared understanding of the need to create a climate-proof Rotterdam among the municipality and the involved Water Boards. The Rotterdam Climate Change Adaptation Strategy in 2013 gave the city its future vision that the city wishes to be a 100% climate-proof city by 2025. The Strategy stresses the importance of intensive cooperation between the water boards, urban developers, and the City of Rotterdam and Spatial administrators to achieve a climate-proof Rotterdam. Water plan 2 Rotterdam was prepared jointly by the Municipality of Rotterdam, the Schieland and Krimpenerwaard Water Board, the Hollandse Delta Water Authority and the Delfland Water Control Board in 2007. The Water Plan 2 reemphasises the interrelated relationship between water and spatial development and states the importance of strengthening their relationship. Water management policies are increasingly integrated with urban planning in Rotterdam. Water managers and urban planners join hands to build a strong economy and an attractive residential Rotterdam with the concern of integrating spatial planning and water management.

It was found that the national government policies and strategies both in China and Netherlands not only stress the role of urban planning as an instrument in dealing with extensive rainwater as a consequence of climate change, but also facilitate the integration between urban planning and storm water management. Influenced by

the national government policies and strategies, Zhenjiang and Rotterdam at the local level practised policies to facilitate the integration between the worlds of spatial planning and water management. Both in Zhenjiang and Rotterdam, the need for promoting sustainable storm water management and the integration between spatial planning and water management are increasingly adopted in the policy agenda.

Those policies and plans provide a recognition that the political will to improve storm water management and integration between spatial planning and storm water management is growing in the two countries and two cities. The willingness of cooperation between water managers in water authority and urban planners in planning authority is increasing. Compared to Rotterdam, the level of integration in policies and plans in Zhenjiang is relatively low. In Rotterdam, the Rotterdam Water City 2035 and Water Plan 2 Rotterdam were jointly prepared by the Municipality of Rotterdam, the Schieland and Krimpenerwaard Water Board, the Hollandse Delta Water Authority and the Delfland Water Control Board. At the national level in China, there is an attempt at interdisciplinary and interagency cooperation between the Ministry of Water and Resource and the Ministry of Housing and Urban-Rural Development to jointly produce a National Sponge City Guidance. Down to the local level, the making of policies and plans related to Sponge City remains to be carried out by different sectors, which may result in policy fragmentation. Table 9 presents an overview of the political factors.

Table 9 political factors that influence the integration between spatial planning and storm water management

Political factors	China-Zhenjiang	The Netherlands -Rotterdam
● shared understanding of the policy issues and objectives ● the legislation, regulations and strategies that enable and facilitate cross-sector integration	● growing awareness to implement sustainable storm water management from national to local level ● increasing political will, legislation and strategies to integrate storm water management in urban planning ● relatively low level of cooperation in producing plans	● growing awareness to implement sustainable storm water management from national to local level ● increasing political will, regulation and strategies to integrate storm water management in urban planning ● relatively high level of cooperation in producing plans

5.2 Institutional/Organisational Factors

In China, the concepts of the centrally planned economy from the former Soviet Union dominated and influenced the urban planning system and water management system, which are characterised by a hierarchical top-down structure. At the national level, the ministries were set up depending on the different disciplines and sectors. In the provincial and local government, their structures for urban planning and water affairs management have to follow the administrative framework of the central government in order to follow up the policies from different ministries.

The current Chinese planning system contains three types of plans: 1) the Five-year Plan for national, provincial and local Economic and Social Development prepared by the National, Provincial and Local Development and Reform Commission respectively. 2) the National system plan, the Provincial system plan and the municipal comprehensive Plan Prepared by the National Ministry of Housing and Urban-Rural Development (MHURD), the Provincial and municipal Department of Housing and Urban-Rural Development or municipal planning authority respectively. 3) the National, the Provincial and the Local Land-Use Plan prepared by the National Ministry of Land Use and Resources(MLR), the Provincial and Local Department of Land Use and Resources respectively. The Socio-Economic five-year and Land Use Plan influence the content of the City Master Plans.

The current Chinese water management system is complex and labelled as 'the Nine Dragons Who Administer water', which means there are Nine ministries who are responsible for water management, including the Ministry of Water Resource (overall administration of water resources), the MHURD (planning, construction and management of water supply, drainage and sewage), the Ministry of Environment Protection (water quality), the MLR(prevention of groundwater contamination) and so on. The water affairs management agencies (Nine Dragons) have structured their agencies vertically distributed over the central, provincial and local level.

The urban planning system and water management system of China operate in a strict administrative hierarchy, which affects the institutional and organisational structure of the Municipality of Zhenjiang. The inter-organisational network is bureaucratic and fragmented. Based on the results of the interviews, there is a consensus that a close cooperation between different competent authorities is important for successfully implementing the principles of Sponge City in practice. Special Working Team is organised to lead and bring relevant authorities in the development of Sponge City. It helps and supports to a socio-ecological and

integrated approach to implementing sustainable storm water management, and to reduce institutional fragmentation due to specialisation. The Housing and Urban-Rural Department, the Land and Resource Department, the Water Authority, the Planning Authority and so on are involved in the Special Working Team to join hands to develop Sponge City.

Compared to China, the Netherlands has a much more simplified and democratic administrative system. Different with Chinese complex and fragmented planning system, the Dutch approach can be characterised as integrated and comprehensive. The spatial planning in the Netherlands is shifting towards fewer rules, less central control where possible. According to the new Spatial Planning Act 2008, that replaces the original national key planning decision at the national level, the provincial plan at the provincial level, and the municipal structure plan at the local level should be replaced by the structural visions, which are characterised by a strategic and indicative policy.

Water management in the Netherlands is characterised by a multi-level governance system from the European Union to the local level. 'Decentralised whenever possible, centralised whenever necessary' as the motto of water management indicates that it is based on a relatively high degree of a decentralised model. Compared to the Chinese 'Nine Dragons who Administer water' and a set of water-related laws and regulations, the administrative system and laws for water issues in the Netherlands is much more simplified. In 2010, the ministry of Housing, Spatial Planning and the Environment and the Ministry of Transport, Public Works and Water Management were merged to form the new Ministry of Infrastructure and the Environment (MIE). The MIE is responsible for the water policies at national level. In 2009, the Netherlands accomplished the integration of the water-related legal framework. Eight water laws were integrated into the Water Act.

The merge of ministries and an integrated water-related legal framework in the Netherlands results in an integrated water management. In Rotterdam, different authorities attempt to team up with each other and jointly work for a Climate Proof City. Interviewees express their consensus seeking attitudes in the joint working. In China, with the influence of planned economy, the governmental administrative structure of municipalities is similar to the central government and the decision-making is top-down in nature. Both in water management and urban planning, there are various agencies at the national, provincial and municipal level. As the Decree No. 140 of Zhenjiang states the planning and water related-authorities have responsibility to prepare their own plans. In addition, there

is a hierarchy in those plans and the time horizon might be different. For example, the city master plan prepared by the Department of Housing and Urban-Rural or Planning Authority for 20 years should be produced according to the Socio-Economic Five-Year Plan prepared by the Department of Development and Reform Commission for each 5 years, and a Land Use Plan prepared by the Department of Land and Resource for a period of 15 years. The complex and fragmented plans/policies-making and decision-making process may result in a heavily internal communication and bureaucratic and fragmented inter-organisational network. The establishment of the Zhenjiang Working Team for Sponge City with steering power has the potential to reduce government bureaucracy and fragmentation and promote horizontal integration. Table 10 presents an overview of the institutional/organisational factors.

Table 10 Institutional/organisational factors that influence the integration between spatial planning and storm water management

Institutional/organisational factors	China-Zhenjiang	The Netherlands-Rotterdam
• the delineation of actor roles and responsibilities for the two sectors • Internal communication and inter-organisational network	• A special working Team(government) • The Internal communication and inter-organisational network is bureaucratic and fragmented • The establishment of Zhenjiang Special Working Team has potential to reduce government bureaucracy and fragmentation	• Team up with each other (governance) • The internal communication and inter-organisational network is more flexible to policy integration.

5.3 Economic Factors

There was not much information available from literature review and interviews about how economic factors affects the integration between spatial planning and water management in this study, especially, in Chinese context.

For both the Zhenjiang and Rotterdam case study, it was found that there is no direct funding for promoting integration between spatial planning and storm water management. The government of Zhenjiang is the receiver of the Sponge City Demonstration Project budget. The Working Team for Sponge City is responsible for the allocation of budget to Sponge City projects. The interviewees did not share the information about how to allocate the budget. In Rotterdam, the water boards and

municipality try to team up the projects if possible. On the one hand, it helps to avoid to do projects of the water boards, municipalities, provinces and state with similar goal in Rotterdam separately. On the other hand, teaming up water-related projects with others, such as recreation, regeneration, ecology conservation, helps to achieve an integrated goal-setting, plus-sum outcome and save money. Table 11 presents an overview of the economic factors.

Table 11 Economic factors that influence the integration between spatial planning and storm water management

Economic factors	China-Zhenjiang	The Netherlands-Rotterdam
● funding for integrated process ● allocation of budgets to cross-cutting issues or to sectors	● no direct funding for an integrated process ● the budget is far from enough, a Private-Public Partnership approach is expected to be exerted to bring relevant authorities and experts together in every Sponge City project	● no direct funding for an integrated process ● team up between water boards and municipality avoid to separately do the projects of water boards, municipalities, provinces and state in Rotterdam

5.4 Process, Management and Instrument Factors

Urban planning guidance, policy and legislation in Zhenjiang are evolving to integrate the Sponge City development principles. Consistent with the national policies and guidance related to Sponge City development, Zhenjiang intents to use regulatory planning instruments and regulations to implement the principles of Sponge City to deal with excess water in the new and redevelopment areas. The planning authority uses regulatory planning instruments to provide material for consideration in the planning and decision-making process, such as controlling parameters for low impact development in various projects regulated in the Urban (rainwater) Water Drainage and Flood Control Sectoral Plan for the period between 2013 and 2020.

The application of rain gardens in Jiang'er residential area shows that using controlling parameters in the uptake of sustainable storm water measure may result in the irrational implementation of those measures. One interviewee(UPC2), an urban planner and played a leading role in the Jiang'er demonstration area, got criticisms from another interviewee(WMC1) who is a water engineer. The water engineer argued that 6 percent of sponge area is enough for this area and there is

no need to have such big area for rain gardens. To some extent, it reflects that there is a lack of communication between urban planners and water managers in Jiang'er redevelopment process. In addition, it might not be positive as interviewees suggested that Special Working Team helps and supports a socio-ecological and integrated approach to implementing sustainable storm water management. In addition, there is one thing that could be dangerous and should be paid attention. It is that Zhenjiang government might be keen to have a Sponge City project to show, which may fall into the thinking about 'political achievement (Zhengji Gongcheng)' which was discussed in section 1.2.1. Short-term and ambitious goals are pursued in Jiang'er residential area redevelopment project, which was plan to transfer into a sponge area in 120 days.

After having a review of how planning authority takes account of sustainable storm water measures in urban plans and the practice in Jiang'er residential areas, it reflects that the Chinese planning approach is dominated by a rational planning approach. The rational planning approach is dominated by a narrow instrumental/scientific focus (Allmendinger, 2009). Jiang'er redevelopment practice shows the planning authority justifies its choice in the planning and decision-making in line with rational planning requirements. Planners who work as experts with specialist technical skills are regulators and play a dominant role in decision-making process.

In addition, there is a doubt about using the planning control system (planning application permission or rejection) to incorporating Sponge City measures into every planning application at this early stage in China. It might be too early to impose this regulation. Sponge City is a new paradigm shift, it takes time to increase the understanding and acceptance of this idea. In addition, individual planning applicants may get excessive burden from this regulation. One Dutch interviewee stated that even if the municipality and water boards work together, they cannot solve the water problems as well. The relevant authorities should help people to be aware of the problems, such as by using App to increase the understanding and the sense of responsibility of the public.

Water Assessment used in the Netherlands is a combination of rational planning and collaborative planning. Firstly, the urban planners and water managers are the main actors in Water Assessment, that shows the dominance of rational planning in the Water Assessment where professionals are included and laypersons are excluded. Secondly, the Water Assessment is a process of interaction between water managers and urban planners to ensure that water aspects are integrated into

urban planning process from the earliest stages. The water assessment is a consensus building process. It brings different interests and communities together to reach the consensus. As a result, the water managers and urban planners can co-work to a production of an agreement. In the process of water assessment, the water managers and urban planners require skills such as facilitation and negotiation. It reflects that there is a collaborative planning thinking in Dutch Climate Proof City making. In collaborative planning, different groups of stakeholder work on a collective concern and action.

In Rotterdam, all interviewees have positive comments on the Water Assessment (Watertoets). It is recognised as an effective mechanism for consensus building and conflict resolution between the water sector and the planning sector. Since the adoption of the Water Assessment, the water interests were taken into consideration in urban plans and decision-making process. It helps to connect the divided sectors of water management and urban planning due to specialisation. With the Water Assessment, water managers and urban planners have the opportunities to understand and communicate with each other, and then reach consensus.

In addition, compared to the panning approach of China, the Netherlands made more efforts on information sharing and exchanging to spread know-how. For example, Helpdesk Water, an online information instrument, not only provides an information base for people working with water but also facilitates to integrate the worlds of spatial planning and water management by exchanging knowledge. Table 12 presents an overview of the process, management and instrumental factors.

Table 12 Process, management and instrumental factors that influence integration between spatial planning and storm water management

Process, management and instrumental factors	China-Zhenjiang	The Netherlands- Rotterdam
• communication channels between two sectors • mechanisms/instruments to anticipate , detect and resolve policy conflicts between two sectors	• meeting organised by the special working Team • planning process: one report and two permits • rational planning • planners and water managers act as regulators	• regularly meetings • Water Assessment; water opportunity map and help desk • communicative planning • Planners and water managers act as facilitator, negotiators and mediators

5.5 Behaviour, Cultural and Personal Factors

In China, influenced by hierarchical institutional structure and departmentalism due to specialisation, the water authorities and planning authorities work separately. There is a lack of previous cooperation. The interagency and interdisciplinary cooperation between them is weak historically. The change in the concept of storm water management facilitates the water managers and urban planners to rethink the value and position of storm water as an important element in the planning and decision-making process. It is well understood, according to the interviewees, that they are taking up the challenge of different thinking in storm water management. They also view the cooperation between urban planners and water managers is important to implement sustainable storm water techniques.

In the Netherlands, it is acknowledged that water managers with a engineered focus and urban planners with a more holistic system focus have some tensions in storm water management in Rotterdam. The interviewees stated that the water managers and urban planners have a long tradition of working together on storm water management, which helps to build a common vision, a constructive working relation reduces the tensions and a cultural awareness of cooperation. It helps to decrease tensions between them.

In addition, both the water managers and urban planners have a communicative and a consensus-seeking attitude, which largely contributes to conflicts reduction. One of the interviewees was educated in the urban planning field but currently works in a water authority. Her cross-sector working experience helps to make sure there is enough spatial relevancy in a water plan. The interviewee works as a mediator who not only knows the language and vocabulary of technical-oriented water engineers but also the language of design and planning.

Compared to Zhenjiang, it is found that Rotterdam has a better previous cooperation, higher trust along with a constructive working relation, higher cultural awareness and willingness of cooperation, a better communicative and consensus-seeking attitude. Table 13 presents an overview of the behaviour, cultural and personal factors.

Table 13 Behaviour, cultural and personal factors that influence the integration between spatial planning and storm water management

Behaviour, cultural and personal factors	China-Zhenjiang	The Netherlands-Rotterdam
● the relationship between water authorities and planning authorities and between water managers and planner -previous cooperation -existing level of trust -willingness and openness to cooperation with other organisation -information sharing, collective approaches and language	● Under the leadership of the Special Working Team for the Demonstration Projects, the water managers and urban planners talk more to each other. ● Influenced by departmentalism, the water authorities and planning authorities work separately. The interagency and interdisciplinary cooperation between them is weak. -a lack of previous cooperation -lower trust along with institutional fragmentation -lower cultural awareness and willingness of cooperation -low information sharing and communicative attitude.	● As a low-laying area, water provides threatens and opportunities to Rotterdam, the planning authorities, the city maintenance authorities in Rotterdam Municipality; they have a long tradition of cooperation with the water boards. ● The interagency and interdisciplinary cooperation between them is higher than Zhengjiang. Urban planners and water managers have -better previous cooperation, -higher trust along with a constructive working relation, -higher cultural awareness and willingness of cooperation -a better communicative and consensus-seeking attitude.

Chapter 6 Conclusion and Recommendation

6.1 Conclusion

Conventional storm water drainage brings immense pressure to cities due to the quick spread of hard and impervious surfaces as the consequence of rapid urbanisation. As a result, storm water runoff cannot infiltrate sufficiently and timely, and concentrates rapidly in urban areas. In a changing climate, the storm water flows are increasing in volume, intensity and frequency, which make the situation worsen.

It is acknowledged that managing storm water runoff solely through conventional all-grey infrastructure is regarded as unsustainable, especially under the face of climate change. Conventional grey infrastructure heavily relies on hard and structural engineering that stays out of the sight of the public, such as networks of buried drainage pipes. Conventional all-grey infrastructure is not able to address the issues of excessive storm water runoff via increasing hard surfaces that are impermeable to water, changing storm water frequencies and intensities as a consequence of climate change.

The rise of sustainable storm water management, including Sponge City in China and Climate Proof City in the Netherlands, brings new insight into urban water management. Conventional method of collecting rainwater into a sewer system as fast as possible is proposed to be replaced with sponge-like cities which use urban planning and design approaches to controlling and reusing storm water runoff. Sustainable storm water management promotes natural and soft storm water management techniques that control storm runoff at the source, and helps to prevent pollutants from getting into the runoff.

However, the uptake of sustainable storm water management is not a barrier free process. It might not only meet technical barriers, but also social and institutional barriers. The most commonly identified barrier was the lack of a coordinated institutional framework. In addition, a close connection between water management and urban planning is important to advance sustainable storm water. The purpose of this research was to explore the changes in the integration between urban planning and storm water management as a result of the uptake of

sustainable storm water techniques in China and the Netherlands, along with possible approaches that Chinese cities can learn from the Netherlands.

With the aim of having an Analytical Framework of integration to give theoretical and conceptualised insights on factors that might exert influence over the integration between storm water management and urban planning in China and the Netherlands, a review of existing literature related to interagency and interdisciplinary integration has been made. The researcher adopted and adapted factors identified in four literature(Stead and Meijers, 2009; Bolposta, 2012; Howe et al, 2013; Van der Knaap and Pijnappels, 2010) related to interagency and interdisciplinary integration and the relationship between storm water management and urban planning. The Analytical Framework of integration is divided into 5 domains with sub-aspects: 1) Political factors 2) Institutional/organisational factors 3) Economic factors 4) Process, management and instrumental factors 5) Behaviour, cultural and personal factors.

The application of those factors in Chinese and Dutch case studies not only helps to understand the storm water management and urban planning in the two countries, but also gains insight into the interdisciplinary and interagency integration in storm water management and urban planning.

In terms of political factors, it was found that both Zhenjiang in China and Rotterdam in the Netherlands have a shared understanding of the need to strengthen the relationship between storm water management and urban planning from the national to the municipal level. The political will is growing to facilitate the integration between storm water management and urban planning in Zhenjiang and Rotterdam. Compared to Rotterdam developing water and planning strategies, Zhenjiang imposes policies and regulations to seek the integration. Woltjer and Al (2007) concluded four types of integration strategies to link water and planning which helps to give insight into the differences of integration approach practiced in the Netherlands and China (Figure 14).

	Functional regions	Socio-cultural regions
Regulatory	**1. Conventional** *Key objectives:* • Public management of water quantity and quality *Key instruments:* • Technical expertise • Functional separation of water from other policy subjects • Reliance on draining water away and blocking water out • Reliance on norms and standards	**2. Spatial planning** *Key objectives:* • Water integrated into broader policy making *Key instruments:* • Comprehensive approach, water as a broader issue • Stronger references to water in the practice of spatial planning • Water as a source of aesthetic quality in planning
Strategic	**3. Water planning** *Key objectives:* • Making water management more important politically and socially *Key instruments:* • Separate water management regions and agencies • Processes for creating political and public support • A role for water management demands in land-use decisions • Ensuring sufficient space for water	**4. New water culture** *Key objectives:* Water as a source of social coherence and participation—a new water culture *Key instruments:* • Using water strategically to create new capacities, new identities • New coordinating institutions • Water as part of attractive living and working conditions

Figure 14 Four strategies to integrating water management and urban planning (Woltjer and Al, 2007, p220)

According to the overview of current policies, regulations and strategies in the two countries, China is moving to a Spatial Planning Approach by promoting a controlling mode of government and the Netherlands is moving to a New Water Culture Approach by promoting an enabling mode of governance. Water has become a culture in the Netherlands. In details, water becomes an increasingly important element of urban planning and development, gains the space where it needs, and turns to governance and partnerships between different levels of government and with different actors including innovators, investors, water managers and urban planners. It is suggested that China should be aware that Sponge City development spans sectors and involves multiple sectors, therefore, a more participative and collaborative approach should be taken for in decision-making process.

In terms of institutional/organisational factors, it was found that the internal communication and inter-organisational network in China are bureaucratic and fragmented as a consequence of a complex water management system labelled as 'the Nine Dragons Who Administer water' and urban planning system including three type of plan at national, provincial and municipal levels. The internal communication and inter-organisational network are more flexible to policy

integration in the Netherlands as a result of a much more simplified administrative system. It is suggested that China should make efforts in administrative simplification to some extent to make internal communication and inter-organisational network more flexible and easier, which contribute to collaboration and discussion between various parties, and knowledge and information sharing.

In terms of economic factors, there was not much information available from the interviews and literature review. It was found that no direct funding is given for promoting the integration between storm water management and urban planning in the two cities. Zhenjiang has the Special Work Team for Sponge City as the receiver of the Sponge City Demonstration Project Budget, which exerts influence on fund allocation. In Rotterdam, the authorities which are associated with storm water management attempt to team up to avoid costs. Sustainable storm water management techniques, such as rain garden, swales, curbless street, etc., are varied and extensive. Therefore, more actors and agencies will be involved in implementing Sponge Cities, such as traffic, property investment, and nature conservation. It is suggested that the Special Working Team extends its function to keep updating the information of projects that have the potential to implement sustainable techniques from. It offers opportunities to facilitate the cooperation between different sectors and helps to avoid the costs as a result of separately doing the projects with overlapping goals on the same areas.

In terms of process, management and instrumental factors, it was found that China in the phase of moving to Spatial Planning Approach seeks to integrate water considerations in urban planning by regulatory practices. It reflects a rational planning approach in China, the planning and water professionals make choices with regulated planning requirements. Therefore, planners act as regulators. The Netherlands in the phase of moving to a New Water Culture Approach to facilitating the integration between storm water management and urban planning through new platforms for coordination. It includes Water Assessment which allows that water considerations are integrated into urban planning process from the earliest stages, Water Opportunity Map whish visualises water system conditions and preconditions for land use, and inline information instrument-*HelpdeskWater.nl* which shares, exchanges, and spreads know-how in water management. As a result, planners act as facilitator, negotiators and mediators. It is suggested that China should rethink its planning approach, that would be better to embrace collaborative planning to some extent. Planners in China should be aware that they not only could be

regulators but also facilitators, negotiators and mediators in the planning and decision-making process, which could contribute to consensus building.

In terms of behavioural, cultural and personal factors, it was found that urban planner and water managers in two case study areas are confronting the challenge of different thinking in storm water management, a socio-ecological and integrated approach or technocratic approach. When China takes action to enhance the acceptance of Sponge City in water management and urban planning fields, it is important to know which factors that might bring barriers. In addition, based on Dutch experience, there are some tensions in the course of integrating storm water management and urban planning. Chinese urban planners and water managers should be aware that a communicative and consensus-seeking attitude helps to mitigate tensions. In addition, one Dutch interviewee, with cross-sectoral working experience between urban planning and water management, suggested that a mediator who not only knows the language and vocabulary of technical-oriented water engineers but also the language of design and planning is important. The mediator contributes to the result of enough spatial relevancy in a water plan or water considerations in an urban development or redevelopment plan. Furthermore, China could learn from the Netherlands about how to build a constructive working relation, increase the trust between two authorities, and increase cultural awareness and willingness of cooperation.

In conclusion, this report reflected five changes that are accompanied with sustainable storm water management resulting in a closer connection with urban planning in China and the Netherlands. It is found that there are main changes in policy discourse, the applied government or governance system, the institutional changes, economic resource and investment arrangement, the role of planners as regulators or facilitators, negotiators and mediators, the integration of knowledge between different sectors. They are all relevant and important to the integration between sustainable storm water management and urban planning. If what is a change and challenge in the process of integrating sustainable storm water management and urban planning is better recognised, there are more chances to advance sustainable storm water management. There is a paradigm shift that a sectoral and technocratic approach that dominated in conventional storm water management has been changed, and sustainable storm water management comes to show a broadening of disciplines, functions, and solutions, that needs a socio-ecological and integrated approach. Challenges, arising from the paradigm shift, especially, integrating sustainable storm water management and urban planning, remain several questions to us. For example, to what extend water

managers and urban planners recognise the importance of the integration; how institutional issues (cross-sectoral coordination and cooperation)are interpreted and addressed; how the integration between the two worlds contributes to the effectiveness of economic resources and investment arrangement for water issues; how do urban planners and water managers use planning instruments to facilitate the integration in urban planning process, and how well that they recognise and deal with their different views and language on water-related issues, etc.. Answering these questions might help us to solve the complex game, '*making connections between functions, actors, institutions to ensure a defensible plus-sum outcome* (Warner et al, 2012, p5)'

6.2 Research Limitation

At the beginning, the research plan was to carry out two or more case studies in China. However, it appeared that the plan was too ambitious to accomplish. Contacting proper water managers and urban planners, who practised in the implementation of Sponge City and are willing to contribute to this research, is a very time-consuming process. It took much more time than expected. There was an attempt to contact Sponge City practitioners in the city of Wuhan, Zhenjiang, Changde, Xixian new district,. It turns out practitioners in Zhenjiang are more willing to accept the requests of interviews, which is one of the main reasons that Zhenjiang was chosen for the case study. In addition, Zhenjiang started practising Low Impact Development in 2007, which is much more earlier than other 15 cities in the first round demonstration programme. Therefore, even it is known that more case studies will contribute to a more accurate and convincing result, the researcher was only able to conduct one Chinese case study at the end.

This research was carried in the Netherlands, therefore, the interviews with Chinese water managers and urban planners were conducted through phone and e-mail. The interviews with Dutch water managers and urban planners were conducted through face-to-face. It was found that the interviewees are able to share more information via face-to-face interview. With the phone and e-mail interview, it is harder to ask interviewees to extend their answers. In addition, some governmental agencies in Zhenjiang municipality blocked the international phone calls. It largely hindered the process of searching possible contact persons. It is suggested for future researchers to go back to China to carry out the research if possible.

In addition, this report is largely based on interviews with some Chinese and Dutch urban planners and water managers. As assumed that interviewees as water managers and urban planners working in governments may prefer to give more positive answers rather than negative answers, it is proved in Zhenjiang Jiang'er redevelopment project. Even some interviewees suggested that organising on Sponge City Special Working Team helps to reduce institutional fragmentation due to specialisation, especially, integrating water management and urban planning. However, the Jiang'er redevelopment as the first demonstration project shows there is a misconnection between the two worlds.

6.2 Research Recommendation

The case study analyses in this research were based on an Analytical Framework of political factors, institutional/organisational factors, economic factors, process, management and instrumental factors and behavioural, cultural and personal factors, which are the results of synthesising and then choosing the most discussed influential factors identified in four academic papers. As a result, this research neglect certain factors such as Citizen Engagement. It turned out that citizen engagement actually plays an important role in promoting water considerations in the planning and decision-making process. An interviewee stated that public participant largely affected the implementation of water squares in Rotterdam, since their resistance could cause the termination of a project (WMNL2, interview). In Zhenjiang, residents also show resistances to apply rain garden in their community, because they think that the trees in rain garden could block the sunshine to their apartment, and the space for bicycle and motorcycle parking and for recreation is getting less. Therefore, it is suggested that further research focusing on the integration between water management and urban planning could involve Citizen Engagement Factors in.

In addition, in terms of institutional and organisational factors, it is suggested that power relations could be added as one of sub-factors. In the Dutch situation, the application of Water Assessment shows that urban planners and water managers have the equal voice to discuss their considerations in a development or redevelopment project and try to compromise and build consensus. However, in Chinses context, it remains unclear which authorities in the Special Working Team are more powerful, whether there is an authority or expert in domination in the planning and decision-making process, which are the overlaps and conflicts of those involved authorities' roles and responsibilities. In terms of economic factors, there

was not much information gained from literature review and interviews in this study. It might be because that the interview question, 'are there any financial supports that enable and facilitate the achievement of integration?' was too vague and broad. It is suggested that any researcher, who is interested in integrating storm water management and urban planning and taking into account economic factors, could raise questions that are specific project-based, and talk with people who were involved in this relevant project. For example, for Dutch situation, interview questions could be 'who are the investors and beneficiaries of water squares'; 'what are the role of the water authority and the planning authority in water squares investment?'.

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Appendix 1 Sponge City Measures

Sponge City Measures

The Sponge City measures consist of the following 6 elements (Calid.cn, 2015).

1) The first and most important is on-site infiltration (Shen). With the rapid urbanisation, the addition of impervious surface, soil compaction, and tree and vegetation loss it results in alteration to the movement of water through the environment. Therefore, with the Sponge City, urban storm water management should maintain or closely replicate the naturally hydrology of the site. Infiltrating Storm water runoff as close to its source as possible helps to reduce the runoff volume to a sewer system, recharge groundwater and the impacts of development and redevelopment on water sources such as pollutant loadings. In short, Sponge City attempts to maximise on-site infiltration by using natural landscape features.
2) The second is runoff storage (xu). Impervious surfaces are a central part of the built environment, which can cause increased runoff volume. Therefore, urban development should emphasise to minimize the generation of runoff by preserving and creating natural space. So runoff from such surfaces can be captured and stored for later use.
3) The third is detention (Zhi). Large storm events can make it difficult to retain all the runoff generated on-site by using infiltration and storage practices. Therefore, a conveyance system should be used to route excess runoff through and off the site (such as ponds). It helps to slow flow velocities, lengthen the runoff time of concentration, and delay peak flow rates.
4) The fourth is filter (Jing). Filtering and treating water pollutant at its source by retaining the hydrologic function of the soils and protecting vegetated landscape before infiltrating it into ground or discharge to water bodies helps to improve water quality.
5) The fifth is urban storm water runoff reuse (yong). The surface detention or other water storage not only capture water but also recycle the water for non-potable needs. For example, the rainwater on parking lots can be collected and reused for landscaping and washing cars.
6) The last elements is discharge (pai). With a Sponge City approach, the volume of runoff transported off-site will be reduced. While for the excessive storm water that cannot be captured or reused, a conveyance system is needed to transport storm water to water bodies.

Appendix 2 Interview questions

Questions for water managers and urban planners in Zhenjiang/Rotterdam

General	1. What is your role and job affiliated to storm water management? 2. Can you briefly characterise the storm water challenges confronting your organisation? 3. What is working well in Zhenjiang/Rotterdam right now related to sustainable storm water management?
Political	1. Is there a shared understanding of the need to integrate storm water management in spatial planning between the water authority and spatial planning authority? 2. How do you arrive a common vision to integrate storm water management and urban planning? 3. Are there legislations, regulations and strategies that enable and facilitate the achievement of integration?
Institutional factors	1. Do you think Zhenjiang/Rotterdam face decision challenges about distribution of responsibility for sustainable storm water management as cross-cutting issues within city agencies (transportation, parks, planning, public works, environment)? 2. Whether the possibility of changing precipitation patterns due to climate change has altered how you do your storm water-related jobs? 3. How do you evaluate the interagency and interdisciplinary cooperation between planning and water authority with regard to storm water management? For planners: Throughout your plan works, which agencies/bureau do you interact with regard to Sponge City/Climate Proof City? /Will the opinions of water managers change your land use plan? For water managers: Do you or your organisation able to make decision in the land use planning? to what extent do you think your or the water boards' opinions have been taken into consideration in

	the planning and decision-making process?
Economic factors	1. Are there any financial supports that enable and facilitate the achievement of integration? 2. Which competent authority is the budget owner for sponge city/climate proof city project?
Process, management and instrumental management	1. How do you interact with the Zhenjiang/Rotterdam spatial planning authority (or the water authority) with regard to Sponge City/Water Proof city? 2. What instruments and approached are used to encourage urban planners and water managers to work in a coordinative environment?
Behaviour, cultural and personal factors	1. It is acknowledged that water managers and urban planners have distinctive professional cultures. Water managers consisted of engineers and hydrologists work from a technical viewpoint, on the other hand, planners have more political and economic visions. Have you ever met any conflict with water managers/ urban planners due to different professional consensus in the course of Climate Proof City development? How do you solve the conflicts to achieve a professional consensus? 2. Have you met the situation that when you view storm water issues as the principal concern on spatial planning/land use planning, while it is in conflict with the practice of spatial planning where many other aspects have to be taken into account? If so, how to overcome?

Appendix 3 Interviewees

China

Organisations	Interviewees-expertise
National Level-Chinese Academy of Urban Planning and Design	Urban Planner(In text:UPC1)
Zhenjiang Urban planning and Design Institute	Urban Planner(In text: UPC2)
Zhenjiang planning authority	Urban Planner(In text:UPC3)
Shanghai water authority	Water Engineer(in text: WMC1)
Zhenjiang water authority	Water manager(In text: WMC2)

The Netherlands

Organisations	Interviewees-expertise
Rotterdam-Department of Urban Planning	Urban planner(In text: UPNL1)
Rotterdam-Department of City Maintenance	Strategic advisor on water management(in text: WMNL2)
Rotterdam-Department of City Maintenance	Strategic advisor on water management(in text: WMNL3)
Hoogheemraadschap van Delfland Water Board	Water manager (in text: WMNL1)

Appendix 4 Zhenjiang records of fluvial floods caused by intensive rainfall

Date	precipitation	Waterlogging depth	Waterlogging time	consequences
2005.06.15	55 mm in half an hour	70-75 cm	4-6 hours	Several roads suffered from flood causing road closures
2006.06.23 & 07.20	60 mm	40 cm	4-8 hours	
2007.07.07 -07.09	Continuous rainfall; the highest precipitation is 110 mm	80 cm	1.5-9 hours	15 waterlogging areas
2008.08.01	Extremely heavy rainfall The highest precipitation is 80 mm	30 cm	1-3 hours	9 waterlogging areas
2009.06.14	Extremely heavy rainfall	20-30cm		Work sheds in construction areas collapsed. Worker god injured.
2010.07.04 &07.12& 07.22&08.24	Four Extremely heavy rainfall events; The highest precipitation is 100 mm	80cm	2-5 hours	Nine waterlogging areas
2011	Many cities suffered extensive rainfalls and results that people can see sea in the cities in this year. Zhenjiang had less problems but there some areas suffer waterlogs for 0.5 to 1 hour			
2012.07.02 /07.03/07.04/08.08	Five extremely heavy rainfall events The highest precipitation is 90 mm	30cm	1-3hours	10 waterlogging areas
2013.06.23 /06.26	The highest precipitation is 87 mm. the average precipitation is 55 mm/hour	30cm	0.5-2 hours	11 waterlogging areas
2014.07.22	Orange rainstorm warning signal; the precipitation is 78 mm in one hour.	40cm	Above 2 hours	28 waterlogging areas