Public participation as a means for adaptation to extreme precipitation in light of climate change

A study on the role of public participation in the process of adaptation to extreme precipitation in Shenzhen, China

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Figure cover: own editing of photo S. Derbaix ◦ flooded street in Xili, Nanshan, Shenzen 2014.

Colophon

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Preface

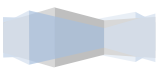
Worldwide urban settlements continue to develop and expand. But with the rise of technological innovations like engines on fossil fuel and computers, developments of highly urbanized areas has grown exponentially. Next to the many benefits that these accelerated developments entail there are also a number drawbacks to it.

Accelerated emissions of fossil fuels has contributed to climate change as it is visible and tangible nowadays. The changing climate implies new extreme environments and therefore, when not adapted to, a decline in the quality of life. One of the characteristics of climate change in many metropolitan areas around the word that that puts this quality of life at risk is the increase of extreme rainfall in frequency and intensity. In order to ensure citizens´ safety and to be able to keep a certain level of quality of life, current approach to urban developments should be reconsidered.

Before you lies the master thesis on the role of public participation in the adaptation process to extreme rainfall in Shenzhen, China. The research has taken place to conclude the masters´ program of the faculty of Social and Behavioral Sciences at the University of Amsterdam (UvA). The chosen topic derives from intrinsic interest and the inherited professional work experience on this domain in the Netherlands. The choice for conducting the research in the city of Shenzhen stems from both the provided opportunity from the University of Amsterdam and the intrinsic desire to go abroad.

This research, however, could not have happened without help of several people. In the first place I would like to express my gratitude to my personal supervisors dhr. prof. A. (Arnold) Reijndorp and ms C.W. (Ching Wen) Yang MSc. I also would like to thank all respondents who completed the survey or participated in an interview and thereby have contributed greatly to the research. I am grateful for the freedom, support and encouragement that my employer, Amsterdam Rainproof, and my parents, Hans Boxem and Jeanette Poesse, have given me. Finally I want to thank my girlfriend, Tamara Vieveen, for her understanding, patience and unconditional support during my last phase of studying.

Shenzhen, you have puzzled me, surprised me and inspired me but above all you have opened my eyes and taught me a lot. See you soon!



Amsterdam, 17th of august 2015.

Abstract

The trend of rapid urbanization is highly visible in the case of Shenzhen. This ongoing urbanization entails many spatial, socio-economic and environmental challenges. Meanwhile climate change places even greater burden on the livability and the combination of those two factors causes major challenges for Shenzhen. Torrential rainfalls have already caused huge social and economic losses over the past years and since these extreme cloudbursts are expected to increase in frequency and intensity, thorough adaptation measures are required. As a reaction to these arising problems, China has set up a National Policy Framework for adaptation policies in 2007. So far, however, the climate adaptation system in China is strongly scientific and technological based, and although public participation can (among others) increase the effectiveness of plans, the quality of the content, build trust and capacity and improve the environment, public participation have been unusual.

This research aimed at exploring the role of public participation in Shenzhen´s attempt to adapt to extreme rainfall and the main views on this subject from both the public and private domain. By means of conducting interviews with several employees of governmental departments, former governmental departments, planning bureaus and private companies (all related to water management), the implemented measures and the main views on public participation from government point of view have been investigated. The main views on public participation of - and the measures taken by the private domain have been examined through surveying among inhabitants in an area that have been flooded in the past.

This study revealed that, today, public participation in adaptation to extreme rainfall in Shenzhen is virtually absent. Reasons for this include the lack of mindset, the tight time frame for developments and not recognizing the capabilities of the private domain to contribute. Both the private domain and the government think that local inhabitants actually can have valuable knowledge and that a part of them are willing to participate, but that they do not have the capabilities to really contribute.

The first step to enhanced public participation would be to educate and inform the private domain and to institutionalize it with the creation of a platform for stakeholder engagement. To benefit physically from public participation, other, in this research underexposed, stakeholders of the private domain such as private developers offer great opportunities to enhance adaptation to extreme rainfall since they can apply physical measures. Further research on these stakeholders is needed.

Table of Contents

Colophon 3
Preface 4
Abstract 5
1. Introduction 9
1.1 Urbanization & Shenzhen 9
1.2 Climate change 9
1.3 Problem statement 10
1.4 Purpose of the paper 11
1.5 Research question(s) 12
1.6 Definitions 12
1.7 Conceptual model 13
2. Theoretical framework 15
2.1 Spatial Planning history 15
2.2 Planning culture 16
2.3 Public participation 17
2.4 Levels of participation 18
2.5 Adaptation policy framework 19
3. Research methodology 23
3.1 Research design 23
3.2 Research methods 24
3.3 Instruments for data collection 26
3.3.1 Interviews 26
3.3.2 Surveys 26
3.4 Conducting data collection 27
3.4.1 Interviews 27
3.4.2 Surveys 29
Enrichment box: SEZ and urban villages 31
4. Results 33
4.1 Climate change and extreme rainfall 33
4.2 Government policies, regulations and organization 38
4.3 Government's approach to extreme rainfall 46

4.3.1 Implemented measures 46
4.3.2 Expectations of the private domain 54
4.4 Private domain's approach to extreme rainfall 56
4.4.1 Implemented measures 57
4.4.2 Expectations of the government 62
5. Conclusion 67
Climate change, policies and organization 67
The role of public participation 68
Main views of the government and the private domain 69
6. Reflection and recommendations 71
6.1 Theoretical reflection 71
6.2 Comparison with western countries 73
6.3 Recommendations for enhanced adaptation in Shenzhen 74
6.4 Reflection on the research process 75
6.5 Recommendations for further research 77
7. References 78
Appendix 82
Appendix 1: Interview instrument 82
Appendix 2: Survey instrument 83
Appendix 3: Interview Ms. Echo (A) 90
Appendix 4: Interview Mr. Liwei (B) 91
Appendix 5: Interview Mr. Tang (C) 93
Appendix 6: Interview Ms. Wu (D) 95
Appendix 7: Interview Mr. Yao (E) 98
Appendix 8: Interview Ms. Wei (F) 100
Appendix 9: Interview Mr. Liu (G) 103
Appendix 10: Interview Ms. Lu (H) 106
Appendix 11: Table with categories for qualitative analysis 108
Appendix 12: Climate change 109
Appendix 13: Extreme rainfall events in Shenzhen 110
Appendix 14: Return period of storm intensity formula 112
Appendix 15: Urban construction and public utility 113
Appendix 16: Demographic characteristics 114
Appendix 17: Statistical test results. 117

List of figures

Figure 1: Coherence of the different facets of the research.....14
Figure 2: Spatial planning, stakeholders and disciplines. 15
Figure 3: Planning culture and public participation. 17
Figure 4: The adaptation policy framework.....20
Figure 5: The functioning of the adaptation policy framework in China 22
Figure 6: Flooding of Xili in May 2014 29
Figure 7: Research areas Sea World (Left) and Xili (right). 30
Figure 8: Location map of Shenzhen region.....31
Figure 9: Number of extreme rainfall events (>200mm/day) Urban Weather Station 34
Figure 10: Organizational structure of (rain)water planning.....41
Figure 11: Financial structure of water infrastructure.....43
Figure 12: Allocation of responsibilities 63

List of tables

Table 1: Different approaches to participation.....18
Table 2: Methodological approaches towards the sub-questions. 25
Table 3: List of interviewees and their characteristics.....28
Table 4: List of other persons that provided context information 28
Table 5: Dates of conducting surveys.....30
Table 6: Extreme events in Shenzhen.....35
Table 7: Drainage pipeline networks. 46

Enrichment Box.

In this report, one enrichment box is included. This box provides the reader with some extra information that is beyond the scope of this research but nevertheless important for the understanding of the context of Shenzhen and water management.

1. Introduction

1.1 Urbanization & Shenzhen

Globally, by 2050, 66% of the world's population is projected to be living in urban areas (UN, 2014). This trend of urbanization is highly visible in the case of Shenzhen. The designation of Shenzhen as a Special Economic Zone (SEZ) (NG & Tang, 2004) had major impacts on the development of Shenzhen. By the end of 1986, Shenzhen consisted of 514.467 (registered) inhabitants (Huasheng, 1991) and between 1980 and 2001 Shenzhen's population increased a fourteen-fold (NG & Tang, 2004). Nowadays, the population of Shenzhen is estimated to be around 10,7 million(registered) inhabitants (UN, 2014). Although this already seems to be a major increase, the 'floating population', those wo are not registered as citizen of Shenzhen, are estimated at a total of 2,7 million people (NG & Tang, 2004). This ongoing urbanizations entails many spatial, socio-economic and environmental challenges, and as the world continues to urbanize, sustainable development accomplished by integrated policies to improve the quality of life are needed (UN, 2014). With this urbanization process going on, flooding has become a threat to the safety of inhabitants in the city as it plays an important factor in intensifying the flood process (Shi et al. 2007) . These challenges will only grow in complexity as one puts it into another changing contextual factor: climate change.

1.2 Climate change

Li (2013) emphasizes that the number of days of heavy precipitation in the PRD (Pearl River Delta) increased significantly and that the consecutive dry day periods are getting shorter. Based upon China's National Climate Change Program, issued by the National Development and Reform Commission (2007), the annual rainfall on national level will possibly increase with 2-3% by 2020, and will possibly increase with 5-7% by 2050. In addition, they emphasize that the most significant increase could be expected in the southeastern coastal regions. The Frequency of extreme weather events together with the urbanization in flood-prone areas are expected to increase flood frequency and the scale and degree of flooding in de PRD. However, Shenzhen is already prone to torrential downpours: with an average of 9,7 days that have 55 millimeters or more of rain, and an average of 2,2 days that have at least 100 millimeters of rain annually (Shenzhen Municipal Meteorological Bureau, 2009). The exposure and sensitivity of central cities are very high because of highly exposed populations and assets in low-land areas (Yang et al. 2015). As Yuan et al. (2003, in Yang et al. 2015) state: ''*In Shenzhen, 16 of the 18 local flood events recorded during 1980–2000 were caused by rainstorms*" (p.385). Although climate change and urbanization seem to be two distinguished elements, they are indeed closely linked. ''*While urbanization has increased incomes and improved*

livelihoods, it also has had significant environmental impacts. As urban areas expand, they directly impact the environment through the conversion of land'' (Crutzen, 2004 in Güneralp & Seto, 2008, p.720). The shift of natural ground to urbanized areas increases run-off, resulting in floods occurring faster. However continuing construction of drainage projects may help mitigate waterlogging, it cannot be eliminated entirely since extreme precipitation events are expected to increase in frequency and intensity (Yang et al. 2015).

1.3 Problem statement

The economic impact of these floods on China's economy is tremendous. The Chinese Minister of Water Resources, Chen Lei, said in 2007 that China's annual (direct) losses since 1990 as a result of floods are close to 2 percent of the National GDP (Gleick, 2009). Influenced by various factors such as typhoon rainstorms, urbanization and tidal backwater, more than 30 flood and waterlogging disasters have hit Shenzhen during the last 30 years (Yan, 2014). The direct economic losses of these rainstorms are estimated (according to incomplete statistics) at 4.5 billion RMB (Yan, 2014). The most serious rainstorm, known as the ''6.13'' rainstorm, caused a direct economic loss of 1.2 billion RMB and the ''511'' rain event of 2014 affected many cities in Guangdong province, including Jiangmen, Shenzhen, Zhuhai, and 5 other cities (yan, 2014). Here, a total of 339.200 people of these 8 cities were directly affected and the direct economic losses added up to 545 million RMB, of which Shenzhen accounted for 80 million RMB. Besides economic losses, there are also serious health related issues at stake (Li, 2013). Local extreme weather events and poor drainage makes the flood threat one of high concern for governments as well as stakeholders (Chan et al. 2012, in Yang et al. 2015).

In 2007, China developed a national policy framework which included adaptation policies to help people to cope with the impacts and problems of climate change in both rural and urban areas (Li, 2013). In China's latest document '*China's policies and actions on climate change 2014*' attention is given to mitigation as well as adaptation to climate change. Because China is a mainly centralized governed country, ''*governments at both the national and regional levels play a critical role in water policy and management, with traditionally little input from non-governmental organizations or individual participation in review and decision making*'' (Gleick, 2009. P. 88). Although this system is changing rapidly and although also local governments are eager to act on it, Li (2013) state that ''*little information is available on the outcomes of adaptation efforts to date and there has been little consideration of the implications, positive and negative, of some of the adaptations actions. Such*

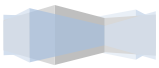
information is greatly needed in order to understand the effectiveness of the adaptation measures already in place and the long-term direction of policy changes'' (p. 413).

So far, the climate adaptation policy system in China is strongly scientific and technological based, and aims at rapidly producing legislation. Public participation in Chinese environmental policy is unusual but there are signs that growing concerns around the topic of water is leading to involvement and interferences by citizens (Gleick ,2009). Public participation can, among others, increase the effectiveness of plans, the quality of the content, build trust and capacity, improve the environment, build a community, avoid wasting resources , prevent conflicts by early involvement of the public and many more(Däne & van den Brink, 2007, Petts & Leach, 2000, Reed, 2008).
In the latest report of *China's policies and actions on climate change* there is, however, no emphasis on participation of the public when it comes to adaptation to extreme weather, and in particular to flooding through extreme rainfall. Moreover, the only topics in which participation of the public are mentioned are those of low-carbon activities and energy and carbon reduction lifestyles (National Development and Reform Commission, 2014).

As Li (2013) states: ''*there is not yet an effective channel for engaging stakeholders in sustained dialogue in the policy area of climate change. No institutionalized democratic or lobbying system allows the involvement of people who are not recognized by the government as being 'relevant' to the discussion*'' (p. 420). Also, the lack of awareness of climate change adaptation does not contribute to the private population's participation in policy discussions in the first place (Zhou & Feng, 2011 in Li, 2013). And as Li (2013) continues: ''*greater efforts to engage social scientists, NGOs and the general public in decision-making and post-project assessment would be crucial to the viability of the genuinely evidence-based policy-making and adjustment*'' (p. 242). So, in the case of Shenzhen, what role does public participation in adaptation to extreme rainfall play and what are the main views of the government and the private domain concerning this subject?

1.4 Purpose of the paper

This research aims at exploring the role of public participation in Shenzhen´s attempt to adapt to extreme rainfall by investigating the measures and expectations from both the public point of view as well as the governmental point of view. This paper aims to investigate what role the private domain could play in enhancing the adaptation to extreme rainfall by means of public participation.



1.5 Research question(s)

To investigate the role of public participation, this thesis concentrates on the main question:

- ***What is the role of public participation in adaptation to extreme precipitation in Shenzhen and what are the main views on it of the government and the private domain?***

To answer this overarching question, different sub questions are established to address the main question:

- *What are the characteristics of extreme rainfall in Shenzhen?*
- *What policies on climate adaptation does China have?*
- *What is the organizational structure of water management in Shenzhen?*
- *How does the government of Shenzhen deal with extreme rainfall?*
    - *What measures have already been implemented?*
    - *What does the government of Shenzhen expect from the private domain?*
- *How does the private domain of Shenzhen deal with extreme rainfall?*
    - *What measures has the private domain adopted?*
    - *What does the private domain expect from the government of Shenzhen?*

1.6 Definitions

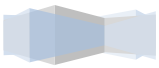
Some terms and concepts throughout this thesis play an important role. Therefore, a brief definition of the most important ones is provided below.

Adaptation	Zevenbergen et al (2011) uses to describe adaptive capacity as: ''*the capacity of a nation, a community […] or even the world to cope with, and adjust to uncertain future developments and catastrophic, not frequently occurring disturbances such as extreme floods*'' (p. 19).
Private domain	Throughout this research, the private domain is referred to in several ways. Words to refer to this definition include citizens, (local) inhabitants, private developers and NGO's. In this report, the private domains is defined as *all parties that by no means have any direct connections with the government.*
Flood management measures	''*Actions that are taken to reduce either the probability or the consequences of flooding or some combination of the two*'' (Zevenbergen et al. 2011 p.313)

Public participation	Although public participation (or stakeholder engagement) is often referred to as the ‘’*process through which the stakeholders have power to influence the outcome of the decision*’’ (Zevenbergen et al. 2011, p.317), this research adopts an even broader definition. Here, public participation is referred to as *the ability of the private domain to contribute physically or mentally to adaptation to extreme rainfall.*
Waterlogging	Waterlogging can occur in different ways and it can subjectively interpreted. For example, to one it may only be perceived when water causes actual damage to property – for instance when water floods into your home. To another person waterlogging may already be perceived whenever rainwater remains on the street for a certain amount of time after a heavy cloud burst. However, waterlogging in this research is defined as *the events in which damage to real estate property occurs due to extreme precipitation*.

1.7 Conceptual model

Answers to each sub question contributes to the overarching question. Characteristics and occurrence of extreme precipitation, as part of the general climate change, will result in flooding of certain neighborhoods. Meanwhile, national policies and regulations are set up in order to adapt to climate change. The organizational structure of water management in Shenzhen along the current national policies and regulations influence the (re)actions of the local government of Shenzhen. simultaneous, the private domain undertakes (re)actions to the occurrence of floods. To investigate what role public participation play in adaptation to extreme rainfall, both parties are questioned on their philosophy of public participation and their expectations of the other domain. The coherence of the different facets of this research are illustrated in figure 1.



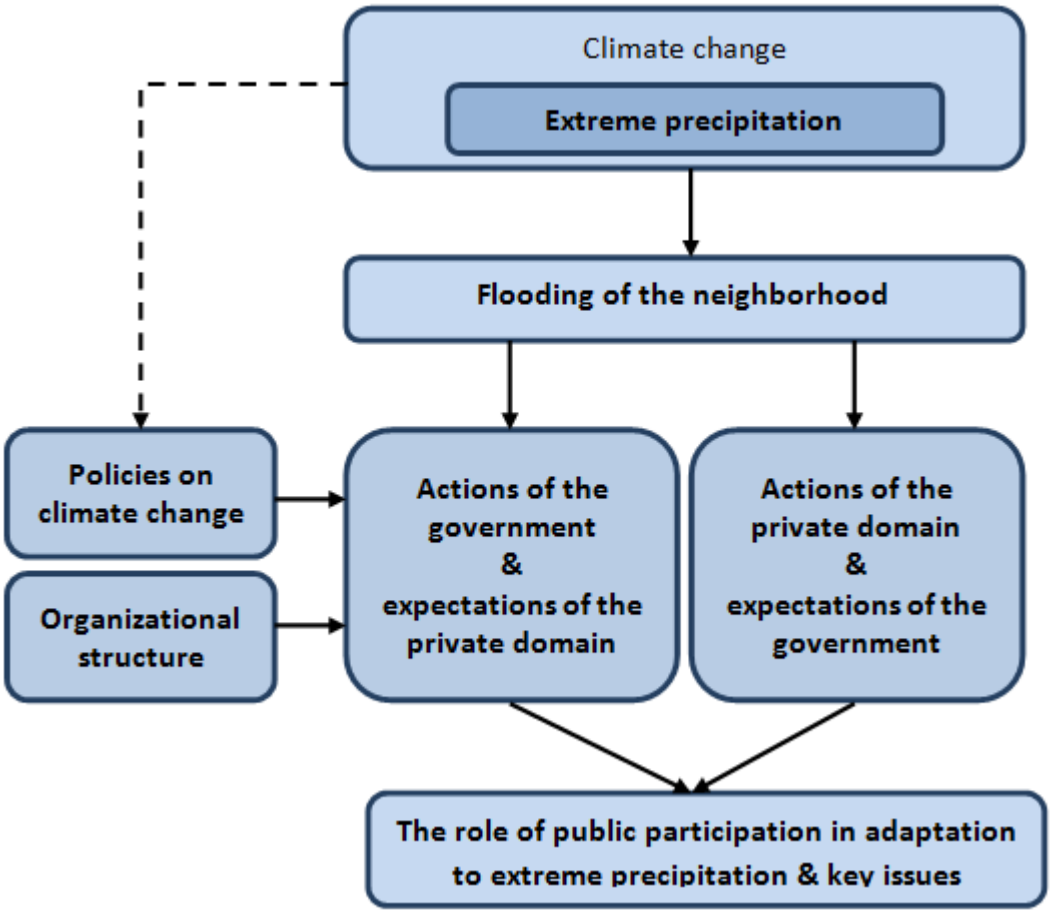


Figure 1: Coherence of the different facets of the research.

2. Theoretical framework

2.1 Spatial Planning history

As the European Commission (1997) states: ''*spatial planning refers to the methods used largely by the public sector to influence the future distribution of activities in space. […] Spatial planning encompasses elements of national and transnational planning, regional policy, regional planning and detailed land use planning*'' (p.24). However, it is important to acknowledge that spatial planning is not a mono-disciplinary activity and solely public sector driven per se. On the contrary, It is about integration of many forms of land use and interests, using many different knowledge, information and expertise from various stakeholders and disciplines to find an appropriate balance (de Wit et al., 2009). Spatial planning thus needs close cooperation with other disciplines such as urban planning, architecture, ecology and water management (Däne & van den Brink, 2007)(figure 2). ''*In turn, the increasing complexity of planning issues makes it necessary to reconsider the planning process. Organizing cooperation on planning issues between diverse actors, including experts and especially local people, has become more important*'' (Däne & van den Brink, 2007. p.36).

In China, ''*the technocratic nature of urban planning does not free planners form discursive politics*" (Xu & Chung, 2014, p. 394) This means that multiple disciplines with multiple stakeholders at multiple scale levels are all interrelated in a complex web of state bodies, regulations and influencing (political) powers. But although China adopted a strict top-down planning regime in the past, it is identified as a country in the process of scale restructuring.

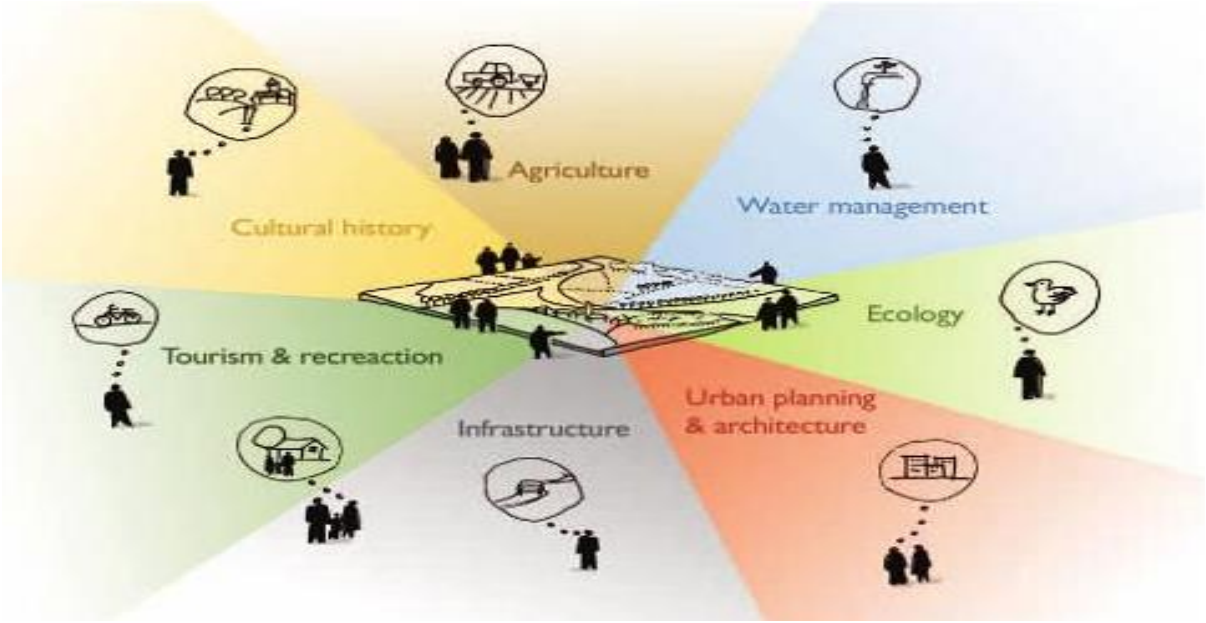
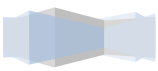


Figure 2: Spatial planning, stakeholders and disciplines. *Source: Däne & van den Brink (2007)*

China is currently moving away of the centrally dominated regime and gradually shifting towards creating more autonomous entities at city and region scale as an outcome of relativization of scale (Xu & Chung, 2014). In Shenzhen, following Xu & Chung (2014), the history of urban planning can be divided into three stages: (1) protecting the environment as a source of amenity under directives from the central state for the sake of economic success (1980's), (2) subscribing to sustainable developments rhetorically as a result of global pressure (1990's) and (3) integration of economy and ecology under forced-in collaboration and rescaling (2000's). The latter indicates that the Chinese government is acknowledging that economic prosperity only may take place when it is not at cost of the environment and ecology. The rapid urbanization of Shenzhen can partly be explained because, and unlike in Europe or the United States, much of the land in China's cities is not private and is thus available for conversion to public uses (Gamer, 2008).

2.2 Planning culture

Spatial planning is influenced by many contextual factors. These different factors create the so called planning culture. ''*These factors include historical and cultural conditions, geographical and land use patterns, the constitutional, administrative and legal framework, levels of urban and economic development, and political and ideological aspirations*'' (European Commission, 1997. p.34). They address seven broad and interrelated factors: the scope of the system, the extent and type of planning at national and regional levels, the locus of power, the relative roles of public and private sectors, the nature of the system of law, constitutional provisions and administrative traditions, the maturity of the system and the distance between expressed objectives and outcomes. Däne & van den Brink (2007) specifically focus on 4 factors that have influences on the possibilities of participation in spatial planning processes at local level (figure 3). This figure shows the main groups of people involved in public participation and the main (inter)linkages between them. It tells that the central-local government relationship has an influence on the decision-making power of local authorities as well as the awareness of the opportunities of public participation. Also, the tradition of democracy has an impact on the awareness and attitude of citizens towards public participation. The prevailing approach to spatial planning has its influence on the work of spatial planners and the legal requirements on participation sets the scene for the organization of public participation by local authorities.



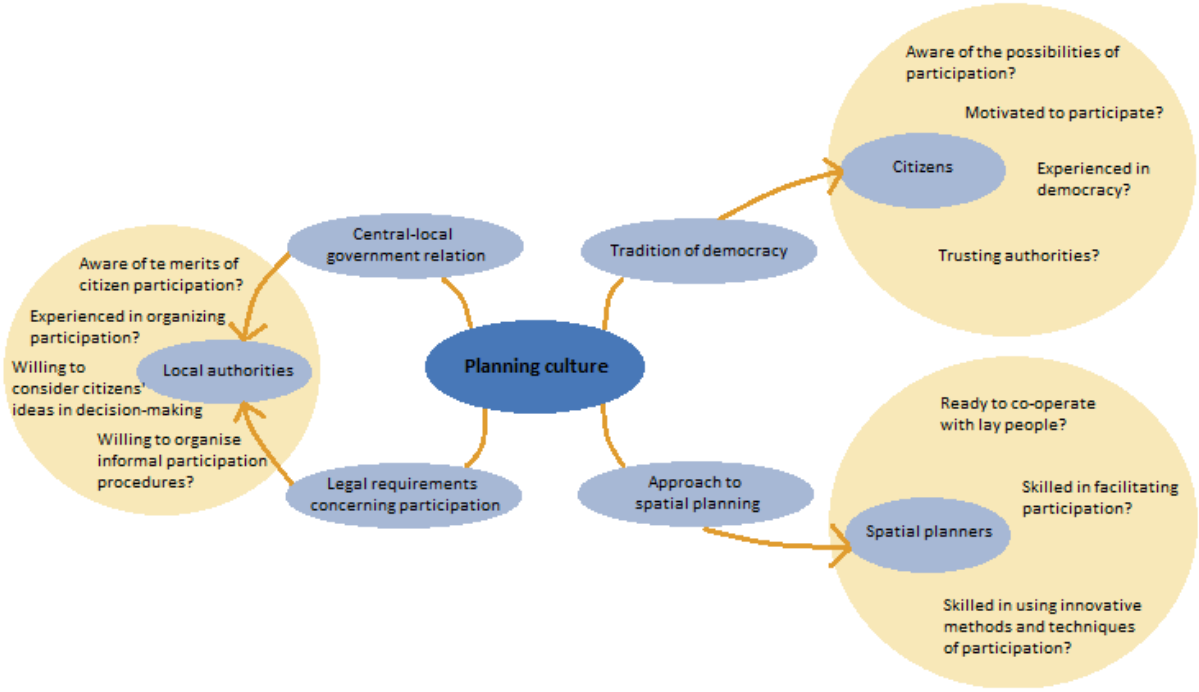


Figure 3: Planning culture and public participation. *Source: Däne & van den Brink (2007)*

2.3 Public participation

Where former top-down planning, in which the rationality of the plans was based upon the planner's knowledge and expertise (Innes and Booher, 2000 in Däne & van den Brink, 2007), ignores the left out stakeholders interests and minimizes the participation level of inhabitants, involvement of public participation can lead to better legitimization of decision making. It can also increase the effectiveness of plans, the quality of the content, build trust and capacity, improve the environment, build a community, avoid wasting resources , prevent conflicts by early involvement of the public and many more(Däne & van den Brink, 2007, Petts & Leach, 2000, Reed, 2008). This means that the general public contains local knowledge not known to planning experts that is of high value and can generate new insights in the planning process at hand. *''Public participation (PP) is also seen as crucial to achieving sustainable flood risk management (SFRM). As flood management is a complex process and includes intertemporal issues, plural values and conflicts of interest, PP enhances policy making by seeking views from the public (i.e. non-governmental organizations (NGOs)) and so can achieve a deeper understanding of flood risk problems as a result. […]However, to date, no NGOs have worked with the FRM institutions in the region''* (Chan et al. 2013. p.508). Public participation can, thus, improve the quality of plans (Däne & van den Brink, 2007).

Why policy-makers organize public participation can, following Leeuwis (2004, in Däne & van den Brink 2007) be divided in two categories: ''participation *as a means* and participation *as an end*'' (p. 40). Using public participation *as a means* refers to using it as an instrument to obtain legitimacy and acceptance of spatial plans. Using public participation *as an end* refers to the factual and democratic rights of citizens to participate in decision-making processes.

2.4 Levels of participation

However public participation means more or less the same as citizen participation to many, Däne & van den Brink (2007) emphasize that there is a difference: the term 'public participation' is a broad term that incorporates many aspects such as education, information provision, consultation, feedback and involvement in the decision-making process whereas the term 'citizen participation' reflects more specifically on the involvement of 'ordinary people'. Already many different researchers have tried to elaborate upon participation by addressing different levels or degrees of participation. The basic participation ladder consists of three levels: information supply, consultation and active involvement. Others vary from inform, consult, give advice, co-produce and co-decide (Däne & van den Brink, 2007) (table 1). Whereas the former meaning of participation referred to the possibility for the general public to react and comment on different decisions, the meaning of it is nowadays more shifting towards the direct and active involvement in the development and implementation of plans.

Table 1: Different approaches to participation *Source: Däne & van den Brink (2007)*

Ladder of citizen participation (Arnstein, 1969)	**Participation ladder (Edelenbos *et al.*, 1998)**	**Levels of participation (IEMA, 2002)**	**Degree of involvement (EC, 2002)**	**Kind of participation**
Manipulation				**Non-participation**
Therapy				
Informing	Inform	Education and information provision	Co-knowing/ information supply	**Non-interactive**
Consultation	Consult	Information feedback	Co-thinking/ consultation	
Placation	Give advice	Involvement and consultation		
Partnership	Co-produce	Extended involvement	Co-operating/ active involvement	**Interactive**
Delegated power	Co-decide			
Citizen control				

Reed (2008) has developed a range of typologies to understand the basis for stakeholder participation. Participation needs to be founded on the philosophy of empowerment, equity, trust and learning, should be considered as early as possible throughout the process and represent different stakeholders systematically. Furthermore, clear objectives must be agreed upon at the outset by the different stakeholders, applying methods should be based upon the decision-making context and highly skilled facilitation is required just as local and scientific knowledge. Finally, he argues that stakeholder participation must be institutionalized, meaning creating organizational cultures that are capable of facilitating active involvement and implementation of measures by the public domain.

2.5 Adaptation policy framework

Lim et al. (2004) developed an adaptation policy framework for climate change, including the process of policy formation and the roles of different stakeholders. The framework consists of five components: (1) scoping and designing an adaptation project, (2) assessing current vulnerability, (3) assessing future climate risks, (4) formulating an adaptation strategy and (5) continuing the adaptation process. Additional, two cross-cutting processes in this framework are addressed: (1) engaging stakeholders in the adaptation process and (2) assessing and enhancing adaptive capacity (figure 4). China has done a lot of work on some of these components (especially on assessing current and future vulnerabilities, scenario development and national and local adaptation strategies formulation) but although this framework might seem promising for use worldwide, special contextual factors need to be considered.

Li (2013) identifies three assumptions behind this proposed framework. First of all, it assumes that ‘’*local policy makers have incentives to address the impact of climate change and ways to integrate adaptation strategies into the national policy process*’’ (p.419). In the current context of China’s politics, however, for a new policy on climate change to be accepted locally, it needs to be included within the discourse of the (economic) growth framework (Schwartz, 2004). GDP is top priority concern of the national Government, so for a new policy on climate adaptation to be successful it should not be at the expense of economic prosperity.

Secondly, it presumes that there is already an active platform for engagement of stakeholders in place. However, implementation and the engagement of stakeholders is most often left behind because there is not yet an institutionalized platform for engaging stakeholders other than stakeholders recognized by the government as being ‘relevant’ to the process. (Li, 2013).

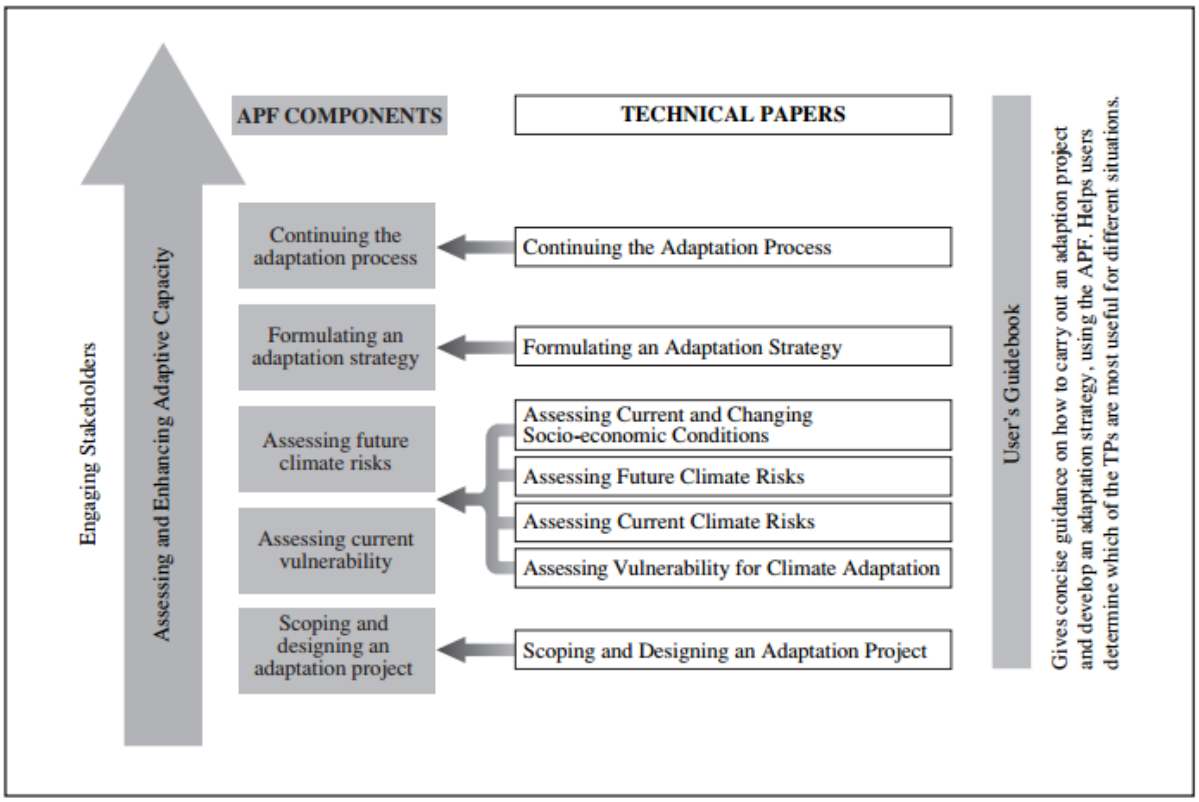


Figure 4: The adaptation policy framework. *Source: Lim et al. (2004)*

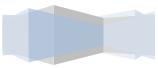
Policy-making in China nowadays only includes governmental stakeholders and natural scientists. Social scientists are having troubles to take (or get) their role in the process since policy makers are only keen on natural scientific and economic implications of their foreseen new policies. Besides, the adaptation policy-making process particularly excludes affected stakeholders from the private domain, like local inhabitants or small private businesses (Li, 2013). Big businesses are in a better position to participate than small businesses since policy developments are geared towards GDP growth. These adaptation policies can, in turn, affect local inhabitants' lives. Yet, the lack of awareness discourages the general public's participation and the low level of civil society engagement is a result of the fact that the general public has higher expectations of the government than of NGO's (Li, 2013). '' *This is partly a legacy of the historically paternalistic culture of governance*'' (Li, 2013. p.421).

Thirdly, it assumes that policy makers are eager to assess efforts made to adapt in the past and that they are aware that their current adaptation efforts are only the beginning of a long-term process. Evidence-based policy making and assessment has yet to be developed. Policy-makers like to explore all successful pilots but are not keen on assessing failed ones. Comprehensive further assessment of

adopted policies is most often neglected, and only the successes are assessed and rolled out on bigger scale.

The current adaptation policy framework show the strengths (links with science and evidence on climate change) but also its three weaknesses (figure 5): ‘’ *social scientists and non-government stakeholders have yet to play a significant role, […]there are few institutionalized channels to allow non-government and non-academic stakeholders to influence policy-making, […] the possible impacts on the people affected are not evaluated before or after policies are formulated [and] policy experimentation and the focus on rolling out successful cases means that comprehensive further assessment of adopted policies is not a priority*’’ (Li, 2013. p.422). Therefore, upscaling of best practices on a National scale can lead to adaptation measures that not fit the local context. Thorough assessment of new effects of adopted policies on social and environmental issues is lacking.

This policy model therefore tends toward authoritarian environmentalism, as opposed to democratic environmentalism (Gilley, 2012). Authoritarian environmentalism has two sides: a policy-making process that is more or less dominated by a relatively autonomous central state with no role for social and private stakeholders on the one hand, and a diminishing individual (local inhabitant’s) liberty as it should obey and behave accordingly to the set policies in order to decrease environmental destructive behavior on the other (Beeson, 2010). Democratic environmentalism, on the contrary, can be defined as ‘’*a public policy model that spreads authority across several levels and agencies of government, including representative legislatures, and that encourages direct public participation from a wide cross-section of society*’’ (Gilley, 2012. P 288-289).



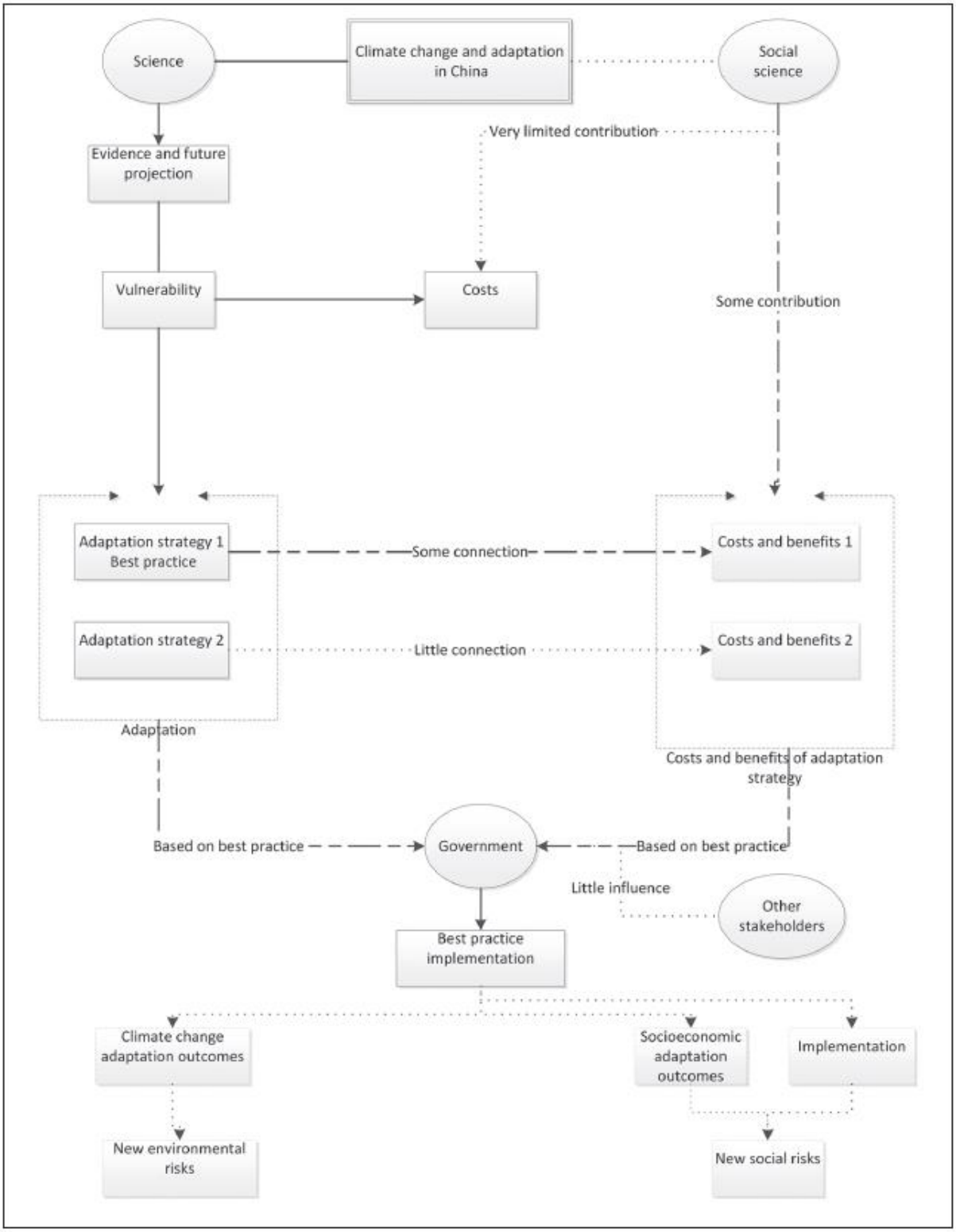


Figure 5: The functioning of the adaptation policy framework in China *Source: Li (2013)*

3. Research methodology

3.1 Research design

Since this topic has not yet been investigated much over the past years in China, It is hard to define and clarify clear concepts and develop precise research problems. Therefore, an exploratory case study design is used for this research . With an exploratory research one can gain background information on a certain topic, clarify existing topics and establish research priorities for the future to contribute to the policy arena (USC, 2015).

Besides, the research tends more towards the 'pure' research (O'Leary, 2010) since it provides new information and insights into the subject which are not directly usable to effect change. One needs to keep in mind that this type of research generally does not generate findings that are generalizable to the population at large, because of the small samples size that is used. Therefore, it did not bring forward definite conclusions but rather founded assumptions and guiding conclusions.

To investigate the research question at hand, the choice is made to split the part on the government and the private domain. To be able to answer the research question at hand, a case study is carried out. A 'case' associates often to a study on location, such as a community or organization and the emphasis lays on an intensive examination of the setting (Bryman, 2012). The units of analysis in this study were the inhabitants who are living in an area that is known for frequent floods (private domain) and different governmental employees of water-related bureaus (government). Especially the part on the private domain can be seen as an exemplifying case (Bryman, 2012), since it can exemplify a broader set of 'cases' (read: areas known for floods) in Shenzhen. In order to select the right case(s), knowledge from different governmental officials, people from the street and the Shenzhen news is used. Two neighborhoods of interest were selected based upon this information. The selection of interviewees from the government was more difficult and therefore more based on the 'snowball effect'.

3.2 Research methods

Concerning the problem statement and concerning the different sub questions at hand, this research used a so called 'mixed' approach. Advantages of both the qualitative and quantitative approach are used to bridge the shortcomings of each separate approach. The methods applied in this research (table 2) can be divided into two sections.

The first part, focusing on the government and climate change, is approached qualitatively. The limitation of the small number of interviewees in combination with the desire for in depth information resulted in the choice for a qualitative method: interviews and textual analysis. Units of analysis were employees of different governmental departments on water management, employees of the Shenzhen Meteorological Bureau, other employees/founders of NGO's or companies and policy documents on climate change.

The second part, focusing on the general public's actions to adapt to extreme rainfall and their expectations of the public domain is approached using a quantitative approach with acceptance of qualitative data: surveys. Because of the large group of respondents needed and for practical reasons this was the most suitable method. The units of analysis were the owners/employees of shops, restaurants or bars in an area which in the past has been flooded due to extreme rainfall. These units of analysis were chosen because their properties are located on the ground floor and therefore make it more likely to find perceptions of the general public that has ever experienced a flood from extreme rainfall.

To answer the first sub-question - *What are the characteristics of extreme rainfall in Shenzhen?* - different climate change documents, reports, mostly official data and records were use and analyzed using textual analysis. Furthermore, an interview with an employee of the Shenzhen Meteorological Bureau is carried out. Through the interview, one was also able to gather information about flood events and their geographical characteristics, to get insights in the most vulnerable areas of Shenzhen which was used to select the case study.

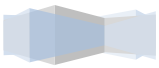
The second sub-question - *What policies on climate adaptation does China have?* – is investigated by making use of textual analysis on various policy documents. These documents were obtained by searching on different governmental websites, searching for scientific literature and by interviews among employees of different municipal departments. Some of the documents were only written in Chinese and have therefore been translated by fellow Chinese students.

The third and fourth sub-question - *How does the government of Shenzhen deal with extreme rainfall?*- and – What is the organizational structure of water management in Shenzhen? - is researched by conducting interviews with employees of different municipal departments affiliated with water management. Furthermore, employees of different planning bureaus (whether or not formerly governmental) and NGO's/private companies were interviewed. Lastly, different Chinese (policy) documents, translated by fellow Chinese students, were used.

The last sub-question - *How does the private domain of Shenzhen deal with extreme rainfall?* – is investigated using a 'mixed approach': using a quantitative perspective with acceptance of qualitative data (O'Leary, 2010). A survey (see chapter 3.3) is conducted among owners/employees of a bar/restaurant or shop in two different areas that have experienced floods from extreme rainfall in the past. This is done by going door to door.

Table 2: Methodological approaches towards the sub-questions.

Sub-question	Approach	Method	Units of analysis	analysis
What are the characteristics of extreme rainfall in Shenzhen?	qualitative	document review & interview	climate change reports, official meteorological institute	textual analysis
What policies on climate adaptation does China have? / What is the organizational structure of water management?	qualitative	document review & interviews	policy documents, officials of water departments	textual analysis
How does the government of Shenzhen deal with extreme rainfall?	qualitative	Interviews	Officials of different layers of water departments	Textual analysis
How does the private domain of Shenzhen deal with extreme rainfall?	quantitative with acceptance of qualitative	surveys & interviews	General public living in an area known for floods	statistical analysis



3.3 Instruments for data collection

This chapter will discuss how the instrument for surveying and the instrument for interviewing have been composed. The sub questions of this research are used as guidance for this.

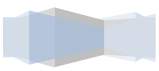
3.3.1 Interviews

Conducting interviews has its advantages and disadvantages. Some of the advantages are: ability to gather rich and profound data, it is flexible and it allows the researcher to generate both verbal and non-verbal data. Some disadvantages of this method are: little anonymity for the interviewee, it can be difficult to gain respondents in an ethical and justifiable manner and there can be a risk of 'leading' the conversation as an interviewer.

Especially in this case (doing empirical research in China), cultural and language barriers, as well as my background as a 'Dutch Water manager', could have been obstacles in the process of data gathering. In China, for instance, there is a law on confidentiality. This means that the government is not allowed to provide confidential information to third parties (such as researchers) which could have made it difficult to obtain this information. The language barrier was tried to tackle by using an interpreter. However, one, then, must be aware of the possibility of information loss during the process of translation. Finally, the position of the researcher was tried to solve by clearly stating (upfront) that under no circumstances the researcher was (or is) judgmental on their water management approach and that the interview is only going to be used for research purposes. Conducting the interviews had a semi-structured and informal character. This way the interview had the character of an informal conversation, leaving room to go deeper in given answers or interesting remarks. To somehow keep the power as an interviewer to steer the conversation, a general list of questions have been drawn up upfront which is used as a guideline during the interviews (appendix 1). These questions were compiled on the basis of the different sub questions of this research.

3.3.2 Surveys

Using surveys as a method for data collection also has its advantages and disadvantages. Advantages could be: the ability to reach a large number of respondents, it can represent a much larger population, it allows for easy comparison of the data, it generates standardized, quantifiable empirical data and, finally, it provides a high level of anonymity and confidentiality for the respondents. Difficulties associated with this method can be: to obtain a representative sample size, to obtain in-depth data, to obtain the amount of quantifiable data a researcher need and there is some skill required to analyze the data statistically (O'Leary, 2010).



To enhance the bond of trust between the researcher and the respondent, chosen is to start the survey instrument with an introductory paragraph about the background of the researcher, the topic and the subject, the purpose of the research, a guide for filling in the instrument and the confidentiality of the data. Following this introduction, the questionnaire started with some demographic questions (closed) to 'warm up' the respondents. These demographic questions were necessary to be able to draw general characteristics of the sample later on.

Then, questions about their residential location and experience(s) with – and perception of floods from extreme rainfall were posed. Subsequently questions about, the whether or not, undertaken measures, responsibilities, willingness to participate, the expectations of the government and the foreseen role for public and private parties in preventing damage from extreme rainfall were posed. The questionnaire concluded by asking respondents their contact information and whether they are open to be contacted again for elaboration or clarification on their given answers.

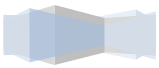
The survey instrument had both closed and open questions (appendix 2). The closed questions allowed for easy compatibility for statistical analysis whereas the open questions provided more qualitative, in depth information to the answers on the closed questions. Also, the amount of questions and the variation of open and closed questions were chosen in order to ensure that it would not take too much time to fill in. Lastly, the survey instrument has been translated into simplified Chinese by a Chinese student, followed up by a check of one of my fellow (Chinese) students. By translating the survey upfront, much of the language barrier could be overcome. However, getting the respondents was sometimes still a problem.

3.4 Conducting data collection

This chapter will elaborate on the process of data collection. Therefore, the two methods for doing this, interviewing and surveying, are here described.

3.4.1 Interviews

Finding appropriate contacts for interviewing is not an easy task. Therefore, contacts were gained before going to Shenzhen, by email through the snowball effect (O'Leary, 2010) by means of own contacts and network in the Netherlands. Also, and as an introduction to the research project, the introduction week in Shenzhen organized by the International New Town Institute (INTI) provided useful contacts. Writing emails to the general email address of governmental websites, using help



and effort of a local governmental employee (Mike), actively asking interviewees about new interesting contacts and asking help of employees of the Shenzhen Center for Design resulted in conducting 8 interviews (table 3). Besides these interviews, information from other persons met during other meetings and events was used for context in this research (table 4).

Table 3: List of interviewees and their characteristics

Date	Location	Name	Time
01/04/2015	Futian Ecological Civilization Research and Promotion Association	Ms. Echo	+/- 10.00 - 12.00
08/04/2015	Ivita Company	Mr. Liwei	+/- 10.00 - 12.00
09/04/2015	Shenzhen Institute of Urban Planning and Design	Mr. Tang	+/- 19.00 - 21.00
12/04/2015	Shenzhen Apecland Design Co. LTD.	Ms. Wu	+/- 10.00 - 14.00
13/04/2015	New Town Development and Construction Office Guangming	Mr. Yao	+/- 16.00 - 17.30
17/04/2015	Shenzhen Meteorological Bureau	Ms. Wei	+/- 11.00 - 13.00
29/04/2015	Water affairs bureau, water supply and drainage	Mr. Liu	+/- 10.00 - 12.30
29/04/2015	Shenzhen Institute of Urban Planning and Design	Ms. Lu	+/- 14.00 - 15.30

Table 4: List of other persons that provided context information

Name	Organization
Huang Weiwen	Shenzhen Center for Design (NGO)
Conjong Lee	NGO on Public Participation
Ming Liang	China Development Institute
Michael Gallagher	Urban Planning and Design Institute Shenzhen
Tat Lam	Urbanus
Michael Patte	Riptide Culture & City
Ying	Shenzhen Heyiyuan Architecture Design co.LTD
Mike	Government Department on Air Pollution

All interviews took place in the office of the interviewee. As a result, the threshold to participate for the interviewees was lowered. Conducting the interviews in their familiar environment also created an informal and relaxed atmosphere , bridging the gap between the researcher and the respondent (O'Leary, 2010). Six interviews have been recorded and transcribed. Due to circumstances, two interviews have been captured by means of open and interpretative note taking (O'Leary, 2010). One must keep in mind, however, that this way of capturing an interview is already a preliminary form of analysis. The six recorded interviews have not been transcribed literally: only the most important passages were written down. This is also a preliminary form of analysis from the researcher. The transcripts of the interviews as well as the notes taken during the other interviews are included in appendices 3 to 10 . Data derived from the interviews is analyzed by means of encrypting statements and distributing them in thematic categories. This table with the different categories is included in appendix 11.

3.4.2 Surveys

The goal of this part of the research was to investigate whether the private domain is willing to take measures and participate in the process of adaptation to extreme rainfall (or to what extend this already happens). Because most inhabitants live on the first floor or higher (and therefore increasing the chance of never having experienced a flood from extreme rainfall), the choice has been made to conduct surveys only in premises on the ground floor. To increase the chances of respondents having had an experience with a flood, the areas Sea World (Nanshan district) and Xili (Nanshan district) are chosen as cases. The area of Sea world has experienced a flood from extreme rainfall in June of 2007, whereas the area of Xili has experienced a more recent flood: May 2014 (figure 6).

The population size of the city of Shenzhen, and therefore also the population size of the two research areas, made it impossible to interrogate the entire population. Also limited by time, the goal was set at more than 30 surveys per area in order to be able to meet the conditions for minimal statistical analysis (O'Leary, 2010). The respondents were approached by going door by door, holding the Chinese version of the survey in hands, and have been conducted during six days: three days in Sea World and three days in Xili (table 5).

The advantages of applying this method are: usually good response rates, builds up trust, it may motivate respondents, it can provide clarification and it enables the researcher to read non-verbal cues (O'Leary, 2010). Disadvantages include: it can be time consuming, fieldwork is limited to geographical boundaries, it does not guarantee for anonymity and it requires some practical training of the researcher. Arranging translators to do the fieldwork was impossible. The language and culture barrier may, therefore, have resulted in some misunderstandings or misinterpretations.

Figure 6: Flooding of Xili in May 2014
Source: Derbaix (2014)

Flooding of Sea World in June 2007
Source: Wu (2007)

The surveys have been conducted in the surroundings of the research areas (figure 7). The data obtained from the surveys are entered in the computer and analyzed using the program SPSS. The selection of data and the results from the analysis will be presented in chapter 4.

Table 5: Dates of conducting surveys.

Date	Location	Time
15/04/2015	Sea World	+/- 10.00 - 12.00
20/04/2015	Sea World	+/- 10.00 - 16.00
21/04/2015	Sea World	+/- 11.00 - 16.00
22/04/2015	Xili	+/- 12.00 - 17.00
23/04/2015	Xili	+/- 12.00 - 17.00
27/04/2015	Xili	+/- 12.00 - 18.00

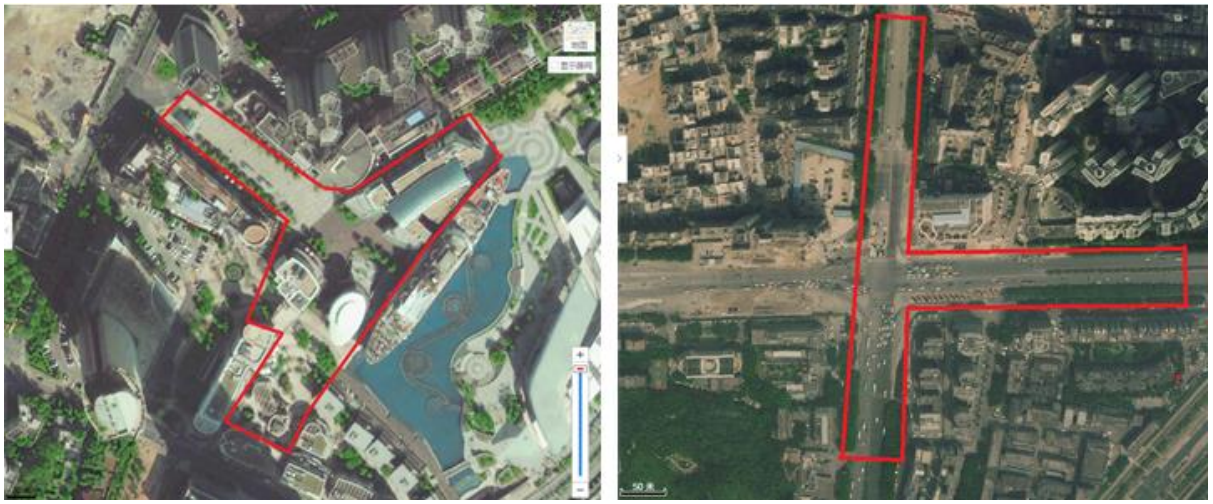


Figure 7: Research areas Sea World (Left) and Xili (right). *source: Baidu Maps (2015)*

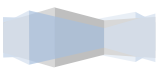
Enrichment box: SEZ and urban villages

Shenzhen (figure 8) is one of the special economic zones in China and It has been growing rapidly from rural land into an industrial city since the mid- 1980s (Chen & de Medici, 2009). The explosive growth of Shenzhen resulted in overgrowing of the surrounding villages, instantly becoming 'urban villages' (*chengzhongcun*)(Wang et al., 2009). In 2005, Shenzhen had gobbled 241 villages (Liu, 2007 in Wang et al., 2009). Specific developments, policies and land acquisition strategies of Shenzhen' government has led to collective land ownership in the urban villages by its inhabitant and highly densely built up areas (Wang et al., 2009). Applying the same spatial planning and development strategies as in the city of Shenzhen s is therefore difficult to implement. This, in turn, has its effects on water management both in and outside the villages.

''We have [a] map of places that have a high risk of flooding, like Nanshan, Bao'an and Longgang districts. Often the old villages in the different places of Shenzhen are vulnerable to floods because of the development of the city and the roads, which are more elevated'' (Wei, interview F)

Figure 8: Location map of Shenzhen region *Source: Shi et al. (2007). Own adjustments*

Also, different districts have different drainage systems due to the commissioning of the Special Economic Zone in Shenzhen. Belonging to this first SEZ were the districts Luohu, Futian, Nanshan and Yantian (SZ government, 2007). In 2010, the SEZ expanded almost five times its original size by adding Bao'an and Longgang districts to the zone (Xinhua, 2010). This distinction is essential because the districts inside the original SEZ (Second line Custom) in general have realized a division between rainwater sewage infrastructure and wastewater sewage infrastructure (Yan, 2014, interview C). The districts outside this original SEZ border still suffer from some serious mixed-flow issues. Also, urban villages are difficult to manage. As Tang (interview C) explains: ''*these areas are the only areas that don't have a separate sewage system because other departments regulate this. The city obliges them to do a separate system but they just don't do it. These systems are however connected to our normal systems, and because there are many illegal sewage connections in the urban villages, we cannot really calculate the needed rainwater and wastewater capacity*''.



4. Results

In this chapter, the results of the research will be discussed. First, the characteristics of extreme rainfall in Shenzhen will be described followed by the policies on climate adaptation in China and its organizational structure. Then the measures implemented and the expectations of both the private domain and government will be presented.

4.1 Climate change and extreme rainfall

General climate change

Shenzhen is a coastal city with low latitude and subtropical climate (Du, 2007). Influenced by the global warming and the urbanization process, the annual average temperature of Shenzhen has increased with 1.6 degrees in the past half century, the relative humidity is decreasing and the total hazes days are decreasing (appendix 12). Especially the temperature rise has close connections to the development of extreme cloudburst events since increasing temperatures allow the air to contain more moist, which could lead to more intense rainfalls. The weather system is very complex, and although many factors are of influence on extreme precipitation, deeper investigation is beyond the scope of this research.

Shenzhen Meteorological Bureau

The Bureau consists of three departments: Climate department, Weather Forecasting department and Lightning Protection department. The weathercast department predicts the weather by comparing actual observations to different models with different resolutions. To do so, they use 155 AWI (automated weather observation) stations throughout Shenzhen, each with a scope of about three – five kilometers. These stations measure the general meteorological parameters like temperature, air pressure, wind speed and direction, relative humidity, precipitation, visibility and air quality (interview F). The weather stations that are used in Shenzhen collect data every minute, enabling real time calculations and adjustments of predictions during extreme rainfalls.

Extreme rainfall

Shenzhen has a high frequency of heavy rains that affects widely and harms severely. The rain season lasts from May to September (Du, 2007) and the city has average annual rainfalls of 1966.5mm, divided over an average raining days of 144, of which 9 of them are torrential rains and 2.2 of them are heavy rains (SMPGEMO,2012). Roughly speaking, in the past 50 years the cumulative rainfall in Shenzhen has shown considerable fluctuations, making an overall trend not obvious. In the

50's and 60's of the last century, the extreme rainfall with daily rainfall of over 200 millimeters have been very frequent. However, because of the sparsely populated and the small size of the built-up area at that time, it did not stay in peoples memory that deeply (SMB, n.d.). In the 1980's, on the other hand, Shenzhen experienced a period with very little extreme precipitation. In that period, the Shenzhen National Basic weather station has never recorded any extreme precipitation event of over 200 millimeters per day. Since 1993, extreme rainfall events of over 200 millimeters per day have already been recorded 9 times (figure 9). Interview (F) shows that the frequency of extreme cases increases: in the last ten years there were four extreme events and in the year 2008 alone three. The speed of this change will depend on the level of carbon emissions in Shenzhen and China.

An important characteristic of extreme rainfall is the time span in combination with the amount of precipitation: the intensity. The records show that 30 minutes extreme events often cause flooding of streets, houses, shops and underground stations. Due to the large amount of rainwater in a small time period, the sewage and storm water drainage systems will overflow because they are not dimensioned upon these intensities. To consider a rainfall event as an extreme case, the Shenzhen Meteorological Bureau adopts the definition of: 55 mm or more in 24 hours. ''*However in our experiences, if it rains 50 mm in one hour or 50 mm in only 30 minutes it will result in floods*'' (Wei, interview F).

In Shenzhen, the maximum amount of rainfall in 30 minutes consist of 104.4 mm and was recorded on July 28th, 2010 (table 6). This table shows that there are 3 other cases recorded of over 100 mm in half an hour. Other tables of recorded cases on maximum amounts of precipitation in different periods of time are listed in appendix 13. These tables show that these events have very significant amounts of water: up to 517.4 mm on June 14th, 2008!

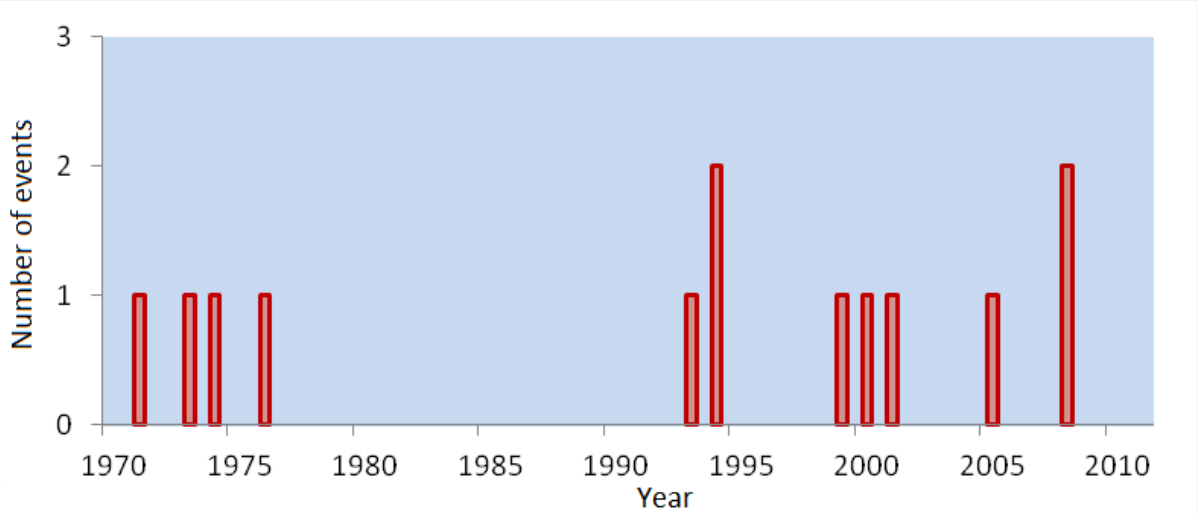


Figure 9: Number of extreme rainfall events (>200mm/day) Urban Weather Station *Source: SMB (n.d.)*

Table 6: Extreme events in Shenzhen

Source: Wei (Interview (F))

Date	precipitation (mm/30 min)
28/07/2010	104.4
09/09/2010	103.9
20/05/2012	102.2
27/06/2010	101.8
09/09/2010	95.6
30/03/2014	80.2
29/07/2010	77.4
11/07/2011	77.3
21/09/2010	74.5
09/09/2010	73.3
03/06/2009	73.1
30/08/2013	72.8
14/06/2009	72.4
04/06/2009	72.1
10/09/2010	72.1
17/05/2014	71.8
25/08/2007	71.3
10/09/2010	71.0
25/06/2009	70.3
17/04/2011	68.7
20/05/2014	68.4
12/10/2011	68.1
30/03/2014	67.6
22/07/2010	67.4
09/09/2010	67.4
04/08/2014	66.2
17/04/2011	65.0
05/06/2013	64.9

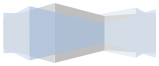
The event led to 5 dead, 3 missing, over 70 houses collapsing, 500 locations with different levels of waterlogging or flooding, and nearly 100 locations with dangerous slope-landsides. Around 1 million people were affected by this flooding event and It led to over 10 million direct economic losses (SMPGEMO, 2012).

An important factors that is of influence is the topography of a neighborhood. Most parts of Shenzhen are hilly and steep terrains which ensures that flood events have a strong locality and partiality character. In other words: there is disparity in the geographical distribution of floods. Based on the floods frequencies and impact levels, the city could be divided into the following areas (SMPGEMO, 2012):

1st frequently flooded: Bao'an, Longgang, Guangming , Pingshan
2nd frequently flooded: Qinghai ,Houhai in Nanshan district.
3rd frequently flooded: Luohu, Futian, Yantian.

The increasing frequency of extreme rainfall events in combination with the declining ability of the urban surface to absorb these downpours results in waterlogging and water damage more and more often. As for today, most urban areas in Shenzhen will experience serious waterlogging issues when it rains with an intensity of over 30 millimeters per hour. This has, in turn, adverse effects on transportation, production, safety and livability.

For a city, to be able to adapt, it is essential to predict the order of magnitude of the climate change in the future as accurately as possible. Therefore, the China Meteorological Administration introduced a new technical specification which enables revision of the Shenzhen storm intensity formula (appendix 14, Shenzhen Water Supply and Drainage, 2014) leading to more accurate and objective corresponding return periods.



Meteorological impact assessment of urban construction

Identifying and clarifying the adverse effects of local climate change on urban development and discussing the consequent restrictions on urban developments by means of conducting impact assessments can greatly enhance the processes on climate issues within planning departments. To achieve that, new result of climate impact assessments have been applied in the new ´Shenzhen Urban Design Standards and Guidelines´ in 2014 (SMB, n.d.). The guidelines are based on a number of 'climate-friendly' measures, including encouragement of vertical green, regulation of the microclimate, encouragement of built-up areas to increase the water permeability and reduce the urban heat-island effect.

Joint actions for a climate-friendly city

To slowly shift towards a more climate-friendly city, multiple stakeholders should opt in and actively work on both mitigation and adaptation. SMB (n.d.) identifies three key stakeholders: government, business industry and citizens.

The government should:

- Develop policies, laws and regulations to steer the city development to a low-carbon city.
- Make use of scientific urban planning, prompting the city to adapt to climate change
- Create a market environment leading in finance for low-carbon technologies
- Organize fundamental research on climate change and provide access to scientific knowledge.

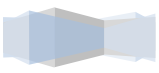
Industry businesses are expected to:

- Develop and participate in low-carbon technology research.
- Participate in the low-carbon technology market.
- Participate in climate change science.

Lastly, citizens should:

- Pay more attention to climate change issues.
- Enhance awareness of energy conservation and emission reduction.
- Fully understand the local climate.

The following chapter (4.2) will address the current policies and regulations on climate change and the organizational structure. Subsequently, chapter 4.3 will discuss the governmental approach of adapting to extreme rainfall and chapter 4.4 will elaborate upon the role that citizens assign themselves in the process of adaptation to extreme rainfall.

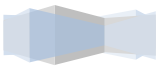


Synthesis and reflection

The annual average temperature of Shenzhen has increased with 1.6 degrees in the past half century, the relative humidity and the annual haze days are decreasing and the extreme rainfalls in Shenzhen will increase in frequency and intensity. Especially the intensity of cloudbursts result in flooding. Most common flooded districts in Shenzhen are Bao'an, Longgang, Guangming, Pingshan, and Nanshan. New adjustments to weather systems and return periods formula provide more accurate predictions. Yet, more accurate data on micro climate would help forecast more precisely.

One way to do that is to improve the grid of the current radars. Another option would be to look into new technical and social innovations as in the concept of 'smart city'. Being able to use all (geo)data of smartphones from inhabitants around the city, more information on micro climate could be received. Furthermore, the city of Shenzhen has quite some elevation which can lead to accelerated and concentrated rainwater run-off. However, these altitude difference does not need to be a threat but can rather provide opportunities to steer rainwater towards specially designed areas for emergency storages.

Also, flood events have a strong local and partial character and to be able to adapt to extreme rainfall three key stakeholders should actively and simultaneously work on mitigation and adaptation: the government, the business industry and the citizens. Especially the role of the government and the inhabitants will be explored in the following chapters. Rainwater does not follow administrative boundaries and is only subject to gravity. Therefore adaptation measures in - and effective coordination between public and private domain are necessary. First of all, this integrated approach will be in need of integrated spatial planning (Däne & van den Brink, 2007).



4.2 Government policies, regulations and organization

Growing attention

As a reaction to the foreseen and observed climate change, the Chinese Government has set up a special institution addressing climate change in 1990, established the National Coordination Committee on Climate Change (NCCCC) in 1998 and invoked the National Leading Group to Address Climate Change in 2007 to formulate strategies, measures and policies (IOSCPR, 2008). In 2008, the Department of Climate Change was set up under the Ministry of National Development and Reform Commission (Li, 2013). Besides, the Experts Committee on Climate Change has been set up to enhance scientific research on this matter and thus improving scientific decision-making. This can be linked to the stage of assessment of current and future vulnerabilities of the Adaptation Policy Framework (Lim et al. 2004) and the 'natural' science element in the Adaptation Policy Framework of Li (2013).

Over time, awareness have grown that local governments are the key players in implementing actions as a response to climate change. By the end of 2010, every province in China (and some cities with special importance for climate change) has created its own Climate Change Adaptation Plan that mirrors the National level plans (Li, 2013). Governments at all levels have improved policies on finance, investments and industrialization (IOSCPR, 2008). Also, the Chinese Government released the National Strategy for Climate Change Adaptation in 2013, outlining the guiding principles of adaptation by 2020 on a national level (National Development and Reform Commission, 2014). Local government then, should create policies according to the national guidelines which reflects upon the central-local government relation (Däne & van den Brink ,2007). These developments the past decade show that there is growing emphasis on mitigation and adaptation to climate change. However, if this is true, it should be visible in terms of laws, policies and regulations.

Laws, policies and regulations

There are only a few laws and regulations enforced in order to adapt to climate change, including the Water Law, Flood Control Law and Regulations on River Administration (IOSCPR, 2008). China has enhanced its integrated observation system for climate change in order to be able to deal with extreme weather events like typhoons, intense regional rainstorms and floods. Drainage and flood control plans have been worked out at city level and climate change has been taken into consideration by means of raised design standards (IOSCPR, 2008). Yet, the CCICED (2014) claims the opposite: climate change is not (yet) included in urban developments. Also Wu, interview (D), adds a nuance to this *''There are becoming more and more policies on this topic. […]But if you only focus*

on the water problem, especially on the rainwater, it is not enough to influence policies''. Here, opposite information indicate that different views exist and that growing interest for the subject is not transferred to all layers of society automatically. To fully implement policies and regulations on local level, awareness, knowledge and skills and a decent organizational structure are necessary.

Public awareness and participation

Following the IOSCPR (2008), China has emphasized greatly both on education and publicity concerning the environment and climate change and public participation in relevant activities. It will enhance education and training on climate change among the different levels of education. Also, to reduce the impact of extreme weather, the government invested tremendously in weather forecast services in order to be able to understand climate change more accurately (technocratic approach; assessment of current and future vulnerabilities, Lim et al. 2004) and they provided information on preventive measures and protection to the public against extreme weather conditions (Li, 2013). This can be seen as the first level of participation on the basic participation ladder (Däne & van den Brink, 2007).

China ,thus, stresses the importance of public awareness and capabilities in participation and, therefore, building a good social climate to do so. Yet, most of the actions and intensions of these policies are aimed to enhance the public's awareness of - and their participation on energy conservation and emission reduction. Despite the organization of the 2014 National Forum on Comprehensive Disaster Reduction and Sustainable Development, which drew wide public participation through giving out promotional materials, training and lectures (National Development and Reform Commission, 2014), It does not really direct towards public awareness of and participation on adaptation and mitigation to extreme rainfall. It rather focusses on a low-carbon lifestyle. Also, the CCICED (2014) points out that mechanisms for public participation in environmental aspects of urban development need to be updated and improved in order to encourage people-oriented urbanization. This reflects upon the lack of an institutionalized and active platform for stakeholder engagement (Li, 2013).

Knowledge and skills

One way to gain knowledge and skills is by piloting new concepts. In 2010, eight cities have been appointed to experiment with lowering carbon emissions, meaning that the cities could develop their own plans and goals based upon central government guidelines (Li, 2013). An example of how national policies can be implemented on local scale, with own approaches adjusted to the local

context, are the green spaces policies. To reduce the urban heat-island effect, green spaces and roof gardens were considered as important solutions. The city Beijing started with roof garden legislation in 2004, whereas other local governments such as Guangzhou and Shenzhen have introduced their own vision on green roof policies (Li, 2013).

However, despite Shenzhen has claimed to have green roof policies in place, Yao points out that these policies are very young and until today only implemented on government buildings, interview (E). Liwei, who owns a company on urban agriculture and grows some vegetables on the roof, confirms the minimal policies on green roofs: '' *The government doesn't even encourage such a company''*, interview (B). An important reason for this, is that health improvement is not as important as commercial and economic improvements to the government. This reflects upon the central-local government relationship of the planning culture in China (Däne & van den Brink, 2007) where all developments must be placed within the discourse of economic prosperity and thus have to fit the economic growth framework (Schwartz, 2004). He also points out that, to be able to implement green roofs, structures of buildings should capable of carrying the weight. Here, adjusted construction regulations are needed in order to be able to fully implement green roof policies.

Another example of a pilot, implemented in Guangming, is the concept of LID. This idea came from abroad - and pushed through from higher political levels: authoritarian model (Gilley, 2012) - and is implemented in Guangming because of its advantages. Advantages of Guangming for the implementation of the LID concept include: plenty of space, greenery and trees and ownership of 53% of the total surface of the area by the district government, interview (E). The amount of land held by the government makes it easier to implement LID developments (Gamer, 2008). However, Tang is very sceptic about the implementation of the LID concept, interview (C). He thinks that the concept is still very premature and that real implementation strategies and regulations are still lacking. Since this concept is implemented in Guangming, more and more cities are applying it. This can be seen as an classic example of experimenting with one policy in a place and, if successful, upscaling the best practice to other locations. However, upscaling might lead to adaptation measures that not fits the local context (Li, 2013), because one can question whether Guangming is the appropriate area to pilot with this concept.

Now that general policies, regulations, public awareness attempts and piloting concepts have been discussed , the organizational structure of water management in Shenzhen sets the context for the local level.

Planning for (rain)water drainage

The Shenzhen Municipal Water Affairs Bureau is on municipal level responsible for creation, maintenance and adjustments of main (national) policies and regulations and the formulation of plans on water resources, flood control, water supply, water saving, water/soil conservation, sewage recycling and seawater utilization (Shenzhen Government, 2006) which, in turn, needs to be published by the City Government (interview H). This bureau develops plans for the whole city and It also manages the mayor (and essential) infrastructure and rivers (figure 10). Every district of Shenzhen has its own Water Affairs Bureau , all being part of the Municipal Water Affairs Bureau. These district bureaus develop policies and regulations on a smaller scale and they manage the smaller rivers and water infrastructure (interview E).

The actual development and design of plans is done within private companies, semi-private companies or former governmental departments that can get hired by government, as Tang explains. (interview C). Lu adds the notion that some planning bureaus are not governmental but not a private company either.

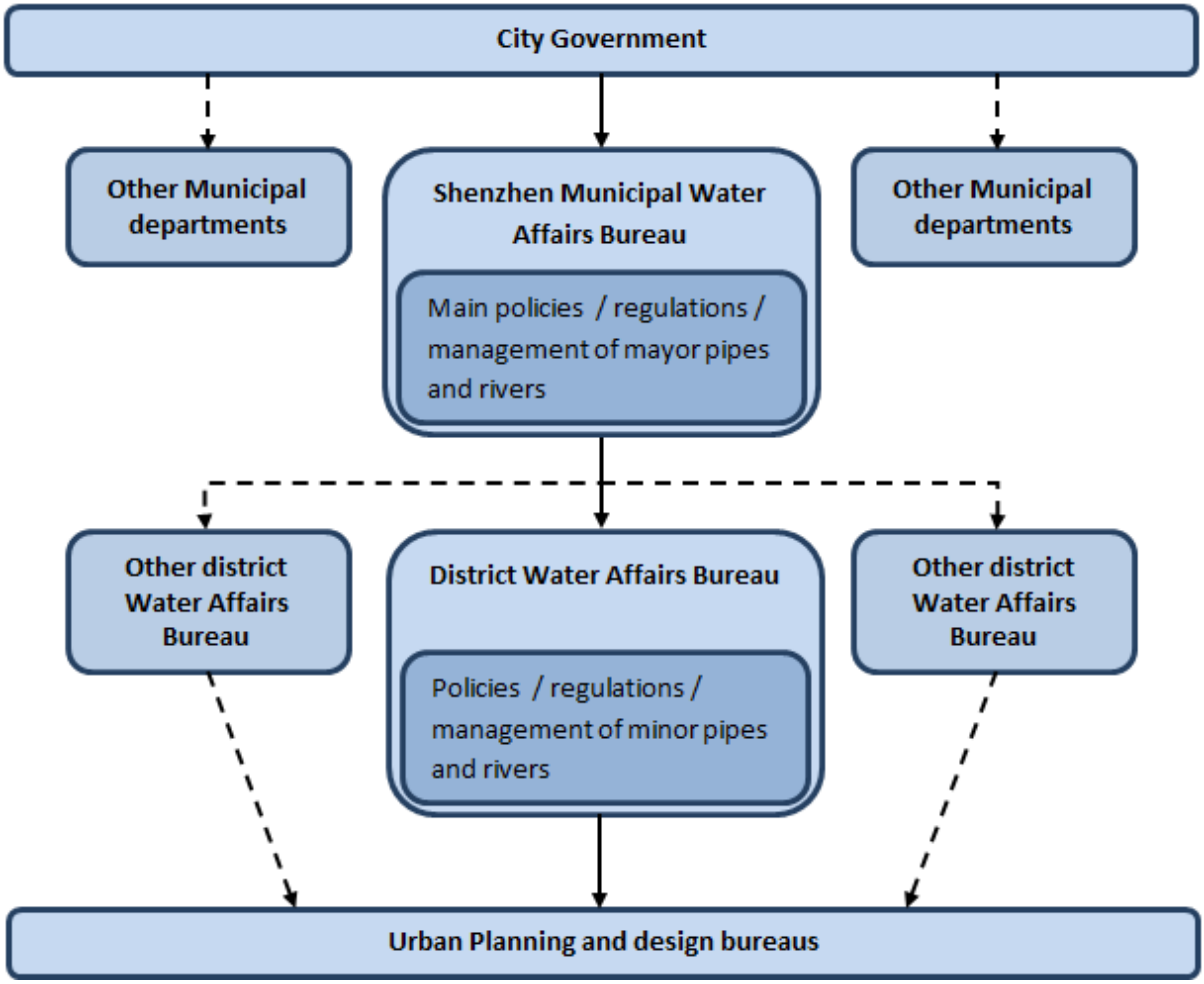


Figure 10: Organizational structure of (rain)water planning

The planning bureaus can work for the government or other companies (such as private developers), but all the assets that will be designed are state owned (interview H). In 2006 the government changed the statues of many departments from a governmental department to an individual department, that often still works for the government but need to run on their own. Diverting these departments is a result of a policy from the government to open up the market, ass Liu explains In that way, urban planning bureaus can work throughout the city, or even outside the district boundaries (interview G).

When the Water Bureaus have new projects coming up, open betting and tendering will occur.
An Urban Planning bureau make the general plan, then the developments will get designed, followed by designs of the traffic department and road design department in combination with drainage/water department (interview C). When designing a plan, ''*we have to ask other bureaus such as traffic department what their regulations and policies are. We have to ask all opinions from all the different departments. When they are satisfied we give them the plan back*'' (Lu, interview H). This can be seen as the integration of many different forms of land use interests, knowledge and expertise from different disciplines (de Wit et al, 2009). However, Tang did not mention what this consultation of different department exactly entails: if it is only a verification whether the plan fits their regulations it may not be seen as an integrated approach.
Wu also work sometimes on contract basis for the government. However, she put a couple of caveats to the way of planning these days.

''*Planners should always have own opinions about what the public thinks. But at this moment they don't have that. There are many reasons for that. The most important one is the system now in China. All the questions about the city come from the bottom up level, but the guidance and basis to do your design comes from the upper level of planning*" (Wu, interview D).

This, again, points out that the planning culture in China is a rather authoritarian model and that stakeholder participation is lacking institutionalized instruments. Also, as she further explains, the rate of population and economic growth results in an urban planning system in China that only has 'basic logic'. This, in turn, reflects upon the notion of the need for adaptation policies to fit the growth model (Schwartz, 2004). Here one can see that the way planning for water management is organized is highly dependent upon costs efficiency: the best (cheapest) plan is chosen by means of tendering certain projects .

Financial structure

For implementation of diverse plans and the maintenance, repairs and renewal of urban (rain)water infrastructures, large financial resources are needed. First, the water bureau comes up with plans which they then pass on to the development bureau of Shenzhen. When they approve the plan, it will be passed on to the financial department pending on financial approval and, if this is settled, the plan return to the water bureau. The last step is to set the plan for public (planning bureaus, departments and companies) tendering (interview G). The financial bureau, then, pays the amount of money needed for the plan of the winning tender to the Water Affairs Bureau which pays the company of the winning tender in turn (Figure 11). To be able to afford these developments, the government assigns a certain amount of money for water related issues every year (interview H). The government receives money from taxes and a part from the collected taxes will be reserved for the drainage infrastructure annually (interview E). The construction of pipes, pumps and bigger water related developments are all paid from this fund. Inhabitants only pay taxes on wastewater, which is based upon the amount of used drinking water; there is no fee on rainwater disposal.

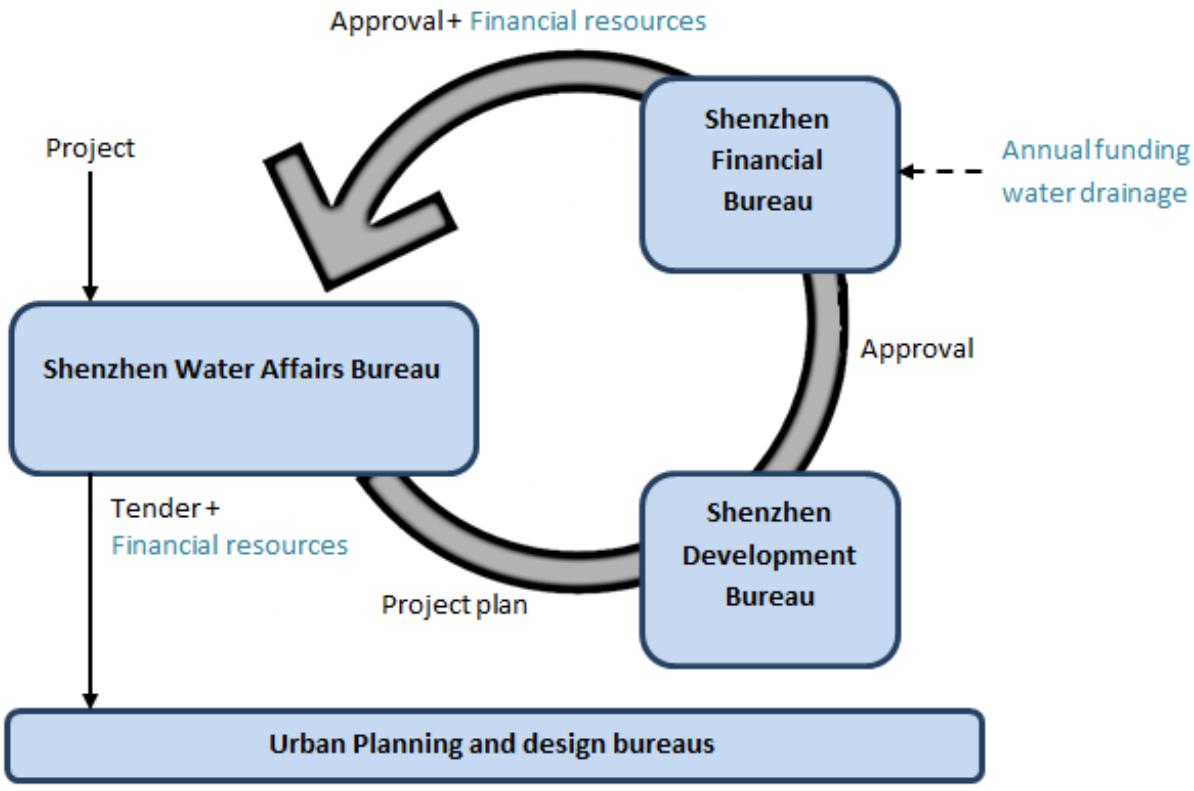


Figure 11: Financial structure of water infrastructure

Synthesis and reflection

The introduction of various commissions, departments, adaptation policies and plans throughout the past decades show that there is increasing attention to mitigation and adaptation to climate change. Many committees have been established to improve the scientific evidence and knowledge of climate change, reflecting upon the assessment of current and future vulnerabilities of the policy adaptation framework of Lim et al (2004). However, there are only a few laws, regulations and policies in place and adaptation policies in Shenzhen should fit within the discourse of the growth framework. This can place considerable pressure on the effectiveness of different water measures.

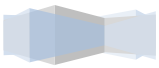
Also, the planning culture of China (a rather authoritarian policy model) causes local governments to be dependent on the guidelines of the national government (reflecting upon the central – local government relation) which may result in upscaling one of the best practices to other cities that does not fit the local context. One could question, for instance, whether Guangming is the right area to experiment with LID developments, since this area is already very spacious and green by itself. Would it not be more useful to experiment with LID in densely populated areas where most of the surface is impermeable and where waterlogging often occurs?

Meanwhile, the government claims to be working on public participation by means of information supply (first level of participation). However, almost all of the efforts from the government to enhance public participation is made on low carbon society and an institutionalized platform for engaging stakeholders on participation level two and three is lacking. Also, some real instruments or incentives for public participation seem to be missing.

On the local level, the Municipal Water Affairs Bureau is responsible for creation, maintenance and adjustments of main policies and regulations and the formulation of plans on water related issues. This is done in a very authoritarian policy making model: only a small group of government employees develop these policies without possibilities for affected stakeholders to participate. Systematically representation of different stakeholders in this process (Reed, 2008) and an institutionalized platform for engagement of the appropriate stakeholders (Li, 2013) is thus lacking. Furthermore, every administrative district has its own Water Affairs department and the actual development of plans is done through tenders. This tendering provides opportunities for private companies to develop a unique selling point. Spatial planning companies can become experts on rainproof design making. Although all water tasks are incorporated within one municipal department, it seems that an overall integrated approach is lacking. Surface water, water quality,

sewage, storm water and spatial planning seem to be distinct departments, with little or no cooperation between them. This can provide all the more opportunities for companies to stand out.

Lastly, the financial resources for (rain)water infrastructure comes from taxes on wastewater and other general taxes. There seem to be no separate tax differentiation for rainwater infrastructure and the designation of separate amounts of money for separate components of the water cycle infrastructure appears to be missing. Besides, there seem to be little incentives and financial encouragements available to involve affected stakeholders. Providing incentives and financial subsidies are great opportunities for the government to involve the left out stakeholders. Perhaps exact knowledge of long terms costs and benefits of rainproof measures and design is lacking, and more research about this could lead to reconsideration of taxes and incentives.



4.3 Government's approach to extreme rainfall

Results on the implemented measures by the government of Shenzhen and the expectations of the private domain are presented in this chapter by, first, discussing the implemented infrastructure, followed by the emergency measures in case things go wrong. Secondly, potential problems and improvements, exploration of practice and social and technological innovations are described as part of the implemented measures. Lastly the expectations of the private domain are discussed.

4.3.1 Implemented measures

Infrastructure characteristics

The city of Shenzhen has built 160 flood control reservoirs by the end of 2012, covering a water-collection area of 604,5 km^2 with a flood control capacity of 778 million m^3 (Yan, 2014). Throughout Shenzhen there are 110 drainage pumping stations situated with a total installed capacity of 572 m^3/s. Most of them are located in the lower-lying western coast areas. Despite these pumps, these areas are sometimes still suffering from floods (Yan, 2014). Furthermore, the underground infrastructure for wastewater and rainwater consists of a total of 10.420 km drainage pipes of which 44,5% is rainwater infrastructure (table 7). Pingshan new district contains relatively the least amount of rainwater drainage (33,8%) whereas Futian District has relatively the highest amount of rainwater drainage (57,0%). Nanshan district accounts for 52,6% of rainwater drainage, 43,9% of sewage infrastructure and only 0,8% of combined sewage infrastructure. For the development of the total amount of sewage pipes over the past recent years, see appendix 15 (China Statistics Press, 2014). In general, the rainwater sewage will dispose to the nearest, one of the 310, river (interview C). Of these 310 rivers across Shenzhen, 90 will directly lead to the sea (SMPGEMO, 2012) and have a catchment area larger than 1 km^2 (Yan, 2014).

Table 7: Drainage pipeline networks. *Source: Yan (2014). Own adjustments*

Administrative Districts	Total(km)	Sewage (km)		Rainwater (km)		Combined (km)	
Futian District	1077,33	453,96	42,1%	614,38	57,0%	8,99	0,8%
Luohu District	527,98	231,55	43,9%	289,63	54,9%	6,80	1,3%
Nanshan District	1077,16	484,79	45,0%	566,54	52,6%	25,83	2,4%
Yantian District	211,25	97,77	46,3%	113,27	53,6%	0,21	0,1%
Bao'an District	2458,58	1079,90	43,9%	1045,05	42,5%	333,63	13,6%
Longgang District	2274,38	868,49	38,2%	786,65	34,6%	619,24	27,2%
Guangming New District	766,44	144,91	18,9%	414,06	54,0%	207,47	27,1%
Pingshan New District	934,63	296,48	31,7%	315,58	33,8%	322,57	34,5%
Longhua New District	790,62	269,94	34,1%	359,44	45,5%	162,24	20,5%
Dapeng New District	301,95	27,94	9,3%	133,58	44,2%	140,43	46,5%
Total	**10420,32**	**3954,73**	**38,0%**	**4638,18**	**44,5%**	**1827,41**	**17,5%**

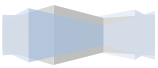
However this infrastructure sound robust, the rainwater systems design return period has been adjusted recently (Interview C). Where former construction projects were calculated and designed on a two-year return period, the construction project nowadays have raised design standards, meaning a design of a two-year return period in general areas and a design of 3-5 years return period in low-lying areas and important and busy road interchanges (Yan, 2014., Shenzhen Water Supply and Drainage, 2014., interview G and H).The return period of 3-5 years means a rainfall of 60 mm/day.

There are, actually, 2 different standards: for rainwater planning there is a 24 hours standard and for the city council the system will be designed upon a standard per hour (interview G). These design standards mean that in 'normal' areas sewage overflows may only happen once every two years and in the low-lying areas or road interchanges a sewage overflow may only happen once in every 3 to 5 years. This upgrade of the design standards is a result of experiences with floods from extreme rainfall in the past few years: ''*Because China has developed greatly the last years, this upgrade of the regulations (that cost more money to build) have become affordable*'' (Yao, interview E). This may be a logical consequence since experiences in the past allow for learning to prevent the repetition of mistakes (Walker et al. 2006, Marx et al. 2007 and Bohensky, 2008 in Tschakert & Dietriech, 2010).The drainage department designs underground infrastructure following those standards. This include drainage pipes under main roads, sidewalks and inlets (interview C). However, bigger storms than the design standards exist and emergency situations can therefore arise.

Emergencies

In case of emergencies, The Emergency Management Office of Shenzhen Municipal People's Government is responsible for the daily contact with the 32 different Shenzhen Command Centers (Shenzhen Emergency Management Office, n.d.) of which two are related to water management: Shenzhen Command Center for Flood, Drought & Typhoon Emergencies and Shenzhen Command Center for Water Supply and Drainage Accidents. Both command center offices are set up within the Municipal Water Affairs Bureau.

The Command Center for Flood, Drought and Typhoon Emergencies is responsible for prevention and controlling of floods from heavy rain related disaster events. The Center should organize relating offices, authorities and organizations for emergency preparations. It should timely report the incidents and need for evacuation to the city municipal government, to better coordinate and



command forces associated to get involved in serious emergencies evacuation (Shenzhen Emergency Management Office, 2012).

The City Water Authority is in charge of operating and repair of water supply, drainage and sewage network. The Municipal Urban Management is, among others, responsible for informing relevant organizations to indicate and hand out warning signals for jeopardized areas whereas the Municipal Department of Education is responsible for carrying out publicity and education on flood prevention and emergency knowledge among students and teachers in schools and kindergartens. The latter task can be seen as enhancing the social capital of inhabitants (Restemeyer et al, 2013) and as the first level of participation (Däne & van den Brink, 2007). Lastly, the Municipal Meteorological Bureau is responsible for monitoring and forecasting of heavy rains and other extreme weather types and releasing warning signals in time.

Warning signals

In case of an extreme rainfall event, there are three warning levels: yellow, orange and red (Interview F). A yellow warning will be issued when rain intensities of 50 mm in 6 hours is predicted, an orange warning when 50 mm in 3 hours is predicted and a red warning will be issued in case of 100 mm in 3 hours is predicted. However, the Shenzhen Emergency Management Office (2012) distinguishes four different warning levels on rainfall:

1. General (orange): when a river reaches a once in five years water level (applied to Shenzhen river, Maozhou river, Guanlan river, Longgang river and Pingshan river).
2. General to serious (red): when the above mentioned rivers reach a once in twenty years water level.
3. Serious (red): when rainfall or river water level of once in 50 years is reached, meaning rainfall intensities of 200 mm within 3 hours/ 270 mm within 6 hours/ 410mm within 24 hours.
4. Very serious (red): when rainfall or river water level of once in 100 years is reached, meaning rainfall intensities of 240 mm within 3 hours/ 320 mm within 6 hours/ 460mm within 24 hours.

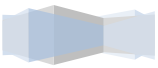
In order to enhance the specification of warning signals, the Command Center releases district-specific warning signals according to the predicted flood situations in each area. Also, when a warning is issued, the weather forecast system automatically sends out a warning message to sub departments in each district via text messages and an automated phone call (interview F). Every district has people in charge of spreading the warning. People responsible for each dwelling building will try to inform the dwellers and electric billboards are also used to inform the local inhabitants.

The Shenzhen Meteorological Bureau has the responsibility to warn at the highest level, which in turn is responsible for informing the second level and so on, until the message reaches the local inhabitants. This emergency information supply can be seen as the first level of participation (Däne & van den Brink, 2007).

Potential problems and improvements

As mentioned in the introduction of this thesis, the ongoing (and unforeseen) population growth and the ongoing and excessive use of land may result in inadequate drainage capacity. Another potential problem would be the aging of the drainage pipelines. Some of the older pipelines and pipe networks are, at that time, designed using lower standards meaning that these pipes are smaller and therefore reducing the flow rate and thus the capacity of the system (Yan, 2014). Some parts of the drainage system are aging and worn-out due to years of usage. Parts of the sewage pipes may be prolapsed and poor maintenance and incorrect maintenance can result in flow retarding or even clogging (Yan, 2014). Besides, the rivers where the rainwater sewage discharges can in itself be a problem. The construction style as it is makes a simple and unilateral drainage channel. Culverts from adjacent rivers and culverts in lower-lying parts of the river are bottlenecks and hinder the flood drainage capacity of the city (Yan, 2014). In the case of space limitations downstream, it is urgent to redesign the parks alongside and upstream of the river, allowing for better regulation of the water and more storage capacity to reduce the flood.

There is also a lack of a clear guidance for drainage in construction projects. Besides the Water Supplies Bureau, other municipal bureaus such as the Transportation Bureau, the Building Service Bureau and the Community Administration Bureau can have their own impact on the construction of drainage facilities that, without clear guidance, results in poor performance of the fulfillment of plans (Yan, 2014). Also the connection with the developments in the urban villages (see enrichment box) need closer attention. In order to control water quantities and water quality, transparent coordination and cooperation between property owners in urban villages and the water bureau of Shenzhen is needed. Lastly, management of drainage capacity needs improvement. The incomplete, or sometimes missing, data of drainage pipes leads to low utilization of its capacity. This is a result of the lack of long-term quantitative and dynamic records of the implemented pipes and the unsystematic and unscientific evaluation methods that are used now (Yan, 2014). This is remarkable when one takes the comprehensive technocratic and scientific assessment of current and future situation of Shenzhen (Lim et al., 2004) into consideration.



Exploration of practice.

To solve the issue of bottlenecks and insufficient capacity of the draining rivers in Shenzhen, the government of Shenzhen is looking for solutions to improve the rivers by means of flood retention areas near them. An example of this is the case of the Futian river. Mr. Fukuda, a tributary of this river, flows in the middle of Shenzhen and is designed using a flood control standard of once in a century (Yan, 2014). As part of the engineering projects in 2008 (aiming at improving the ecological landscape of the Futian River), the water passage capacity has been tested. Stemming from this test, and due to the Xiangtan River flowing into the Futian river and forming a bottleneck, the water level rose far above the permitted level. To be able to achieve the set standard, calculations show that a flow rate of 69 m^3/s is needed. By implementing flood retention zones in the adjacent green spaces, the required flow rate will be reduced by 24 m^3/s.

Another example of creating green flood retention areas near rivers is the project on the Pingshan river. The aims of this project is threefold: dealing with waste water, flood control and improvement of landscape (interview G). Here, the polluted rainwater will be treated first (the so called 'first flush') and then reused for irrigation. The abundant amount of water will be discharged to the river. This is an example of a more integrated approach to water management (de Wit et al., 2009).
In the Pingshan river project, where the standard for design is also once in a century, the concept of 'sponge city' is also applied in terms of LID developments. Here, green sidewalks are implemented to infiltrate as much rainwater as possible in the ground. For further LID measures they have kept a demo-area ''because *the technique and the concept is not very mature yet*'' (Liu, interview G).
The basic concept of the project is to control the rainwater and so to reduce the peak flow from it.

The LID concept in Guangming derives from a top-down policy (see chapter 4.1). To resist the run-off from extreme rainfall events, LID developments such as swales, permeable pavements and green roofs are being implemented in Guangming (Qin et al. 2013). LID measures are effective in flood reduction during the more heavy and intense rainstorms but their performance depend heavily on the characteristics of the cloud burst (Qin et al. 2013). However, Yao adds a nuance to this assumption: ''*LID does a great job for handling medium and smaller size rainfalls, but for extreme rainfall it doesn't do that much*'' (interview E). One of the reasons he gives for this is the immaturity of the LID concept in China. Besides, he states that most Chinese cities do not have the ability to properly deal with extreme rainfall because most Chines cities rely on traditional underground infrastructure. However, Wu argues that the LID concept is more than only not paving or building every square meter of land.

''*I think that we need to use as least money and resources as possible. Use the original nature and think of something that needs little maintenance. The first think that we use in our LID projects is the existing surrounding. We also talk to the local inhabitants. In that way we can get to know how people use and experience their surroundings as it is now*'' (Wu, interview D) .

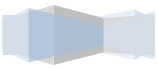
This reflects the second level of participation (consultation, Däne & van den Brink, 2007) and meets the typologies of empowerment, equity, trust and learning and early involvement of stakeholders (Reed, 2008). Following her, LID should be implemented across districts and it should be connected to the large original structures. Therefore, Wu dislikes the LID developments in Guangming New Town: ''*I know the LID from Guangming New Town […]. They actually have a double system (LID and sewage), so they don't trust their LID development*'' (Wu, interview D).

Lastly, the city of Shenzhen is developing more new concepts. Tang refers to the idea of building lowered playing fields or parks that can serve as emergency storage during extreme rainfall (interview C). But, here again, the concept is still in its infancy.

Technological and social innovations

As for technological and social innovations as a solution to the problem of extreme rainfall, Shenzhen is still exploring. The only technological innovation that are used are the models to research an monitor the functioning of LID measures and flood simulation models (interview H). Within the Shenzhen Meteorological Bureau there is only technological improvements in regard to the maintenance of the observation stations and adjustment of the software they use for analyzing the data (interview F).

On a social innovation scale, the government is also encouraging little to forge new and enhanced collaborations with other parties (both governmental and non-governmental). Following mr. Liwei, who owns a green roof and urban farming company, the government does not encourage them to do something with rainwater because he thinks that ''*the government has different ideas about the green roofs, so all different actors think about it differently, so they do not really cooperate with each another really well*'' (interview B). This can be put in perspective of the model of Däne & van den Brink (2007), where local authorities might not be familiar with the concepts and benefits of public participation and spatial planners not equipped with the capabilities for facilitating public participation and cooperation.

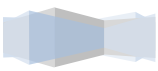


However, Lu adds a nuance: ''*we are trying to cooperate with the private domain. For example when a piece of land is sold, we try to apply regulations in the agreement on flood control, or you have to do some green roofs or raingardens*'' (interview H). But because of a lack of knowledge and experience, it does not get implemented. By this, she means that some departments or employees are willing to do more than the existing tasks, but that an institutionalized platform for stakeholders involvement (Li, 2013) is lacking (policies and regulations). She also says that just few bureaus and departments have this mindset; the majority does not really emphasize it. Tang (interview C) addresses the point of the government beginning to pick up ideas on collaborating with other parties. But, as he states, this does not develop to the next stage because there are not any incentives or encouragements on developing other than following the set standards. Here, again, the government of Shenzhen is still working on the first level of public participation (Däne & van den Brink, 2007).

Synthesis and reflection

In Shenzhen, roughly half of the sewage infrastructure consists of a separate rainwater system. The standards for design have recently been upgraded from 1:2 years event to 1: 3-5 years event (following a technocratic approach), which is quite firm. This means the system is designed on 60mm/day and inside the first original SEZ boundary the sewage system has been developed the most. Due to economic developments in Shenzhen, this upgrade (which is very expensive) has become affordable. However, one could debate about the financial effectiveness of this measure: these large pipes are, statistically, only required once every 5 years. The rest of the times they are only partly used.

In general, the rainwater will be discharged to one of the 310 rivers crossing Shenzhen, that eventually will be disposed to the sea (making use of pumps). This way of drainage is often used but can cause a number of problems. Ageing, bad maintenance, older design standards in place and bottlenecks in the rivers may harm the effectiveness of the system. Besides, discharging directly to surface water can lead to a decrease in water quality when run-off rainwater is heavily polluted. Here, policies on waste reduction and waste separation are needed to improve the run-off quality of the rainwater. Also, many inlets of the rainwater sewage are clogged by trash causing more waterlogging. Citizen co-operation and active involvement (participation level three, Däne & van den Brink, 2007) on this matter would greatly help reduce the bad water quality and waterlogging.

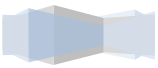


However, if things go wrong, there seem to be a very sophisticated, although outdated, warning system present. This emergency information provision can lead to an increase of the social capital of inhabitants and therefore increase the abilities for residents to take care of themselves (Restemeyer et al., 2013) and can be seen as the first level of public participation (Däne & van den Brink, 2007). However, times are changing and a warning system via social media would probably be much more effectively.

Lastly, Shenzhen has a shortage of accurate data on the functioning of their sewage networks. This information can be very helpful to enhance its capacity and functioning. Considering the relatively technocratic approach of the government, this is surprising to notice.

New concepts to deal with these problems are arising. LID developments, implementation of green roofs and the creation of emergency flood retention green spaces are examples. However, the idea of using these spatial measures to adapt to extreme rainfall are premature and guiding policies and regulations are still lacking. As for now, these concepts seem to have been copied from abroad and are now being experimented in different cities throughout China.

To enhance public participation, the government of Shenzhen should first ensure broad awareness by informing the private domain (first level of participation) and implement policies and regulations that either obliges or challenges the private domain to get involved subsequently. The government claims to be doing this already, but this education and information provision is on more general environmental issues, instead of adaptation to extreme rainfall. At the same time, active involvement of the private domain (third level of participation) should be institutionalized in order to work accordingly. Here, a distinction between the private developers and the citizens must be made. Whereas citizens can have important knowledge and advice to bring in to the development process (participation level 2) and can actively carry out, for instance, policies on waste reduction on streets, they probably cannot get involved further since they are not the ones who are actually developing or owning ground floor properties. The private developers are the ones that can actually co-create with the government and implement rainproof measures (participation level 3). However, to reach this, it is essential to have skilled spatial planners that can maintain an integrated approach and have the right skills to facilitate the different stakeholders (Däne & van den Brink, 2007). Mayor barriers in the planning culture of Shenzhen are still the issues of empowerment and involvement of the different affected stakeholders, equity and trust (Reed, 2008).



4.3.2 Expectations of the private domain

Previous chapter showed that the different governmental department of Shenzhen are not really collaborating with each other and that the collaboration with other, non-governmental, parties might be even further away. Although they are discovering several new concepts and ideas, it is still in its infancy and cannot be considered serious in this stage. To see why this phenomenon is happening, it might be interesting to see what the government of Shenzhen actually expects from the private domain and if they see a role for them.

The general perception from the government of local inhabitants is that they actually might have important knowledge and insights (although, only a few people) and that they are willing to actively help, but that they cannot actually do something themselves. As Lu addresses:

''*some of them [like to help actively to think of better solutions]. I think that local inhabitants can help […], we still have some intelligent people out there. After we have finished a plan, we ask for peoples opinion and they will give us some opinions. Citizens mostly only disagree upon the minor details of a plan*'' (interview H).

Here, Lu addresses the notion of the awareness of the local government of the merits that public participation can entail (Däne & van den Brink, 2007), but that the involvement is only at the end of the whole planning process (Reed, 2008). However Lu and Tang think that people cannot actually help physically because they live in high buildings, not on the ground floor. In other words: people do not have the mindset. The only thing Lu can come up with is the possibility of placing sandbags in front of the doors/windows in case they own a shop on the ground floor and Tang can think of the possibility of inhabitants to take measures to protect the infrastructure and keep them clean (interview C and H). Yao attributes the lack of mindset to other factors like the lack of knowledge environmental protection (interview E). More information and education from the government might be needed (participation level one).

Wu agrees on the willingness of the people to participate on the one hand, but the incapability's on the other. With this she refers to the incredible pace at which the city (must) develop, which does not leave any space and time to allow for broad public participation (interview D). As Wu continues:

''*there is some public participation, but most of it is within the urban villages. [Here] public participation is more like negotiating: if the city doesn't develop, the land of the farmers won't become more valuable. If the farmers lose their land then they only have their house left. So the*

public participation is more bargaining about the price on which the farmers are willing to lose their land'' (interview D).

The question can be raised whether, instead of the general public, the private developers have more possibilities to participate in adaptation to extreme rainfall. Wu is clear about this : ''*I don't think that they have any responsibilities on this matter. When they want to develop something, they just ask the pipe engineer*'' (interview D). Liu, on the other hand, does emphasize that in her opinion private developers actually can play a role, but to achieve that policies on that matter have to be implemented first (interview G). However, as mentioned by more of the interviewees, she thinks this is difficult because of the inexperience with such new ideas and concepts. As Yao also indicates: '' *We try to encourage the LID developments in the projects of the private developers, but because it is not compulsory they have the rights to decide if they will implement it or not. So they do not do it*'' (interview E).

Although it seems that many interviewees does not (yet) seem to see a role for the private domain, and in particular the local inhabitants, times might change in the near future. The government is getting to know with these new thoughts and concepts and is planning on studying more on this topic. The lack of knowledge and experienced with this new approach of dealing with extreme rainfall is preventing the government from implementing it. First, the government is currently spreading information and education about environmental concepts to the inhabitants. This can be seen as a first step and as participation level 1 (Däne & van den Brink, 2007).

Synthesis and reflection

The general opinion from the government of the private domain is that they might have useful information and that they also want to be involved. However, the perception is also that they are incapable of taking measures themselves and that they also don't have the actual mindset for it. This can partly be explained by the fact that most inhabitants do not live in the ground floor. Also the idea of involving private developers is not very much alive. Although the government does not see a role for the local inhabitants and private developers yet, times might change in the near future since the government is looking into public participation more attentively. New policies and regulations and the institutionalization of public participation is than needed. However, the government lacks knowledge and experience with these new concept, and extensive piloting will be necessary. Besides, the private domain first have to be informed and educated on the issue (participation level one), followed by encouragements to get involved actively (participation levels two and three). This requires also some effort and attention from the government.

4.4 Private domain's approach to extreme rainfall

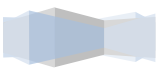
Results on the implemented measures by the private domain and the expectations of the government are presented in this chapter. First, general demographic characteristics of the respondents are presented followed by the taken measures from the private domain. The chapter concludes with discussing the expectations of the government.

Demographic characteristics

In total 100 surveys are conducted, almost evenly divided over the two research areas. Roughly one third of the respondents is male, two third is female (appendix 16, table 1). It can be deduced that in both areas more women than man have completed the survey and that the ratio in each area is almost the same (appendix 16, figure 1). The age distribution in each research area is also more or less the same: the age categories 16 – 25 years old and 26 – 45 years old represents almost all respondents (appendix 16, figure 2). The age distribution by gender within the two different areas vary slightly (Appendix 16, figures 3 and 4). In Xili the share of 26 – 45 year old men is slightly bigger than the share of men within the same age category in Sea World. The share of 16 – 25 year old men in Xili, on the other hand, is smaller than the share of men in the same age category in Sea World. However, due to the relatively small amount of respondents in both areas, big differences in numbers may appear rather fast. Finally, the shares of women in each age category are almost similar. These characteristics of the sample are reasonably representative of the population of Shenzhen.

Since the research on the approach of the inhabitants have been carried out in two different areas it is useful to see whether there is a significant difference between experiences with floods in both areas before proceeding discussing the results on each sub question.

Following the Pearson Chi-Square test and the corresponding coherence measures Phi and Cramer's V, there is no significant difference between the experience with a flood in both areas (appendix 17, tables 1,2,3). Subsequently, the choice has been made to combine the data of the two areas for the sequel of the research. The independent comparative variable, therefore, is not the location of the area but the experience with a flood.



4.4.1 Implemented measures

This chapter elaborates upon the results of the sub question – what measures has the private domain adopted? - using varying relationships resulting from the statistical analysis of the conducted surveys. To answer this question, data of the following survey questions have been used:

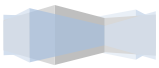
1. Do you live on the ground floor?
2. Have you ever experienced a flooding from extreme rainfall?
3. How do you experience a flooding ?
4. Do you take measures yourself to prevent water damage?

Housing levels and flood experiences

A hypothesis one might come up with is the assumption that inhabitants living on the ground floor might have more experience with flooding from extreme rainfall opposed to inhabitants living on the first floor or higher. The corresponding Chi-Square test (appendix 17, table 4) shows that there is no relationship between the experience with a flood from extreme rainfall and the housing level.

It is even more striking that only 24% of the inhabitants living on the ground floor has ever experienced a flood as opposed to 42% of the inhabitants living on the first floor or higher. This could be a result of a relatively small amount of respondents in the group living on the ground floor, which makes the numbers quickly subject to large differences. Another remark must be made concerning the credibility of the data since the method of conducting the surveys (see chapter 3.4.2) can lead to skewed data. By conducting the surveys only in ground floor properties, the share of respondents answering with 'living on ground floor' is probably artificially higher then when conducting the surveys on the street. In Shenzhen, the greater share of inhabitants are living on the first floor or higher (interview C and H). Also, because most properties in the target areas are shops, restaurants or bars, the chances are high that a certain amount of respondents are employees of the business, rather than the owners. Then, the question might be misinterpreted: respondents might have answered the question as 'working on the ground floor' or 'I'm now at the ground floor'. Finally, this uncertainty also makes it uncertain whether the respondents working as an employee answered the 'experience with a flood' question reasoning from their own perspective (home situation) or from the perspective of the corresponding property they work in.

In conclusion: there is no relationship between the housing level and the experience with a flood from extreme rainfall. However, various deficiencies could underlie the results of this comparison.



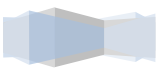
Perceptions of a flood

It is interesting to see how the respondents perceive a flood from extreme rainfall and if there are any significant differences between respondents who have never experienced one to those who did. The corresponding Chi-Square test (appendix 17, table 5) shows that there is no relationship between the experience with a flood from extreme rainfall and different perceptions of a flooding.

From the cross-tabulation one can deduce that the majority of the respondents perceive a flood rather negatively. Roughly 40% feel threatened by it, 43% have a negative attitude towards it because of anticipated property damage whereas only one sixth of the respondents perceive a flood as a nuisance. Needless to say, in general, inhabitants of Shenzhen have a fairly negative perception (perceiving it worse than only as a nuisance) of a flood from extreme rainfall. Furthermore, as the Chi-Square test already pointed out, there is hardly any difference in perception between respondents who did experienced a flooding and respondents who have not experienced a flooding. This is somehow surprising since one might expect that having an experience with a flood would affect one's perception of it in a negative way.

A couple of explanations for this observation can come to mind. The first one, and maybe the most straight forward, is that respondents who did not have such an experience can empathize strongly with others who have, and therefore they can put themselves in the same situation. Besides, the question is difficult to deny or easily to agree upon (O'Leary, 2010). Finally, people could have had indirect experiences with a flood from extreme rainfall by means of stories from family members or friends who did experience such a flood. This in turn results in an increased empathy.

In conclusion: there is no relationship between the perception of and the experience with a flood from extreme rainfall. In general, the majority of the respondents perceive it as a fairly negative experience.



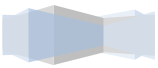
Taking measures to prevent water damage

Based on the resiliency theory (Restemeyer et al, 2013), one might expect that citizens who ever had an experience with a flood implement more measures to prevent it from happening again. The corresponding Chi-Square test (appendix17, table 6) shows that a relationship between the experience with a flood and whether respondents take measures themselves does exist, although it being a low association relationship leaning towards a moderate association. As the relationship might look straight forward, a distinction between different implemented measures, however, must be made.

Some respondents (12%) undertake physical measures to protect their property: putting sandbags / dam in place, strengthen the balcony and the glass door, close doors and windows and move valuable stuff (even a car) to higher places. Other measures often mentioned are making sure that people's lives are safe, making use the information of the weather forecast to prepare accordingly and take actions to prevent the drainage system from blocking. Lastly, two respondents referred to the protection of the environment: '*I never cut any trees or forest and protect the eco system*' and *'It is the responsibility of everyone to protect the environment'.* Some of these measures can be seen as active involvement of the private domain (participation level three). However, these actions are not agreed and aligned with the approach of the government. Other actions (such as paying attention to the weather forecast) can be seen as participation level one.

The respondents who don't take measures themselves also have different reasons. Firstly, there is a large group (13%) that state that they have not experienced a flood so far. Another large group stresses that they don't know what to do: ''*No idea about what to do*'' (respondent 52), referring to a lack of education and information (participation level one). Also, many respondents (9%) had the feeling that they are powerless on their own or that they didn't have the capabilities to do something: ''*I want to do more, but I feel I have little power/influence. I hope the government can unite people to act on the probl*em'' (respondent 6). This refers to the lack of empowerment, equity and trust of stakeholder involvement (Reed, 2008). Also, the group of people who stated that they do not know what to do can have overlap with this group: if you do not feel empowered, you automatically might not know what to do.

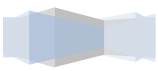
Lastly, respondent 67 stated that she did not live on the ground floor (and therefore no measures are needed) and respondent 21 stated that she tried to do so, but it did not help.



The finding of this relationship can be explained using the resilience theory. People who ever experienced an extreme event such as a flood from extreme rainfall in the past tend to show a learning curve, and put measures in place to adapt to the next extreme event (Restemeyer et al. 2013). The physical measures that respondents put forward are traditional examples of individual adaptation. Making use of the weather forecast information shows that provision of information (level one) is essential in adaptation processes. Keeping sewage inlets clear of rubbish could lead to improved adaptation on both individual level and community level. Also, taking measures themselves might be a result of having a shop/house on the ground floor, which enables them to actually put useful measures into place (also in combination with the urge to do so after previous experience(s) with flood(s)).

The other group of people who never experienced a flood show less participation because: they never experienced it an thus never had to cope with such situation (although, hearing the news or stories from friends should provide enough information to become more resilient), they don't know what to do (partly because of the lack of experience and information) and they feel powerless on their own. It is logically to think that these respondents probably live on the first floor or higher: in that case people might think it is more difficult to contribute to adaptation.

In conclusion: the relationship between the experience with a flood and putting measures into place exists and shows a low (to moderate) association. Explanations for this are the resiliency learning curve and the capabilities of people living on the ground floor to put useful measures into place. Some citizens actively put physical measures in place to protect their property and lives, or try to keep the sewage inlets clean. Those who did not experience a flood do not know how to contribute to the adaptation process because of a lack of information and education provision (participation level one) and feel powerless.

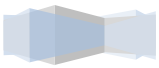


Synthesis and reflection

There is no significant difference between the experience with a flood in both areas. The independent comparative variable, therefore, is not the location of the area but the experience with a flood. There is no relationship between the housing level and the experience with a flood from extreme rainfall, which can be explained to a large extent by the fact that most people live high above ground level. There is also no relationship between the perception of and the experience with a flood from extreme rainfall. In general, the majority of the respondents perceive it as a fairly negative experience.

The relationship between the experience with a flood and putting measures into place, however, does exists and shows a low (to moderate) association. Explanations for this are the resiliency learning curve and the capabilities of people living on the ground floor to put effective measures in place.

The general tendency is that inhabitants think that citizens contain valuable local knowledge to reduce the flooding but that there is a lack of a platform to join forces in order to get empowered. Also ,the people who does not put measures in place either did not have had an experience with a flood so far or often do not know what they can do and feel powerless. As can be derived from previous chapters, the government is also looking into more public participation. A first step to public participation would be information provision and education, followed by the institutionalization of a platform for stakeholder engagement. People need to be empowerment (and united) to get involved in the adaptation process to extreme rainfall.



4.4.2 Expectations of the government

This chapter elaborates upon the results of the sub question – What does the private domain expect from the government of Shenzhen? - using varying relationships resulting from the statistical analysis of the conducted surveys. To answer this question, data of the following survey questions have been used:

1. Who should, according to you, be held responsible for the rainwater management in Shenzhen?
2. Are you willing to participate as a citizen in helping the government to deal with extreme rainfall?

To provide these statistical analysis with more in-depth information, the answers from the following open questions are used: What do you expect from the Government with regard to dealing with extreme rainfall? What do you think that citizens should do to prevent damage from extreme rainfall? What do you think that the government should do to prevent damage from extreme rainfall?

Responsibilities

A part of the expectations from the private domain of the government (of Shenzhen) on this topic can be explained by looking into their opinion about the allocation of responsibilities. A bar chart of the responsibilities according to the respondents opinion is made (figure 12). What clearly emerges is that the vast majority (79%) of the respondents find that the responsibility for rainwater management is pluralistic. A combination of governmental layers, water authorities and citizens should be held responsible. On the other hand, only roughly 5% of the respondents think that it should be a matter of one of the governmental layers only (national, provincial or municipal government or water boards). Lastly, none of the respondents find that the responsibility for rainwater management is one for citizens alone. Although it would be interesting to see if there is any relationship between the experience with a flood and the opinion on the responsibility, the sample size on this matter did not allow for such analysis.

Examining the proposed responsibilities closely, and especially the expectations of the government, reveals that inhabitants (in general) expect the government to solve the issue at hand. Many respondents (21%) addressed the issue of the improvement of the functioning of the drainage system. ''*Government should spend more money on the drainage systems*'' (resp. 24) and ''*enhance the management of the drainage system and prevent blocking of the inlets*'' (resp. 81) are two of the remarks. Besides improvement of the infrastructure, 20% of the respondents also expects the government to alarm citizens in time and provide public education on what to do. Respondent 53

emphasizes: '*there should be an early warning in time'* and respondent 30 adds: '*more professional guidance and training courses for the community'*. This reflects upon the first level of participation (Däne & van den Brink, 2007).

Lastly, a group of respondents (8%) expect the government to solve problems as quickly as possible when a disaster strikes and a few stresses the importance of implementing new policies. Respondent 6 expects the government to have '*open and transparent politics'* and respondent 34 adds, because '*many buildings collapse after a major storm, the government should reinforce building safety standards*'.

In conclusion

Most inhabitants think that the responsibility for rainwater management is pluralistic. However, the majority expect the government to solve rainwater problems by improving the infrastructure and providing necessary help during a disaster. Also, they like to have more and better education on how to deal with these events and expect an early weather warning. Surprisingly, following the remarks in previous chapters, very few respondents addressed the issue of empowering the private domain. Here, participation level one (information) seem to be sufficient.

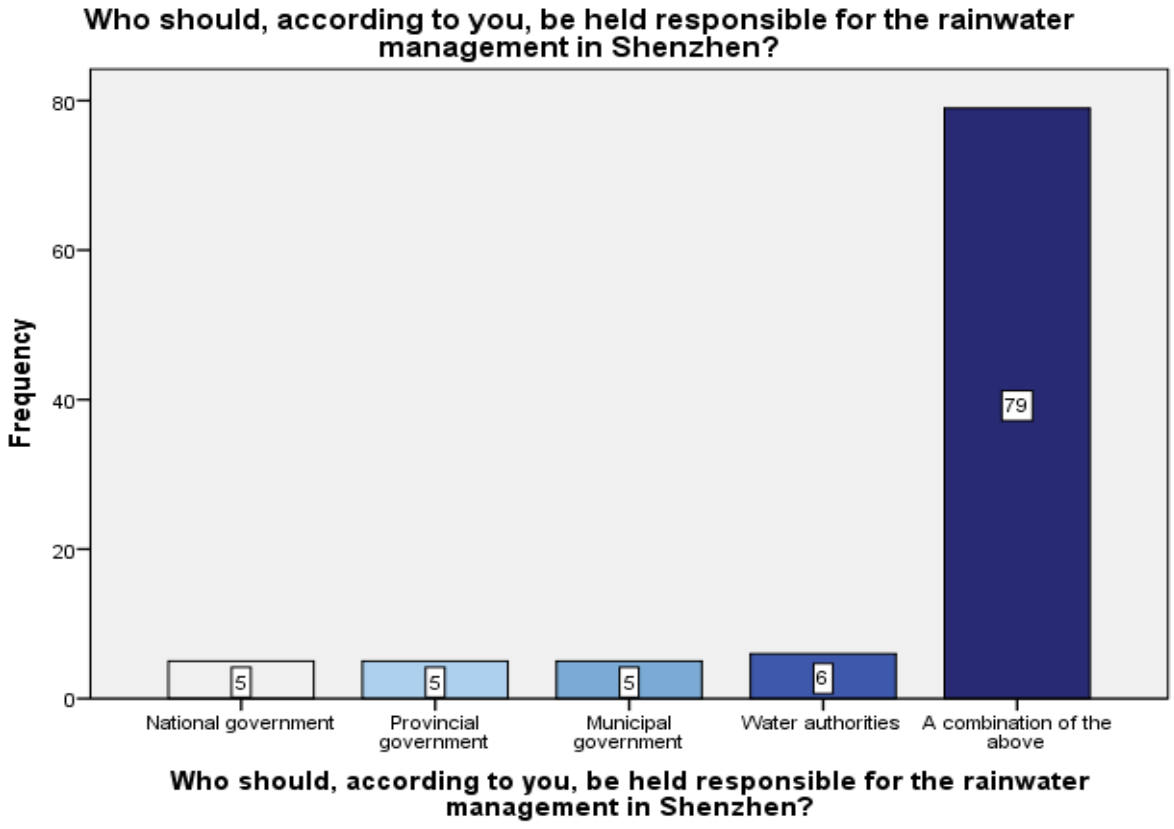


Figure 12: Allocation of responsibilities

Willingness to participate

Another part of the expectations from the private domain of the government can be explained by the extent to which citizens see a role for themselves in the process of adaptation to extreme rainfall. Following the result of the Chi-Square test, a relationship between having an experience with a flood and the willingness to participate does not exist (appendix 17, table 7).

From the cross-tabulation one can deduce that the majority of the respondents are willing to participate (79,8%) and that 19,2% of those respondent state that they are already doing so. Also, and although there may no relationship be assumed, it is noteworthy that people who ever experienced a flood are, relatively, more willing to participate: 86,9% compared to the 65,4% of the respondents who never experienced a flood.

But what does this participation mean in the eyes of the respondents? Following the answers to the first open question there are some various categories identifiable. A vast amount of the respondents (26%) see environmental protection (partly) as their role in the adaptation process to extreme rainfall. ''*Citizens should not do anything that possibly damage the environment or disrupt the eco balance''* (resp. 48) and *''plant more trees, bad people cut the trees''* (resp. 8) are some attitudes. However, the term environmental protection can be interpreted quite broadly and whether all facets of environmental protection address the issue of adaptation to extreme rainfall with the same magnitude can be arbitrary. Of course, more trees means less impervious surface which can benefit reducing run-off. However, in order to be able to make a contribution to the problem at hand, these trees need to be planted in places where they are actually needed. It is hard to deduce what kind of environmental protection measures the inhabitants exactly mean, and whether they focused their answer on the given problem or whether it is a more general answer, applicable to a multitude of climate problems.

Besides environmental protection, respondents (20%) also addressed the issue of knowing what to do before and during a disaster and the ability to save themselves. Respondent 6 elaborates: *''learn more about basic living skills, prepare for doomsday. Have the ability to save yourself*'' whereas respondent 30 adds: ''*Learn prevention methods to decrease property loss''*. Generally, the types of measures mentioned within this category are about obtaining knowledge to perform risk management in terms of individual safety and individual materialism. This necessary information, however, has to be provided by a third party, and usually one referred to the government (participation level one, Däne & van den Brink, 2007).

Another category often referred to by the respondents (17%) is the category 'helping the government'. This varies from *'monitoring the government on doing their job right'* (resp. 2) to *'giving advice to the government about the infrastructure, the construction and also protect the infrastructure'* (resp. 53) to *'cooperating with the government about the evacuation actions'* (resp. 54). Here one can see that some of the respondents are actually willing to participate with the government, by giving advice (participation level two, Däne & van den Brink, 2007) or by taking actual physical measures such as maintenance of the infrastructure or improving the infrastructure (Participation level three, Däne & van den Brink, 2007). Others only see their role as a controller of the functioning of the government.

Finally, a small group of respondents see it as their task to unite people. As respondent 14 stated: ''*Unite as people, more people = more power*''. This remark can be traced back to the results on why some people don't take measures (chapter 4.2.2). Some respondents don't have the feeling that they can do something on their own (i.e. that they don't have any influence on the government) or that what they can do on their own won't help seen in the bigger picture of rainwater adaptation. These remarks reflect on the lack of empowerment, equity, trust and learning (Reed, 2008).

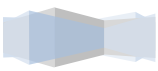
On the other side, answers to the question on what the private domain think that the government should do provides a more nuanced insight. Although respondents stated to be willing to help the government on this subject, answers to the latter question show that still a mayor part (19%) of the respondents expect the government to deal with the situation in terms of improving the sewerage and flood defense infrastructure. As respondent 38 states: ''*public facilities, building constructions and infrastructure projects should be long lasting and address possible water problems. Carefully planned road and drainage system, so water is drained properly*''. Respondent 53 adds to this: ''*Completing the infrastructure, and it also should be protected and maintained regularly*''.

As derived from the answers to the pervious question people state that they are willing to participate. However, answers to this question (16%) state that for that they first have to gain more information and public education from the government ''*The government should take some measures to let the residents know more about disaster prevention*'' (respondent 60).
Lastly, a smaller group respondents emphasizes the necessity to actively involve citizen participation: *''do more surveys on the opinion of the people''* (resp. 20). These last two examples show that first, the awareness and the level of knowledge of the private domain needs to be raised (participation level one, Däne & van den Brink, 2007) and secondly, the opinion and experiences of local

inhabitants need to be questioned in order to get them to participate actively (participation level two, Däne & van den Brink, 2007). This, however, requires greater efforts of the government.

In conclusion

A relationship between the experience with a flood and the willingness to participate as a citizen does not exist. In general, the majority of the inhabitants are positive about participating in the adaptation process to extreme rainfall. To do so, first information and education are needed (participation level one, Däne & van den Brink, 2007). Besides that, people need to gain the feeling that they can actually contribute and that their opinion is heard by the government (basic rules that underlie public participation, Reed, 2008). As for now, the majority of the inhabitants still expect the government to deal with the problem in terms of upgrading and implementing more or better rainwater infrastructure. For the future, people seem open to give advice and actually help the government in the adaptation process to extreme rainfall. Yet, education and an institutionalized platform for them to participate is strongly needed.



5. Conclusion

The city of Shenzhen has developed and will still develop extremely fast. Rapid population growth continues to put pressure on scarce resources, land use and livability. Meanwhile, climate is changing, placing even greater burden on current and future challenges. one of these challenges is adaptation to extreme rainfall. To tackle this issue, China has recently developed an adaptation policy framework. Yet, it is quite scientific and technocratic in nature and although public participation can, among others, lead to better legitimization of decision making, increase the quality and effectiveness of plans and build trust and capacity, it has been unusual in Chine environmental policy making. Nevertheless, there are signs that public participation in China is growing around water related topics. Therefore, this chapter will enumerate and elaborate on the main findings of this research which together will form an answer to the main question:

What is the role of public participation in adaptation to extreme precipitation in Shenzhen and what are the main views on it of the government and the private domain?

Climate change, policies and organization

Climate change in Shenzhen is occurring: the average annual temperature has increased with 1,6 degrees in the past half century, the relative humidity and the annual haze days have been decreasing and the extreme rainfall events will increase in frequency and intensity. This increase in extreme precipitation will lead to more waterlogging and floods. Bao'an, Longgang, Guangming, Pingshan and Nanshan are the most commonly flooded districts of Shenzhen. The Shenzhen Meteorological Bureau is responsible for accurate weather forecasting and issuing of emergency announcements. For more precise and accurate predictions on the micro climate within the city, however, the bureau is in need of measure equipment with a finer resolution. Because flood events have a strong local and partial character, the government, business industries and citizens should actively and simultaneously work on mitigation and adaptation. This, however, requires much effort.

To address the issue of climate adaptation (and mitigation) in China, several commissions, institutions and departments have been established the past decades to do research about, and set up policies and regulations. The government is also working on more public participation by means of education and information provision. Yet, most of the efforts on policies, regulations and education concern air pollution and carbon emissions, passing extreme rainfall into oblivion. An

institutionalized platform for engaging stakeholders on participation level two and three also seem to be missing and instruments or incentives for active public involvement are lacking. Besides, local adaptation and mitigation policies of Shenzhen have to fit into the discourse of the national growth framework, making it difficult to fully adapt.

In Shenzhen, the Municipal Water Affairs Bureau is responsible for the main policies, regulations and plans on water related issues. Every district has its own sub department of the Water Affairs Bureau. Although all water topics are united in this bureau, little or no cooperation between different departments results in a lack of an overall integrated approach. The Water Affairs Bureau also has obligations concerning the implementation of an extensive warning system during extreme events. The infrastructure for (rain) water management and the emergency system is paid by general taxes and taxes on wastewater. A clear distinction of financial resources for storm water management is absent.

To deal with climate change and the intensifying cloudbursts, the design standards for (rain)water sewage have been raised to 1: 3/5 years (meaning a system that is able to handle up to 60/mm day) recently. Roughly half of the sewage infrastructure consists of a separate system, with most developed systems within the original SEZ zone. Rainwater, generally, will be discharged to one of the 310 rivers running through Shenzhen whereby water quality can become an issue. A lack of accurate data, maintenance and ageing of the infrastructure results in suboptimal functioning of the drainage system. To compensate for the lack of drainage facilities, new concepts to adapt to extreme rainfall like LID and Sponge City are being experimented with. If these pilots have been proven successful, it is very likely that they will be scaled up to other districts and cities throughout China as best practices. For wide implementation, however, Shenzhen is still very inexperienced and lacks the necessary knowledge.

The role of public participation

As for now this research shows that, viewed from the government, public participation in adaptation to extreme rainfall is virtually absent. The concept of public participation is starting to grow within governmental departments by means of more information supply and education. Efforts on this first level of participation, however, are more geared towards mitigation to general environmental issues instead of adaptation to extreme rainfall. More information supply and public education on this topic would be necessary to create more awareness.

Also participation of other stakeholders other than normal citizens is absent. Private developers only have to meet the prescribed standards when developing. The lack of awareness and an institutionalized platform for public participation results in the complete absence of it. Public participation could help to implement more measures and increase the quality of adaptation. However, the government of Shenzhen is inexperienced in facilitating this, and pilots should be carried out to enlarge knowledge and experience. Based upon this, the government can put policies and regulations in place to fully commit to participation accordingly.

A part of the private domain, however, state to actually take measures to adapt to extreme rainfall, although a large part think that they cannot actively contribute. Measures taken include putting physical measures in place to protect property, protection of lives, protection of the environment and cleaning inlets of storm drains. However, these measures have been taken on own initiative and without active encouragement of the government. Paradoxically, the private domain thinks they have valuable knowledge to improve adaptation but the majority does not feel empowered to do something and still expects the government to solve rainwater problems by improving the infrastructure and providing help during a disaster.

Main views of the government and the private domain

The general perception from the government of local inhabitants is that they actually might have important knowledge and insights (although, only a few people) and that some of them are willing to help actively, but that they cannot actually help tremendously. The government also thinks that, in general, there is no mindset among the private domain because people live above ground floor. Because the government is beginning to see the benefits of creating more awareness, they are willing to start with more information supply and public education. Because of limited time for developments, however, the government does not seem to be keen on participation beyond the scope of informing and educating.

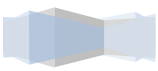
Most of these perceptions follow closely to the perceptions of the private domain. Here, the private domain also thinks that they can provide the government with valuable knowledge to be able to adapt better to extreme rainfall. Also, in general, the majority of the inhabitants are positive about participating in the adaptation process to extreme rainfall but to get involved, citizens first want to have more and better education and information on adaptation to extreme rainfall. Besides that, people need to gain the feeling that they can actually contribute and that their opinion is heard by the government. In other words, people like to be united or empowered to be able to participate

actively. Although people like to get involved more (participation level one and two), the majority sees adaptation to extreme rainfall as mainly a governmental issue.

Returning to the main question of this research, the role of public participation in adaptation to extreme precipitation in Shenzhen to date is almost absent. Reasons for this are not recognizing the capabilities of the private domain to contribute, the tight development timeframes, the lack of awareness and knowledge and an institutionalized platform for public participation.

For now, the governments' perception is that the role of the private domain is minimal because it cannot easily contribute to the problem but there are signs that government is beginning to recognize that the private domain might contain valuable knowledge to improve adaptation. However, the government does not yet see a great role for active participation of the private domain. The private domain, on the other hand, also has the perception that they are not able to (greatly) contribute physically. Yet, also the private domain is convinced that they have valuable knowledge that can contribute greatly to the adaptation efforts of the government. The private domain seems to be more willing to participate than the government would like. Although, this is to a certain extent because the private domain, however, still expects the government to deal with adaptation to extreme rainfall. Shared ownership of the problem is still hard to find.

To see what these found result might mean for adaptation to extreme rainfall in Shenzhen, the next chapter will reflect upon the usability and meaning of the results and will bring forward recommendations for enhanced adaptation and further research.



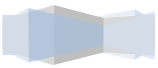
6. Reflection and recommendations

In this chapter the results are reflected on the theory , a comparison with adaptations efforts in western countries is made, recommendations for enhanced adaptation in Shenzhen are stated and strengths and weaknesses and/or uncertainties of the research followed by recommendations for further research are described.

6.1 Theoretical reflection

Following the theory, spatial planning and its accompanied developments should be about creation of an integrated approach by means of organizing cooperation between various affected stakeholders representing various groups with different levels of knowledge. Yet, even within the own governmental bodies of Shenzhen, a lack of coherence and close cooperation causes failure of the planning system to protect the environment in an integrated manner (CCICED, 2014). Because (rain)water does not follow administrative boundaries, water management is strongly intertwined with all kinds of other facets of developments in – and the livability of a city. Integration of sectoral and spatial policies at city level is greatly needed (CCICED, 2014) and the mainstreaming of climate resilience and adaptation capacity of Chinese cities will become important. For instance, the quality of surface water is dependent upon proper disposal of rainwater (overflows of the system leads to water deterioration), design and layout of busy roads nearby and the presence (of absence) of policies on waste management.

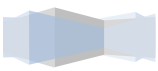
To process the excessive amount of rainwater in a way that causes no damage demands for storing water in alternative places as opposed to underground infrastructure. Because processing of rainwater is dependent upon spatial designs, micro surface elevation, soil characteristics and many more, mainstreaming of climate adaptation within the different municipal departments is crucial. Mainstreaming is the integration of climate adaptation goals into existing policies (Uittenbroek, 2014). Or, as Bouwer & Aerts (2006) explains: ‘’*the integration of adaptation policy and measures into ongoing (national) sectoral planning and decision-making processes*’’ (p. 58). This could, besides a viable comprehensive approach, also lead to more efficient and effective use of financial and human resources (Klein et al., 2007).
All these different tasks and responsibilities lie within different governmental department, thus to get an integrated approach close cooperation is highly needed.



Furthermore, an integrated approach also demands correct stakeholder engagement and public participation. Available theories suggest that especially four factors influences the possibilities of public participation in spatial planning processes and that there are various levels of public participation to be addressed (Däne & van den Brink, 2007). In Shenzhen, the central-local government relationship results in national policies and guidelines with very little to no public participation that sets the outlines for local governments to act upon. The local government of Shenzhen seem to lack awareness of the merits of public participation as well as the experience with organizing it However, a slow shift to involve inhabitants at least on participation level one is emerging. This could easily be reached by means of establishing broad education and information programs in order to increase awareness and knowledge among local residents.

On the other hand, citizens feel powerless to act (they do not feel they are equally empowered) but are motivated to participate. They point out that they want more education and information about climate change and adaptation to extreme rainfall. Yet, besides getting informed and educated, the private domain also seem eager to participate more actively. However, how or in which way they picture this exactly remains unclear since they also address the issue of feeling powerless to be able to act physically. What is lacking for more active involvement, nevertheless, is an active and institutionalized platform for stakeholder engagement. For that, individual citizen and social organization participation rights should be clearly defined in regulations and laws at both provincial level and municipal level and they should provide a reliable legal basis for participation in social governance (CCICED, 2014). This means, inter alia, that institutionalizing participation needs to be based upon the philosophy of empowerment, equity and trust and as early as possible throughout the process (Reed, 2008). This requires mayor changes in daily activities and routines of the government and, considering the relentless pressure to develop within very tight timeframes, might not be as easy as suggested.

As the description of Li (2013) o the functioning of the adaptation policy framework in China already indicated, climate change adaptation in Shenzhen is fairly scientific in nature and strategies are based upon a number of best practices, leaving little or no room for stakeholder engagement and assessment of the implications of adaptation policies on social factors. However, as adaptation to extreme rainfall should go hand in hand with improving the livability of a city by means of an integrated approach, some level of public participation would be crucial.



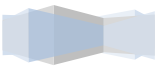
6.2 Comparison with western countries

In different cities throughout Europe, adaptation to climate change is becoming a major issue. In Amsterdam and Copenhagen, new climate adaptation strategies are being implemented as a reaction to the foreseen growth in extreme rainfall.

In Amsterdam, Waternet (who is responsible for the fulfillment of both the municipal and water board tasks on water management in the city), acknowledges that simply increasing sewer capacity will be insufficient and financially unfeasible. They therefore stretch the importance of a city-wide approach and the integration of the public domain to be able to process extreme rainfall in a proper way. Space within urban areas, both public and private, should be addressed as opportunities for the storage of (excessive) rainwater. In January 2014, Waternet initiated the program Amsterdam Rainproof to encourage this strategy. By means of a network approach, this program aims at connecting and involving all kinds of different stakeholders throughout the city to co-create awareness, develop knowledge and to get every stakeholder to enhance adaptation to extreme rainfall (Amsterdam Rainproof, n.d.). Here, together with many different stakeholders (for instance: civil servants, administrators, housing corporations, inhabitants, business owners, neighborhood initiatives and insurance companies), the program is exploring various incentives to get both public and private domain to act rainproof (Amsterdam Rainproof, 2014).

The municipality of Copenhagen decided to adopt a climate adaptation plan after the most devastating cloudburst in July 2011, causing over 1 billion euro damage (Ramboll, 2014). This plan consists of over 300 projects on rainwater retention and the main strategy emphasizes on water discharging by means of open canals and detaining of rainwater on existing greenspaces (City of Copenhagen, 2012). In Ørestad, Copenhagen's new city district, climate adaptation was taken into consideration from the very beginning and road water, rainwater and wastewater will be collected and treated separately. Also the elevated metro line is a nice example of climate proof developments.

These two examples show the multitude of ways to deal with rainwater. Commitment and adjustments of daily routines are, however, essential in order to adopt a new approach.



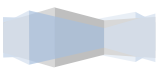
6.3 Recommendations for enhanced adaptation in Shenzhen

For Shenzhen, to enhance adaptation, it is firstly highly advisable to improve cooperation between all different departments in order to develop an integrated approach and to mainstream the adaptation strategy to extreme rainfall. Now, (close) collaboration between different departments seem to be missing resulting in an inefficient and incomplete approach and diminishes the possibilities to cope with rainwater in a different way than traditional underground infrastructure. Furthermore, close collaboration with administrative districts upstream to some of the rivers flowing through Shenzhen would be necessary to be able adjust the water quantities at certain times, allowing for more space to buffer rainwater during extreme rainstorms. Also close collaboration with the system of the various urban villages throughout Shenzhen is crucial to design, maintain, and adjust rainwater and sewage systems correctly. As it is all linked together, authority to act upon and monitor these administrative sub districts is necessary.

Besides the mainstreaming within governmental departments and collaborating more closely with other administrative districts, for an integrated approach to work, participation of the private domain must be institutionalized by developing or adjusting certain laws and regulations, creating an active platform for stakeholder engagement.

As has emerged from this study, local citizens first need better information and education and are open to this. Besides, the local inhabitants indicate that they are willing to share their knowledge on their local neighborhoods or even want to actively help preventing floods by means of cleaning storm water drains. In order to do that, inhabitants have the desire to get empowered and have the need to gain an institutionalized channel to be heard. The government should be able to organize this. However, this might be as far as it gets in terms of the capabilities of local inhabitants to get involved in participation. Both parties do not see an active role for the inhabitants to physically enhance adaptation to extreme rainfall since most of them are living above ground floor.

Which, however, still does offer great opportunities, and although only minimally highlighted in this study, is the participation of other private stakeholders such as private developers and insurance companies. In Shenzhen, they could play a major role in adaptation to extreme rainfall since they can actually put physical adjustments to properties in place. Compulsory policies and regulations or financial incentives (tax reforms) could be instruments for the government to achieve involvement of these parties. As can be derived from this research, only encouragement on voluntary basis does not seem to work.



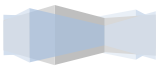
Taking the planning culture of Shenzhen at hand, compulsory policies on, for example, mandatory harvesting and reuse of rainwater in properties to be newly developed would fit fine. Private developers seem to have more than enough financial margins to be able to absorb this. Another option would be the use of non-financial compensation instruments, where extra property rights rather than money rewards are assigned to compensate landowners or developers for certain land use decisions or obligations (Veen et al., 2010). However, to be able to implement this correctly, correct stakeholder engagement and representativeness, negotiation powers and democratic procedures are necessary factors, making it more difficult to implement in the context of Shenzhen.

Finally, technological developments allow for new and better data to provide better solutions. Here, many opportunities for the city of Shenzhen to develop towards a smart city are arising. Computer simulated stress tests of flood events could help identify major wet spots and provide important information even before a disaster happens. Moreover, the city of Shenzhen is home to a number of physical characteristics that, if designed correctly, could greatly enhance the capacity to absorb extreme rainfall. One of these characteristics is the massive amount of green spaces present throughout the city. Green space in itself already enhances adaptive capacity, but when they also will be designed for emergency water retention areas, the adaptive capacity of the cities' system will greatly increase. Another characteristic is the present elevation differences. When looked upon as opportunities rather than threads, these height differences can be used to steer rainwater to place where it cannot do any harm. With technological innovations highly accurate data can be obtained, new information can be developed and rainwater can be controlled, detained, discharged and steered in desirable directs. It is almost paradoxical to see that the city where electronics are put together, does not used technological developments for the purpose of water management.

6.4 Reflection on the research process

This research has resulted in generally valid and useful findings. Yet, despite every effort to carry out the research as thorough and accurate as possible, some critical remarks on the research process should be taken into consideration.

The mayor limitations of the study lie within time constraints, language barriers, freedom of speech, the willingness to openly express one's opinions and the approach to carrying out the surveys. The research had to be carried out within a timespan of six weeks, putting pressure on the making and scheduling of appointments. The language barrier has slowed down the research process because

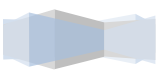


for (almost) every appointment a translator had to be arranged. Furthermore, the language barrier probably have resulted in a large loss of essential information along the translation process. The English language proficiency of the translators varied greatly and professional jargon hindered the translation process. Besides, many documents and policy reports were only available in Chinese and were time consuming and inconvenient to translate.

Furthermore, since the government has introduced legislation on the duty of confidentiality on public sector information, it was difficult to be able to speak to (the right) employees of governmental departments. Those instances that it did succeed, one could wonder to what extent the interviewee was able to speak freely. On the other hand, the same response occurred when asking about citizens' opinion on the government. Many respondents seemed to be reticent to answer questions about the government and distrusted the purpose of the research. Here, valuable information may have been lost.

Lastly, the method of conducting surveys and the final quantities so obtained may have affected the findings. The obtained sample size is not large enough to be able to tell with certainty that the findings are also applicable to the population at large. If one look at the total amount of properties on the ground floor, conducting surveys in only two research areas alone would not be enough to be representative. Also, the method of going door by door may have influenced results. Because many shops, restaurants and bars are situated on the ground floor, it was hard to ensure that only the property owners filled in the survey. Besides, often one survey was filled in by 2 people or more at the same time resulting in a combined opinion of more people in one. Also, having an interpreter alongside during surveying would have had a positive influence on the number of respondents and could have helped to get ambiguities out of the way.

However, despite the enumerated weaknesses, the results are nevertheless very valuable since they provide a good insight in citizens' opinions on participation and could be seen as representative of current population. With this research, the government of Shenzhen may come to realize that both the inhabitants and the government itself are open to some form of participation and that this kind of participation can enhance the adaptation strategy. Introducing participation level one should not be too difficult to accomplish. Also, with this research, the government might realize that partipation of other stakeholders from the private domain offer great opportunities for enhancement of adaptation to extreme rainfall. To improve the validity and representativeness of the research, a number of recommendations for further research will be described in the following paragraph.



6.5 Recommendations for further research

To enhance and strengthen current findings, further research making use of interpreters without language barriers would be essential. To get a representative and valid insight in the private domain's opinions, a larger sample size need to be achieved. It could, hereby, be interesting to distinguish the opinion of the general inhabitants and the ground floor property owners. Furthermore, this research has focused only (from the private domain's point of view) on the opinion of the local inhabitants whereas it might be very useful to also investigate the role and opinions of the private developers and other stakeholders, being part of the private domain. Looking at the context of Shenzhen, they could probably have the most physical influence with regard to public participation on adaptation to extreme rainfall.

Also, to get a more representative opinion from the government' point of view, it would be essential to bridge the gap between researcher and government employee in order to be able to speak freely and in depth and in order to be able to speak to the right persons. To achieve this, an insider from the Shenzhen Municipal Water Affairs Bureau would be necessary.

Lastly, this research comes up with the growing demand for (the beginning of) public participation. What it did not research, however, in which way institutionalizing public participation in the context of Shenzhen could appear. A research on the processes of urban planning and urban developments would greatly enrich current research since it could give insight in the strengths, weaknesses, opportunities and threats of implementing public participation in the different development processes.

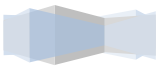


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Photo references

Figure cover: Derbaix, S. (2014). Inhabitant of Xili during flood event.
Figure 6 left: Derbaix, S. (2014). Inhabitant of Xili during flood event.
Figure 6 right: Wu, W. (2007). Interviewee and inhabitant of Sea World during flood event.
Figure 7: Baidu Maps (2015). (online) [consulted at 24-06-2015] via: http://map.baidu.com/

Appendix

Appendix 1: Interview instrument

List of interview questions

1. Can you give an introduction about yourself? Background + work experience
2. Can you give an introduction about this company / department?
3. What are the relationships of this company / department with the government? Is it funded or financially supported by the government?
4. How are different stakeholders & water management related to each other? Which departments or other stakeholders have which responsibilities in the process of water management? What is the role of private developers / inhabitants?
5. What role does climate change and extreme precipitation play in your field of work?
6. How is adaptation to extreme rainfall governed? How does the storm water drainage system look like? What kind of capacities? What other measures does the government take?
7. Which policies on adaptation to extreme rainfall (or climate change in general) exist?
8. Is adaptation to extreme rainfall become a major issue in recent years? Why or why not?
9. Which areas in Shenzhen are most vulnerable to floods due to extreme rainfall?
10. Do you think that the local inhabitants can play a role in preventing damage from extreme rainfall? Why or why not?
11. Does the government actively encourage the private domain to take measures to prevent damage?
12. Do you think that public participation is becoming bigger in the development of Shenzhen?
13. Where did the whole LID concept derive from? Why is it implemented here?
14. What role can LID play in adapting to extreme rainfall?
15. Wat is your future vision of Shenzhen's adaptation to extreme rainfall?
16. How is climate change measured? What is the definition of extreme rainfall?
17. Is Shenzhen implementing 'smart city' concepts and pilots? Where is the weather information used for?
18. How will extreme rainfall look like in the future?
19. Do you have any other contacts within the government or other companies, related to this topic, that might be interesting for this research?

Appendix 2: Survey instrument

Survey Extreme Rainfall

My name is Tjerron Boxem and I'm from the Netherlands (Holland). Currently I'm doing my graduate research for my study Urban & Regional Planning at the University of Amsterdam. Besides that, I'm employee of the programme 'Amsterdam Rainproof', which is a governmental programme aiming at preparing Amsterdam for extreme rainfall as a result of climate change.

With my study here in Shenzhen, I would like to investigate how Shenzhen is adapting to the extreme rainfall and how government and inhabitants respond to it. Therefore, I would like to ask a couple minutes of your time to ask you about your actions and thoughts about extreme rainfall in Shenzhen.

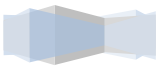
First, a number of general questions on demographic characteristics will be posed. Following, questions about dealing with extreme rainfall and your expectations of the government will be asked.
The data will be processed anonymously and used for academic purposes only.

Please cross the answer that applies the most to each question. When an open question occurs, please write your answer in the corresponding blank space.

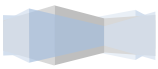
Your feedback is of incredible value for my research. Completing the survey will take just a couple of minutes.

Do you have questions about the survey and / or want to receive the results of the study afterwards? Do not hesitate to contact me via:

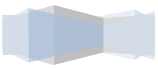
tjerron@rainproof.nl or Christian.boxem@student.uva.nl
Phone number: 15989569422



What is your gender?	☐ **Man** ☐ **Woman**
What is your Age?	☐ **0 - 15 years old** ☐ **16 - 25 years old** ☐ **26 - 45 years old** ☐ **46 - 65 years old** ☐ **66 years or older**
How is your home situation?	☐ **Single** ☐ **With partner without children** ☐ **Family with children**
What is your highest education level?	☐
What is your employment?	☐ ☐ **Unemployed** ☐ **I prefer not to say**



In which district do you live?	
Do you live on the ground floor?	☐ **Yes** ☐ **No**
Have you ever experienced a flooding from extreme rainfall?	☐ **Yes** ☐ **No**
How do you experience a flooding?	☐ **As a nuisance** ☐ **As a threat** ☐ **Bad because of damage to my house/shop** ☐ **I don't mind**
Do you take measures yourself to prevent water damage?	☐ **Yes** ☐ **No**

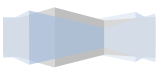


If yes: which measures and do they help?

If no: why not?

Who should, according to you, be held responsible for the rainwater management in Shenzhen?

- National government
- Provincial government
- Municipal government
- Water authorities
- Citizens
- A combintion of the above



What do you expect from the Government with regard to Dealing with extreme rainfall?	
Are you willing to participate as a citizen in helping the government to deal with extreme rainfall?	☐ **Yes, I already do that** ☐ **Yes, especially local citizens can come up with good solutions** ☐ **No, the government is responsible** ☐ **No, no time/not interested**

What do you think that citizens should do to prevent damage from extreme rainfall?	
What do you think that the government should do to prevent damage from extreme rainfall?	

Finally, may I approach you in The near future again to ask You some extra questions About this topic? This can be by phone, mail Or face to face.	☐ **Yes** **Phone number:** _____ **E-mail:** _____ ☐ **No**
End of the survey **Thank you for your cooperation!**	

Appendix 3: Interview Ms. Echo (A)

Shenzhen Futian Ecological Civilization Research and Promotion Association
Ms. Echo /Chief executive officer
1 Translator. Date: 01-04-2015. 10.00-12.00.

T: Can you introduce this company?

E: We are a NGO serving to the government. So we get hired by them. We do research about new policies and we do public broadcasting of new policies.

T: On what topics and why these?

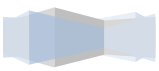
E: Dust pollution, helping people to give information on water resources, emergency departments and alarming disasters. We provide information and brochures so people can not how to conserve the environment or how to be prepared in cases of emergencies.

T: What role does rainwater play within your organization?

E: In our organization we don't focus on how many times areas get flooded an how many damage it causes. Also, the government have a rule that employees of the government may not give away such sensitive information.

T: Do you know areas that get regularly flooded from extreme rainfall?

E: In Meilin area, many underground car parks have been flooded last year.



Appendix 4: Interview Mr. Liwei (B)

Mr. Liwei, from the Ivita Company. (Green roofs and urban gardening).
Datum: 08-04. 10.00-12.00
2 translators, 1 student, 1 from the company itself.

T: First of all: I think You've met Linda Vlassenrood from the INTI last week?

L: Linda and I are working together on the project: double city. It is about a green roof, and we worked together on it last week.

T: Can you give a brief introduction about yourself? Background, education, function etc. And also a brief introduction of this company: What is this company exactly, how is it founded?

L: The company is working on urban agriculture. Before I did a different job. But once I knew about the pollution in the city, It got my attention. I was directly determined to change the mind of the consumers and so maybe I can change the environment of the city. The situation is very bad and the knowledge of the people little. The environment is very important. So I started this company in 2011.

T: How big is this company?

L: this company has 60 employees. 40 workers on the farm.

T: Is there any relationship with the government? Maybe the company got any funds from the government?

L: The government doesn't help. So it is a private company. The government doesn't even encourage such a company.

T: why not?

L: Government does not pay attention to much to health. Because the topic is not very important until now. Maybe in the future. Certain people realize it, but there is no politics on it now. Commercial and economy is more important to the government now. First governments always choose for the money, the health comes later.

T: Can you tell me more about the 3 farms that this company owns?

L: Two farms are located in Shenzhen, 1 on Huizhou. The farms are all located on the land, naturally. 60.000 M2 in total. Each farm around 20.000m2. The 2 farms in Shenzhen are located on the boundaries of Shenzhen, so in the periphery.

T: What is the future vision of this company: is it to apply more urban agriculture IN the city?

L: We try to combine the two types of farming: naturally and by using modern equipment. I have a very small green roof in Luohu, just one building. It is not the vision to have a green roof on every building. There are two type of people to do the green roofs: the first one is to grow the vegetables on the roofs, the other one is just for fun.
It is very expensive to build buildings that are capable of carrying green roofs, so that is not a goal of this company. Not many buildings in Shenzhen now are capable of carrying the weight of a green roof.

T: do you harvest rainwater to reuse for watering the plants?

L: Yes, on this one green roof they collect (on small scale) rainwater to water the plants. On our big farms we have wells. I know 1 company that owns a green roof.

T: where does your company earns money with?

L: We earn our money by selling our vegetables to families.

T: how do these 3 farms deal with extreme rainfall? Do you take measures to prevent damage from it?

L: We make rows of plants, including pipes. The water will be drained by these pipes. Sometimes there is a minor problem with flood, but we don't really pay attention to it.

T: is there any cooperation between this company and the government on water-related issues?

L: The government already make all the water infrastructure, so we don't have to contact them.

T: So the government is not encouraging you to catch the rainwater on the roof?

L: The government controls the irrigation infrastructure, drinking water and wastewater. In that way they control the farm. The government doesn't act on encouraging us to do something with rainwater

T: Are there any policies from the government on green roofs or urban agriculture?

L: There are no policies on indoor farming. But there is one policy about the roof: you can't plant big plants because of the danger for typhoons. Also, not everyone can plant green roofs: the building must be capable of carrying the weight.

T: So is this company talking/cooperating with the private developers in order to strengthen the construction of new developments so that green roofs could be implemented?

L: The government has different ideas about the green roofs, so all different actors think about it differently, so they do not really cooperate with each another really well..

T: Do you know areas in Shenzhen that get commonly flooded?

L: The lower parts of Nanshan. Pretty much everywhere. A lot of places get flooded.

Appendix 5: Interview Mr. Tang (C)

Urban Planning and Design Institute Shenzhen.
Wei Zhen Tang /Water engineer
1 Translator. Date: 09-04-2015. 19.00-21.00.

T: Could you introduce yourselves and this company briefly?

W: This company works on municipal planning, but is a private company. I work for the department that is working on drinking water, drainage, LID & rainwater design. We can get hired by the government to design for projects al around the city.

T: How does the organizational structure of rainwater management look like? Which stakeholders/departments are involved and which responsibility do they have? What kind of standards do you use?

W: The drainage department designs underground infrastructure following standards (those standards are the same as the Russian standards). This include drainage pipes under main roads, sidewalks and inlets. An Urban Planning bureau (like this) make the general plan, then the developments will get designed, followed by designs of the traffic department and road design department in combination with drainage/water department. For rainwater drainage it is very simple: there is only one department working on this topic. However, urban villages are difficult to handle. These areas are the only areas that don't have a separate sewage system because other departments regulate this. The city obliges them to do a separate system but they just don't do it. These systems are however connected to our normal systems, and because there are many illegal sewage connections in the urban villages, we cannot really calculate the needed rainwater and wastewater capacity. However, our rainwater system has over-capacity, because of the Russian standards. Rainwater flows to one of the 310 rivers we have in Shenzhen, and will eventually flow into the sea. Also, in some areas we make use of pumps to elevate the water to higher places.

T: What role does climate change and extreme rainfall play in your field of work?

W: Rainfall not that much. Adjusting standards takes a long time and they recently just got adjusted.

T: Which policies on climate adaptation exist with concern to extreme rainfall?

W: The government is very aware of the rainfall issues because of the many disasters we have in Shenzhen. Sometimes we have 3 floods per year. But to act upon it is still in the premature phase. Cooperation with different departments takes a long time to adapt. For example, the LID concepts that is implemented now in some cases is still very premature. There are no real implementation strategies and regulations yet. So there are not really policies on extreme rainfall. On Climate change and mitigation in general there are some.

T: Which areas are the most vulnerable to floods from extreme rainfall?

W: In Bao'an district there are quit common floods because it lays outside the SEZ (and therefore has a weaker storm water sewage system) and it is one of the lowest geographical areas. But in Nanshan and Longhua we see floods as well.

T: Do you think that local inhabitants can play a role in preventing damage from extreme rainfall?

W: Citizens can try to protect the drainage system and keep the inlets clean (no waste on the streets).

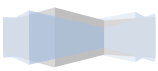
T: does the government actively encourage inhabitants to take measures to prevent damage from rainwater?

W: The government has picked up on this idea of information supply and involvement, but it is yet just an idea. We however have 'save water day' and some information campaigns already, so it is developing. There is not yet any encouragement of the government to the citizens to keep the drainage intact and keep the inlets clean. There is also not really a mindset among resident: only very few live on the ground floor or are owning a roof. There are also no encouragements on alternatives like implementing green roofs etc.

Infrastructure is just developed following the set standards.

T: Does the government take measures to prevent damage from extreme rainfall?

W: Besides raising the standards they are developing new concepts. But as said: everything is pretty much in a premature phase. We are also developing the idea of lowered playing fields where we can store rainwater for a maximum period of time of 36hours.



Appendix 6: Interview Ms. Wu (D)

Wenyuan Wu
Apecland (HongKong) Design & consultant Co., Limiterd – General Manager
Shenzhen Apecland Design Co., LTD. – Landscape Master
China Development Institute Centre of Urban Research – Visiting Researcher
Shenzhen Nanshan District Urban Management Advisory Committee – Committeman

Muneharu Yokomatsu
Apecland (HongKong) Design & consultant Co., Limiterd – Director Chief Planner
Shenzhen Apecland Design Co., LTD. – Chief Landscape Architect
China International Urbanization Development Strategy Research Committee – Specialist Committeeman.

1 translator. Date: 12-04 -2015. 10.00 – 14.00

T: Can you give a brief introduction about your background?

W: After my master degree I went to Beijing to become an urban planning teacher. After 4 years I came to Shenzhen, to do a job in urban planning management for the government. In 2000 I started Apecland Design company because designing is what I like. Although my former job was good, I prefer this.

T: what is the unique selling point of your company? What is the main focus?

W: Each form of design needs a special license. China is very strict on that. So it is quite difficult. So I decided to focus on landscape architecture. Later I found out that this is also what I really like. Now, for instance I work on urban parks.

T: Do you only work in Shenzhen, or also in other cities?

W: In whole China. Even sometimes in foreign countries, like burnet. Malaysia. There we work on renewing the landscape of rich Sudans. At this moment not to many projects in Shenzhen. We did Sea world in Shekou, and also: ghanku (?!).

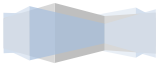
T: what are the relationships between this company and the government?

W: For signing contracts, we do some projects or consultants for the government. But the government is always changing. In 5 years they can totally change, so it is difficult to work together with the government. Architectures don't have own opinions. They can just work on projects and later on put in a minor opinion. But urban planners should always have own opinions about what the public thinks. But at this moment they don't have that. There are many reasons for that. The most important one is the system now in China. All the questions about the city come from the bottom up level, but the guidance and basis to do your design comes from the upper level of planning. You can't change the upper level ideas. The way that we design is not very scientific. The development of china is very fast and the population is growing so rapidly, and the cities got expanded so the urban planning in china has only 'basic logic'.

T: What role does extreme rainfall play in your field of work that of landscape design?

W: Our projects come from the contracts. So actually nobody does research about the rainwater. We just find some problems on the sight, and then we decide to do the research by ourselves. Than we collect information about the history and geography (elevations, flooded areas).

She shows a couple of examples of projects around China on the beamer



About making double use of spaces: in a naturally way dealing with problems. Although in the coastal case the former approach to water nuisance was, was to elevate the build area with 2 meters of sand. The damage of rainwater depends upon the intensity of the rainfall. So if it is in 4 hours or just in 2. In this case, every six hours it is also high tide. That makes this case complicated. What we now want to do is, during high tide, to prevent the rainwater from flowing in this area. So to store the rainwater somewhere else before it comes to the area.
T: what kind of LID projects do you use?

W: not paving the areas, not building every square meter. I think that we should go back to make more use of the natural flows of the nature. During normal rains there is often not a problem, but when it rains really hard then we should need to do something about it. The rainfall differ from region to region. Some regions only have 800 mm per year, in Shenzhen it is around 1800-2000 mm per year. In other countries, people may think that LID is some kind of skill/technique. But here I think of it as my own idea. I think that we need to use as least money and resources as possible. Use the original nature and think of something that needs little maintenance. The first think that we use in our LID projects is the existing surrounding. We also talk to the local inhabitants (because often there is no, or little digital data available). In that way we can get to know how people use and experience their surroundings as it is now.

T: do you think that the local inhabitants are happy with that?

W: yes of course. However, In Shenzhen the influence of the local people is very little. Shenzhen is a fast improving, and thus unique city. There is some public participation, but most of them are within the urban villages. It depends upon the interest of the people and the topic. But public participation is more like negotiation: if the city doesn't develop, the land of the farmers won't become more valuable. If the farmer lose their land then they only have their house left. So the public participation is more bargaining about the price on which the farmers are willing to lose their land.

T: so in your field of work, do you take extreme rainfall into consideration?

W: We can only give rough guidance to the developers. It is up to them what they do with it. But I think that LID by architects often is a too small system. LID should be cross districts. I know the LID from Guangming New Town, but I don't trust them. They actually have a double system, so they don't trust their LID development. In my opinion LID is all natural, or should be connected to the large Natural structure. For very Flat areas LID is difficult to implement. In many developments, there is lots of homogenization. If people don't use nature, nature is useless to us. I care about the activity in nature.
In this project, we made our own goals and targets: the first one is to protect the farmland and the farmers, the second one is to keep the geography of the nature. Third one is to make sure of the structure of the land use of the industrial area. The last one is to have the character of a city without losing the obvious character of the area.
What we often do is to use the land, the mountains and the hills, as a green access of an area.

T: what policies are there on extreme rainfall?

W: There are becoming more and more policies on this topic. The most famous concept now would be the concept of the 'sponge city'. However, I think that only considering the rainwater in the face of climate change is to narrow, and the system is quit complicated. You need to consider this topic in the whole system as it is now, and how it will be in future developments.

T: is there pressure from high levels of politics?

W: Yes. But if you only focus on the water problem, especially on the rainwater, it is not enough to influence policies.

T: In Shenzhen, which different departments have what kind of responsibilities when considering the water management? So what is the organizational structure?

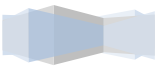
W: LID design should at least be considered at the comprehensive plan level. The best way to do this is to communicate this with the mayor. About the departments: the whole situation is controlled by the urban planning department and the infrastructure is the job of the civic engineers department. If a project is connected to the coastline, then there's also the 'sea-department'. For water supply & drainage there is also another department. However, in different areas / cities in China this is organized differently. In different places different departments will have different functions and powers.

T: Do you think that local inhabitants and private developers have any role in the water management of Shenzhen?

W: The most important function of the local inhabitants would be their choice of location to live in. The place where they want to be situated must have many natural resources that they can use easily. About the private developers: I don't think that they have any responsibilities on this matter. When they want to develop something, they just ask the pipe engineers.

T: Do you know areas in Shenzhen that are commonly flooded due to extreme rainfall?

W: Shekou. Near Sea World. I have some pictures actually. When they designed the Sea World square, they wanted to show the ship very obviously so they had to make the square below street level. Of course this makes it more vulnerable to floods. I don't think this was a correct thing to do but somebody insisted on doing this. Underneath the square there lays the main drainage pipe with a diameter of 3,5 meter. When it got flooded, there was almost 4 meter of water!



Appendix 7: Interview Mr. Yao (E)

Tao Yao - Deputy chief.
New Town Development and Construction Office, Guangming. Water Affair Office.
1 Translator. Date: 13-04-2015. 16.00 – 17.30.

T: first of all: thank you for having me here. Could you give me a small introduction about yourself and your background?

Y: My name is Yao Tao, I work in the Guangming City Planning Bureau. We're dealing with all the works in Guangming area that have relations with the water affairs. This is my first job.

T: can you explain more about the department: what does it do exactly?

Y: We are the Water Affairs Bureau of Guangming district. We have multiple tasks: we are the management of all the water including water supply (drinking water), storm water, wastewater. We make the policies. We don't develop the infrastructure, we make the policies to manage the developments. We make the rules for the different design departments what they can and what they cannot do. We are a fully governmental department.

T: what kind of policies do you have concerning extreme rainfall, or rainwater in general?

Y: There is another department: the Environmental Protection Department, that has some policies on storm management. There are different levels, depending on the severity of the event (very heavy storms, moderate storms etc.). We mostly use LID in our work. We started working with LID in 2008.

T: Why did you start working with LID and why in this area?

Y: Because Guangming has advantages: Guangming area is big and we have a lot of trees and green. This department also has control over 53% of the ground coverage in Guangming, so we have a lot of space that we can use for LID developments.

T: But where did this idea of LID development came from?

Y: The LID idea come from abroad. Different Chinese experts said that Guangming had advantages to implement it. So they started here. Since 2008 a few cities like Guangming and Shenzhen are trying to do the LID. Now more and more cities are implementing this. Now there is a new concept: the sponge city.

T: Do you think that LID has a mayor influence on dealing with extreme rainfall?

Y: LID does a great job for handling medium and smaller size rainfalls, but for extreme rainfall it doesn't do that much. I think that Chinese cities don't have the ability to deal with extreme rainfall, so cities get easily flooded. Most Chinese cities rely on traditional underground infrastructure, and the standards of this kind of infrastructure is not that high. Most rainwater pipes lead to the sea or rivers, but during storms the water level of the sea and of the rivers rise. Therefore the rainwater cannot be discharged, resulting in floods.

T: Is the government working on different solutions to prevent floods from extreme rainfall?

Y: Retaining water in different places as a solution to the problem is a difficult way of LID. Also, the LID concept is still immature here. We are not experienced on this topic so we need to take the LID concept to other places and experiment more with it first.

T: Are there also policies on implementing green roofs in place?

Y: We are working on building a green roof, but we just started with it. We use different levels of assessment for green (not only green roofs): the better quality of the green, the higher the chances that the government would encourage the development with some financial grants. The green roofs are often initiatives of the government, also build (or planned) on top of governmental buildings.

T: Do you think that the private domain, like the private developers or the local inhabitants can play a role in dealing with extreme rainfall?

Y: They can try to grow some vegetables on the roof. But I think most inhabitants will only grow them because of the food, not of the fact that it could help to catch rainwater. This is the first time that the government is spreading the information on the environment concept to the individuals. They don't have much knowledge about the help that they could offer with green roofs. Also, I think that the government should do some encouragement in terms of financial grants.

T: How about regulations?

Y: We have some compulsory regulations on the green infrastructure planning. The green infrastructure planning regulations applies for the whole city of Shenzhen, the regulations on the implementation of LID only accounts for Guangming. There are no regulations for private individuals.

T: What kind of role does the private domain play in rainwater management?

Y: In most parts of China, the individual people don't have much knowledge about environmental protection. So maybe only a few people will do the help since there is not yet a mindset to it. The government is planning on studying more on this topic, because it could be an promising thing to involve individuals. Maybe in the future we will encourage people to participate on this matter. The private developers need to develop a plan how they will design the drainage, that needs approval of the Water Affairs Bureau. We try to encourage the LID developments in the projects of the private developers, but because it is not compulsory they have the rights to decide if they will implement it or not. So they do not do it.

T: What role does climate change in approaching the water management and the standards used for drainage?

Y: The LID regulations were only approved until last year. The places that already had been developed with the LID concept only needed small adjustments. The national regulations for drainage standards has just been upgraded last year, because of experiences with common floods from rainfall in the past few years. Because China has developed greatly the last years, this upgrade of the regulations (that cost more money to build) have become affordable.

T: Is the government also developing upon the predicted climate change in the future, or are the standards only raised based on the past experiences?

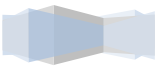
Y: No, this upgrade of the regulations is based upon predictions of future climate.

T: Where does the money come from to pay for the rainwater infrastructure?

Y: The government receives money from the taxes. A part from the collected taxes will be reserved for the drainage infrastructure annually. Inhabitants have to pay a wastewater fee, which is based upon the amount of used drinking water. The rainwater infrastructure will be funded out of this tax as well.

T: Do you know which areas are often flooded in Shenzhen due to extreme rainfall?

Y: The mayor road through Shenzhen (Shennan Ave) is often flooded, due to a mistake in the design of it. In Longhua (Bao'an district), some underground garages got flooded last year. Also in Fuyong.



Appendix 8: Interview Ms. Wei (F)

Shenzhen Meteorological Bureau
Xiaolin Wei
No translator. Date: 17-04-2015. 11.00-13.00

T: Could you give a brief introduction about the company and its tasks?

X: This is a platform where we've integrated many systems that the weather forecasters can use to predict the weather. I can introduce you to the observational units, and how we do the weather forecast as well as the extreme rainfall forecast. We have 155 AWI (auto weather observation station) in Shenzhen, each with a scope of about 3 – 5 kilometers. These measure the general meteorological parameters like temperature, air pressure, wind speed and direction, relative humidity, precipitation, visibility, air quality and so on. We also have several wind profile observation stations. Some of them are located in Hong Kong, the rest in Shenzhen. Also, we have 1 national station in Shenzhen, just outside our office. There are three departments: climate, weather forecasting and lightning protection.

T: so how is the air quality in Shenzhen?

X: I think it is quite good for Chinese standards. If you compare Shenzhen with other metropolises we have quite clean air.

T: Do you also make use of the data of amateur weather forecasters, that collect their data for instance on their own roof or backyard?

X: No, we don't have that. Not many people will do that, so we don't collect that data. Sometimes, when there's hail, it is very difficult to observe that accurately. So when we have a hail event we collect the news or information from people that send us pictures. Besides that, we do not really make use of amateur data. When we do the weather forecast we generally have a system the we rely upon, Mecas (?) which is quite similar to the system they use in America. Around the world, there are a couple of different mayor models, that vary a little bit. We compare the observations and predictions of the different models. Also, we compare our actual observations from our stations to the predictions made by the models. In that way we can validate and, if necessary, adjust our model.

T: is there a model that is the best?

X: We found that the EC model will always over predict precipitation. If this model doesn't predict any precipitation at all, generally we will trust it because normally they already over predict. We make use of different models with different spatial and temporal resolutions. One model has a resolution of 12 square kilometers, whereas another model has a resolution of 4 square kilometers.

T: would it be preferable to have a higher resolution in the future?

X: From the master scale resolution model we can see the general circulation and the general view. But if you want to know where the precipitation at what time will occur, we need more accurate models with a finer resolution. If you want to see where the highest precipitation rate will occur you need a finer resolution than 12 or 4 square kilometers.

T: Do you also collect the data of extreme events, like hurricanes, thunderstorms and extreme rainfall?

X: We have records of every warning signal that we've issued in the past years. We have eleven weather warnings, and each one has a different amount of levels. For typhoon we have 5 warning levels, for heavy rain we use three levels: yellow, orange and red. Yellow

means: in 6 hours it might be, or it already is affected by the heavy rain (50 mm in 6 hours). Orange means: in 3 hours it might be, or it already is affected by the heavy rain (50 mm in 3 hours). Red means over 100 mm in 3 hours. We have records of the different extreme rainfall events in Shenzhen of the past, sorted on intensity (see pictures of the tables). Sometimes we focus on the 1 hour predictions of precipitation, sometimes we focus on the 24 hour predictions. The records on the 30 minutes extreme events are closely related to the floods in the city. You can see that often the amount of rainfall in the first 30 minutes does not differ much from the hourly numbers, so it has much to do with extreme rainfall.
Our stations collect data every minute, so during extreme rainfall the system calculates real time, and adjusts predictions every time.

T: what is the standard definition that the Shenzhen Meteorological Bureau uses to define extreme rainfall?

X: Definition of heavy rain is: 50 mm in 24 hours. However in our experiences, if it rains 50 mm in one hour or 50 minutes in only 30 minutes it will result in floods. So there's a strong time component. Intensity is important. The definition of heavy rain is only a reference, not a standard.

T: What is the role of climate change in your field of work? Do you observe for instance that the extreme rainfall is occurring more and more in Shenzhen?

X: This is an evaluation of the climate change of Shenzhen. Here you can see the annual average temperature between 1962 -2010 (50 years). The temperature increased on average with 1.6 degrees Celsius, the last 50 years. The humidity is decreasing as well as the visibility. We have records on extreme warm days, lightning storms and haze. Also, the extreme precipitation has increased over the past 50 years. The annual precipitation has a flat rate, but the increasing chance is not significant. However, the frequency of the extreme cases have been increased after 1980. Also, in the history of Shenzhen we have meteorological records stating that there were 19 extreme events (of over 300 mm). After 1990, we had 9 events and in the latest 10 years we had 4 events. In 2008 alone we even had 3 events.

T: Do you know what could be the reasons for this?

X: We are still researching this phenomenon, until now we only have the observation results.

T: which districts are most common flooded from extreme rainfall?

X: We have this map of places that have a high risk of flooding, like Nanshan, Bao'an and Longgang districts. Often the old villages in the different places of Shenzhen are vulnerable to floods because of the development of the city and the roads, which are more elevated. If the AWI stations monitor precipitation over 50 mm/hour or 30mm/half hour it will appear in red on the map. The system then automatically send out warnings to the inhabitants.

T: so how do the inhabitants receive this warning?

X: Via text message and an automated phone call with a message about the amount of rainfall that already has been falling and also the predicted amount still to come.

T: And what does the inhabitants do with this message, do they take measures?

X: Yes. Every district has different people in charge of spreading the message. They work for the government service centers in each block in each district. Once these employees receive the warning from upper level, it is their task to notice the people in their area that can put measures in place to avoid water problems. Like operating some pump stations.

T: but are they also warning the local inhabitants?

X: We use electric billboards to inform the local inhabitants. Also the people responsible for each building will try to inform their dwellers. So it is about getting the warning down every level of responsibilities, until it reaches the local inhabitants. The Shenzhen Meteorological Bureau has the responsibility to first warn the first level, which in turn is responsible for informing the second level and so on.

T: Does this bureau have tight connections and cooperation with other governmental departments like the environmental protection, water bureau of the planning department?

X: yes we have close connections with other departments of the government, especially during extreme weather events. We also co-operate with the education department. When we issued the higher weather warnings (yellow, orange and red) for heavy rains and typhoons, the education departments will send warnings to different schools and kindergartens. The children can stay home in those cases. Also, when we issue a warning for landslides we contact the land planning department to discuss the risk.

T: this is during extreme events (coming in the near future), but does this bureau also co-operates closely with other departments to inform and enhance developments in the city?

X: There is one research result about air ventilation that has been considered in adjusting the standard for the city planning departments. Besides that, if the government or even Non-profit companies need information or data from this bureau we will supply that.

T: Do you also co-operate with the Shenzhen Water Affairs Bureau?

X: Generally it is about floods. So we inform them when the predicted intensity of rainfall will be exceeded, so they can take measures to prevent floods. For instance: they discharge some water reservoirs in order to create more storage capacity.

T: Does this bureau also invest in new developments and techniques to collect meteorological data? Something like smart city?

X: There is one meteorological service company that helps us to maintain our IWA stations. We also have a company that work for us to develop our software programs. They are more a commercial company.

T: In Amsterdam we have the development called 'Het polderdak', which combines meteorological data with the smart city concept to put micro-water management into place, to prevent floods. Do you have such kind of developments in Shenzhen?

X: But the amount of water that you can store on the roof is not enough to prevent damages is it?

T: No, but if you combine multiple micro-water management measures with the macro system, each and every bit may add up in the end.

X: Interesting. To my knowledge we are currently not looking into these kind of things. Maybe the governmental Flood Control Department knows more about such developments? Also, I think that the roofs need heavy construction when they need to store the water on top of it. In china it is also difficult to implement it because nobody cares about the roof. Some people just use the place by themselves. The roof is owned by every dweller of the building, so that makes it also difficult to implement.

T: How do you think that the extreme rainfall will change in the future?

X: The frequency of the floods and the extreme dry periods will greatly increase. The speed of this change will depend on the level of carbon emissions in Shenzhen and China.

Appendix 9: Interview Mr. Liu (G)

Shenzhen water affairs bureau
Engineer water supply & drainage.
Pingshan river reconstruction project – LID design

Liu Xiao
Elom Huan

1 Translator. Date: 29-04-2015. 10.00-12.30

T: Could you introduce yourselves and this company briefly?

L: My name is Liu Xiao and I'm working for the water supply & drainage department where I work with project designing. I have a master degree in environment engineering and I am currently already 3 years employed in this company. Elom is mainly focusing on ecology: soil and water hydrology and evapotranspiration. The first part of the company is for the river construction & reservoir. In total there are 6 departments within this company. Our work focusses mainly on water supply and drainage: removing the mud from the river.
The six departments are:

1) Water supply department
2) Drainage department
3) Monitoring department
4) Reconnaissance (underground) department
5) Landscape design department
6) Ecology research department

T: So is this bureau part of the Shenzhen Municipal Water Affairs Bureau?

L: In 2006 they changed the status from governmental bureau into an individual bureau. The government still owns this bureau, but it is not officially government anymore. There is a difference between an officially governmental bureau and an individual, but still owned by the government, bureau. The property and company still belongs to the government and is managed by them, however bureau needs to run on its own. More market-driven.

T: How does this department relate to the other governmental departments, like for instance the flood control department?

L: There is no obviously relationship between them. Before the Water Bureau was overarching, and this department was a branch of them. But now if the water bureau has any new projects coming up, they open it up for every company/department to bet on the project. In that way it is more market oriented.

T: why did the government choose for splitting this department and others off from their organization?

L: It is because of the policy of the government to open up the market. For us it means not only concentrating on the local, fixed area but in this way we can work everywhere.

T: Which kind of stakeholders are involved in dealing with rainwater, if you take the whole picture into consideration?

L: Every year the rainwater is around 1900mm.

T: Yes, that is the total precipitation but that is not exactly what I meant. What I mean is: which departments / groups / persons have a role when dealing with rainfall?

L: When we have a plan for the project we've been working on, we give the drawings to the Shenzhen Municipal Water Bureau that needs to approve the design. For designing we use standards.

T: what kind of standards do you use?

L: We design our infrastructure upon a cloudburst that will statistically happen once in the 3 – 5 years. This means a rainfall of 60 mm/day. There are actually 2 different standards: for rainwater planning we use a standard on 24hours, for the city council we design our system upon a standard per hour. The city council is about roads.

T: What is the actual difference: when do they use the one standard, when do they use the other?

L: In a small division, like a 2 km2 we use the city council standard (per hour). For a big area we use the water planning standard (per 24/hours). The city council standard is important because of the peak intensity of a rain event.

T: Where does the money come from to build the infrastructure for the separate infrastructure for the rainwater?

L: It is paid by the government.

T: I understand, but how does the government collect the money for the water infrastructure?

L: when the water bureau comes up with a plan, they give it to the development bureau of Shenzhen (they control all development of Shenzhen). When this department approves, the plan is passed to financial bureau. After the financial bureau approved the plan, they give it back to the water bureau. Lastly, the water bureau can set the plan out for the public to bet upon. The financial bureau pays the amount of money to the water bureau, and the water bureau pays the winning tender of the project.

T: You apply LID design in working on the Pingshan river. What kind of LID do you use?

L: There are three parts in this project: dealing with waste water, flood control and landscape. First we treat the waste water in a certain place. Then we reuse the cleaned waste water for irrigation of the landscape. The rest of the water will be discharged into the river. We also purify the 'first flush' from rainfall. The first flush is polluted because of the air and the roads. To separate the first flush (after 7 mm) from the rest of the rainwater we use an overflow system. In that way, only the first 7 mm will be discharged to the treatment plant.

T: In the Netherlands, we like to use LID concept in terms of increasing the 'sponge' effect in a city.

L: Yes, we also have that. In this project we use LID for the same idea. The standard that we use in this project is 1:100 years. We have major downpours here in Shenzhen. An example of LID implemented in this project is the green sidewalk, where rainwater can infiltrate in the ground. It is similar to the sidewalks in Guangming New Town. The idea is that as much as possible rainwater can infiltrate in the ground in this area. In the area of this project we have kept space for a demo-area, because the technique and the concept is not very mature yet. This project is about rainwater control and to reduce the peak flow from it. We've installed a rainwater tank of 1300 m3 in the ground, to collect clean rainwater. This water can, then, be used for irrigation of the green spaces. We also

implemented lowered green spaces that have permanent water in it, but can store al rainwater from the surroundings.

T: Do you have any policies on rainwater management or adapting to the climate change by, for instance implementing green roofs?

L: Many government buildings have green roofs implemented now. However, for the individual apartments or buildings it is difficult because policies take long to make up. Who will pay for it, who will maintain it, and who is in charge? We still have to overthink these rules and make a policy out of it.

T: Do you think that also private developers or the owners of these buildings can play a role in adaptation to extreme rainfall?

L: We first have to make new policies on it, before we can push for new technologies and designs within the building bureau.

T: But do you think that the private domain (private developers but also inhabitants) are willing to act on it or that they are willing to help?

L: How to choose the grass for green roofs. It should be the right type. Also the type of soil should be overthought. It is difficult to make a policy on it because we don't have enough experience with those kind of choices.

T: Do you see benefits in collecting rainwater for the purpose of reusing it inside of buildings?

L: The university and Olympic stadium in Longang have this implemented now, as a demo project. It is initiated by the government.

T: Do you look into the possibilities of using new technology in rainwater management? For example the concept of 'smart city'?

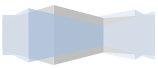
L: The boss of this bureau talked with a sensor supplier from Germany. We are trying to make a demo area near the reservoir so we can control the flow of this reservoir. But we don't have any 'smart city' concepts on micro water management scale yet.

*T: *Now explaining the concept of the polder roof, and developments in the Netherlands*.*

L: here it is different. Over here 'the rain belongs to the government', which it makes it difficult to involve the private domain.

T: Which areas in Shenzhen get flooded the most because of extreme rainfall?

L: Bao'an.



Appendix 10: Interview Ms. Lu (H)

Shenzhen Institute of Urban Planning and Design
Ms. Yu Lu
1 Translator. Date: 29-04-2015. 14.00-15.30

T: *Can you give a brief introduction about your background?*

L: My name is Yu Lu, and I'm working for the low carbon and ecological planning department in this company for about 10 years already. I am in charge of a team of 10 people. Before that I studied hydrology and environmental engineering.

T: C*an you explain more about this company and department: what does it do exactly?*

L: Our company have about 450 employees. We do urban planning and research. In this company we have 13 different departments. We do urban planning projects in Shenzhen and in the whole of China. My department it owned by the civil engineering planning department. Our company is not owned by the government but is not a private company either. We work for the government or for other companies (such as real estate developers). But all the assets that we design are state owned. If we make a plan, then the government pay us. The profit, however belongs to the country. We only design the plan, when they are satisfied we give them the plan back.

T: What is the organizational structure of water management in the city?

L: The city water affairs bureau does not design or make plans themselves. They are management, not engineers. They have to ask us or other planning institutions to make the plans. They often do this by giving away tenders. For us, planners, we mostly work on district level or on city level, not neighborhood level. The money maybe will come from the water affairs bureau or from the urban planning bureau. But when we do the planning, we have to ask other bureaus such as traffic department what their regulations and policies are. We have to ask all opinions from all the different departments. Under the civil roads (the bigger roads) , the sewage pipes are under the management of the government. We have three types of water pipes: rainwater pipes, drinking water pipes and wastewater pipes. All are managed by the different departments in the water affairs bureau.

T: Do these different departments work closely together?

L: Yes, because they all work for the same bureau. The boss of the bureau can demand cooperation between the departments. But between the different municipal bureaus it is different. Cooperation between the different bureaus are more difficult.

T: Does every district have a separate water affairs bureau?

L: Every district has its own water affairs bureaus, but they are all part of the municipal city bureau. The municipal city water affairs bureau make the regulations and policies, that will have to be published by the city government. The city water affairs bureau also develop the plans for the whole city (but they often hire companies like us for that). The bigger rivers and pipes are managed by the city water affairs bureau. The smaller rivers and pipes are managed by the district bureaus.

T: where does the funding for the rainwater management in the city come from?

L: Every year, our government assigns a certain amount of money for water issues. The construction of the pipes, pumps and the development of plans are all paid from this fund. Inhabitants pay taxes. We have to buy the drinking water. That's a price that we have to pay for the drinking water. There is also a fee we have to pay for the wastewater, but we don't have to pay any fee about rainwater.

T: so the rainwater infrastructure get paid out of the wastewater taxes?

L: No. We pay taxes over our income. Those taxes they use to for all kinds of facilities and needs in the city, including rainwater infrastructure.

T: What kind of standards do you use for designing rainwater infrastructure?

L: The pipes can protect the city from 1: 3/5 years. This means that our pipes can handle up to 30/40 mm/h , but I'm not sure.

T: Are there any policies on climate change and extreme rainfall? Does climate change play any role in your work as planner?

L: When there will be extreme rainfall, the government will send text messages to warn all citizens. Because of the climate change the rainwater will be more intense, so more rainwater in shorter time. Therefore the planning standards have changed. Before the standard was 1:2 years. We are not only trying to solve the rainwater problem with bigger pipes, but also by temporal storage like parks and LID developments, such as green roofs, permeable streets and raingardens.

T: Do you also try to incorporate the private domain in your field of work?

L: Yes, we are trying to cooperate with the private domain. For example when a piece of land is sold, we try to apply regulations in the agreement on flood control, or you have to do some green roofs or raingardens. But in most districts they still do not do this because the LID concept is still in a premature phase.

T: Do you think that the government is trying to involve inhabitants within the whole problem of floods from extreme rainfall?

L: Maybe some of the bureaus have the mind set on this. But the mayor does not really emphasize it.

T: But do you think that citizens/inhabitants can play a role in dealing with extreme rainfall?

L: I think ordinary persons can only do very little, because we live in high buildings, not in houses on the ground. So we cannot control the control the house construction. The building is constructed by the companies and we only buy it. So we can do very little.

T: And what about the local shop owners on the ground floor? Do you think that they can do something to prevent damage to their shop?

L: I don't really know. Maybe they can put sandbags in front of their doors.

T: Do you think that local inhabitants are willing to help actively think of better solutions?

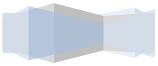
L: some of them. But not many. I think that local inhabitants can help actually. We still have some intelligent people out there. After we've almost completed a plan, we ask for peoples opinion. And they will gives us some opinions. Citizens mostly only disagree upon the minor details of a plan.

T: Do you make use of technological innovations on water management, such as 'smart city' concepts?

L: We do research on how we can use the LID technology. In our plans we use the models and computers to simulate the flooding from rainwater. We use the model MIKE FLOOD from Denmark. We measure the real rainwater's quantity and quality and then we compare it to the predicted simulation of the model. Around 20/30% reality varies to the model.

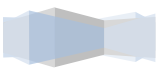
T: Do you know which areas get most flooded from extreme rainfall?

L: Bao'an.



Appendix 11: Table with categories for qualitative analysis

Policies and regulations on climate change and adaptation	Characteristics of extreme rainfall	Organizational structure and position
Physical measures	Flooded areas	Financial structure
Information provision		Governmental collaborations
Design standards		Expectations of the private domain
Technological innovations		



Appendix 12: Climate change

As temperature rises, the summer days with high temperatures (over 33 degrees) also keep rising, from a maximum of 10 days per year in the past century up to more than 30 days per year now.

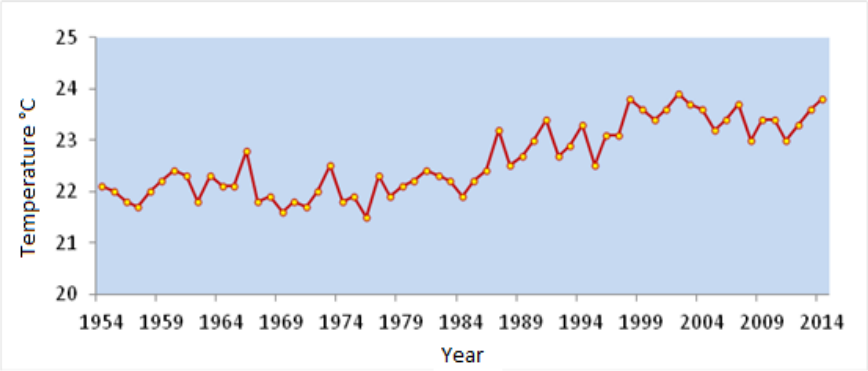


Figure 1: Average annual temperature in Shenzhen. CAI WU WEI Weather Station Source: SMB (n.d.)

The annual average relative humidity in Shenzhen was roughly 80% during the 1960's, whereas today the annual relative humidity has dropped to 65% (SMB, n.d.).

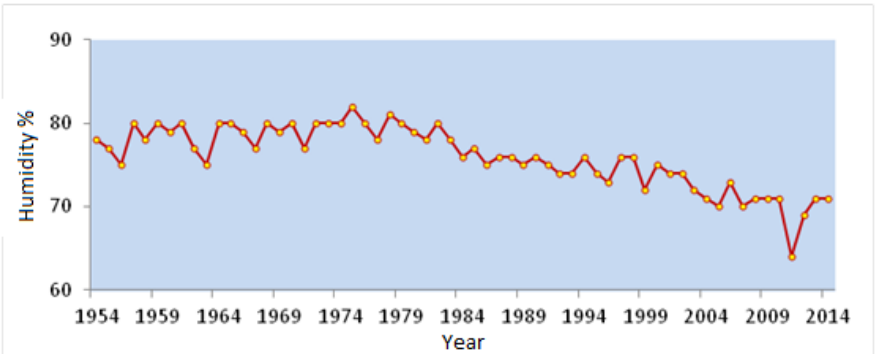


Figure 2: Average annual humidity in Shenzhen. CAI WU WEI Weather Station Source: SMB (n.d.)

Since 2004 there has been a downward trend. By means of effective environmental governance, the annual haze days has dropped to 68 days in 2014, returning to the levels of the mid 90's (SMB, n.d.).

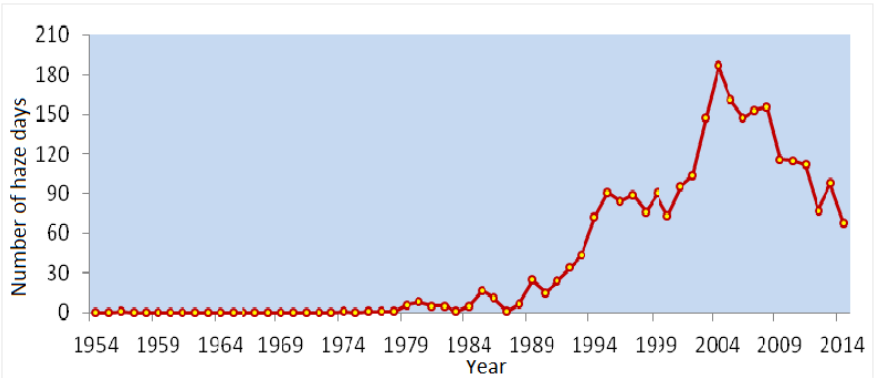


Figure 3: Number of haze days in Shenzhen Source: SMB (n.d.)

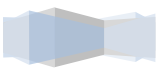
Appendix 13: Extreme rainfall events in Shenzhen

Data derived during interview (F).

Date extreme rainfall event	Amount of precipitation (mm/h)
28/07/2010	125.8
20/05/2012	125.3
17/05/2014	119.9
30/03/2014	116.2
30/08/2013	113.8
13/06/2008	110.4
12/06/2012	108.5
27/06/2010	106.6
09/09/2010	106.1
13/05/2014	105.7
09/09/2010	105.5
25/08/2007	104.7
13/06/2008	104.2
03/06/2009	103.8
22/05/2011	102.2
17/05/2014	101.9
23/08/2013	101.7
14/06/2009	99.8
20/08/2014	99.7
19/04/2008	98.9
05/06/2013	98.7
29/04/2012	98.6
29/04/2012	97.2
30/03/2014	97.1
10/09/2010	96.9
29/04/2012	95.9
09/09/2010	95.7
09/09/2010	95.6

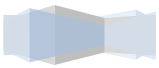
Date extreme rainfall event	Amount of precipitation (mm/2h
22/05/2011	187.8
17/05/2014	173.8
13/06/2008	163.6
17/05/2014	158.1
11/05/2014	156.7
29/04/2012	156.0
30/08/2013	154.7
13/06/2008	154.0
30/08/2013	148.1
30/08/2013	146.0
19/04/2008	145.8
30/03/2014	145.3
03/06/2009	145.2
30/03/2014	145.1
13/05/2014	144.3
29/04/2012	143.6
30/08/2013	143.5
13/06/2008	142.7
28/07/2010	142.1
19/04/2008	139.8
11/05/2014	137.8
29/04/2012	137.2
23/08/2013	137.1
25/07/2012	135.9
21/06/2012	132.2
13/06/2008	131.3
22/07/2010	131.0
13/06/2008	130.9

Date extreme rainfall event	Amount of precipitation (mm/3h)
17/05/2014	235.9
11/05/2014	222.5
22/05/2011	220.3
30/08/2013	210.9
13/06/2008	192.8
23/08/2013	190.0
11/05/2014	183.8
30/08/2013	177.0
28/07/2010	176.8
23/08/2013	176.6
11/05/2014	174.0
17/05/2014	171.1
30/03/2014	170.8
30/03/2014	170.0
30/08/2013	168.4
13/05/2014	168.3
13/06/2008	168.0
20/05/2014	166.3
21/06/2012	165.9
19/04/2008	165.1
29/04/2012	165.1
30/08/2013	163.5
11/05/2014	162.2
29/04/2012	159.3
13/06/2008	156.3
19/04/2008	154.3
30/08/2013	154.1
19/04/2008	152.9



Date extreme rainfall event	Amount of precipitation (mm/6h)
11/05/2014	319.8
11/05/2014	289.5
11/05/2014	275.8
17/05/2014	273.0
11/05/2014	264.4
11/05/2014	260.1
22/05/2011	254.0
13/05/2014	243.7
11/05/2014	243.1
30/08/2013	238.4
11/05/2014	236.3
11/05/2014	227.4
13/06/2008	225.5
28/07/2010	225.4
13/06/2008	221.3
11/05/2014	218.4
11/05/2014	215.3
23/08/2013	214.6
13/06/2008	213.6
30/03/2014	212.8
30/08/2013	209.6
30/03/2014	209.3
30/03/2014	207.7
30/03/2014	207.6
19/04/2008	207.3
11/05/2014	206.5
30/08/2013	206.1
11/05/2014	205.6

Date extreme rainfall event	Amount of precipitation (mm/24h)
14/06/2008	517.4
14/06/2008	504.7
12/05/2014	458.2
12/05/2014	442.1
14/06/2008	433.2
14/06/2008	420.6
14/06/2008	412.0
12/05/2008	409.4
14/06/2008	393.1
13/06/2008	388.6
13/06/2008	386.7
12/05/2014	379.4
14/06/2008	376.3
12/05/2014	371.8
12/05/2014	371.0
14/06/2008	370.4
13/06/2008	369.8
13/06/2008	368.1
14/06/2008	367.9
13/06/2008	363.1
12/05/2014	362.7
12/05/2014	359.6
13/06/2008	356.1
17/05/2014	344.7
12/05/2014	343.1
14/06/2008	341.3
12/05/2014	339.5
13/06/2008	338.4



Appendix 14: Return period of storm intensity formula

Rainwater design flow rate calculated by the following formula:

Q = q• ψ• F (L/s)

Type:

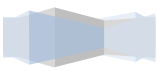
Q -- Rain design flow rate (L/s)

q -- Design rainstorm intensity (L/s • hm2)

ϕ -- runoff coefficient

F-- Catchment area (hm2)

Return period T（year）	formula
T=0.25	1907.631/（t+8.601）^0.708
T=0.33	1861.018/（t+7.893）^0.696
T=0.5	1774.853/（t+7.447）^0.654
T=1	1572.098/（t+6.000）^0.577
T=2	1455.259/（t+4.097）^0.518
T=3	1378.039/（t+3.749）^0.482
T=5	1358.201/（t+3.158）^0.452
T=10	1275.955/（t+1.210）^0.408



Appendix 15: Urban construction and public utility

18-1 URBAN CONSTRUCTIONS AND PUBLIC UTILITY （2008-2013）

Indicators	2008	2009	2010	2011	2012	2013
Parks,Gardens and Green Areas in UrbanDistricts						
Coverage Area of Afforestation (hectare)	97 605	97 598	97 592	97 575	97 670	98 635
Developed Areas(hectare)	35 471	36 609	37 384	37 918	38 906	39 267
Green Coverage Rate in Developed Areas(%)	45	45	45	45	45	45
Area of Gardens and Green Areas(hectare)	96 381	96 374	96 368	96 352	96 382	96 697
Developed Areas(hectare)	30 830	31 821	32 495	32 960	33 820	34 136
Rate of Green Areas in Developed Areas(%)	39.1	39.1	39.2	39.2	39.2	39.2
Public Green Areas(hectare)	14 205	14 527	16 987	17 271	17 508	17 750
Per Capita Public Green Areas(sq.m)	16.2	16.3	16.4	16.5	16.6	16.7
Number of Parks(unit)	615	653	683	824	841	869
Area of Parks(hectare)	15 986	20 452	20 541	21 907	21 948	21 950
Public Facilities and Environmental Sanitation in urban Districts						
Length of Roads(1000 m)	5 849	6 035	6 184	5 977	6 015	6 364
Area of Roads(10 000 sq.m)	8 630	8 864	8 941	10 616	10 629	11 496
Per Capita Area of Roads(sq.m)	9.0	8.9	8.6	10.1	10.1	10.8
Total Length of Sewer Pipelines(1000 m)	9 984	12 153	12 844	10 420	11 472	10 420
Design Scale of Sewage Disposal(10 000 tons/day)	251.5	262.5	266.5	390.0	421	470
Number of Street Lights(unit)	221 642	280 000	305 629	320 915	240 718	250 771
Volume of Living Garbage Disposal(10 000 tons)	441	476	479	482	490	522
Volume of Living Garbage Harmless Disposal(10 000 tons)	415	449	453	458	466	513
Rate of Garbage Harmless Disposal(%)	94.2	94.3	94.6	95.0	95.1	98.4

Note: 1.From 2011,the statistical scope of Length of Roads,Area of Roads,Toads,Total Length of Sewer Pipelines and Number of Bridges have been adjusted.

2.From 2012.the statistical Scope of Number of Street Lights has been adjusted.

Appendix 16: Demographic characteristics

Area	Number	Man	Woman
Sea World	49	18	31
Xili	51	21	30
Total	100	39	61

Table 1:Number of respondents and the male/female distribution by research area.

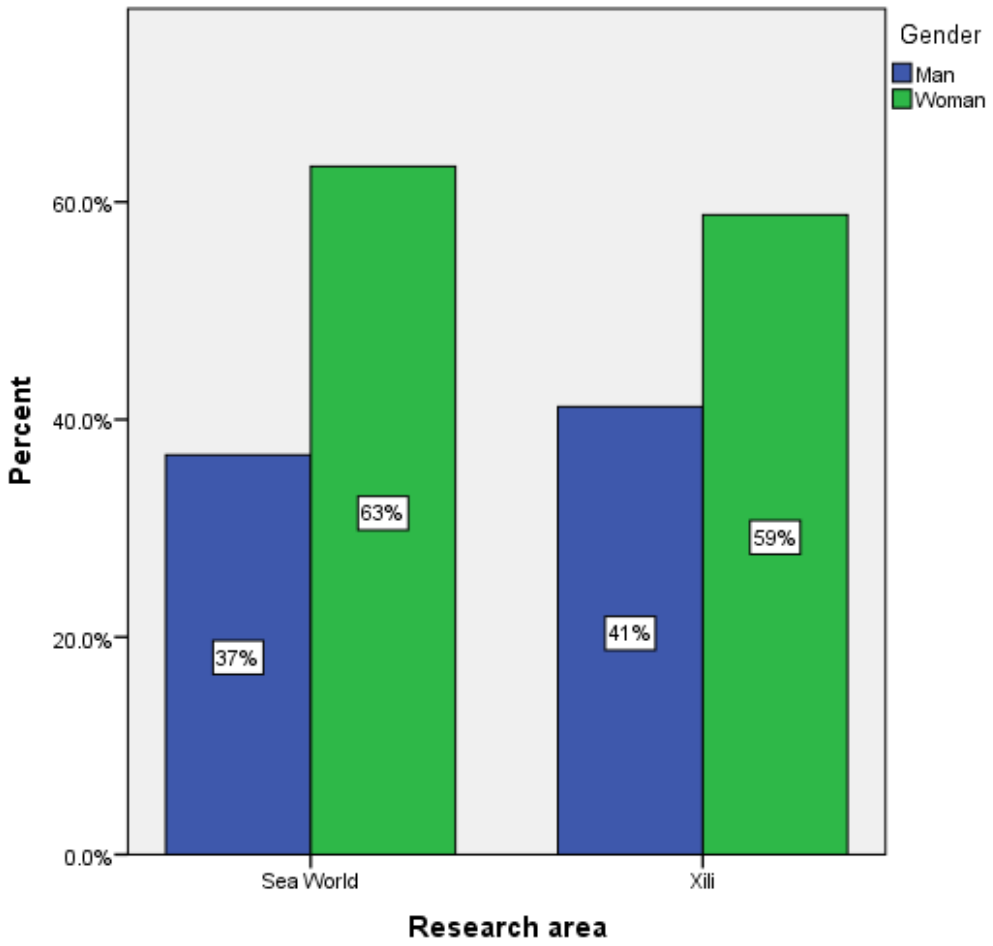


Figure 1: Male/female ratio in both areas

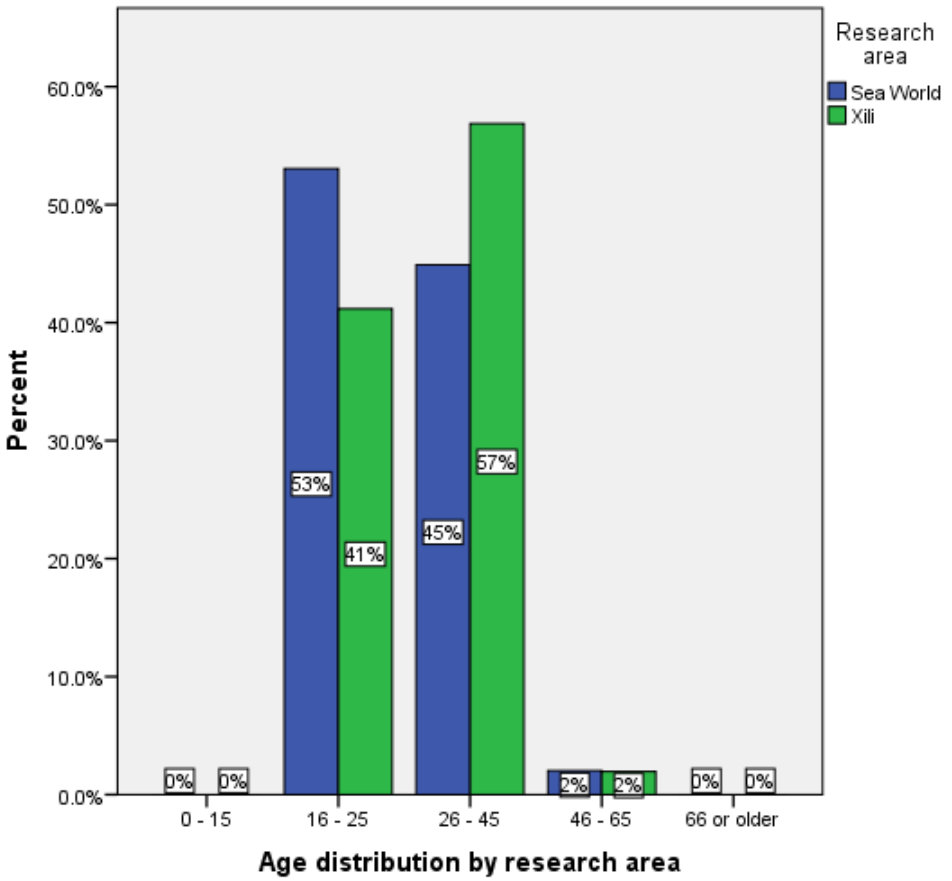


Figure 2: Age distribution in both areas

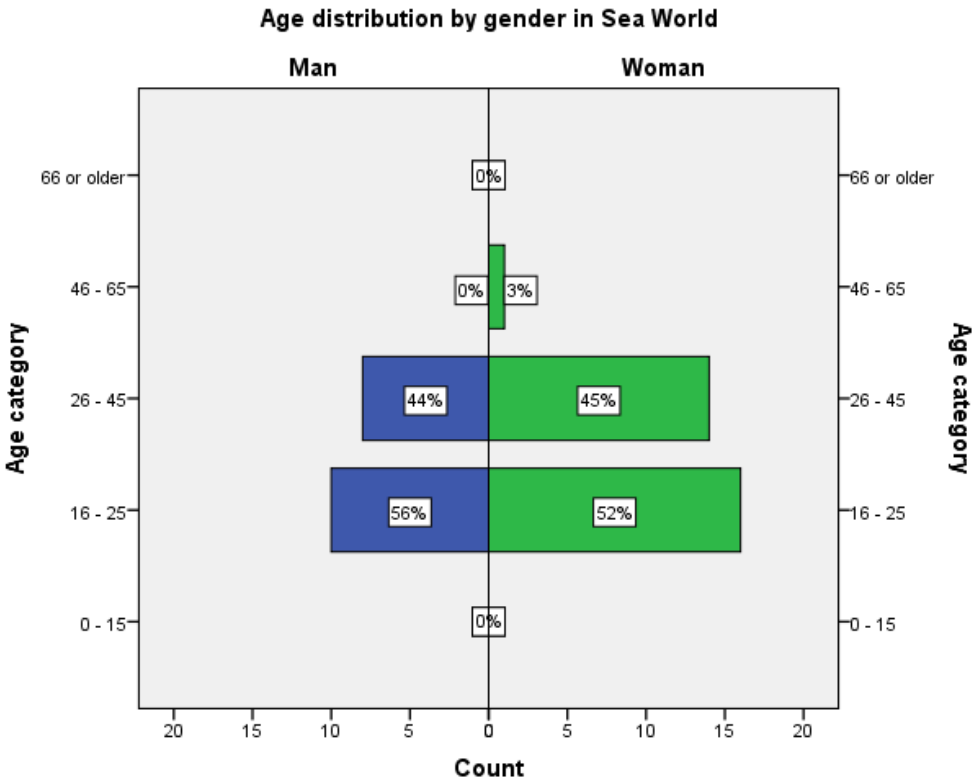


Figure 3: Age distribution by gender in Sea World

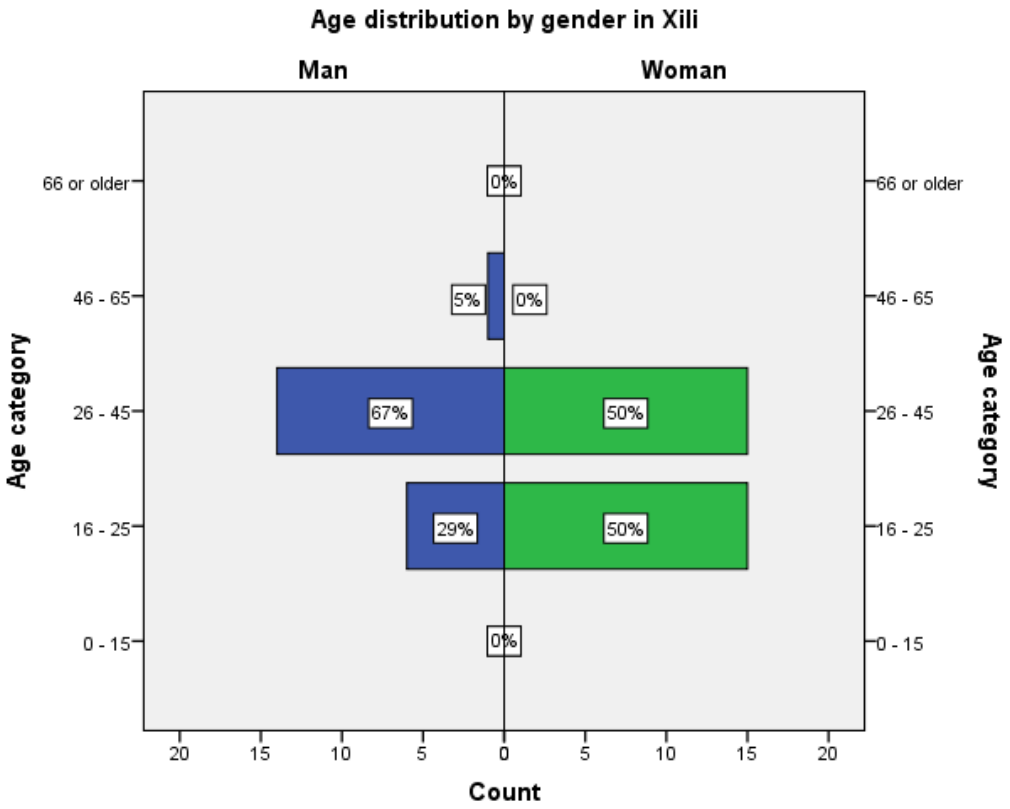
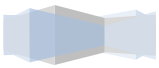


Figure 4: Age distribution by gender in Xili

Appendix 17: Statistical test results.

A cross-tabulation of the experience with a flood and the area of interest have been applied and a coherence measure has been calculated using the Pearson Chi-Square test. The null-hypothesis for this calculation is: *the variables are independent*. The test shows that the Pearson Chi-Square is 2,545 and that the coherence is not significant (.111)(table 1). One, thus, can say that both variables are independent. However, the amount of the Pearson Chi-Square does not say anything about the strength of the cohesion since it depends, among other things, upon the total amount of respondents (Grotenhuis & Matthijssen, 2009) The coherence measures Phi and Cramer's V don't have this disadvantage. The value of .160 of these coherence measures show that the association between the location and the experience with a flood is a low association (table 2).

To see whether this low association also accounts for the whole population, an independent T-test have been carried out. Using a T-test for two independent variables allows for comparing whether the means of a variable vary between two groups. First, the Levene's test provides insight into the differences of the variances. The score of .009 (table 3) tells that, in this case, the equal variances may not be assumed. The corresponding significance in this row (.113) shows that both averages do not differ significantly from each other. In other words: one may assume that there is no significant relationship between the experience with a flood and the area that the respondent lives in.



Have you ever experienced a flood from extreme rainfall? * Location of carrying out the survey Crosstabulation

			Location of carrying out the survey		Total
			Sea World	Xili	
Have you ever experienced a flood from extreme rainfall?	Yes	Count	23	16	39
		% within Location of carrying out the survey	46.9%	31.4%	39.0%
	No	Count	26	35	61
		% within Location of carrying out the survey	53.1%	68.6%	61.0%
Total		Count	49	51	100
		% within Location of carrying out the survey	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.545[a]	1	.111		
Continuity Correction[b]	1.933	1	.164		
Likelihood Ratio	2.556	1	.110		
Fisher's Exact Test				.151	.082
Linear-by-Linear Association	2.520	1	.112		
N of Valid Cases	100				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 19.11.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.160	.111
	Cramer's V	.160	.111
N of Valid Cases		100	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 1:Pearson Chi-Square test, Phi and Cramer's V

Characterizations	
>.5	High association
.3 to .5	moderate association
.1 to .3	low association
0 to .1	little if any association

Table 2: Strengths of associations. *Source:AcaStat (n.d)*

Group Statistics

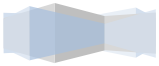
	Location of carrying out the survey	N	Mean	Std. Deviation	Std. Error Mean
Have you ever experienced a flood from extreme rainfall?	Sea World	49	1.53	.504	.072
	Xili	51	1.69	.469	.066

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Have you ever experienced a flood from extreme rainfall?	Equal variances assumed	7.113	.009	-1.600	98	.113	-.156	.097	-.349	.037
	Equal variances not assumed			-1.597	96.756	.113	-.156	.097	-.349	.038

Table 3: Results of the independent T-test

To determine whether there is a relationship between the flood experiences and the levels of housing, a cross-tabulation, along with a coherence measure Chi-square, has been applied (table 4). The variable 'housing levels' had only two assigned categories: 'living on the ground floor' and 'not living on the ground floor'. Notice that in this case the variable 'experience' has been assigned as the dependent variable since the hypothesis suggests that the experience might be different.



Have you ever experienced a flood from extreme rainfall? * Do you live on the ground floor? Crosstabulation

			Do you live on the ground floor?		Total
			Yes	No	
Have you ever experienced a flood from extreme rainfall?	Yes	Count	5	33	38
		% within Do you live on the ground floor?	23,8%	42,3%	38,4%
	No	Count	16	45	61
		% within Do you live on the ground floor?	76,2%	57,7%	61,6%
Total		Count	21	78	99
		% within Do you live on the ground floor?	100,0%	100,0%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2,394[a]	1	,122		
Continuity Correction[b]	1,676	1	,196		
Likelihood Ratio	2,520	1	,112		
Fisher's Exact Test				,138	,096
Linear-by-Linear Association	2,370	1	,124		
N of Valid Cases	99				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 8,06.

b. Computed only for a 2x2 table

Table 4: Relationship between housing level and experience with a flood

To determine how the respondents perceive a flood from extreme rainfall and if there are any significant differences between respondents who have never experienced one to those who did, a cross-tabulation, along with a coherence measure Chi-square, of the two questions 'have you ever experienced a flooding from extreme rainfall' and 'how do you experience a flooding ' has been applied (table 5). The variable 'perception of flooding' originally had 4 categories assigned: 'as a nuisance', 'as a threat', 'bad because of damage to my house/property' and 'I don't mind'. However, because only 3 respondents answered this question with 'I don't mind', this category has been abolished in the analysis since including this category would result in not meeting one of the conditions (a maximum of 20% of the cells with an expected count less than 5) for a Chi-Square test.

How do you experience a flooding? * Have you ever experienced a flood from extreme rainfall? Crosstabulation

			Have you ever experienced a flood from extreme rainfall?		Total
			Yes	No	
How do you experience a flooding?	As a nuisance	Count	7	9	16
		% within Have you ever experienced a flood from extreme rainfall?	17.9%	15.5%	16.5%
	As a threat	Count	14	25	39
		% within Have you ever experienced a flood from extreme rainfall?	35.9%	43.1%	40.2%
	Bad because of damage to my house/shop	Count	18	24	42
		% within Have you ever experienced a flood from extreme rainfall?	46.2%	41.4%	43.3%
Total		Count	39	58	97
		% within Have you ever experienced a flood from extreme rainfall?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.508[a]	2	.776
Likelihood Ratio	.510	2	.775
Linear-by-Linear Association	.024	1	.877
N of Valid Cases	97		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.43.

Table 5: relationship between perception of and experience with a flood

To test whether a presumed relationship between the experience with a flood and the amount of implemented measures is applicable to the respondents of Shenzhen, a cross-tabulation, along with coherence measures Chi-square, Phi and Cramer's V, of the two questions 'have you ever experienced a flooding from extreme rainfall' and 'do you take measures yourself to prevent water damage' has been applied (table 6). The variable 'do you take measures' had only two categories:

yes and no. This question, then, was followed by an open question (if yes, which measures and do they help? if no, why not?) for more in depth information about the kind of measures or the reasoning behind it.

Do you take measures yourself to prevent water damage? * Have you ever experienced a flood from extreme rainfall? Crosstabulation

			Have you ever experienced a flood from extreme rainfall?		Total
			Yes	No	
Do you take measures yourself to prevent water damage?	Yes	Count	27	26	53
		% within Have you ever experienced a flood from extreme rainfall?	71.1%	42.6%	53.5%
	No	Count	11	35	46
		% within Have you ever experienced a flood from extreme rainfall?	28.9%	57.4%	46.5%
Total		Count	38	61	99
		% within Have you ever experienced a flood from extreme rainfall?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.608[a]	1	.006		
Continuity Correction[b]	6.508	1	.011		
Likelihood Ratio	7.789	1	.005		
Fisher's Exact Test				.007	.005
Linear-by-Linear Association	7.531	1	.006		
N of Valid Cases	99				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 17.66.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.277	.006
	Cramer's V	.277	.006
N of Valid Cases		99	

a. Not assuming the null hypothesis.

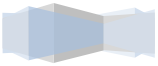
b. Using the asymptotic standard error assuming the null hypothesis.

Table 6: Relationship between the experience with a flood and taking measures

To see whether people who have experienced a flood from extreme rainfall are more willing to participate in the process of adaptation to extreme rainfall, a cross-tabulation, along with coherence measures Chi-square, of the two questions 'have you ever experienced a flooding from extreme rainfall' and 'are you willing to participate as a citizen in helping the government to deal with extreme rainfall' has been applied (table 7). To do so, the categories 'no, the government is responsible' and 'no, no time / not interested' are merged in order to meet the conditions of the Chi-Square test. Furthermore, the open questions 'what do you think that citizens should do to prevent damage from extreme rainfall' and 'What do you think that the government should do to prevent damage from extreme rainfall' following this closed question are used to provide more in-depth information about the reasoning behind it.

Are you willing to participate as a citizen in helping the government to deal with extreme rainfall? * Have you ever experienced a flood from extreme rainfall? Crosstabulation

			Have you ever experienced a flood from extreme rainfall?		Total
			Yes	No	
Are you willing to participate as a citizen in helping the government to deal with extreme rainfall?	Yes, I already do that	Count	8	11	19
		% within Have you ever experienced a flood from extreme rainfall?	21,1%	18,0%	19,2%
	Yes, especially local citizens can come up with good solutions	Count	25	35	60
		% within Have you ever experienced a flood from extreme rainfall?	65,8%	57,4%	60,6%
	No, the government is responsible / no time	Count	5	15	20
		% within Have you ever experienced a flood from extreme rainfall?	13,2%	24,6%	20,2%
Total		Count	38	61	99
		% within Have you ever experienced a flood from extreme rainfall?	100,0%	100,0%	100,0%



Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1,899[a]	2	,387
Likelihood Ratio	1,990	2	,370
Linear-by-Linear Association	1,229	1	,268
N of Valid Cases	99		

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 7,29.

Table 7: The relationship between the experience with a flood and the willingness to participate