

# The Netherlands, Germany and England: A comparison of adaptation and accommodation strategies against flooding



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## Abstract

Awareness is starting to rise concerning the need for adaptation strategies in the face of more intense as well as frequent flooding of urbanized delta-areas. Until now the focus laid mostly on mitigation strategies as well as implementing adaptation strategies from a highly local level. In this research the concept of adaptation will be investigated more thoroughly, attempting to fill the gaps which exist here. A comparison between countries and their flood-prone cities will also be made here in order to assert the type of adaptation strategies implemented as well as how these strategies are attempted to give form from a more national level rather than highly local. An adaptation tool will furthermore be created to contribute to the practical dilemma's of uncertainties and vulnerabilities relating to flooding as well as attempt to highlight which variables and concepts are most appropriate to the term adaptation. These investigations will be done by the use of textual analyses of both academic literature as well as policy and planning documents thereby covering and combining both theoretical and practical knowledge. It has become apparent through the research that comparative analysis is very helpful bridging both gaps and that countries and cities can learn a lot from one another as well as strengthen their own weaknesses further. The adaptation tool helps to highlight what areas can gain most from further improvement, reducing both the vulnerability and exposure of the society as well as the built environment.

## Keywords

Adaptation, adaptive capacity, vulnerability, resilience, risk, adaptation strategies, adaptation tool, flood, delta-city, government, government agencies.

## 1. An introduction

### 1.1 Topic introduction

Climate changes have become an overarching phenomenon which highlights the importance of resilience and adaptive capacity at all levels varying from an individual to the entire human population in an area. Climate changes, and global warming, are causing the estuaries and river-systems to flood more intense and more frequent. As a vast amount of people tempt to live at these geographical locations for economical and historical reasons the impacts of these floods can have severe consequences. According to the Intergovernmental Panel on Climate Changes, the adverse effects of predicted climate changes are a “widespread increase in the risk of flooding for many human settlements” (IPCC, 2001). Flooding can be interpreted in many different manners, for the purpose of this paper the term flood will mean that the water crosses the land and enters the urbanized area, thereby causing negative consequences and reduced safety of the human population (Few, 2003).

Around the year 2007, a boost occurred in Europe to draw more attention to the problems related to global warming. This boost was do due to an increase in awareness that societies living near shores or delta areas have become more vulnerable as some devastating events struck. A couple of examples are the tsunami which struck a vast part of India in 2004, hurricane Katrina destroying the built area of New Orleans in 2005 and more recently in 2011 the tsunami which struck Japan with long lasting residual effects of the nuclear power plants which were destroyed by the incoming water. A typhoon caused large floods in Taiwan in 2011, whereas the Netherlands were paralyzed in early 2012 by the northern wind which wouldn't allow the water to be pumped out of the country. These events highlight the need to reduce vulnerability as well as augmenting the resilience of societies (Brozka, 2009).

However, long before these events occurred three basic strategies on how to handle the increasing water levels were already mentioned by Bijlsma et al. (1996). Planned retreat, accommodation strategies and protect are the main options they give at this time. Protect can either be achieved through the building of hard structures, like levies, or through the use of soft structure options. These soft structures are mostly enabled by the natural processes of the earth by providing dunes and other natural protection barriers. As most people live near water a certain level of protection will always be needed. However, within the strategy of protect an important element is omitted, that of being prepared for a possible flood and its consequences.

Human societies, nowadays, are highly structured by agencies and governments who mostly attempt to keep their people safe and satisfied. Therefore a look will be taken at how governments and related agencies give form to adaptation strategies and their implementation. The focus will be on the term 'adaptation' as this focus is becoming even more important as mitigation strategies alone will not suffice long into the future as current changes in climate already show pressurizing delta cities (Nicholls et al., 2007). Nicholls et al. (2007) define adaptive capacity as “the ability of a system to evolve in order to accommodate climate changes or to expand the range of variability with which it can cope”. In this case a system would refer to a community or society and its living environment, being a city and its residents for example. It is therefore currently needed to reduce vulnerabilities of societies which can be accomplished through the promotion and implementation of adaptation strategies.

McCarthy et al. (2001) define adaptation as “actions targeted at the vulnerable system in response to actual or expected climate stimuli with the objective of moderating harm from climate change or exploiting opportunities”. From this definition it becomes clear that the Earth will not become a perfectly safe environment to live in. The possibility of a flood to occur in delta areas is therefore continuously present. As changes in climate become more vivid delta cities will have to acknowledge their current as well as future vulnerability. In order to reduce this vulnerability significant improvements in adaptability of these cities and their societies are needed. Significant improvements to secure safety as much as possible are plausible concerning flood related events.

As the effects of human interference become more noticeable with every extreme storm or flooding governments, related agencies and societies are becoming increasingly aware of the incurred consequences when a storm or flood would hit. There is an increasing need for adaptation possibilities accompanied by accommodation strategies to circumvent the consequences of a flood. The comparing of adaptation approaches and how they are used by different countries has become increasingly important for finding and implementing suitable strategies for vulnerable regions. This is also acknowledged by the European Union which attempts to implement adaptation strategies to the more national levels rather than only promoting it at the local levels which mostly only occurs due to the initiatives of the local residents (Jordan et al., 2010). As a sequel many of the European Union member states have attempted to incorporate adaptation strategies in to their water-management plans, policies and regulations. This trend has come about most obviously ever since 2007.

As the novel focus on the term adaptation is coming about a couple of problems arise. The first and foremost problem is that of knowledge. The current knowledge base on adaptation is only recently starting to evolve. However, most generated knowledge lacks opportunities or even possibilities to compare approaches as well as the definition given to adaptation. This comparing feature is not even promoted or suggested by the European Union. The second problem is that knowledge is mostly based on the local scale level, as it is believed that adaptation occurs and is implemented here most. As mentioned in the previous paragraph however the European Union is attempting to implement adaptation strategies towards the national level (Jordan et al., 2010). As it is here were a major knowledge gap exists more research will have to be done in order to formulate effective adaptation strategies.

In order to make an attempt to fill these gaps of knowledge and comparability of adaptation approaches the focus of this thesis will lay on the national governments as well as their related agencies of three countries. First a look will be taken at the term adaptation, what it implies, the agreements, disagreements relating to this term and which elements are important in relation to this term. Secondly, a look will be taken at how the mentioned organizations give form to adaptation strategies and how they intend to implement them. A look will also be taken at the countries' vastest cities in relation to reducing their vulnerability to flooding events. The chosen countries and cities will be introduced below.

## 1.2 The countries

For this research the Netherlands, England and Germany have been chosen to be compared to one another. These three countries have some basic similarities as well as interesting differences which have been of great importance for choosing these countries. From each country a delta city has also been chosen to be compared in order to give more insights to the differences of adaptation at the national to the more local scale. The cities are Rotterdam, London and Hamburg respectively. Some of the overarching elements as well as differences will be discussed briefly where after each country and their chosen city will be shortly presented.

### 1.2.1 Similarities and differences

The first similarity is that one of the largest intergovernmental associations who deals with the effects of climate change is the European Union which overarches the policies of all three countries. Up to this day however, the European Union has barely taken steps to set policies in order to initiate mitigation strategies amongst its 27 member states. Whereas adaptation strategies attempt to keep society and its living environment prepared for a flood to come mitigation strategies attempt to extenuate the event all together. Even though mitigation strategies are important, it will not succumb the effects related to temperature and sea-level rise to such a point that no further action needs to be taken in order to keep societies safe. In the previous years, the European Union has attempted to incorporate adaptation policies. However, at present this still seems to be initiated at the local governmental level or even on community level (Jordan et al., 2010), leaving vast amounts of people and built areas in delta areas uncovered. It is therefore that three member states have been chosen as it can be assumed that they attempt to incorporate adaptation strategies. The chosen countries are shown in figure 1 below.

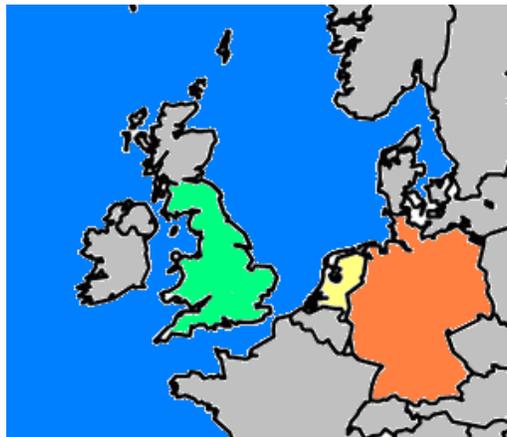


Figure 1: The three countries – Green is England, Yellow is the Netherlands, Orange is Germany, Blue is the North Sea.

Another important similarity is that each country has at least one major delta-city which has to cope with the possible occurrence of a flood. As it is in highly populated places where most devastating consequences appear when a levy is breached. The Netherlands, England and Germany are in close proximity to one another in a geographical sense, each bordering the North Sea. The North Sea and the rivers flowing through these countries can cause severe problems if climate change continues to fasten. Furthermore the North Sea can be pushed up even more than

average estimations of water level rises (IPCC, 2001). This is especially so when a northern wind strikes, which blocks the water from going back into the Atlantic Ocean. Pressure on the river mouths is formed keeping the water captured inside the countries. This phenomenon causes the city of Hamburg trouble as this is the lowest and thereby most vulnerable point along the river flowing towards the sea from the mountains. The Netherlands however suffers from the same problem as they continuously need to pump out water due to the low-lying land of the western side of the country. In the year 1953 a dyke was breached causing nearly 5,000 deaths in the Netherlands (Dehenauw, 2003). However, at the same time England was also hit showing the related vulnerabilities of these countries (RMS, 2003). This makes it very interesting to compare these three countries on how they implement adaptation strategies. A picture of each delta-city has been show below, picture 1.1 through picture 1.3, each having a haven port function.



Picture 1.1 Rotterdam



Picture 1.2 London



Picture 1.3 Hamburg

Apart from these major similarities of being European Union member states as well as their geographical proximity the three countries have some major differences as well. Each country have different protocols by which policies are being implemented and monitored. This relates to the level of involvement of the central government versus private parties which differs per country and sometimes even by provinces or regions. As such vast differences can be assumed to arise when attempting to implement adaptation strategies from a national level. Comparing these different manners of implementation even though the water-related problems are of a similar nature creates possibilities for comparison as well as for possible adoption of other strategy implementation manners.

### 1.2.2 The Netherlands - Rotterdam

The Netherlands is a country which is known for its way of handling the rising sea-level, vast amounts of rainfall and other climatic side-effects. The Netherlands has multiple governing agencies that promote the water safety and reverse negative effects. In the Netherlands the Water boards have had an eminent role ever since communities started living in the low-lying part of the country. The Dutch Water boards currently seem to loose significance as this technical approach of building levies and water-pumping systems is out of date to the Dutch standards of proceeding. The Netherlands still has major problems when a Northern wind strikes for more than a few days as has become apparent early January 2012 (van Boekel, 2012). As shown in 1953 and later two nearly floods in 1995 and 1997 (Helsloot, 2009) it becomes apparent that the Dutch citizens cannot depend on the mitigation strategies alone to apprehend their own safety. A government and its related water-management organization which are under such vast pressure to protect its citizens are now seeking to take a more adaptive approach next to the mitigation strategies at hand. These mitigation strategies will be needed as long as the economic heart and

the highest proportion of citizens live in areas which are multiple meters below the sea-level.

The Netherlands has many larger delta-cities, in fact this so-called metropolitan area is located for its largest part in flood-prone areas due to the low-lying nature of the country itself. However, the city of Rotterdam has been chosen due to the major rivers passing along it, which have allowed the city its main-port function. This main port function however makes it vulnerable to climate change impacts. The river Meuse flows alongside Rotterdam, however, as can be seen on picture 1.1, if it would cross the river's borders it would have vast consequences. Another crucial point here is that the rivers are starting to lay higher than the surrounding land. This can also be seen in the picture, where the water is almost as high as the ground floor of the buildings.

### 1.2.3 England - London

England also borders the North Sea, even for a larger part than the Netherlands does. However, England has less low-lying land than the Netherlands, making it less vulnerable on this account. England does not have an agency in place like the Water boards of the Netherlands which will most likely cause vast differences in the way they go about reducing the vulnerability of the people. England however does have flood insurance regimes in place, something totally absent in the Netherlands (Huber, 2004).

The city of London has been chosen for England due to the river Thames which passes through it, as shown in picture 1.2. The Thames Barrier is a vast water work which attempts to achieve the protection of the city of London. The Thames Barrier was set up after a severe flood in 1953 caused by a high sea level in the North Sea (Lavery and Donovan, 2005).

### 1.2.4 Germany - Hamburg

Germany, partly in proximity to the North Sea, has been chosen as they are said to be front-runners in mitigation strategies. This, however, has led to the problem that they are lagging thoroughly behind when it comes to adaptation strategies (Jordan et al., 2010). Germany is furthermore known for its provincial differences in managing water issues, which relates to the differences in problems with water sources. This makes it even more interesting on how the central government attempts to accommodate and increase adaptation.

The Elbe River has been causing trouble as it streams off into the North Sea. It is in the city of Hamburg where this river tempts to cause most trouble, as in the years 2002 and 2006. These troubles are mainly confronting Hamburg this city and its residents have to cope with the incoming water from the sea as well as the outgoing water from the mountains, meeting at its lowest point at the city itself.

## 1.3 Aim

In this paper the focus will be laid on how the governments, agencies and organizations responsible for the water management and water safety issues, give form to the promotion of adaptation. Apart from pure adaptation strategies, a focus will also be on accommodation strategies. Accommodation strategies can help

increase adaptive capacity of a region or society. The research will therefore be in stages, answering three questions, being:

- (1) A theoretical question: How can one define adaptation and which variables are most valuable to this concept?
- (2) An empirical question: To what extent are adaptation strategies represented and given form in the documents from the governments and related agencies?
- (3) A synthetic question: How do the governments and related agencies of the Netherlands, England and Germany give form to adaptation and accommodation strategies compared to the selected flood-prone delta-city's governments and their agencies?

The comparison will include at least agencies and organizations which contribute to the water safety, how they dispersed geographically and how the agencies or organizations dealing with such issues attempt to become adaptive. By comparing the country characteristics insights can be gained on how the Netherlands or any other country can approach water safety and adaptive capacity in different manners than they are doing currently. Furthermore, as water hazards hit infrequently, each country will have to learn from the mistakes and experiences gained from the past and the experiences made by other countries. All in all it is becoming increasingly important to understand how governments and other large organizational structures deal with and influence the adaptation and accommodation strategies against larger scale water troubles.

From these three research questions two major products will be attained. The first product is a conceptual model to compare the countries and cities manner of attempting to use adaptation strategies. This conceptual model will then be translated into a visual aid, or more precisely a matrix, which is the second product. Even though these are the two main products a review of the tool and how applicable it is to measure adaptation through policy and regulation documents really is. This should help the debate about what variables and subcomponents come about strong for defining the core concepts needed to define and analyse adaptation in future comparative research. Such evaluation entails analysing which variables are most effective to such an analysis which will be done by using the analysis of the three countries and their chosen cities. It is for the general debate and measurability of adaptation as well as allowing countries and cities to see their differences that this research has been set up.

The end result of this thesis will concern the comparative insights that can be gained from looking at other countries or regions concerning adaptation strategies. Furthermore a next step will be developed for theory to develop more applicable designs of measuring adaptation strategies. This step will hopefully reduce the gaps in the current debate about adaptation in flood-prone delta's. A plausible step ahead will also reduce the uncertainties which are currently felt in practice when attempting to implement adaptation. Therefore this research will attempt to highlight adaptation concepts as well as how adaptation strategies can be implemented. In the end of this research an indication of possible steps for the governments and related agencies into the future can be given.

## 1.4 Methodology

Now that the three research questions have been formulated the methods of attaining the results will have to be composed. This will be done in this section. Being that there are three different types of research questions, different methods as well as guidelines will have to be produced. These will be discussed in this section for each research question individually.

### 1.4.1 The theoretic

The theoretical question is concerned with defining the term 'adaptation' and the most valuable variables to this concept. In recent years adaptation has become a relatively important concept with the academics. The academic literature will be verified for finding the most relevant definition. Furthermore the literature will be used to accumulate existing variables for the measuring and testing of adaptation. These variables will then be compared and selected to create a conceptual model. The aim of this literature review will be to create a conceptual model and a matrix to allow textual analysis of this concept.

The University of Groningen has an academic literature database called PurpleSearch as well as one called SciVerse. SciVerse is a larger database, accumulating academic literature of multiple universities worldwide. In combination with the university's account this database can be visited and inquired. The databases function on the basis of search terms as well as names of the authors. For this research however the search terms have been used. A start was made with standard terms such as: adaptation, adaptive capacity, resilience, vulnerability, flooding and risk. The titles and abstracts have been scanned to relate the importance of the found articles. The second step consists of reading the articles thoroughly and highlighting other authors and articles which come about as important within the article. Then these articles are also checked for their relevance. This technique can be referred to as snow-balling. The technique is finished when a no new relevant results are to be found. In appendix one a word list is added, which show some relevant terms for the entire research.

### 1.4.2 The empirical

The empirical question concerns itself with the extent to which adaptation strategies are given form in the policy documents and plans from governments and water-related agencies of the three countries and cities. Textual analysis will be used in this part of the research for each country and city independently. The definition and variables which will be defined in the next chapter will be used here as guidelines. The allocating of the policy documents and plans will be done with the help of the Google search engine as this does not concern academic literature. The search terms adaptation and flood in combination with the country or city name will be used for the initial search. An attempt will be made to allocate documents created by different agencies. These agencies will be checked for their relevance also through the Google search in combination with their status on the national level of the selected country. As secondary data analysis is not self-written, the authenticity, accessibility and applicability, will be gathered and checked by doing so (O'Leary, 2010).

For the next step the documents will have to be analysed. This will be done by hand, without the help of textual programmes due to the formatting of these policy documents. A feature which is highly relevant here which can be taken over to manual analysis is that of categorizing results. For this reason a couple of basic

categories will be set up for the answering of the empirical question, being: motivation, aim/goal, problem awareness, role of actors involved or to be involved, the time looked ahead subdivided into the short-term, mid-term and long-term, and named adaptation strategies. By using such a categorisation differences and similarities can not only be highlighted but also a plausible reason for these differences and similarities can come to the fore. Another category concerning important quotes which do not fit into one of the named categories will also be added as this may imply important aspects which will otherwise be missed out on.

This approach will make it easy for other scientists, researchers or bureaus to retrace the steps that have been taken during the analysis, as page numbers show where the information has been gathered from the document itself. This allows others to do the same research but with other countries, regions or cities whilst keeping the results comparable whilst keeping the contextual differences of each country, region or city in perspective. This approach therefore, has some major advantages concerning the replication and verification of the analysis to be done. A plausible disadvantage that should be taken into account is the multitude of languages involved in this analysis, being the English language, Dutch as well as German. For this reason, as well as the categorization a word list in appendix 1 is added with the translations for the most crucial words.

#### 1.4.3 The synthetics

It is in this part of the analysis where comparisons are to be made between the countries themselves, the cities and between the countries and the cities. The comparison focuses on how the adaptation strategies are given form and how much emphasis is applied to them. The results of the previous section will also be used here in order to make a proper comparison in combination with an adaptation tool. This adaptation tool will be created in the beginning of chapter 4. The variables and components will then function as the manner of categorizing the analysis of the documents for this section. Again the terminology is added, together with the translations, in appendix 1. However, even if all the documents were in the same language words and concepts can be explained and understood differently. This will be elaborated in chapter two, where an attempt will be made to define the concept of adaptation. The results from the categorization will then be used to fill in the matrices of the adaptation tool which will be produced in the theoretical part to compare the results visually. As adaptation and how it is measured is still openly debated and no sign of agreement is yet to be gained this debate will hopefully contribute to getting a tad closer to this agreement.

In the coming chapter the term adaptation and a comparison will be made. In chapter two a conceptualization of adaptation will be presented along with the most important variables of this concept. Chapter three will guide the reader through the analysis of how the adaptation strategies are represented and given form in the documents publicized by the governments and water related agencies of the chosen countries and cities individually. Chapter four will start with the creation of a conceptual model in order to create a comparison tool which will be referred to as the adaptation tool. This tool will then be used present the similarities and differences amongst the countries and cities analysed. Chapter five will then conclude the research all together. At the end of this paper a clearer interpretation of what adaptation is, which variables are most significant for this concept as well as how the countries and cities compare or rather differentiate from one another when it comes

to implementing adaptation strategies should become clearer. Furthermore gaps of existing knowledge and uncertainties in practice should be one step closer to being reduced concerning the implementation of adaptation strategies at a larger scale.

## 2. Adaptation in flood-prone urbanized delta areas

This chapter will focus on the term adaptation and what adaptation implies. The term adaptation has no agreed upon definition making analysis of this concept troublesome. Below the concept of adaptation will be elaborated as well as the agreements and disagreements relating to its definition. After having defined the concept of adaptation a look will be taken at which variables are most fitting for making a comparison between the chosen countries and cities. At the end of this chapter a conceptual model in the form of an adaptation tool will be presented on which basis further analysis is to be pursued.

### 2.1 Literature review

Resilience, vulnerability and adaptive capacity have become terms with multiple meanings, interlinkages, and dependencies with one another. In the field of ecology, resilience was initially defined as “a measure of the persistence of systems and their ability to absorb changes and disturbance and still maintain the same relationships between populations or state variables” (Holling, 1973). This type of ecological resilience can be expressed by the magnitude of disturbance that can be absorbed before the system changes its structure by modifying variables and processes that control its behaviour (Galderisi et al., 2010). Resilience can also be defined as “the ability to absorb disturbances, to be changed and then to re-organize and still have the same identity (retain the same basic structure and ways of functioning). It includes the ability to learn from the disturbance” (Resilience Alliance, 2012). Sub-criteria like redundancy, robustness and resourcefulness are also incorporated in this concept, forming the general criteria of resilience (UNESCAP, 2008).

According to the World Meteorological Organization (1999) vulnerability is “a function of the type of structure or land use under consideration, irrespective of the location of the structure or land use”. Vulnerability is mostly described as the degree of loss which results from a flood. Furthermore, vulnerability is often calculated by the value which is given to the material world and the people affected, their incurred injuries and the material and social worlds’ resilience (WMO, 1999). According to the WMO there are two manners in which to reduce this absolute vulnerability. The first is the structural vulnerability, which can be reduced through construction codes and rules. The second, and most relevant here, is that of population vulnerability reduction which is mostly done by changing the functional features of the settlements. In this type of vulnerability, the geographical and contextual factors do not seem to play a prominent role. However, with perceived vulnerability this has a significant role. The closer people live along the shoreline for example, the more they are aware of the consequences of a flood. This may even lead to a higher perceived vulnerability than the absolute vulnerability; consequently they have a higher risk perception (Messner and Meyer, 2005).

According to Galderisi et al. (2010), resilience and vulnerability can be related in three different manners. The first, flip-side effects, states that something is vulnerable to the extent that it is not resilient. Secondly resilience can be seen as a component of vulnerability or vice versa. The third and most prominent relationship between these two concepts is that they can be considered independent factors. Resilience and vulnerability act in different phases after the event (readiness, response and recovery) at individual, community and institutional level in order to

contribute correspondingly to improve adaptation and minimize disruptions (Paton, 2008). The interrelation between the two concepts of vulnerability and resilience is therefore far from agreed upon.

Resilience and vulnerability are in close accordance with adaptation as these three concepts are highly interrelated. Agreement on how this interrelation can be understood is however lacking so far. Adaptation can reduce vulnerability and increase resilience according to some experts. Others however say that by increasing adaptation resilience decreases. According to McCarthy et al., (2001) adaptation refers to actions targeted at the vulnerable system in response to actual or expected climate stimuli with the objective of moderating harm from climate change or exploiting opportunities. Climate adaptation measures are taken to cope with the consequences of a changing climate and avoid future risks. Adaptation is aimed at reducing the risks and damage from current and future negative impacts or achieving potential advantages in this way.

Adaptation encompasses both national and regional strategies as well as practical measures taken at all political levels or by individuals. It can be preventive or reactive, and it applies to natural as well as to social systems. Ensuring the sustainability of investments over their entire lifetime taking explicit account of the changing climate is often referred to as climate proofing (UBA, 2008). According to Füssel (2007) the temporal scope of climate proofing a continuous process whereby the planning and implementation process can vary between a few months and multiple decades. Both the UBA (2008) and Füssel (2007) highlight the importance of adaptation strategies to target the longer term. Adaptation should preferably be a continuous process, meaning that the strategies are reviewed and updated regularly to optimize them. In this manner the vulnerabilities of the populations and the build areas in delta cities and countries can be reduced for both actual and expected flood-related events.

General Differentiating Concept or Attribute	Example of Terms Used
Purposefulness	Autonomous ↔ Planned Spontaneous ↔ Purposeful Automatic ↔ Intentional Natural ↔ Policy Passive ↔ Active Strategic
Timing	Anticipatory ↔ Responsive Proactive ↔ Reactive Ex ante ↔ Ex post
Temporal scope	Short term ↔ Long term Tactical ↔ Strategic Instantaneous, Contingency, Routine ↔ Cumulative
Spatial Scope	Localized ↔ Widespread
Function/Effects	Retreat – Accommodate – Protect Prevent – Tolerate – Spread – Change – Restore
Form	Structural – Legal – Institutional – Regulatory – Financial – Technological
Performance	Cost – Effectiveness – Efficiency – Implementability – Equity

Table 2.1: Bases for characterizing and differentiating adaptation to climate change (Smit et al., 1999).

According to Smit et al. (1999) adaptation refers to 'adjustments in ecological-social-economic systems in response to actual or expected climatic stimuli, their effects or impacts'. This definition of adaptation is very similar to the definition given by McCarthy et al. (2001), however leaving the moderation of harm out of the definition. This moderation of harm is crucial as it indicates that even though adaptation strategies are implemented and carried out, the consequences of a flood may still have to be dealt with by the protecting agencies as well as the populations. However Smit et al. (1999) have a list of differentiating concepts and attributes of adaptation which indicate where the trouble of agreeing on adaptation and how to implement it arise. In table 2.1 general criteria like purposefulness, timing, temporal scope, spatial scope, functions or effects, form and performance are included to highlight the ongoing debates. The purpose of adaptation can consist of opposites like autonomous versus planned adaptation or whether adaptation should occur naturally or that it should be initiated intentionally. The opposites relate to the question whether or not adaptation should be a natural process or that it should be policy induced.

The timing of adaptation is a very important issue as it does not relate to how it is initiated but rather to when it is to be initiated. If adaptation occurs after a major flood lives can be lost already and material damage to the built area is incurred. However, if adaptation occurs before the flood, being in an anticipatory sense, fewer lives would be lost whilst reducing the amount of material damage. A problematic feature of adaptation is that the perceived need to adapt is mostly highest after a flood with devastating effects. Before the flood this urge to adapt is minor to almost non-existent among both populations and governing agencies. This suggests that in order to initiate adaptation prior to such a major event a more planned and intentional adaptation strategy should be used. Whereas after such a flood, as adaptation will most likely trigger itself, natural and more autonomous adaptation can take place.

The spatial scope of adaptation relates to the geographical area and the population size it is implemented in. Currently it is supposed that adaptation is merely initiated at the local level. This is often initiated by the local governments or even on a smaller scale by the local population who feel the need that they have to be prepared for a flood. As mentioned earlier, adaptation is attempted especially by the European Union to be initiated on a higher scale level, preferably national to internationally. Furthermore, countries like the Netherlands and vast regions in England feel the need to pursue more adaptation strategies as they realize that the mitigation strategies alone will not suffice into the far future. Adaptation strategies are therefore needed to prepare the flood-prone areas for when a levy is breached or when the water levels have risen too much. It is however troublesome to insert national adaptation strategies when there is no felt need to pursue such strategies by the larger population.

The felt need to reduce a population's vulnerability continues into the debate of the function of adaptation strategies. There are three main strategies relating to how to handle the increasing water levels according to Bijlsma et al. (1996) and Nicholls et al. (2007):

1. (Planned) retreat: where the emphasis is on the abandonment of land and structures in highly vulnerable areas and resettlement of inhabitants.

2. Accommodate: where the emphasis is on conservation of ecosystems which are to be harmonized with the continued occupancy and use of vulnerable areas and adaptive management responses.
3. Protect: where the emphasis is on the defending of vulnerable areas, population centres, economic activities and natural resources.
  - a. Hard structure options (concrete)
  - b. Soft structure options (use of natural processes and protection mechanisms).

Different governments and different countries will have their preferences and their different historical backgrounds influencing the choice between these three effects of the adaptation debate. The focus will lay on the planned retreat and accommodating strategies. The planned retreat however, is only included when formalized in policy documents or regulations. Some protective measures with soft structures can also be included when they overlap with the accommodating strategies which attempt to manage the responses more adaptively. The important difference here is whether it can be used as an adaptation strategy or a mitigation strategy. Mitigation strategies are strategies used to prevent floods from entering, for example, by building levies. In this research however a look is being taken at how different countries incorporate adaptation strategies.

According to Füssel (2007) there can be four different objectives for implementing adaptation strategies; reducing potential impact, expected impacts, residual impact or handling unavoidable impacts. These adaptation strategies all focus on different types of impacts which come with a flood-related event. However, according to the Centre for European Policy Studies (2008) there can be many more reasons for implementing adaptation strategies. These focus on policy objectives like informing the potentially vulnerable, early warning systems and the assembling of disaster relief services. Climate proofing of public policy is an important policy objective, as it assumes that public policy set up by the governments should incorporate adaptation strategies. This should be done continuously and should keep the long-term envisioned to also reduce future vulnerabilities (UBA, 2008).

## 2.2 The concepts

As can be seen in the previous section there are a lot of sides to adaptation which are not currently under debate. In this section however, a look will be taken at what concepts have come up over the years to define adaptation, as well as which seem most relevant to this research. These concepts will then create the conceptual framework for the following chapters. Apart from the general conceptualization of the boundaries within which the research will take place many more concepts have been used to describe adaptation and adaptation strategies. These concepts have been grouped and presented in table 2.2. It should be noted that there are many more of such contributions to defining adaptation. However, these seem most relevant for the comparison between the three chosen countries and their cities. Some of the concepts have been briefly discussed in the previous section as they also relate to the ongoing debate about how to define and implement adaptation.

Concepts	Sub-components	Description
Problem awareness	High – Moderate – Low	Assessing, communicating and adaption assessment (Füssel, 2007)
Taking a self-interest	Yes/No	(Biesbroek et al., 2010)
Aim of adaptation	General	Potential impacts; expected impacts; residual impacts; unavoidable impacts (Füssel, 2007)
	Policies objectives (7 sub-components)	Informing the potentially vulnerable; assisting in the provision of early warning and disaster relief; providing incentives for appropriate investments and enabling adaptation; 'climate proofing' of public policy (in cases with state ownership or collective goods); planning and regulating short-term infrastructural assets to reduce future vulnerabilities; regulating adaptation 'spillovers' (to prevent the most vulnerable social groups bearing new social and economic risks); and compensating for the unequal distribution of climate impacts (Centre for European Policy Studies, 2008)
Purposefulness	Autonomous vs. planned/ natural vs. policy.	(Bijlsma et al., 1996 in accordance with Füssel, 2007) Attempting to get public acceptance (Neumann et al., 2000)
Timing	Anticipatory vs. responsive/ proactive vs. reactive	(Bijlsma et al., 1996)
Climate proofing/ temporal scope	Short term; long term; continuous	Short term and long term (Bijlsma et al., 1996), adaptation is continuous - planning horizon varying between a few months and a few decades (Füssel, 2007) and climate proofing - the sustainability of the adaptation approach (UBA, 2008)
Spatial scope	Localized vs. Widespread	(Bijlsma et al., 1996)
Function/effects	Vulnerability reduction vs. Exposure reduction	Prepare urban areas for floods vs. Keep urban areas away from floods (Oosterberg et al., 2005)
	Retreat; accomodate; protect	(Bijlsma et al., 1996)
	Prevent; tolerate; spread; change; restore; building adaptive capacity	(West and Gawith, 2005)
Form	Structural; legal; institutional; regulatory; financial; technological	(Bijlsma et al., 1996)
	& educational	(Füssel, 2007)

Table 2.2 An overview of mentioned concepts.

The multitude of concepts available and the lack of agreement which should be involved, lead to the necessity of a different approach to defining adaptation. In figure 2.1 a simplistic conceptualization is given of how one can position adaptation. The first two concepts have to do with the timing of inferring adaptation, whereby the adaptation in question can either be anticipatory, also referred to as proactive, or rather responsive, also referred to as reactive, to events (Bijlsma et al., 1996). The second two concepts are of purposefulness, ranging from planned to autonomous

adaptation. The purposefulness has quite some agreement amongst researchers, as for instance Bijlsma et al. (1996), Füssel (2007) and Neumann et al. (2000) agree that this has to be included. Adaptation can either be planned, mostly by policies, or adaptation can occur naturally, or autonomously. In figure 2.2 the same type of conceptualization is used, however between the variables of spatial scope and function of adaptation. Spatial scope indicates that adaptation can either be meant for local areas only or more widespread or even on a national or international scope (Bijlsma et al., 1996). The other variable constitutes of the functions of adaptation, which in this case means that adaptation attempts to either reduce the vulnerability or the exposure of populations to the flooding. Oosterberg et al. (2005) describe this as either preparing the urban areas for floods or keep the urban areas away from the floods.

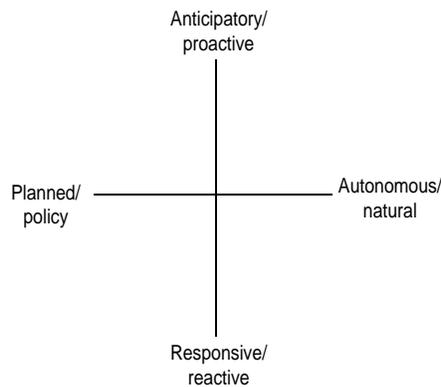


Figure 2.1 Basic representation of adaptation grading - timing vs. purposefulness (Bijlsma et al., 1996, Füssel, 2007, Oosterberg et al., 2005).

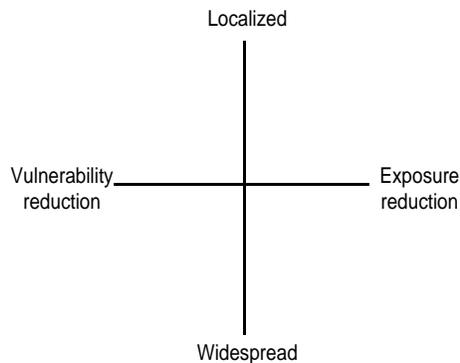


Figure 2.2 Basic representation of adaptation grading – function vs. spatial scope (Bijlsma et al., 1996).

When looking at the timing-axes of figure 2.1 two extremes can be distinguished. One being that adaptation strategies are implemented before the event of a flood and the other after the event of a flood (Bijlsma et al. 1996). There are two crucial elements which influence the timing of the adaptation strategies to be implemented, the first being the problem awareness of the nation and the relevant agencies and second the self-interest taken by these organizations. High problem awareness would indicate a high self-interest as it is of national concern or else adaptation would not even be an issue of debate. This means that with a low problem awareness adaptation does not seem important and therefore there is little self-interest taken by the governments and water related agencies. According to Biesbroek et al. (2010) key drivers to create a higher self-interest as well as a higher problem awareness are factors such as

extreme weather events and impacts, EU policies, the economic cost of inaction, scientific research, media, non-governmental organization advocacy, private sector interests, examples from other countries, recognizing opportunities and the UNFCCC. There are therefore many possible influences which can indicate that there is a need for action for the government and related agencies to take.

Füssel (2007) goes into more detail about the purpose of adaptation strategies compared to Bijlsma et al. (1996). He states that there are four different types of impacts which can be attempted to be reduced with help of adaptation strategies. Here these impacts will solely be used to indicate the purpose for which adaptation takes place. The first type of impact, being potential impacts, can be seen as the impact level if no adaptation took place at all. The second type of impact, being the expected impacts shows the impacts in combination with only autonomous or natural adaptation occurring. Residual impacts, according to Füssel (2007) assume the combination of autonomous adaptation with reasonable planned or policy induced adaptation. Unavoidable impacts refer to the impacts that will still occur after the event even though there was perfect adaptation implemented. At present the adaptation is mostly an autonomous process, which is mostly only prompted in a responsive manner, meaning after the flood-like event.

Figure 2.2 shows a picture of a basic representation between the function and spatial scope for adaptation. The function of policies to protect the population for the impacts of the water can be divided into three classifications, being protect, accommodate and retreat or move (Bijlsma et al. 1996 and Nicholls et al., 2007). These basic classifications each have their own sub-components. Protection strategies have three such components. Prevent, restore and change are hard structured strategies trying to influence the water from staying out of the inhabited area. Then restore what has been broken down if the flood was too vast (West and Gawith, 2005). Accommodation strategies may consist of educational measures (Füssel, 2007) and building adaptive capacity (West and Gawith, 2005). Educational measures are basically the informing of the communities what can happen when a flood strikes and what can be done to protect themselves. Building adaptive capacity also uses educational measures whilst taking measures to reduce the community's or population's vulnerability. The last classification of retreat or move strategy is when the occurrence of a flood either tolerated or that action is taken in the form of moving away from the flood-prone area (West and Gawith, 2005). The second axes of this figure represents the spatial scope, which can vary from highly localized, being only a small community to widespread in the sense of national to international appliance of the adaptation strategies (Bijlsma et al., 1996). Currently the focus of adaptation strategies are mostly at the local level, which needs to be expanded to the more widespread national level concerning educational and building adaptive capacity measures. These measures can make populations aware that moving away from the flood-prone area may be a plausible option to reduce incurred damages.

### 3. The case studies

In the previous chapter an indication of what adaptation implies has been given. The most important elements which relate to this concept have also been discussed. In this chapter some of these elements will be allocated in relation to how countries, cities and their agencies interpret them and give them form in the physical world. The empirical question, as stated in chapter one will be answered by doing so. This question is concerned with the extent to which adaptation strategies are represented and given form in the documents by the governments and other related agencies. In the first section of this chapter a look will be taken at what aspects should be discussed per country and city as well as the documents to be used for doing so. In the second part each country and city will be discussed individually. This chapter will be finished off with a comparison section, highlighting the main similarities as well as major differences.

#### 3.1 What to analyse

##### 3.1.1 Sub-components

In order to create a picture of the similarities as well as differences between the selected countries and cities each will be analysed separately. The analysis concerns itself with some basic questions such as what strategies does each country or city intend to use in order to adapt and how they motivate the use of such strategies. A couple of sub-components will be discussed here:

- Awareness and general aim of the involved agencies
  - Awareness versus self-interest taken
  - Roles of most important actors
- Approach of the adaptation strategies
  - Types of strategies
  - Intended spatial scale
- The focus of the strategies
  - Timing: anticipatory or responsive
  - Exposure or vulnerability reduction oriented
  - Time frame: climate proofing
- How implementation is achieved or intended.

These sub-components will be analysed with the help of the categorization indicated in the first chapter. This first wider analysis is important to acknowledge possible contradictions which may arise from the adaptation tool which is to be set up and used in chapter four. For starters however, a look will be taken at the different documents selected for the analysis.

##### 3.1.2 Selected material

The concept of adaptation will be analysed amongst a couple of documents set up by government agencies. In table 3.1 an overview of the selected documents is given. For the countries an attempt has been made to select three documents each set up by a different agency. By doing so a more thorough representation can be given how the country organises itself when concerning itself with water and water safety issues. Germany is an exception, as the German authorities as well as research institutes believe that vast areas will suffer from droughts rather than excess water causing flooding (UBA, 2008). A much more regional approach is therefore taken. As the city of Hamburg will be explored as well, there will be no consideration for documents considering regional approaches. For Germany therefore only two documents will be

used for the analysis. In 2007 the European Union advised its member states to take adaptation strategies into account when setting up national legislation concerning water management and land distribution issues (Jordan et al., 2010). Therefore the documents chosen for the countries are mainly from the years 2007 and 2008. The Netherlands seems to be a front runner with its document 'Maak ruimte voor klimaat!' translated to 'Make space for climate!' (VROM, 2007).

The right-hand side of table 3.1 shows the selected documents for each of the cities. For the analysis of the cities a total of two documents have been chosen each which is due to the smaller spatial scale of cities compared to countries. After looking for proper documents the relevance of choosing only two documents per city was highlighted as these documents are mostly set up by multiple agencies working together and updating their work once every few years. As the time of creation of the selected documents may not differ too many years, only the most recent two to this point in time have been selected. A list containing all documents which are used for the analysis has been added in the appendix (appendix 2).

Country	City
<u>The Netherlands</u> - VROM (2007) - V&W (2008) - PBL (2011)	<u>Rotterdam</u> - RCI a (2010) - RCI b (2010)
<u>England</u> - DEFRA (2008) - ASC (2010) - Environment Agency UK (EA) (2010)	<u>London</u> - London Climate Change Partnership (LCCP) (2009) - Mayor of London (MoL) (2009)
<u>Germany</u> - BMU (2008) - Umwelt Bundes Amt (UBA) (2008)	<u>Hamburg</u> - HafenCity (2002) - HafenCity (2006)

Table 3.1 An overview of the chosen documents for the analysis.

## 3.2 The Netherlands

### 3.2.1 Awareness

The Netherlands is a low-lying country located on a delta-plain where four major rivers cross towards the sea. The economic heart as well as the most populated area is located two meters below sea-level on average (VROM, 2007; p. 19). It is however not a novel phenomenon that the Netherlands has to protect itself against incoming water and the threats that come with it. Ever since the flood in 1953 a Delta Committee has been set up to introduce flood protection policies. These policies propose flood safety standards to manage the chances of the country of being flooded (PBL, 2011; p. 20). At present times the Netherlands looks to reduce its vulnerability through the use of structural measures and spatial development in combination with sectoral and technical measures (PBL, 2011; p. 17).

The Netherlands, as a country battling water from reaching its population, is highly aware that there need to be measures taken to keep vast areas from flooding. This is however not a new awareness, as it became clear in previous years that even without climatic influence the Netherlands would have to improve the way it handles water-related phenomenon (VROM, 2007; p. 19). As the Netherlands is a relatively small country concerning its surface, vast amounts of society and businesses have located themselves near the rivers and the North Sea, thereby increasing the need to keep all dykes and weirs up to date. Climate change as well as expected economic and social

developments furthers this need, making improvements necessary to assure protection in the future (PBL, 2011; p. 16). Due to the relative size of the Netherlands, and the proportional stakes at hand the central government fulfils a key role in providing the larger protection measures as well as the policies and regulations which are set up. As the Netherlands is an example country concerning water issues and water protections measures the governments continually want to make improvements. Awareness as well as the self-interest taken by the central government can therefore be said to be high.

The central government of the Netherlands is also aware that even with all protection measures at place, a residual risk will always be at hand. For this reason an attempt is made to inform all citizens, businesses as well as lower governments about this risk and what can be done in such a scenario (V&W, 2008; p. 24). Delegation of tasks to lower government levels is also prolonged, as it is believed that each government knows their own region best as well as what spatial or technical measures are most appropriate (V&W, 2008; p.25). The central government provides action views and binding legislation to the municipal governments, provincial governments, water boards, and security regions (PBL, 2011; p. 50). Proper cooperation between these different governments and water boards reduces the vulnerability of a region. Security regions consist mainly of nursery personnel, fire-fighters, and policemen who operate in collaboration with the municipalities, which come into action after the occurrence of a disaster-like event (V&W, 2008; p. 23 and p. 32). It should however be noted that the prevention of unnecessary damage and lost lives is a task which is fulfilled by all levels of government (V&W, 2008; p. 24).

### 3.2.2 Approach of the adaptation strategies

As a high level of prevention measures are needed to allow society to function in the low-lying part of the Netherlands an attempt to uphold an approach according to the multi-layer security paradigm seems eminent. This paradigm consists of three layers (nature, infrastructure and buildings) where for each layer five functions have to be thought through. The functions are, in order, pro-action, prevention, preparation, response and aftercare (V&W, 2008; p. 8). Pro-action and preparation are given form by organisational measures through the use of legislation and evacuation and flood exercises (V&W, 2008; p. 37). The purpose of the exercises is twofold. Firstly, exercises are needed in order to see where the weak points are located so that improvements can be made on this front. Secondly, the exercises are believed, at least when performed in public, to stimulate the generating of awareness amongst both businesses and citizens (V&W, 2008; p. 37). The central government sees it as a task of the Dutch citizens to inform themselves about what steps are taken by the government and what steps they can take themselves to decrease their vulnerability during a flood (V&W, 2008; p. 36). The central government itself however should have the information readily available for its citizens. Regional or municipal governments can have more area-specific information, as this task is mostly delegated from the central government downwards (PBL, 2011; p. 12).

Prevention is given form by the use of dykes, weirs and other types of embankments. An adaptive form of these physical measures is the use of dyke rings. Multiple dykes form rings on the western low-lying side of the country to make sure that if a dyke is breached, only a limited amount of the total area is flooded (VROM, 2007; p. 16 and V&W, 2008; p. 27). This so-called compartmentation technique has a leading role in current Dutch prevention measures. Further a physical approach to control the peak

discharges is by using the aspects of nature. The Netherlands has been changing nature's course over the past centuries. Straightening rivers, getting rid of the obstacles in riverbeds and many more adjustments have been made to the rivers and the coastal zones (VROM, 2007; p. 26). Policy is now used as the main measure to retrieve the land around the overflow-area of the riverbeds in order to allow water to be temporarily stored there (PBL, 2011; p. 21). Policies are given form in legislation as well in the municipal spatial plans, which allocate the areas and what type of land use is permitted (VROM, 2007; p. 39). These spatial plans can allocate blue and green structures of nature, allowing a greater intake of water during times of excess water (VROM, 2007; p. 29). The municipal spatial plans can furthermore create possibilities for climate proofing the cities by adjusting the building requirements. For example, the use of green roofs, the construction of parks, ponds and water features, adapting water sewer systems or the allocation of neighbourhood responsibilities can be stated in these plans (PBL, 2011; p. 45, 48 and 50).

As can be seen, on all fronts, the central government has the role of delegating tasks and adjusting legislation. By attempting to stay innovative concerning delta technology the Netherlands attempts to uphold its' internationally key role (PBL, 2011; p. 19). It does so by initiating financial measures and incentives for exemplary regions to promote adaptation measures. Even though it was stated at the beginning that awareness is high in the Netherlands, the so-called 'sense of urgency' to adapt is less eminent. A reason for this is the primary focus of the Netherlands on prevention measures rather than adaptation measures (V&W, 2008; p. 23). Due to this the central government's role will remain important to delegate tasks and accordingly incentives to the lower governments and businesses in order to increase adaptation.

### 3.2.3 Focus of the strategies

The Netherlands is attempting to transition from reactive timing towards becoming more pro-active (VROM, 2007; p. 21). As stakes are high both economically and socially this is not unexpected. However, it is severely felt that only the governments are protecting the country in a pro-active manner. Economic sectors as well as the Dutch society do not seem to be aware of the benefits that can be reaped of the climate induced changes (VROM, 2007; p. 29). The Netherlands focuses on the exposure to a flood-like event by building unbreachable dykes, weirs, embankments and the like (PBL, 2011; p. 10). Albeit, the awareness that a residual risk will always remain creates the necessity to reduce vulnerability of both the physical and social world as well. This is mostly done by the use of the above described adaptation measures as well as the implementation of evacuation procedures.

Concerning climate proofing the Netherlands looks at multiple time frames. The government focuses on both the short term and the longer term. For the short term the change of policies and the updating of the water-works are of primary focus. This focus however is intended to be updated with an interval of approximately ten years (V&W, 2008; p. 14). Until the year 2040 an approximation of the different possibilities is currently being evaluated on a cost-benefit analysis (PBL, 2011; p. 21). The longer term focus attempts to visualize what is needed in order to stay dry until the year 2100 or even longer until 2200. However, this intention is currently only implemented by the creation of advisory documents (V&W, 2008; p. 5). Due to the intended updates the Netherlands attempts to stay climate proof in a continuous manner.

### 3.3 Rotterdam

#### 3.3.1 Awareness

Rotterdam is a Dutch harbour city which lies in close proximity to the sea. Currently it is believed to be warranted for floods. However, heavy rainfall does cause problems at current times. With climate changes the pressure is assumed to increase. A program called Rotterdam Climate Proof is set up in order to become adjusted against these changes by the year 2025 (RCI a, 2010; p. 3). Furthermore it has taken a vast self-interest as it believes that it can regain its international position and attract more businesses, thereby strengthening its exemplary function as well as its economical function (RCI b, 2010; p. 6). Rotterdam aims to achieve this position by creating an image of an innovative water- and climate city (RCI a, 2010; p. 3). The region of the harbour is relatively large and consists for a large part of outside the dyke areas (RCI b, 2010; p. 6). Rotterdam can be said to have a high awareness of the climatic changes, the implied uncertainties and positive chances that come with it.

There are many actors involved in the region of Rotterdam in order to climate proof the region. One group of actors consists of research institutes and universities in order to gain more knowledge about the issues at hand and the implications of climate changes in particular (RCI b, 2010; p. 6). The municipal government has a major role to fulfil in order to give direction to the advancements of research, investments from the private sector as well as delegating responsibilities (RCI b, 2010; p. 28). As a primary task however, the government should protect the city against damages. Whether it is the social, environmental or economical sector does not matter, as all should be prepared (RCI, 2010; p 24). The national government, as explained for the Netherlands, should regulate policies and regulations so that it matches the actions of the municipal government of Rotterdam (RCI. 2010; p. 24). For this reason actors have a highly interactive relationship with one another.

#### 3.3.2 Approach of the adaptation strategies

Rotterdam is approaching adaptation strategies from two different scales. The first is by looking at object scale, being the buildings, ponds, squares, underground parking garages and the like (RCI b, 2010; p. 26). Green roofs on buildings, squares that can be filled with water in times of water pressure, and multifunctional underground spaces are only a few implemented examples. Building entire districts on water in suitable harbours is also another option Rotterdam is realising at present (RCI a, 2010; p. 15). Creating flood banks around the river is also a well known strategy, however, this mostly assumes to occur more out side of the city area due to the lack of space within the urbanized area. A manner by which Rotterdam attempts to achieve this is by combining strategies, as for example, the creation of flood banks where buildings are protected by a strip to keep the water out (RCI b, 2010; p. 25). However, as Rotterdam wants to achieve a better international image it prolongs more transitional approaches to becoming more adaptive.

The second scale Rotterdam focuses on a larger scale, ranging from a regional, national to an international scale. Rotterdam is working on intelligent information software which will allow a regional representation of the area and how different water levels and rainfall intensities influence the water management. This software is referred to as Smart Delta City, allowing early warnings of high water pressures and thereby allowing an adaptive approach of what actions fit best to the circumstances (RCI a, 2010; p. 22). This program is part of the regional Rotterdam adaptation strategy (RAS). The knowledge gained from this program will be used to create a

national adaptation strategy (NAS) based on the same but hopefully improved principles (RCI a, 2010; p. 25). The creation of such a strategy is a new constituent for delta cities and regions (RCI a, 2010; p. 25). Rotterdam desires to use the knowledge and experience gained by the Rotterdam adaptation strategy and the case study sites to create an innovative water- management image. For this reason the sharing of knowledge on international markets and co-projects with other delta cities and delta countries is a preliminary goal (RCI a, 2010; p. 5).

### 3.3.3 Focus of the strategies

Research currently conducted by the municipality and other institutions is done in order to fulfil one main goal. The ambition is to be able to create an ultimate adaptation strategy which is proactive in nature and can handle changing circumstances (RCI a, 2010; p. 7). By doing research it is hoped to allocate the most profound uncertainties and construct a strategy as well as spatial development program which can handle changes in climate expectations. Rotterdam focuses on both exposure reduction, by limiting the amount of water which can reach the houses by climate proofing the environment and focuses on vulnerability reduction by making the buildings climate proof (RCI a, 2010; p. 3). The Maeslant weir is a current exposure reduction component for the entire region of Rotterdam (RCI a, 2010; p. 12). However, adaptations in the environment such as creating space for blue infrastructure are also a profound exposure reduction measure currently taken (RCI a, 2010; p. 14).

The proactive nature of Rotterdam is currently limited to research concerning the different possible routes that can be taken in order to adapt to climate changes. These route are highly interlinked with the policies and regulations to be initiated at national level, which are currently still under debate. If the Dutch national government takes too long, and a catastrophe would hit, the proactive nature will suddenly become reactive as research and an improved international image alone will not protect the buildings or people. The physical changes so far focus mainly on the short term. The true adaptation strategies that are currently being researched and set up, such as the Smart Delta City approach and the Rotterdam adaptation strategy (RAS) are typical examples of continuous climate proofing practices.

## 3.4 England

### 3.4.1 Awareness

England has a strong focus on mitigating climate change. It aims to meet the greenhouse gas emissions targets in order to minimize other environmental impacts (EA, 2010; p. 20). However, due to disasters all across the world and an increasing amount of inland floods within England itself it has come to the conclusion that mitigation alone will not be enough (DEFRA, 2008; p. 20). England believes that especially the most vulnerable of society, such as the elderly and low-income households) will be most effected by climate changes (DEFRA, 2008; p. 7 and 11). This is furthermore enhanced by indications that the costs will be larger when no action is taken as well as damages becoming irreversible in their nature (ASC, 2010; p. 20). Due to this increased awareness and evidence that climate is changing, leading to heavier rainfall, higher seal levels, and other effects the Government of the United Kingdom set up a Climate Change Bill in 2008 (DEFRA, 2008; p. 30). As both awareness and self-interest by the central government has risen has become apparent that adaptation will need to occur at all levels in order to minimize the negative consequences. Government, public authorities, charities, businesses and individuals

need to take opportunities created by climate change to their advantage (DEFRA, 2008; p. 8). It is furthermore believed that adaptation measures can be sought in line with sustainable development by public authorities as well as businesses (DEFRA, 2008; p. 42).

As can be seen from the previous paragraph there are multiple actors involved to incorporate adaptation measures. Public agencies have a strong role in England for indicating the direction in which further action is to be taken by the Government. The Department for the Environment, Food and Rural Affairs (DEFRA) attempts to share all information on how adaptation can and has been implemented to show the benefits for businesses and governments to do so too (DEFRA, 2008; p. 5). The Environment Agency attempts to advise the English and Wales' Government on what steps need to be taken in order to incorporate adaptation measures more to reduce risks whilst contributing to sustainable development (EA, 2010; p. 1). The last public agency, being the Adaptation Sub-Committee represents plans and minimal changes needed in an advisory and assessment form which is then implemented in the National Adaptation Programme (NAP). The NAP is then laid before Parliament for approval (ASC, 2010; p. 21). The government is supposed to support this Programme by providing the appropriate institutional environment with as their main task to help enable organizations and individuals to make more effective as well as efficient decisions on how to incorporate adaptation measures (DEFRA, 2008; p. 20 and 21). This task of enabling the businesses and individuals is further enhanced by the belief that the market alone will not be able to convey the required amount of adaptation needed (ASC, 2010; p. 55). The government is really attempting to push businesses and individuals to think about and integrate adaptation.

#### 3.4.2 Approach of the adaptation strategies

As England attempts to enable businesses and individuals to adapt a couple of actions have been taken. The United Kingdom set up a Climate Impact Programme which serves as an advisory service for businesses and local governments to plan their own adaptation strategies (DEFRA, 2008; p. 7). Additionally the Government has set up the Adapting to Climate Change (ACC) programme in order to accumulate all the work which has led both the Government itself and the public sector on adaptation measures (DEFRA, 2008; p. 8). The English Government is making it their main tasks to provide information, appropriate and usable tools which are free of charge, building adaptive capacity at all levels of society whilst attempting to create the optimal regulatory structure (DEFRA, 2008; p. 8). The Environmental Agency is cooperating with a wide range of partners to create a more sound evidence base on climate changes and what this will entail for England (EA, 2010; p. ii). This evidence and knowledge is once again used to inform as well as give guidance to third parties so that they can adapt to the increase rainfall and water pressures (EA, 2010; p. ii). The Environmental Agency however goes one step further, as with the accumulated knowledge a monitoring system is being built (EA, 2010; p. 17). This system will allow further investigation of site management in order to reduce vulnerabilities for the future (EA, 2010; p. 16). As can be noticed, the main focus of the Environmental Agency as well as the Department of Environment, Food and Rural Affairs is nationwide.

The Adaptation Sub-Committee puts its emphasis on all levels, depending on where their advice is needed most. The Adaptation Sub-Committee focuses on five different elements. The first element is that of land use planning. It is believed that national

infrastructure, green parks, as well as new domestic and commercial properties can be incentivised on their relocation (ASC, 2010; p. 23). This basically means that an incentive is given when one does not build in a flood prone area and that green spaces can be introduced to reduce the vulnerability of an area. The second element is that of providing resilient national infrastructure to greater variations in weather extremes. This is a crucial element for England as it lays emphasis on the importance of the functioning of the country even when a major flood or related disaster hits (ASC, 2010; p. 23). It is believed that this is highly important in order to reduce the auxiliary damages and lives lost as communication, food supplies, water and transport can continue to function. Designing and renovating buildings is a third element where possible adaptation measures are to be taken. The focus is especially on new and planned buildings in combination with what type of materials are to be used to reduce damages from inland flood events (ASC, 2010; p. 24). England furthermore attempts to make space for water (DEFRA, 2008; p. 44) whilst managing the natural resources such as ecosystems, habitats and agricultural areas more thoroughly (ASC, 2010; p. 24). The last element where a major weight is given to by England is that of emergency planning. Emergency planning incorporates the precautionary steps and plans created in the case of a natural disaster, or in this case flood, to mitigate the actual consequences (ASC, 2010; p. 24).

These five elements discussed above concern adaptation measures which are to be taken whilst differing in their scale in which they are implemented. Providing national infrastructure is obviously a national affair and possibly even an international affair as it may need to communicate with Scotland concerning boundary-crossing roads. Renovating buildings however is a highly localized affair, depending on the vulnerability of the area to flood risks what type and amount of measures need to be taken. Managing natural resources, land use planning as well as emergency planning are both national and much more regional in their scales. This situation comes about as the national government creates policies and regulations in guidance of the planning that needs to be done at lower scales. From the section above it becomes apparent that the national government of England itself as well as the United Kingdom as a whole puts a lot of effort in national guidance to get the country to become more adaptive at all levels. However, rather than doing a lot themselves, the government attempts to visualize and create opportunities for businesses and individuals to truly reap the benefits of climate changes.

### 3.4.3 Focus of the strategies

As mentioned in the beginning of this section England has a strong focus on mitigation strategies as it attempts to meet the greenhouse gas emissions targets to counteract further environmental impacts (EA, 2010; p. 20). This would strongly suggest that England lays its focus more on exposure reduction. However, as a look is taken at adaptation strategies and how each country or city attempts to give these strategies form as well as implement them, mitigation strategies can be left out for the sake of this analysis. Concerning adaptation strategies, England's emphasis is laid on taking actions now in order to reduce current vulnerability at all levels of society and businesses (ASC, 2010; p. 30). This also highlights the proactive nature of the adaptation strategies adopted by England which integrate flexibility into their changes in order continuously reduce vulnerabilities even when climatic impacts continues to worsen (EA, 2010; p. ii). Furthermore, as a proactive measure, the Climate Change Adaptation Strategy has been set up in 2005 by the Environmental Agency in order to embed climate change adaptation into planning and risk

assessment frameworks (EA, 2010; p. 31). Even as England is attempting to become more adaptive on all levels it shows no real long term visions. The main focus is on reducing current vulnerabilities whilst keeping option flexible for future changes needed due to further climate changes. The Government realises that there will be no precise point in the future where it can be said that 'England has adapted' (DEFRA, 2008; p. 51). However, without a monitoring feature of whether or not adaptation is really occurring and to what extent it is occurring there are no genuine insights to how England will keep on adapting into the more distant future.

### 3.5 London

#### 3.5.1 Awareness

The Mayor, as well as the public authorities in London, are well aware that the businesses and individuals are ill informed and equipped in case of a flood (MoL, 2010; p. 17). It is furthermore acknowledged that compared to England London will have more negative impacts compared to benefits from climate changes (MoL, 2010; p. 17). It is possible to register for flood warnings through SMS, fax or other types of communication services. So far only very few have registered to be warned in case of a potential flood (MoL, 2010; p. 46). The London authorities have taken a high self-interest in order to change these findings. Knowing that this cannot be acquired without outside help, partnership working is seen as essential (LCCP, 2009; p. 6). In 2006 a report was issued by the Carbon Disclosure Project which referred to the 'adaptation tipping point' (LCCP, 2009; p. 39). This tipping point indicates that as the climate is changing humanity will be "faced with many years of continuing unavoidable change" (LCCP, 2009; p. 39). This indicates the awareness that change might still be slow now but that it is indeed coming and will most likely continue for as long as the effects of the climate have not stabilised. Insurance can help promote this tipping point by initiating that the rebuilding and repairing of flood-damaged properties need to take adaptation measures in mind (LCCP, 2009; p. 6). By doing so, awareness at business and individual level would increase as well as build adaptive capacity.

London is one of the greatest cities in Europe and its economical position is of vast importance in the financial markets world wide. Thus London has a lot at stake when it comes to image and safety. For this reason and many more concerning climate impacts, the Mayor and other agencies are actively promoting as well as supporting effective adaptation measures initiated at all levels (LCCP, 2009; p. 44). The Mayor and local authorities will work together with other agencies to promote the maintenance of drainage systems (MoL, 2009; p. 51). These systems have not been maintained properly and can now only handle approximately 30 percent of their actual carrying capacity. The utility and maintenance companies are therefore pushed to increase their effectiveness of their services. This could alleviate ground flooding due to extreme rainfall to a great extent (MoL, 2009; p. 30). The local authorities also need to work together with the Environment Agency in order to manage flood risks and vulnerability. This is done by setting up Surface Water Management Plans, spatial plans as well as emergency plans (MoL, 2009; p. 30).

#### 3.5.2 Approach of the adaptation strategies

As mentioned in the previous paragraphs London is attempting to set up more partnerships to tackle adaptation measures together. Working together with the Environmental Agency, boroughs and other local interested partners, an attempt is made to improve the mapping of who as well as what is at risk of flooding whilst also

looking at the future risks (MoL, 2010; p. 8). Furthermore, in partnership with the Drain London Forum a reporting system will be set up to highlight where and when flooding is occurring. This is believed to raise awareness as well as understanding of the flood risk today and will increase understanding of potential flooding in the future (MoL, 2010; p. 9). At the very local level an attempt is made to bring together neighbouring boroughs in order to set up emergency plans cross-cutting borders (MoL, 2010; p. 31). At the regional level, in cooperation with the Environmental Agency an attempt is made to safeguard space for the Thames in the future, to allow storage banks to be initiated and to enhance existing defences (MoL, 2010; p. 48).

At a broader scale an attempt is made to change the insurance system of buildings and properties. This means that when a property is damaged the properties should be rebuilt in a sustainable manner whilst keeping adaptation to climate changes in mind. These measures will not extent the set premium rate of the insurance (LCCP, 2009; p. 6). Furthermore, building regulation will be revised every three years to stress the increasing need of buildings to become more resilient (LCCP, 2009; p. 23). Through the use of building regulations as well as insurance systems market differentiation can occur. This market differentiation will give companies who take adaptation in mind and implement it in a proactive manner a head start and thereby improving their image on the market (LCCP, 2009; p. 26). Green leases are also an element which can help London become more adaptive to heavy rainfall induced floods. This is done through the obligation of a tenant to fulfil specific sustainability or adaptation obligations whilst renting the property (LCCP, 2009; p. 26). As can be seen, these measures are all intended to work the market and awareness amongst individuals and businesses in a bottom-up fashion (LCCP, 2009; p. 44). The government is starting at a very local level in order to implement strategies whilst waiting for a tipping point in awareness to occur.

### 3.5.3 Focus of the strategies

It seems as though the government of London is planting a seed, that when a flood occurs which raises awareness that things need to change, the basic strategies are already in place and ready to be implemented at a larger scale. When looking at timing it can be said that the government is attempting to be both proactive as well as responsive. However, the setting up of partnerships amongst boroughs and other agencies to set up emergency plans as well as attempting to raise awareness at all levels, gives the government a more anticipatory view. Exposure reduction is done mainly at the barriers of the Thames (RMS, 2003). Adaptation measures, insurance claims and raising awareness are more vulnerability reduction oriented as it is assumed that rainfall will intensify in shorter showers causing more local flooding. The London Climate Change Partnership however, takes the view that when building new buildings, the lifetime of the buildings should be taken into account in combination with climate change (LCCP, 2009; p. 28). The Mayor of London has a starting target, to implement adaptation measures and raise awareness before the year 2031 (MoL, 2010; p. 18). He is well aware that currently awareness among individuals is low and that this has to be tackled first.

## 3.6 Germany

### 3.6.1 Awareness

Germany in comparison to the Netherlands and England covers a vaster area of land. From this land only a minor part is along the coast or along rivers. For this reason Germany believes that a regional adaptation approach is more appropriate (BMU,

2008; p. 19). In the areas where flood risk will increase and where extreme weather events will increase in frequency as well as magnitude passive adaptation measures are believed to be needed alongside mitigation measures (BMU, 2008; p. 43). The initiation of adaptation measures will be a key aspect from an economical point of view (UBA, 2008; p. 5). What becomes apparent in the documents of the governmental agencies is that they calculate the costs of climate change through costs in economical damages incurred rather than the lives at risk (UBA, 2008; p. 7). Furthermore, Germany believes that in order to reduce the costs of adapting and incurring economical damages, the greenhouse gasses have to be tackled in order to reduce the necessity to adapt further in the future (UBA, 2008; p. 11).

The German Government is highly involved in setting standards and gathering information. However, as 80 per cent of the most crucial water-related infrastructure is in possession of private partners and private owners it has little to say over the precise adaptation measures to be implemented (BMU, 2008; p. 44). For this reason, the German Government believes that planning agencies have a crucial role to play as they set up planning documents which indicate what is allowed on what location (BMU, 2008; p. 42). Other important actors in Germany are the building companies who fill in these planning documents further. It is seen in large as their task to keep the civilians dry feet and provide protection to water related impacts (BMU, 2008; p. 42). The German Government furthermore believes that the politicians as well as researchers have a key task in keeping the need for adaptation on the agenda and continue emphasizing the need to keep adapting (UBA, 2008; p. 10).

### 3.6.2 Approach of the adaptation strategies

As mentioned above the German Government attempt to lay the tasks of adaptation at other levels and especially other agencies such as the building companies. However some adaptation strategies are being implemented by the Government such as creating retention areas and flood-adapted methods of construction (UBA, 2008; p. 9). This is kept vague and no further explanation is given within the document yet. An advice is however given to continue to research the possibilities on this front (UBA, 2008; p. 9).

The Government emphasizes the building of awareness of flood risks, which is mainly prolonged through specialized conferences as well as workshops (UBA, 2008; p. 12). These measures vary between regional and local scales depending on the area which is at risk. A major attempt is made to raise awareness through the interaction between the provinces as well as between businesses. An integrated approach along all involved and affected partners is alleged to give the best results in adapting in a timely fashion to the climate changes (BMU, 2008; p. 7). It is furthermore supposed that by making information easily accessible in combination with keeping it on the political agenda awareness can be raised at all relevant societal levels (BMU, 2008; p. 23). This accounts especially for the areas which are perceived to be vulnerable to flood related events. The combination of building organizations with insurance companies can then adjust their premiums and minimal requirements of the buildings to become more climate adjusted (BMU, 2008; p. 37). The integrated approach is initiated at national level whilst it is being carried out with different efficiency throughout the different regions. This is due to the differences in expected climate changes per regions as some regions will become much dryer rather than more vulnerable to flooding (UBA, 2008; p. 5). As a part of this information base, a monitoring system is set up, in order to gain more knowledge about the changes

occurring in reality as well as to inform companies and agencies about the areas where most damages are incurred (BMU, 2008; p. 62).

As Germany's greatest focus lay on reducing the greenhouse gasses in order to reduce the need for expensive adaptation in the future great effort is made to increase the knowledge base as well as international cooperation. Germany attempts to involve itself with developing countries in order to combat climate changes (BMU, 2008; p. 7). The Government sees this as a great opportunity to attempt to stay below the expected two degrees rise in temperature worldwide.

### 3.6.3 Focus of the strategies

In Germany the challenges of climate change are tackled at the more regional and sometimes even local level. For this reason the Federal Environment Agency (UBA) attempts to make the involved parties more forward looking by using calculating models of possible climate changes in Germany up to 2100 (UBA, 2008; p. 5). Germany is furthermore attempting to be continuously climate proofing by keeping the adaptation to climate changes a political issue (UBA, 2008; p. 10). By doing so Germany is attempting to transition between a responsive timing towards a more proactive timing. Currently damages still have to be incurred before real changes in approach and implementation of adaptation measures are initiated (UBA, 2008; p. 7). This can furthermore be seen in the orientation of reductions pursued. Currently exposure reduction is solely a goal to reduce economical damages. However, vulnerability reduction is slowly coming up through informing and creating awareness among the different levels of society. The degree of informing however is very low in comparison to the Netherlands and England.

## 3.7 Hamburg

### 3.7.1 Awareness

The HafenCity Hamburg Master Plan is a building project which will fill the area of 150 hectares from the old city towards the Elbe River, connecting the city sides with one another. The water safety barrier is located around the old city centre because of which the new buildings will need to be protected against the water from the river (HC, 2002; p. 28). The government of Hamburg is well aware that this area is prone to flooding and that protection for the people and the buildings will need to be put in place (HC, 2006; p. 74). Furthermore, elevations of the water can reach a height of 7.50 meters without the inclusion of wind and waves. This indicates that water levels can reach heights of an estimated 8.40 meters above the standard river level (HC, 2006; p. 74). Even though these levels can reach enormous height there seems little awareness in the need to adapt compared to protect. Roads are installed for the fire departments, police and other emergency services (HC, 2006; p. 74). The main involved actors are the planning agencies who create plans and hope to win the competition on whose plan will be implemented (HC, 2006; p. 54). The role of actors and the self-interest taken by the government are therefore lacking concerning adaptation measures.

### 3.7.2 Approach of the adaptation strategies

Hamburg focuses mainly on preventing measures to keep the water out of the built area. This is mainly achieved by elevating the land on which the buildings and the infrastructure are to be built (HC, 2006; p. 58). Planners furthermore attempt to connect the first line of buildings to make a secondary protection line against the water (HC, 2006; p. 58). This idea incorporates underground garages which can be

used as retention areas if some of the water does come past the first line of protection. However, embankments are to be used strategically in combination with the tidal water level variations making this an option to maintain flexibility in the Master Plan (HC, 2006; p. 57). As mentioned above, stress is put on the availability of roads for the emergency services in case of a storm surge or exceptionally high water. For this reason the islands which make out the entire city, need to be connected with at least two elevated roads (HC, 2006; p. 74). One adaptive measure concerning this type of measures is an elevated parking garage at 7.50 meter above the river level which links all buildings at the river side. In case of an emergency situation, such as a flood, the fire department, police and other emergency departments can cross here to get to the area in trouble, through the buildings (HC, 2006; p. 58). The intended spatial scale of these measures is relatively local, as it concerns the buildings, a district and at the most the connecting of the new district with the surrounding districts.

### 3.7.3 Focus of the strategies

As the HafenCity Master Plan does not incorporate the possibility of a flood as an important element the nature of Hamburg in case of a flood will be responsive. Hamburg attempts to keep the planning process and plans flexible (HC, 2006; p. 87). However, apart from raising the protection line and making sure fire departments can reach all areas of the city no proactive measures are taken. Raising awareness in order to reduce vulnerability of the individuals and businesses is not taken into account at all. The focus is solely on exposure reduction in the case of high water. The plan is estimated to take 25 year to implement, however, nothing is said about climate proofing or the like.

## 3.8 Comparison

At this point all countries and cities have been analyzed separately. This has led to the recognition of some fundamental similarities as well as differences. In this section a look will be taken at the focus of the governmental agencies and the diversification of the actors and their roles of initiating adaptation.

From the individual analysis, the Netherlands seems to have the greatest focus on the central and lower governments in the process of initiating and implementing adaptation. A major task is not only changing policies and regulations but also the informing of how businesses and individuals can increase their adaptive capacity as well as implementing adaptation measures themselves. The Government of England also share the same tasks with the exception of the implementation of adaptation measures. This is largely done or at least expected to be pursued by the market, businesses and individuals. The German Government is least aware and thereby least active on the front of implementing adaptation. This becomes eminent by the delegation of implementation to the planning agencies. These planning agencies are mostly non-governmental which is contrary to England and the Netherlands. Germany focuses on the economical damages that may be incurred in a flood-like event, thereby relying on companies to take precautionary measures when locates in a flood-prone area. These differences between these three countries can be related to the amount of land and infrastructure owned by the governments themselves. In Germany 80 per cent of the crucial infrastructure is privately owned, making the influence of the government rather small. In England and the Netherlands the most crucial infrastructure relating to the protection against the water is owned by the

government. In the Netherlands this is even more the case than in England, where some are owned by boroughs.

In general all three countries assist their major cities in taking adaptation measures through the adjusting of policies and regulations. Furthermore, each country attempts to keep an updated database of possible adaptation measures as well as keeping track of successfully implemented measures. This extended knowledge base and the national advice is readily available for the cities. However, as is the case in Germany, where awareness seems lowest, Hamburg seems to protect its citizens and buildings solely by protection measures. This relates to the lack of awareness and pressure from above to research and even implement adaptation measures.

Apart from the physical similarities and differences concerning the cities there was a fundamental difference at what was thought to be the motivation in order to adapt and to keep the people and buildings protected. As such, Rotterdam hopes to improve its international position by showing the world its adaptation measures. According to the Mayor of London however, the first crucial step towards adaptation is raising awareness at all levels of society and the market. Hamburg, with a low self-interest to take a look at adaptation measures focuses on the accessibilities of the different districts. As such in the aftermath of a disaster-like event, the emergency services can reach the hit locations. A further difference between the two cities of London and Rotterdam, which are both well known for their working with water, is the approach of implementing adaptation strategies. Rotterdam implements strategies through a top-down manner, working from the government to the local area where the strategies have to be implemented. London on the other hand looks at adaptation more from a bottom-up manner, working upwards from the micro-level of buildings, hoping insurance companies will take the lead on adapting.

### 3.9 Conclusion

As becomes apparent from the comparison made above there are indeed differences in the ways governments and related agencies give form to adaptation strategies. Politics and hot issues of the public seem to have a vast influence on why and from what angle adaptation strategies are to be implemented. As such economical damages always seem to play an important role. However the damage done to private properties raises awareness that things have to change as becomes especially visible in England. The Netherlands and Germany are two examples how much the roles of the government can differ relating to the implementation of adaptation measures. In the Netherlands the role of the government is highly forthcoming whilst the German Government leaves the implementation to the planning agencies, businesses and private owners of land. In the next chapter a deeper look will be taken at these three countries with the help of the adaptation tool.

## 4. The variables of adaptation

In the previous chapter a look has been taken at the different countries and cities individually. For each country as well as city the level of awareness concerning the need to adapt against flood-prone urbanized areas was looked at. Furthermore their main adaptation strategies have been named and discussed. In this chapter the four variables timing, purposefulness, function and spatial scope will be discussed further to highlight their most important components. By doing so the elements needed for the adaptation tool will be created. This tool will be given form below and the variables and components will function as a categorization for the analysis of the documents. After doing so each of the countries will be analysed again, this time with the guidance of the adaptation tool. The cities however, will be left out here as not enough category-specific information was gathered from the documents. Some conclusions however can be made but these will be discussed in chapter five. To finalize the comparison of the countries a look will be taken at the differences and similarities, whilst rounding the chapter off with a provisional conclusion.

### 4.1 Creating an adaptation tool

In the previous section the important characteristics and debates have been highlighted for adaptation strategies. These inputs as well as the criteria explained for the conceptual framework will be used to generate an adaptation tool. It should be noted that this adaptation tool is meant to highlight the strengths of a country of a region and making it comparable to results from other countries and regions.

For the purposes of comparing results and the focuses of adaptation strategies adaptation matrices have been composed. As adaptation is troublesome to quantify a tool was needed which can make comparisons visual and open to different interpretation. For this reason the differences in context between countries and regions will be needed to be kept in mind. However, strengths as well as weaknesses should be recognisable for countries and regions to show these from which counterparts they can learn the most. As has become clear from the previous sections is that adaptation has many characteristics which are important to be implemented. For this reason an adaptation tool in the form of two matrices has been chosen.

#### 4.1.1 Creating the matrices

Figure 4.1 represents a matrix with timing set up against the purposefulness of the adaptation strategies. Timing will be a continuum as this shows merely when adaptation is implemented, whilst staying one of the most important criteria for adaptation. Then on the other axes the purpose of the adaptation strategies is put, consisting of the four types of impacts named by Füssel (2007). This matrix focuses on the how (planned or autonomous) and when (anticipatory or responsive) the adaptation strategies are taken form.

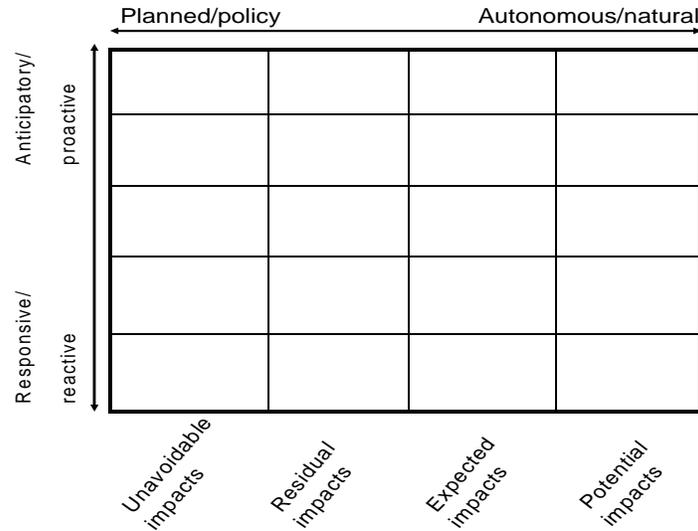


Figure 4.1 Matrix: timing versus purposefulness.

The second matrix, combining function and the spatial scope characteristics of adaptation strategies is visualized in figure 4.2. This matrix highlights what the adaptation strategies intend to target rather than the how and when they are implemented. The spatial scope of adaptation strategies and their implementation can be sub-divided into five different phases on a continuum being; highly localized, localized, regional, widespread (national), and widespread (international). The function characteristics such as protect, accommodate and retreat or move vary from prevent, restore, change, educate, building adaptive capacity, tolerate and spread. The focus in this research will mostly be on accommodation and the retreat function as this incorporates the adaptation strategies the most. It is for this reason that the protect part of the matrix is shaded in a grey colour.

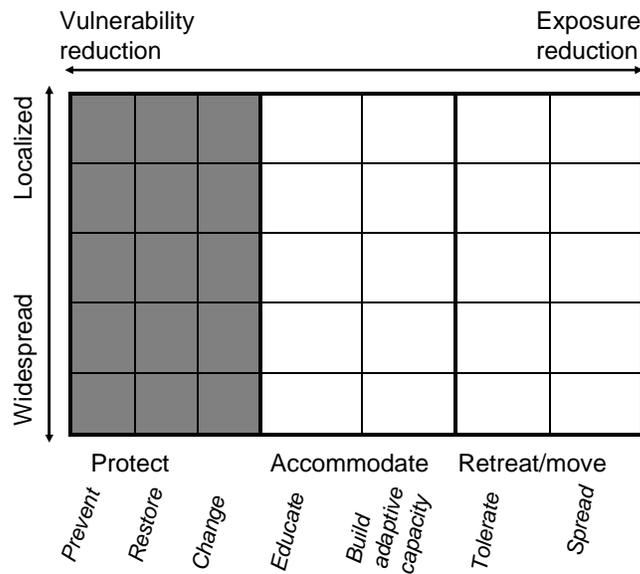


Figure 4.2 Matrix: function versus spatial scope.

### 4.1.2 Scoring procedure

For the scoring procedure, a colouring scheme has been set up which is connected to a numerical scheme. This allows not only a grading system to be set up but also a visual representation. Figure 4.3 shows these numbers and colours associated with their values. With the help of an invented example, figure 4.4, shows the translation of such a scheme, with the first matrix showing the numbers, whilst the second shows the colours. When wanting to make comparisons it is advised to use the same system, thereby making the results comparable to one another. The shadings which will be used will show the strengths and weaknesses. As it is a qualitative analysis, or not dealing with exact digits, this is a seemingly proper way to present and compare results. Due to the relatively minor amount of different grades it is made easier to come to the same conclusions about what grade is needed in what box. Different interpretations can be smoothed out by this process. By doing so, other researchers can compare other countries, regions or cities with these results as well.

5		Very high
4		High
3		Moderate
2		Low
1		Very low
-		Not mentioned

Figure 4.3 The numerical and colour scheme used.

#### Scoring procedure:

- Blank – not referred to at all, neither directly nor indirectly
- 1/very low – named or indirectly referred to
- 2/low – referred to and importance is stated
- 3/moderate – named, argumentation for its relevance, and consequences
- 4/high – named, argumentation, consequences named, and examples of possible implementation stated.
- 5/very high – named, argumentation, consequences named, and how implementation is intended.

Some of the documents are based on previously conducted research. As such the consequences do not need to be named explicitly when this previously conducted research is referred to. However when the manner of implementation is referred to or even explained, it can still be graded as high or even very high. This is done because the consequences have been taken into account and have been previously discussed already.

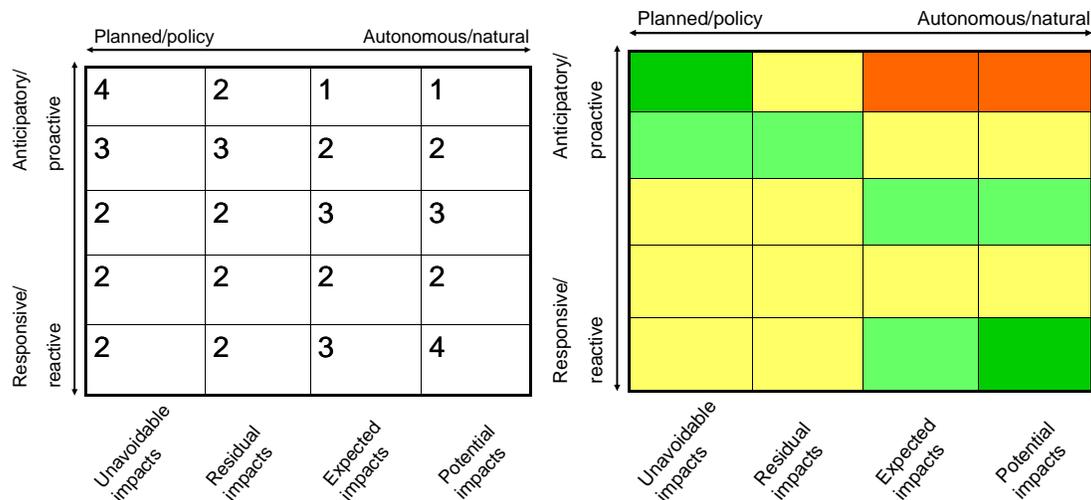


Figure 4.4 an invented example of the use of the numerical and colour scheme.

The problem awareness and self-interest taken by a government or a water-related agency is an important variable. This variable will however not be put in the matrices. It can however be used as a weighing function. If the taken self-interest and awareness is high a multiplication factor of for example two can be used to help compare the countries and regions with one another. In order to attain the proper results the grading can be done by focusing on some basic aspects in the texts, as it is a textual analysis in this case, relating to each of the axes:

- General context: Does the government and related agencies take self-interest for the adoption of adaptation strategies?
- Timing of adaptation: anticipatory or rather responsive?
- Purposefulness: what type of impacts do the adaptation strategies address?
- Function: what functions are filled in what intensity?
- Spatial scope.

The end result of analysing the variables of timing, spatial scope, function and purposefulness will hopefully show differences and similarities between the different nations' and cities' approaches. The colour scheme will be used to present which elements are strongly adapted in a country or city. Basically the end result for each analysis will be two models, one for its timing and purposefulness and one for its function and spatial scope in relation to adaptation to flooding.

## 4.2 The analyses

In the previous section the adaptation tool has been developed with the purpose of creating a possibility to compare countries, regions and cities with one another concerning their approach on implementing adaptation strategies. After a literature review seemingly important elements have been picked to create a tool which highlights strengths and weaknesses of a country, regions or city. The tool is furthermore intended to show where a region can improve its taken adaptation measures as well as show other regions what focus they are comparatively lacking. This can help indicate where and possibly how countries, regions or cities can increase their capacity to adapt.

The adaptation tool is based on four core elements. The first two are that of timing and purposefulness (Bijlsma et al., 1996; Fussel, 2007; and Oosterberg et al., 2005).

The axis of timing vary from highly proactive or anticipatory to highly responsive or reactive. In order for adaptation measures it is believed that anticipatory timing is needed in order to reduce the costs of damages and lives lost. However, other timings should not be forgotten because, even if adaptation takes place, there will always be a residual risk as acknowledged by all countries (VROM, 2007; DEFRA, 2008; and BMU, 2008). The second axis consists of the element purposefulness, which varies from highly planned, policy induced, adaptation to automated or natural occurring adaptation. In order to promote adaptation at all levels of societies, meaning governments, government agencies, businesses and individuals, policies will need to be changed to help promote timely adaptation. Adaptation also occurs natural, which is also important, as risks can cause a perceived vulnerability at these different levels of society (Holling, 1973).

The last two elements which are considered in the second matrix of the adaptation tool are the spatial scope at which adaptation is initiated or even occurring and the function of the adaptation (Bijlsma et al., 1996). The spatial scope, as with the first two elements, varies from one extreme to another, that of highly localized scope, for example focusing on only a singular or a couple of buildings, to the widespread, international scope. This element has been introduced due to the current believe that adaptation occurs mainly at the local level rather than the national or even international level (Jordan et al., 2010). The second element described in this matrix is that of function, varying between vulnerability reduction to exposure reduction. As adaptation can do both, especially the accommodation strategies, concerning educating and building adaptive capacity in combination with the retreat and move strategies of tolerate and spread are of importance here.

As levels of these four extremes seem significant to adaptation a matrix will be filled for each of the countries. In chapter two a scoring procedure has been explained, ranging from very high back to very low, or left blank when an aspect is not mentioned either directly or indirectly. It should be noted however, that adaptation strategies in the form of accommodating or retreating and moving strategies will be referred to here, but not elaborated on as they have been explained in the previous chapter. This chapter may however highlight significant differences to the previous one.

### 4.3 The Netherlands

#### 4.3.1 Timing versus purposefulness

The Netherlands has become highly proactive ever since the flood in 1953. It attempts to prolong this proactive nature through water and safety policies (V&W, 2008; p. 7). The Dutch Government is aware that not all sectors have a proactive nature and do not acknowledge the risks and consequences of flooding. This is especially the case for the economic sector and at individual level (VROM, 2007; p. 29). The Netherlands also attempts to reduce the consequences of flooding by putting emergency plans into place and adjusting policies to this objective (PBL, 2011; p. 20-21). Considering the potential impacts of a flood a cost-benefit analysis will have to highlight what investments need to be taken in order to reduce the negative consequences (VROM, 2007; p. 13). For this reason the Netherlands will not score below a 3 as it names all possibilities and calculates the consequences as shown in table 4.3.1. However, action is only taken in the more necessary areas where the risk is highest.

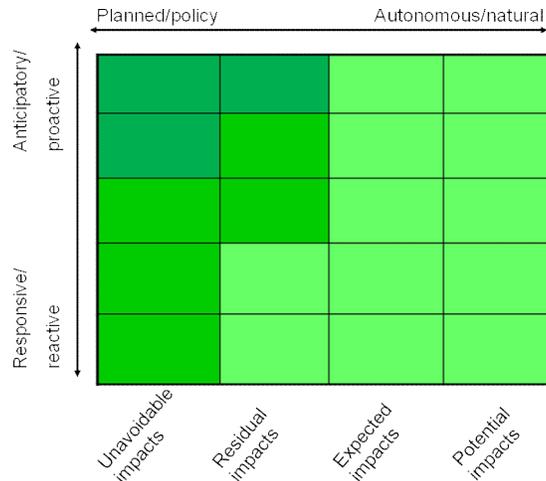


Table 4.3.1 The Netherlands: timing versus purposefulness

#### 4.3.2 Function versus spatial scope

Likely due to the fact that almost 50 per cent of the Netherlands had to be protected against the water from infiltrating that the focus is high in retreating and tolerating the water. Retention areas and flood areas are incorporated into spatial planning varying from the national level to the local level (VROM, 2007; p. 15). Even on an international scope, especially where the rivers cross the borders attention is given to the water and possible consequences. However, these aspects are highlighted in other documents than the ones used for this analysis. Making space for the river is the latest motto which influences the way in which the Netherlands handles the rivers and the water troubles that may come with them (V&W, 2008; p. 16). At the local level high value is taken in the precautionary steps of inserting ponds, canals, parks and other water storing possibilities, also referred to as synergetic measures (PBL, 2011; p. 45).

Secondly there is a major emphasis on the preventing of a flood to occur. This is mainly done by the setting up of dykes, levies, embankments and the like (V&W, 2008; p. 12). The highest amount of emphasis is places on the newly developed 'unbreachable dykes' which have an even lower risk of being crossed by water than the already well-known dykes of the Netherlands (PBL, 2011; p. 10). As such the focus lays on the prevention of a possible flood by strengthening and improving current strategies rather than changing the use of land or infrastructures. This can relate to the high density in a country such as the Netherlands, where it is troublesome to move the Randstad, the metropolitan area, onto higher ground without jeopardizing the economical position as well as livelihoods of the Dutch.

According to the Dutch Government the accommodation strategies which should raise awareness at all levels of society are very important. Education and building adaptive capacity are highly intertwined as one can not be created without the other. In order to know how governments, businesses and individuals can become more adaptive information is needed to be accessed (VROM, 2007; p. 30). This is also believed to be of international importance. The central government makes this information accessible and creates workshops to create awareness of the issue at hand, true building of adaptive capacity at other sectors than at the government is

relatively low. For this reason education scores relatively high, whereas building adaptive capacity scores only a 3 in table 4.3.2.

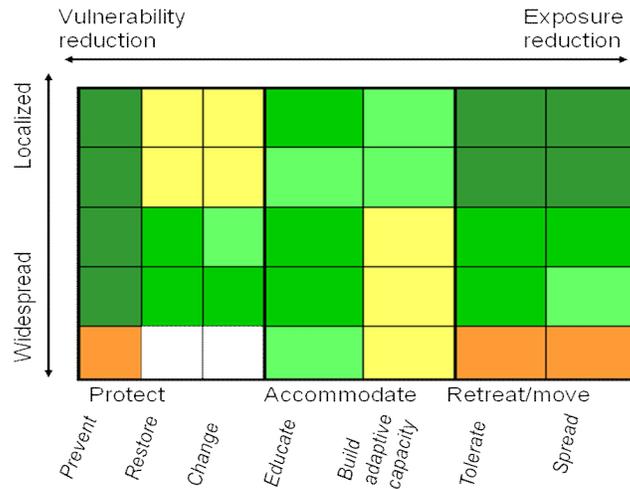


Table 4.3.2 The Netherlands: function versus spatial scope

#### 4.4 England

##### 4.4.1 Timing versus purposefulness

Compared to the Netherlands England has a much more reactive manner of approaching adaptation measures. As such they take the flood in 2003, which is a relatively recent event, as a reminder how many damages and deaths can be involved by a flood (DEFRA, 2008; p. 5). However, since then the government and related agencies such as the Environmental Agency and the Adaptation Sub-Committee are attempting to become more proactive (EA, 2010; p. 6 and ASC, 2010; p. 20). The proactive nature which is set to be achieved wants to be forward looking and maintaining flexibility in its options whilst keeping the far-away future open for debate (ASC, 2010; p. 30).

England, just like the Netherlands, focuses on the adjusting of policies and regulations of water and safety. This is done with the purpose of making it possible for all levels in society as well as the businesses to implement adaptation measures in order to reap the benefits of climate changes and prepare for the negative consequences (DEFRA, 2008; p. 14). However the Government leaves it to the market mechanisms and the insurance companies to promote adaptation measures further (ASC, 2010; p. 40). For this reason, England scores higher with the autonomous changes implemented compared to the Netherlands as can be seen in table 4.4.1.

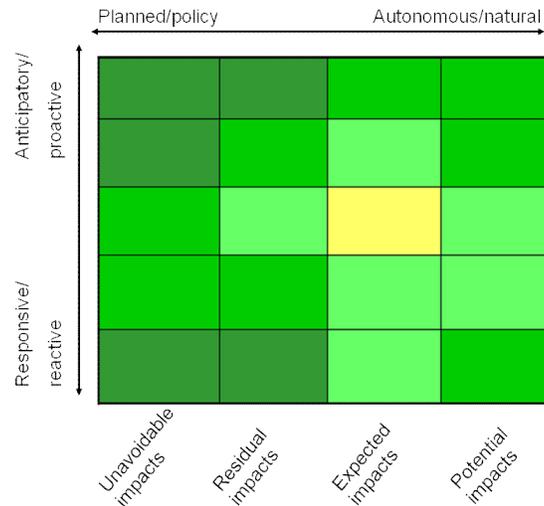


Table 4.4.1 England: timing versus purposefulness

#### 4.4.2 Function versus spatial scope

The Government has put little attention to tolerating or spreading the water. However, it does seem to want to work with the water but does not give any further information concerning this topic. Preventing measures rely highly on the reduction of greenhouse gasses and the maintaining and improvement of water-protection measures such as levies (DEFRA, 2008; p. 7 and ASC, 2010; p. 14). Changes are occurring especially in the ecological areas as creation of habitats is believed to be important not only for the survival of the species but also to handle the weather fluctuations more thoroughly (EA, 2010; p. 8). As such England scores high on the prevention measures excluding the international level which is not considered important for their water safety relating to decreasing the exposure and vulnerability of its society.

England scores relatively high on the element of building adaptive capacity. Education is scoring even a tad higher as this is the basis for informing people and businesses how adaptation can be achieved and what has already been successfully implemented. Especially at the local scale a high score in adaptive capacity can be sought as the local government is implementing their strategies and workshops to increase the adaptive capacity of businesses and individuals. The governments and other related agencies push this concept forward as being able to reap the possible benefits now, which later will be a costly affair. Table 4.4.2 represents the results for England relating to the function and spatial scope of the government and related agencies to adaptation.

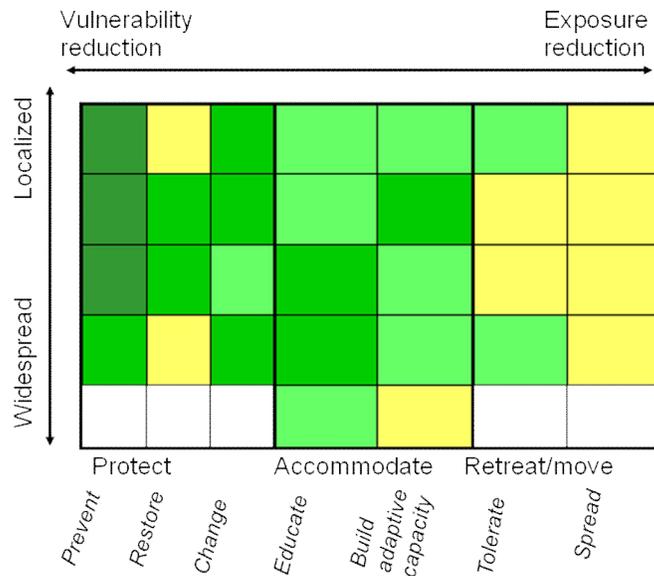


Table 4.4.2 England: function versus spatial scope

## 4.5 Germany

### 4.5.1 Timing versus purposefulness

Germany is currently developing an adaptation strategy (UBA, 2008; p. 11). The vast difference to the other two countries analysed here is that Germany is at a much younger stage of constructing this strategy. Adaptation aspects and possibilities are hardly acknowledged and policies and regulations, according to the two documents, will remain unchanged regarding the implementation of adaptation. For this reason it can be presumed that change will largely occur in a response to a flood or that individuals or businesses themselves will adapt to prevent costs to rise in the future. However, as these aspects are only touched briefly, a maximum of a low 3 can be given. Table 4.5.1 is due to this relatively low maximum much less optimistic compared to tables 4.3.1 and 4.4.1 of the Netherlands and England.

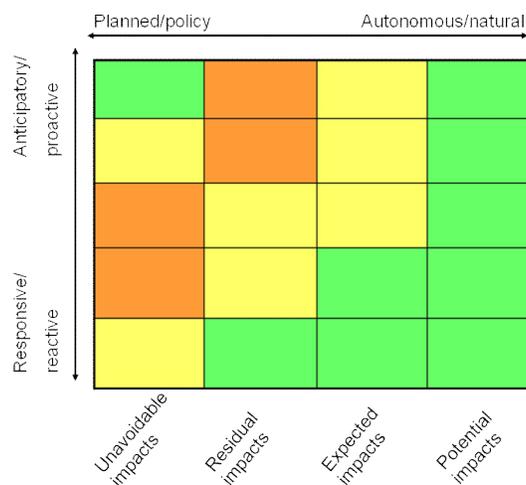


Table 4.5.1 Germany: timing versus purposefulness

#### 4.5.2 Function versus spatial scope

Germany scores very high at international scale when it comes to taking preventing measures. This is due to their focus on reducing greenhouse gas emissions (BMU, 2008; p. 7). The reduction in these emissions is also very important at the national level (BMU, 2008; p. 5). The German Government is now aware that change will need to occur in their attempt of tackling climate changes. A change from the focus on mitigation measures alone to more adaptation strategies will have to be initiated. For this reason a change in water-infrastructures will be analyzed in order to make an indication of what needs to be done to become more adaptive in the flood-prone areas (BMU, 2008; p. 22). Germany scores well on all levels even though this phase has only just been initiated. Internationally some thought has also been given to the implementation of adaptation strategies, especially when it comes due to boundary crossing rivers and their related infrastructures (BMU, 2008; p. 66). However, as with the other countries the focus is highest within the country itself. About the restore element of the protection measures nothing is said, therefore the entire column is left blank in table 4.5.2.

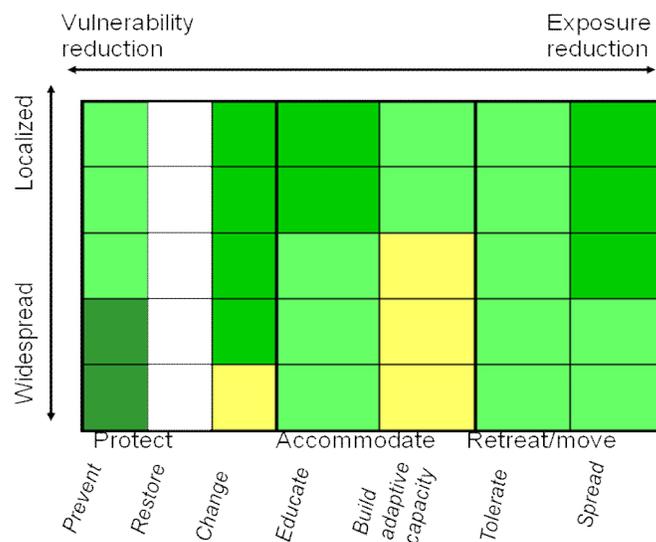


Table 4.5.2 Germany: function versus purposefulness

When it comes to the retreat and moving of important buildings and infrastructure, Germany seems well aware that infrastructure should not be located in flood prone areas in the future (UBA, 2008; p. 8). This is concerned a task for planning agencies who will have to locate differences in the felt and expected climatic impacts in the different regions. As such Germany scores higher at the local and regional scope as it is not perceived to be a national occurrence (UBA, 2008; p. 6).

As mentioned throughout the text, education and adaptive capacity building can be linked closely. This is also what the German Government believes. They state that in order to adapt, the person or agency in question needs to know what use as well as costs come with it (BMU, 2008; p. 59). A high degree of focus is therefore laid on the providing of information, communicating, discussing and coordinating information on what can happen and be done in case of flooding (BMU, 2008; p. 45). A German agency referred to as KomPass develops user-friendly tools to inform interested parties in the regional differences (UBA, 2008; p. 13). The focus is however still on providing information about what might happen rather than what can be done in

order to reduce ones vulnerability as well as exposure to the consequences of climate change. KomPass however attempt to build adaptive capacity by keeping workshops and creating discussions (UBA, 2008; p. 13) which will hopefully lead to a greater data-base of possibilities to adapt in the coming years.

#### 4.6 Comparison

According to the analysis of the countries some visual similarities and differences have arisen. When looking at the timing and purposefulness matrices it becomes apparent that both the Netherlands and England score high on the autonomous planning in combination with policy induced adaptation approaches. This is where most though seems to be made about what needs to be change and how this can be realized. Germany however, is much weaker concerning this approach as only an indication of why these aspects would be important and some consequences are slightly referred to. England however, also scores high in the reactive phase concerning the unavoidable impacts. This specifically related to the awareness that some services, such as emergency services need to be working at all times (EA, 2010; p. 19). This is likely to be a residual manner of thinking from the second World War. England seems strongest of all three countries in this matrix. However, in general the Netherlands is most stable, looking at each of the different levels of timing and purposefulness as shown in table 4.3.1.

The second matrix, concerning the elements function and spatial scope also reveals similarities. One of these similarities concerns the accommodation strategies' components education and building adaptive capacity. All three countries put more emphasis on retrieving as well as spreading information in order to educate people, businesses, governments and other agencies than on building adaptive capacity. This is due to the shared belief that education concerning the effects of climate changes, the costs and the possibilities is needed before adaptive capacity can be built (VROM, 2007; p. 21; BMU, 2008; p. 6; and ASC, 2010; p. 26). The Netherlands shows the largest degree of difference between education and building adaptive capacity. Relating to the accommodation strategies comes another similarity as all countries attempt to share and retrieve knowledge and findings from other countries. This is why all countries are also acting on the international level. A difference which comes about is the spatial scope at which country lays the strongest focus on education and building adaptive capacity. In Germany the focus is stronger at the highly local and local scale, whereas in England and the Netherlands the stronger foci lay on the regional and national scale.

With the retreat and move strategies, tolerate and spread, England scores lowest whereas this country scores highest on the protection strategies. The Netherlands is also strong with both types of strategies, probably due to the fact that it is a densely populated country and that options to protect against the water are more limited in area that they can consume. For this reason the Netherlands is aware that apart from protecting against the water it will also have to tolerate water and water related influences, as the slogan 'Living with water' incorporates (VROM, 2007).

## 4.7 Conclusion

The matrices show a vast difference between the Netherlands and England, who have thought the different elements more thoroughly through, and Germany, who is at the start of initiating adaptation in flood-prone areas. Implementation strategies are therefore less established to not at all at current times. However, when looking at all three countries it does become clear that adaptation strategies can be pursued at all levels, especially through policies. This also refers to the more widespread scale such as the regional and national scope. Information gathering, education and building adaptive capacity are promoted at all levels. Each country however remains to have their own focus, as Germany has their focus relatively more on the local level rather than the national like England and the Netherlands.

## 5. Conclusion

Adaptation to climate changes in flood-prone delta areas has been a central issue throughout the previous chapters. A look has been taken how the Netherlands, England and Germany have given form to these strategies and how their main delta-cities tackle this issue. In the first chapter the three research questions have been set up consisting of one theoretical, an empirical and a synthetic question to shape the analysis. For each research question a conclusion will be given in this chapter. Furthermore an adaptation tool has been created to offer visual guidance to the comparison of these countries and cities. This chapter will provide the conclusions which arose from this analysis. Recommendations for further improvements and studies will be given as well as a reflection on what and how the analysis took place.

### 5.1 The theoretical question

The first question, the theoretical background, concerns itself with the defining of adaptation and the most important variables to this concept. According to McCarthy et al. (2001) adaptation refers 'to actions targeted at the vulnerable system in response to actual or expected climate stimuli with the objective of moderating harm from climate change or exploiting opportunities'. For the purposes of this research climate change relates to the increasing water pressure in the form of flooding. It was the assumption that adaptation would decrease vulnerability and reduce damages and lives lost. The emphasis here was on reducing not eliminating. This was confirmed by all literature involved, not only academic literature but also in the policy documents of the governments and government agencies.

Based on the literature a compilation of variables where to be highlighted with their significance and used to create an adaptation tool. The end result consisted of two matrices combining the four variables timing, purposefulness, spatial scope and function. Each of these variables have been given sub-components which consisted of the variables of different authors, as explained in chapter two, in order to analyse the countries along more specific criteria. These matrices have proven that the many elements that are involved in the defining of adaptation measures and what their foci are can be related to the adaptation strategies. The matrices have shown clear similarities as well as differences between the Netherlands, England and Germany. Within these matrices the debate about whether or not adaptation should be a natural process or rather policy induced. The first matrix, concerning timing and purposefulness shows that the best results are from the Netherlands and England. This is due to their focus on many different aspects in order to become initiate adaptation throughout their countries. The same accounts for the debate between whether adaptation should focus mainly on vulnerability reduction. However, during the analysis it was shown that the both the Netherlands and England, which can be said to be well on their way of becoming adaptive, focus on both vulnerability reduction as well as exposure reduction. They believe that one cannot go without the other as adaptation can not to get rid of risks but rather improves the way of handling vulnerabilities. Adaptation is for when the mitigation strategies do not hold, therefore also reducing the exposure in the second line of protection. Adaptation however, all in all, will remain a complex concept. In the theory section it was furthermore stated that adaptation occurs mainly at the local level. By combining the literature a lot of overlap can be found, suggesting that gaps and disagreements are less than is thought by most agencies. However, as this has barely been done before, this is a novel

agreement. It furthermore shows that there is also a belief that national government can create and accompany change in order to initiate more effective adaptation through for example the adjusting of national policies.

## 5.2 The empirical question

The empirical question concerned the extent to which adaptation strategies are represented and given form in the documents from the governments and related agencies. The expectation was, due to the advice of the European Union to consider adaptation measures that there would be only slight differences between the countries and cities (Jordan et al., 2010). This has been analysed in two chapters, chapter three focusing on the form of the strategies and a bit more in chapter four. The results, however, show vast differences as well as some similarities. A major similarity was the building of programmes to create a clearer image of the true climate changes in order to develop a better understanding of where vulnerability and exposure will rise most. Furthermore, all countries have set up a national adaptation strategy. However, each of these strategies have their own nuances. Germany wants to learn more on where and how they can become more adaptive, whereas England focuses on the initiation of adaptation at different stages of a possible flooding incident. The Netherlands has their focus on becoming more aware and rebuilding their international image as a water-country.

The differences appear not only in their focus of the national adaptation strategy but also on how each country attempts to achieve building adaptive capacity at all levels. The Netherlands attempts to do so in a top-down manner. The national government adjusts legislation, policies and regulations for the lower governments, water-related agencies and businesses to implement. England does more the opposite, the government does change the policies to allow adaptation to be more easily adopted but waits for the market and individuals to initiate adaptation. Germany is in a too early stage to really tell their focus and is therefore mainly focusing on keeping the water out rather than adapting to the changes. As becomes clear is that the extent to which the strategies are adopted will depend on how the incentives or benefits way up against the negative consequences of not adapting. This however, needs to be understood before the approach is going to change, no matter how adaptation is initiated.

## 5.3 The synthetic question

The synthetic question was stated as: 'How do the governments and related agencies of the Netherlands, England and Germany give form to adaptation and accommodation strategies compared to the selected flood-prone delta-city's governments and their agencies?'. In the previous chapter a look has been taken at the Netherlands, England and Germany with the help of the adaptation tool created. The findings highlighted differences as well as similarities between the countries. The conclusion to this question will be subdivided into two sections, one concerning the variables and components and the second concerning the pro's and con's of the measuring technique used by the adaptation tool

### 5.3.1 The variables and components

The adaptation tool consists of four variables and a many more sub-components and levels. For this reason a substantial amount of information is needed in order to fill in the tool as accurately as possible. With only a limited amount of information the tool

can be filled in by looking at the general trend relating to the four axes. A country, region or city may focus mainly on vulnerability reduction at the local level through policies such as is the case with England. This can be visualized easily without more concrete reasons why the focus lays here. The tool can thus be used for a specific and detailed analysis as well as a more general analysis.

Not only the amount of information is crucial for the way one can use the tool but also the descriptions of the different types of sub-components. Take for example the variable purposefulness, concerning the different types of impacts. These components were only vaguely described by almost every country and city from this analysis. This may be due to the focus of all these countries and cities on climate effects, which is a large and vague term as this can relate to all four types of impacts; unavoidable, residual, expected and potential impacts (Füssel, 2007). Füssel (2007) uses the example of a farmer, ranging from dumb to prepared for changes. However, this visualization had no effect as in multiple cases different types of impacts were implied at once. The categorization of impacts can be changed or the countries, regions and cities need to be more aware and more precise about the defining of which climate effects they want to tackle. This tool can therefore work as a handle to make sure the focus lays on the intended levels.

Categorization troubles also become apparent when dealing with the different strategies such as protecting strategies, accommodation strategies and retreat and move strategies. Some strategies implied by the governments can be suggested to take up multiple components of these strategies. As this only became apparent during the analysis there were no guidelines set up to stipulate how these results would influence the results. This creates negative consequences for the traceability of the steps taken in order to fill in the matrices. However, as the strategies considered by these governments and government agencies all have in common to attempt to create more adaptive strategies rather than solely mitigation strategies, overlap is not considered to be a negative influence. It mainly shows that the strategies take account of different types of awareness and needs in order to become less vulnerable or less exposed. However, when making statements about the end results this linkage should not be forgotten as this may be an important difference between this area and another area under analysis. The adaptation tool can not show these possible linkages and will therefore be needed to be stated extra when one wants to create a clear picture of how the region is doing so far concerning adaptation.

The last sentence of the previous paragraph has been kept vague on purpose, as 'concerning adaptation' is an empty statement which needs to be defined before making comparisons. The tool has come about to be capable of considering to types of possibilities to measure adaptation measures. The first, as this analysis is done through a textual analysis, is the measuring of intended adaptation measures to be either initiated or even implemented. The second possibility considers looking at the adaptation measures already truly taken, this can be done in the form of a case study or of reports accessing how well the implementation has worked. When starting the analysis this is important to differentiate as confusion can otherwise arise with either the analyst him or herself or the reader.

### 5.3.2 Pro's and con's of method of measuring

The matrices were filled in based on a scoring procedure which has been elaborated in chapter 2, ranging from blank, not referred to at all, to 5, named, argumentation, consequences stated and stating how implementation is intended. This scale has worked relatively well, however a trouble arose especially when looking at Germany. As stated a low 3 can be given to Germany concerning the occurrence of autonomous adaptation. The element was stronger than a two, however not as strong as the 3's given to the Netherlands and England. Even though this was troublesome making more options possible would make it even more complicated. One extra scale could however be given, referring to the degree of implementation, making these type of differences more distinct whilst keeping a low differentiation scale to maintain a clear visual representation.

It was a strong point to settle the scores with the degree at which the variables and components have been referred to, whilst later colouring the matrices. The colouring of the matrices makes it easy to see differences and similarities straight away. When comparing countries or regions, or when a country seeks to learn or understand an other country's approach this can be helpful as not the entire text has to be read from all other regions or countries. A selection can be made on the bases of strengths and weaknesses, saving a lot of time, and making improvements in adaptation possible before climate changes become even more overwhelming and costly. However, when looking at these results one should be aware that, especially on the basis of textual analysis, that it refers to what is stated in the texts selected rather than what is happening in reality. Not every strategy can be implemented with the benefits calculated beforehand, and possible consequences should be kept in mind. Another aspect to be aware of is the different possible results that come about when different people perform the analysis as differences in culture, prejudices, beliefs, thoughts and the like can influence the scores. To reduce these differences guidelines or discussion sessions could be set up to resolve questionable results coming about from the analysis process.

## 5.4 Conclusion

All in all the adaptation tool functioned as a comparison tool between the countries. However some improvements can be made, especially concerning the scoring levels and the manner in which to differentiate between the different sub-components. The visual representation makes it possible to make quick conclusions and suggestions where a country or region can improve to cover all aspects of becoming truly adaptive. The adaptation tool is therefore helpful for analysis of how well a country or region is doing, comparing itself with other countries or regions, and when done with an interval of time it can also be used to see improvements or worsening of the country or region concerning adaptation. It has been shown through the analyses of the empirical and the synthetic question that adaptation strategies are still highly comparable and when these are performed uncertainties can be reduced to a great extent. Furthermore it has been shown that all countries and cities under analyses can make further improvements concerning the implementation of adaptation strategies. It also has become apparent that each country and even city has their own major strengths concerning the reduction of society's and build environment vulnerability concerning the increasing flooding possibilities due to climate changes. The comparing of adaptation approaches has shown that adaptation has become

increasingly essential in the implementation of policies and regulations on the national level as the European Union suggested in 2007 (Jordan et al., 2010).

## 5.5 Recommendation

Governments need to continue promoting the implementation of adaptation strategies as a vast part of these strategies are concerned with building adaptive capacity. It has shown that they can have a great influence on increasing adaptation as well as raising awareness. As the tool showed, the maximum results can be obtained when adaptation is attempted to be implemented from both national level as well as local level. This is due to the need to keep individuals aware that they are at risk, but when prepared they can overcome a possible catastrophe without significant harm. A government as well as related agencies should keep this in mind. England is a good example for such, having the strategies in place but attempting to use market mechanisms to truly start adapting and reducing costs. Opportunity costs are then calculated and the best alternative, adapting or paying the costs of damages, is then selected.

As mentioned above, the comparing of countries, regions and cities can help reduce vulnerability as well as uncertainties at the practical level. The adaptation tool showed that the gaps and disagreements can be bridged. The adaptation tool indicates a good start which will have to be exploited further in order to bridge the gaps as well as create more benefits for the practical level for governments as well as water-related agencies. Comparative research, not only for countries or regions, but also on the theoretical level can be utilized further. This will benefit flood-prone urbanized areas in the future significantly. This research has set a direction which can be taken and from the case studies it has become clear that this direction has potential not only on the practical and operational fronts but also on a theoretical level.

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## Appendix 1: Word list

The table below shows a list of translated words and synonyms which are important for this research. It should be noted however, that the list is not complete and that it is context dependent.

English	Dutch	German
Accommodate	accommoderen, schikken, aanpassen	unterbringen, entgegenkommen
Adaptation	adaptatie	anpassung
Adaptive capacity	adaptief vermogen	adaptive Kapazität
Anticipatory	anticiperende, vooruitlopend, voorbaat	bij vorausschauende, vorwegnehmend
Autonomous	autonoom, onafhankelijk, zelfbesturend	autonoom
Awareness	bewustwording	bewusstsein
Build	bouwen, stichten	bauen, setzen
Change	veranderen, anders maken	ändern, umsteigen, verwandeln
Climate changes	klimaat veranderingen	Klima Wandel
Climate proof	klimaatbestendig	klimafest
Compartmentation	compartimentering	Kompartimentierung
Durability	duurzaamheid	Haltbarkeit
Educate	onderrichten	bilden, unterrichten
Expected	verwacht	voraussichtlich
Exposure	blootstelling	aussetzung
Function	functie	Funktion
Impacts	gevolgen	Auswirkungen
Localized	gelocaliseerde	lokalisierten
Move	verplaatsen, verhuizen, verzetten, verleggen	bewegen, verschieben, umziehen, verlegen
Natural	natuurlijk, aangeboren	natürlich, ursprünglich
Planned	gepland	geplant
Policy	politiek, staatsbeleid	Politik, regel
Potential	potentieel, mogelijk	Potenzial, möglich
Prevent	voorkomen, verhoeden	verhindern, verhüten
Proactive	pro-actief	proaktive
Protect	beschermen, behoeden	schützen, absichern, behüten
Purposefulness	doelgerichtheid	entschlossenheit, zielbewusstsein
Reactive	reagerend	reaktiv
Reduction	reductie, verlaging, terugbrenging	reduktion, verringerung, minderrung, abbau
Residual	rest, overgebleven	rest, rückstand, abweihung
Resilience	veerkracht, elasticiteit	elastizität, spannkraft, unverwüstlichkeit
Responsive	responsieve	reagieren, empfänglich

Restore	herstellen, restaureren	wiederherstellen, erneuern
Retreat	terugtrekken, terugwijken	zurückziehen, zurückweichen
Risk	risico	Risiko
Society	Samenleving	gesellschaft
Spatial scope	ruimtelijke mogelijkheden	räumlichen Geltungsbereich
Spread	verspreiden, verbreiden, uitslaan	verbreiten, verteilen
Timing	timing	timing
Tolerate	tolereren, verdragen, dulden	tolerieren, dulden, ertragen
Trust	vertrouwen	vertrauen
Unavoidable	onvermijdelijk	unvermeidlich, zwangsläufig
Vulnerability	kwetsbaarheid	verwundbarkeit, ungeschützttheit
Weir/embankment	waterkering	Wehr
Widespread	wijdverspreide, uitgebreide	weit verbreitet

## Appendix 2: Chosen documents for analyses

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