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Spatial planning practices of adapting to climate change

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Abstract

Although spatial planning is considered as crucial for climate change adaptation, e.g. in the EU White Paper on Adaptation, there are uncertainties regarding the role of adaptation strategies in spatial planning practices. In this paper the potential role of spatial planning for climate change adaption is investigated by distinguishing between two adaptation strategies: avoidance and minimisation. A case study in Stockholm, Sweden, serves to analyse the implementation of these ways of adaptation in the strategic and detailed planning stages. Spatial planning documents reveal a mix of avoidance and minimisation strategies. Expert interviews were used for further analyses of the spatial planning processes around these documents. It was found that minimisation measures prevail, and that only under extraordinary circumstances, avoidance measures could be implemented. A conclusion is that a more prominent focus on avoidance measures is needed to utilise the full potential of spatial planning and to ensure more robust adaptation measures. In order to achieve this, a normative adaption hierarchy is proposed as a guiding spatial planning principle in decision making about adaptation to the effects of climate change.

Keywords: *strategic planning, detailed planning, climate change, adaptation measures, Stockholm*

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1. Introduction

Cities are confronted with immense social, economic and environmental challenges, like unprecedented urbanisation rates, far reaching globalisation patterns and, probably most challenging, climate change (Carter, 2011). Not only are cities confronted with the task to reduce carbon emissions, they also have to develop strategies and measures to deal with the effects of climate change, such as extreme precipitation, heat waves and flooding. The challenge of climate mitigation has been transferred into action in a broad range of strategies and concrete measures at all levels of government. In comparison, the task of developing policies and taking measures to adapt to the effects of climate change lags behind, although it is argued that the task of climate change adaptation might be even more demanding than climate change mitigation (Bulkeley, 2013; Carter, 2011; Biesbroek et al., 2010; Adger & Barnett, 2009; De Vries, 2006).

Spatial planning is conceived as being crucial for the implementation of adaptation policies, due to the fact that land use and land development have a significant impact on the vulnerability of cities to the effects of climate change (Bulkeley, 2013; Hurlimann & March, 2012; Measham et al., 2011; Dawson et al., 2009; Macintosh, 2013; Barnett & O'Neill, 2010). Furthermore, adaptation to climate change is a local issue, on the one hand because the scenario uncertainties are highest at local level and on the other hand because vulnerability and its causes are location specific (Næss et al., 2005). Although local adaptation strategies are beginning to emerge (Carter, 2011), there is little scientific insight into how these local efforts are integrated into spatial planning practices, especially in the developed world (cf. Hurlimann & March, 2012; Ford et al., 2011), with a few positive exceptions (i.e. Uittenbroek et al.,2013; Measham et al., 2011). Such insights are highly valuable, as they provide the necessary empirical base of ongoing adaptation efforts to complement theoretical work on the potential role of spatial planning in adaptation to climate change, such as the work by Hurlimann & March (2012).

In this paper we present an analysis of ongoing adaptation practices in the city of Stockholm, Sweden. With this analysis, we contribute to a better understanding of the implementation of adaptation practices at the local level, in terms of the way in which the spatial challenges of adapting to climate change are taken into account in the context of spatial planning. Based on our theoretical findings on the potential role of spatial planning in adaptation to climate change we develop an analytical model which is refined and transformed into a normative planning principle, based on the practical findings in the case of Stockholm. The normative adaptation hierarchy serves to deliberately integrate decisions on adaptation to climate change in the early stages of spatial planning and to ensure a more comprehensive mix of ways to adapt to climate change throughout all spatial planning stages.

First, we analyse the potential role of spatial planning by presenting a theoretical framework on the spatiality of adaptation to climate change.

Second, we explore how different ways of adaptation can potentially be implemented throughout the different stages of spatial planning practice. Third, we present the research methods and the analytical framework. Fourth, we turn to the results of the case study in Stockholm, which are followed by a discussion and the conclusions.

2. The spatiality of adaptation

It is often stated that spatial planning has an important role to play in adaptation practices because both vulnerability to the effects of climate change and adaptation measures have clear spatial characteristics (Biesbroek et al., 2009; Bulkeley, 2006; Davoudi, 2009; Goosen et al., 2013; Overbeck et al., 2008; Roggema, 2009). However, it is important to bring more conceptual clarity into this argument, not the least because of the diversity in the use of the term 'spatial' and the different conceptions of 'spatial' in the context of spatial planning theory. Healey (2004, p.47) distinguishes between two geographical conceptions of space: an essentialist 'Euclidian' and a relational. The essentialist conception assumes that "objects and things exist objectively in contiguous space and that the dimensions of this space can be discovered by analysis" (Healey, 2004:47), whereas the relational conception conceives space as a social construct, as the "inherent spatiality in all relations, whether social, ecological or biospherical" (Healey, 2004, p. 47).

The conception of space in the main argument for the role of spatial planning in adaptation to climate change has clear essentialist characteristics. The spatial characteristics of the effects of climate change are often described by their objective geographical dimensions, for instance in the form of risk maps that combine the effects of climate change with land use patterns or human settlement patterns to create an objective depiction of the geographical distribution of risks (Koks et al., 2014; McGranahan et al., 2007). Furthermore, it seems that the spatial character of adaptation measures is often subjectively defined, for instance by simply stating that there is a clear spatial dimension (Biesbroek et al., 2009; Goosen et al., 2013), or by defining the spatiality according to the geographical dimensions of the measures (Roggema, 2009; Koks et al., 2014). A dike is for instance often referred to as an example of a non-spatial or technical measure (Roggema, 2009; Neuvel & van den Brink, 2009), but like with every measure, a dike has a physical, geographical dimension as well, which makes it difficult to distinguish between spatial and non-spatial measures. This essentialist conceptualisation becomes problematic when it is integrated into the contemporary theoretical debate on the integration of a relational understanding of place and space into the practice of (strategic) spatial planning (see for instance Walsh, 2014). A conceptually clear elaboration on the role of spatial planning in adaptation to climate change at least requires a more careful use of the term spatial, to account for the various understandings of this term in planning theory.

To come to a clear conceptualisation of the relation between adaptation and spatial planning and to define the potential role of spatial

planning in adaptation to climate change, we define spatial planning as the development of future oriented, holistic policies that integrate and balance demands and requirements of society and various governmental policies into a desired future physical organisation of space (Neuvel & van der Knaap, 2010; Hurlimann & March, 2012; Goosen et al., 2013). Other definitions of spatial planning are comprehensively discussed in the literature (e.g. Hurlimann & March; 2012). Within our definition, two dimensions of spatial planning can be identified: the physical environment as the material object of spatial planning and the organisational questions of how to balance different spatial requests, demands and interests of society and how to organise decision making processes in spatial planning practice (Hidding & van den Brink, 2006). The physical environment is on the one hand shaped by biotic and abiotic influences, such as geological, physical geographical, hydrological and climatological processes (Hidding & van den Brink, 2006). On the other hand it is a reflection of anthropogenic relations and processes that should not only be described by its physical or material components (Hidding & van den Brink, 2006; Healey, 2004). Instead, these relations and processes can be described in terms of relational reach and positions in varying and multiple networks (Healey, 2004). We thus take a relational approach to define the 'spatial' in spatial planning. From this perspective, the recognition and perception of places are shaped by its meaning in different relational networks; space can thus be fragmented and represented in various ways (Healey, 2004). With this relational approach, we emphasise that the spatial dimensions of adaptation to climate change should not only be described by its impacts on the physical environment and potential measures. To be able to define the potential role of spatial planning in adaptation to climate change, it is just as important to recognise the impact of the effects of climate change on the relations and processes in society.

To make the relational dimensions of the effects of climate change more explicit, we use Healey's criteria for evaluating concepts of space and place (Healey, 2004). First of all, in terms of the treatment of scale and position and regionalisation, climate change is a global phenomenon which can have simultaneous effects in different places and on different scales; it can be global and local at the same time. The reach of the impacts of extreme weather events can go beyond the places where they occur, they can have significant impacts elsewhere as they can impact societies through multiple relational networks, which can be exacerbated if events occur in nodes. A drought can for instance destroy crops in a specific area, with devastating economic effects for the affected farmers, but its consequences can go much further, even raising global food prices, such as the drought in the USA in 2012 (Crutchfield, 2013). Furthermore, climate change can have effects on specific groups, making them more vulnerable than others. This is for instance the case with the effect of heat waves on elderly people, such as the heat wave in France in the Summer of 2003 (Poumadère et al., 2005). In terms of materiality and identity, the perception of the effects of climate change plays an important role. As Healey (2004, p. 49) states, the recognition

of material objects is always filtered by how we perceive them. The same is true for the effects of climate change, which may appear for instance on risk maps, but which may not be perceived as essential threats. This can however change through time, as perceptions change through time in interaction with imaginative work and materialisation. In concrete terms, this means that the momentum for taking action on climate change adaptation can change suddenly, for instance in response to real extreme weather events. This emergent characteristic of climate change is also reflected in terms of the conception of development and representation. Especially due to the uncertainties related to climate change, future developments are inherently unpredictable. A relational perspective takes these uncertainties for granted, whereas an essentialist perspective would imply the adoption of integrated and linear trajectories.

The essentialist argument that the effects of climate change have a spatial character because of its physical impacts is thus only one side of the medal, it is just as important to see the impacts on anthropogenic structures and processes and the relational manifestation of climate change effects. The same is true for the argument that spatial planning has a special role to play in adaptation to climate change due to its focus on physical space as the material object of spatial planning; the role spatial planning plays in balancing the different spatial requests, demands and interests of society, which have an inherent relational character, is just as important.

3. The potentials of adaptation in spatial planning

In this section we turn to the question how adaptation can be incorporated into practices of spatial planning. To distinguish between different ways of adaptation with relevance for spatial planning, we use a differentiation suggested by Roggema (2009, p. 290). He distinguishes between two occupation strategies, one that concentrates on avoiding vulnerabilities to the effects of climate change and one that adjusts the urban environment to minimise vulnerabilities.

In the first *avoidance* occupation strategy, the mechanism to adapt to a changing climate is the location choice for different kinds of land use. Avoidance strategies choose those locations where the effects of climate change are already minimal; they take the biotic and abiotic conditions, including climatic conditions into consideration and distribute anthropogenic land use in such a way that vulnerability to the effects of climate change is avoided (Roggema, 2009; Hidding & van den Brink, 2006). A good example of an avoidance strategy is to locate land uses with a high potential damage, like new buildings, on higher grounds, to avoid the risk of flooding (Roggema, 2009). This avoidance strategy can be implemented on different administrative levels. Roggema (2009) for instance takes the Netherlands as an example and argues how a strategy to steer urban development to higher grounds in the country can in the end decrease flood risks in the areas below sea level. On a lower administrative level it is for instance possible to locate vital functions for society, like hospitals and schools, in areas with a lower exposure to the

effects of climate change, e.g. on higher grounds in the case of flooding (Wardekker et al., 2010). Other examples of avoidance strategies are for instance to avoid soil sealing in areas where rain water accumulates as a way to deal with heavy rainfall or to use green space to prevent urban heat islands. Such strategies also rely on the capacity of the biotic and abiotic conditions to absorb the negative impacts of climate change and to avoid that anthropogenic developments negatively influence this capacity. It should be noted that avoidance can also mean to deliberately not develop certain areas, for instance not to build in flood prone areas, to avoid (future) vulnerabilities.

In a *minimisation* strategy, location choices for new developments are made according to other criteria than climate change, for instance economic development, connectivity or attractiveness (Roggema, 2009). To adapt to the effects of climate change, the design is optimised to lower the sensitivity of future functions towards the effects of climate change (Roggema, 2009). This can be done at the level of the urban design, but also on more detailed levels, even on single buildings. Furthermore, these measures can be taken at a different location than the exposed areas, which is for instance the case with building dikes to prevent entire cities from flooding. Such optimising measures often have a technical character, adjusting the physical circumstances to enable the proposed developments. Common examples are building dikes and dams or elevating land to protect against flooding, building (larger) sewage systems to dispose rainwater and using specific construction materials to prevent urban heat islands (Wardekker et al., 2010; Roggema, 2009). Minimisation measures can be applied in new developments, but also to climate-proof the already existing built environment (Dixon & Eames, 2013).

Adaptation in local planning processes

At the municipal level, spatial planning in most European cases incorporates two stages. First, a strategic spatial planning stage concerned with the development of framework instruments for the whole municipality and second, a detailed planning stage concerned with the detailed development of specific areas within the municipality and the development of regulatory instruments (Albrechts, 2004, p. 744). These framework instruments, the comprehensive plans, for instance the German Flächennutzungsplan, the Dutch Structuurvisie or the Swedish Översiktsplan, cover the entire municipal area and provide an overview of actual or planned land use patterns (Albrechts, 2004, p. 744). They usually have a discretionary role, providing general guidance, in accordance with the 'performance view' of spatial plans (Albrechts, 2004; Mastop & Faludi, 1997). The regulatory instruments, the detailed development plans, for instance the German Bebauungsplan, the Dutch Bestemmingsplan or the Swedish Detaljplan, indicate detailed site-specific zonings for building, land use and infrastructure (Albrechts, 2004, p. 744). Within the detailed planning stage, the main concern is to translate decisions into a legally binding document, in accordance with the 'conformance view' of spatial plans (Albrechts, 2004; Barrett & Fudge, 1981).

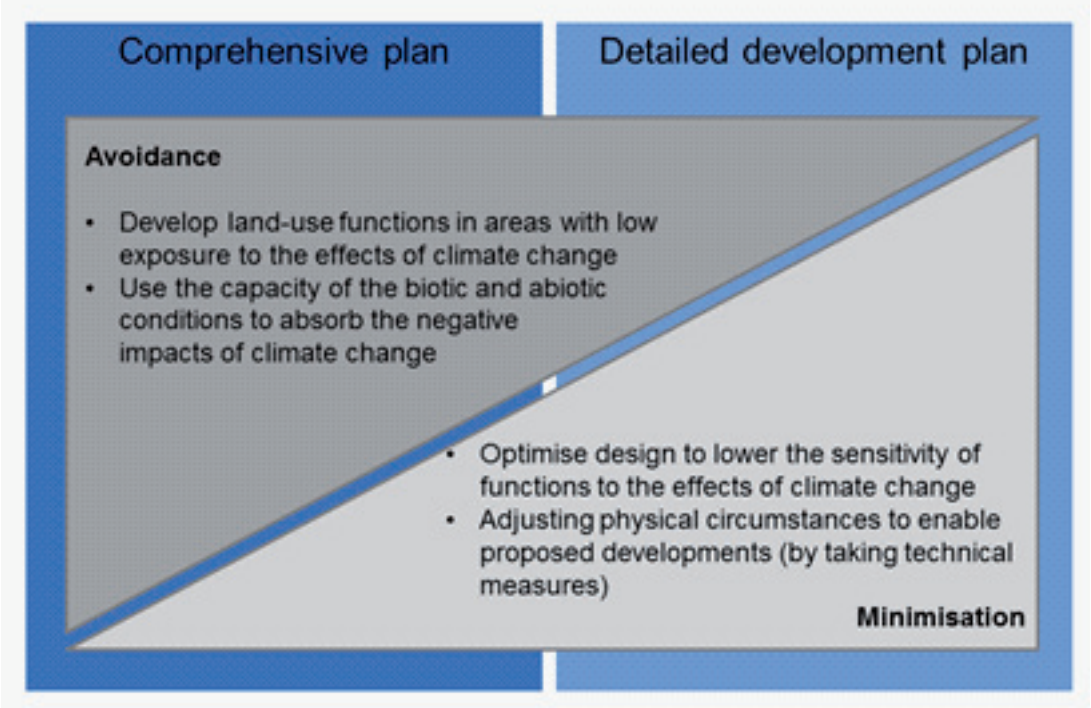

Figure 1. *Ways of adaptation throughout the stages of spatial planning.*

By combining the two stages of spatial planning with the two ways of adaptation, we argue that the strategic stage of spatial planning has the highest potential when it comes to incorporating decisions about avoidance. The comprehensive plans play an important role in guiding decisions about the future distribution of different kinds of land use. Incorporating the effects of climate change in these decisions can lead to a comprehensive plan that avoids vulnerabilities caused by the effects of climate change. The detailed spatial planning stage deals with questions on a smaller scale and the way developments are designed and built in practice. Due to the smaller geographical scale and the more detailed focus of the detailed development plan, it is questionable if avoidance is still possible at this stage, as the important decisions about the distribution of land use are already taken during the previous strategic planning stage. The potential combination of both spatial planning stages and the different ways of adaptation is depicted in Figure 1.

We acknowledge that in practice, there will always be a mix of these ways of adaptation and that the line between avoidance and minimisation is fuzzy. The actual decisions about which adaptation measures are taken is influenced by a multitude of factors, such as awareness, financial resources and knowledge, but it also depends on the other social, economic and political processes surrounding and influencing the actual decision making processes about urban development (Dow et al., 2013; Measham et al., 2011; Adger et al., 2009). Referring to the task of spatial planning to balance the spatial requests, demands and interests in society, climate change adaptation has to be embedded into existing and emerging structures, networks and processes. Here, the relational perspective on the effects of climate change can play an important role, as discussed in the previous section.. In actual decision making processes, it is important to understand if and how climate change interferes

with the existing and emerging relations and networks, but also if climate change is being perceived as an important issue.

Moreover, we acknowledge that vulnerabilities to the effects of climate change cannot be avoided or diminished completely; avoidance and minimisation strategies will not be able to cover all risks (Füssel, 2007; Hissel et al., 2014). In such cases, the negative effects of climate change can for instance be compensated by the development of suitable insurances or funds that can cover the damages (Aerts & Botzen, 2011). Other possibilities are to reduce potential damage by developing evacuation plans (Hissel et al., 2014), by changing behaviour during extreme conditions (O'Neill et al., 2009) or by creating early warning systems (Birkmann et al., 2013).

4. Method

In the previous sections we have described the potential role of spatial planning in adaptation to climate change and presented how different ways of adaptation can potentially be implemented throughout the stages of spatial planning. Now we turn to the analysis of actual practices of adaptation in spatial planning, ultimately to answer the key research question how adaptation to climate change is implemented throughout both stages of spatial planning in practice and if these practices utilise the full potential of spatial planning in adapting to the effects of climate change. To this end, we have conducted a single case study in the city of Stockholm (Sweden). Stockholm was selected as an information-oriented atypical case with a high potential to provide unique insights into practices of climate change adaptation in spatial planning (cf. Flyvbjerg, 2006). First, Stockholm has the potential to provide such information, because the city already made the first steps in the development of a climate change adaptation policy in 2005. The City of Stockholm has developed an action programme on climate change, incorporating a study on adaptation to climate change, to identify the impacts of climate change in Stockholm and to provide the city with a foundation to adapt to these impacts (Ekelund, 2007, p. 6). In the implementation, the City of Stockholm pursues a mainstreaming approach to climate change adaptation. There is however no formal local climate change adaptation strategy. A mainstreaming approach integrates climate change adaptation into existing policies, including spatial planning (Uittenbroek et al., 2013). Second, unlike many other countries, Swedish legislation obliges municipalities to show how a detailed development plan deals with the challenges of climate change, creating a legal incentive to consider climate change adaptation throughout the different planning stages. Third, the City of Stockholm is currently redeveloping an existing harbour on the Baltic Sea cost, in proximity to the city centre, transforming it into a dense urban neighbourhood: Stockholm Royal Seaport (see Figure 2). In the development of this area, climate change adaptation is formulated as one of the central ambitions, which means that adaptation has a prominent role in the development process and in the detailed planning stage.

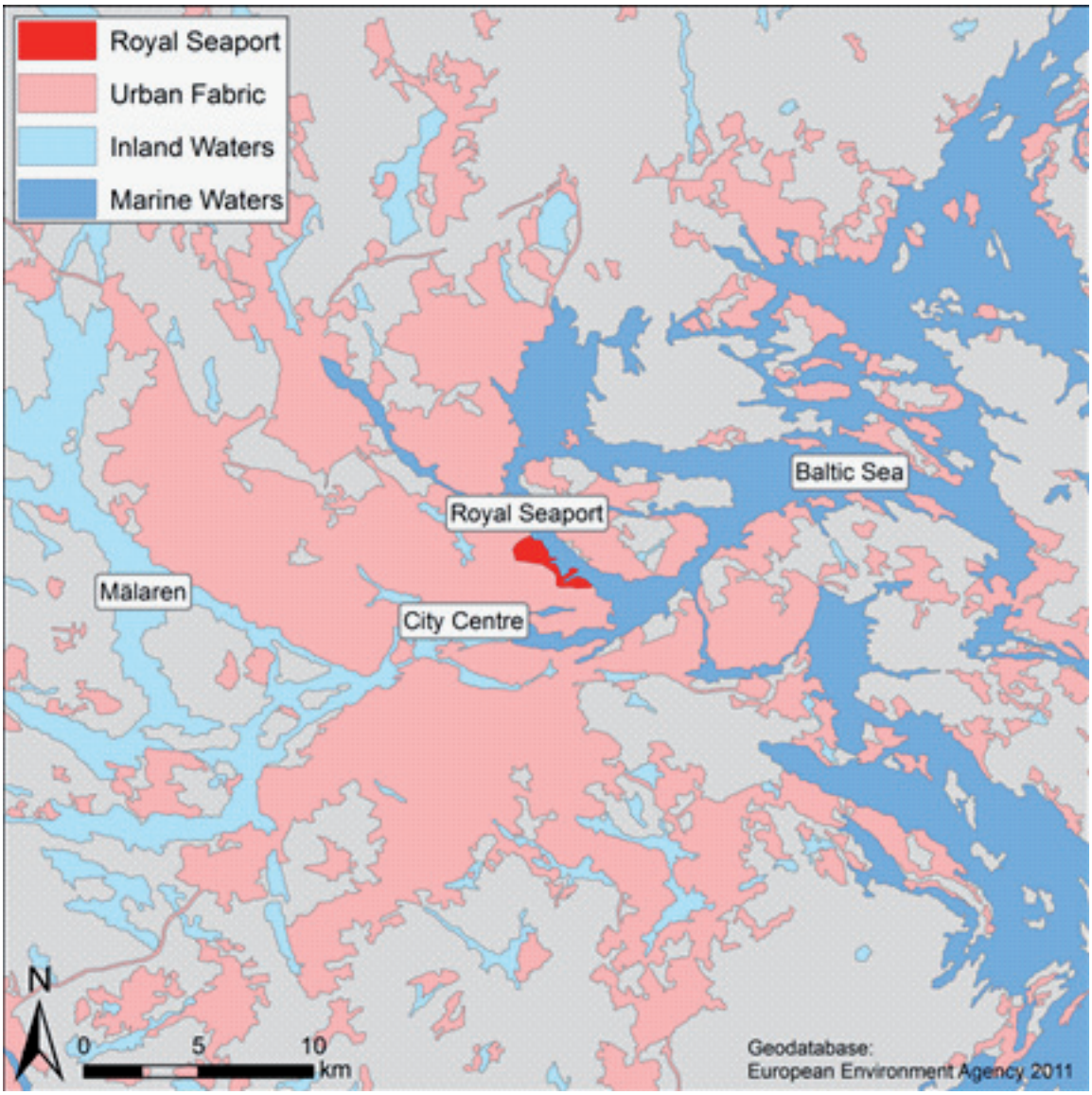

Figure 2. *Stockholm Royal Seaport on the Baltic Sea Coast*

For the purposes of this study, it has been important to use a case study that can provide as much information as possible on the phenomenon of adaptation to climate change in practices of spatial planning. It is considered that atypical or extreme cases can provide such in-depth information, given the fact that they mobilise more actors and basic mechanisms in the phenomena that are being studied (Flyvbjerg, 2006). First, Stockholm can be considered as an atypical case because the implementation of adaptation efforts is generally limited (Carter, 2011) and because the empirical base of ongoing adaptation efforts in spatial planning research is still small (Biesbroek et al., 2013). Second, the special conditions in Stockholm are especially created by the fact that the development of Stockholm Royal Seaport has explicit climate change adaptation goals that go beyond the formal obligations to consider climate change adaptation in detailed development plans. It should however be noted that although Stockholm can be considered as an atypical case, it is explicitly not a critical case with generalizable conclusions that automatically apply in (most) other cases (cf. Flyvbjerg, 2006).

In the case study we used two empirical methods: a document analysis and two series of semi-structured expert interviews. The document analysis focused on the current comprehensive plan, 'The walkable city' (City of Stockholm, 2010a) and the approved detailed development plans (February 2014) for parts of Stockholm Royal Seaport: Hjorthagen-Norra 1 (City of Stockholm, 2008a), Hjorthagen-Västra (City of Stockholm, 2008b) and Värtahamnen-Värtapiren (City of Stockholm, 2009a). All references to climate change adaptation were documented and marked as being either avoidance or minimisation strategies or measures, using the criteria as outlined in Figure 1. Furthermore, several supporting documents in the development of Stockholm Royal Seaport were analysed according to the same criteria, to provide more insight into the development process: the Vision 2030 for Stockholm Royal Seaport (City of Stockholm, 2009b), the Comprehensive programme on Environment and Sustainable Urban Development in Stockholm Royal Seaport (City of Stockholm, 2010b) and the report on the use of the Green Space Index in Hjorthagen (City of Stockholm, 2011). These documents were recommended by several interviewees, as they play an important role in the development of Stockholm Royal Seaport.

Semi structured expert interviews were conducted to get a deeper insight into the role climate change adaptation plays in the planning instruments and into the governance structures behind the implementation of climate change adaptation measures. The interviews on the spatial planning instruments were conducted in November 2010 and the interviews on the governance structures in December 2012. The interviews were held with representatives from the city planning department (Stadsbyggnadskontoret) within the city administration, responsible for the development and implementation of the comprehensive plan and for the development of the detailed development plans for Stockholm Royal Seaport. Furthermore, the interviews on the governance structures comprised an interview with a representative from the development department (Exploateringskontoret), to get more insight into the broader governance structures behind the development of Stockholm Royal Seaport and a representative from the environmental department (Miljöförvaltningen) to get a more insights into Stockholm's efforts in climate change adaptation.

5. Adaptation in the comprehensive plan

The currently valid comprehensive plan for the city of Stockholm was approved by the City Council in March 2010 (City of Stockholm, 2010a). The plan has the title 'The Walkable City', and is a guiding document, i.e. not legally binding. It outlines the spatial development strategies for the city until the year 2030 and identifies the main focus areas and planning aims. The plan outlines four development strategies for sustainable growth: strengthening central Stockholm, developing several strategic nodes in the outer suburbs, increasing the connectivity between different neighbourhoods and creating a vibrant urban environment (City of Stockholm, 2010a). The comprehensive plan highlights climate change,

mentioning the effects of a rising sea level in the Baltic Sea and changing precipitation patterns, which in turn can lead to flooding of Lake Mälaren (see Figure 2) and other lakes or watercourses, affecting low-lying areas and their infrastructure. Furthermore, it mentions increased variation in groundwater levels, which can lead to landslides or damage to buildings (City of Stockholm, 2010a, p. 31) In response to these signalised effects of climate change, the plan aims to 'increase readiness for climate change' (City of Stockholm, 2010a, p. 31). Additionally, an annex of the city plan lists 22 risk factors that have to be taken into account within spatial planning. One of these risk factors is 'climate effects' (City of Stockholm, 2010a).

The comprehensive plan includes two specific measures on how these general remarks should be translated into avoidance strategies. First, the plan refers to socially essential functions, such as hospitals, which must either be located outside the risk areas or designed with 'careful consideration for the risks' (City of Stockholm, 2010a, p. 31). This recommendation stems from the County Administrative Board, a governmental agency that represents the interests of the national government on the regional level and that formally examines all detailed development plans, and is also part of the recommendations in the previously mentioned study on adaptation to climate change in Stockholm (Ekelund, 2007, p. 15f). This can be consider as an avoidance strategy given the deliberate consideration of sensitivities towards the effects of climate change, in this case flooding, and the adjusted geographical distribution of the socially essential functions accordingly. Second, the city plan contains the recommendation to drain rainwater away and handle it locally through porous surfaces as far as possible (City of Stockholm, 2010a, p. 31). This measure is also considered an avoidance strategy, because it takes the infiltration capacity of the soil into consideration and uses this to avoid water nuisance due to heavy rainfall.

Besides these two avoidance strategies, several minimisation strategies can be identified. Most prominent is the redevelopment of 'Slussen', a lock and floodgate in the inner city, separating Lake Mälaren from the Baltic Sea. This project, which comprises a far reaching redevelopment of the area around the existing floodgate, also intends to drastically increase the pumping capacity of the floodgate, to discharge water from Lake Mälaren into the Baltic Sea and prevent floods from Lake Mälaren and the Baltic Sea (City of Stockholm, 2010a, p. 52; Ekelund, 2007, p. 14). Slussen can be considered as a minimisation strategy because it is a technical measure that is specifically taken to adjust the physical circumstances to enable new developments and to protect existing structures, without considering the root causes of vulnerability. The interviewees from the city administration see the redevelopment of Slussen as the single most important adaptation measure for Stockholm as a whole, also because Slussen plays an important role in securing the fresh water quality in Lake Mälaren, the main drinking water source for the city and its surroundings, by preventing salt water intrusion from the Baltic Sea due to sea level rise. Second, although the (re)location of socially essential buildings has been framed as an avoidance strategy, the plan-

ning aim as formulated in the city plan also contains the sentence 'or designed with careful consideration for the risks' (City of Stockholm, 2010a, p. 31). This shows how minimisation strategies are left open as a viable adaptation option. Third, the comprehensive plan recommends adapting buildings and facilities that are planned in areas under threat from flooding or landslides. We consider all these measures as minimisation strategies, as they are all concerned with optimising the design to lower the sensitivity of future functions towards the effects of climate, to support specific kinds of land use.

The comprehensive plan is a strategic and general document in which specific choices affecting future land use are generally rare. As an interviewee from the city planning department (strategic planning) explained, the plan is purposefully kept a strategic document, with the possibility to add planning documents or instruments underneath the actual comprehensive plan, either as part of the city's management and follow-up system in which the annual priorities for urban development in the city's budget are laid down, or as part of the development of new underlying information to support the planning process (City of Stockholm, 2010a, P. 82-83) . The idea is to have a flexible plan that can respond more quickly to developments within different fields, and to keep the document itself up-to-date (Fredriksson, 2011). Consequently, the issue of climate chance adaptation can be incorporated into the strategic planning process at a later stage.

In 2010, the planning administration started to work with clarifying the relevance of climate effects for spatial planning, aiming to incorporate the results into the strategic planning process subsequently, which has however not led to the development of a separate document yet. With the choice to keep the plan itself such a general document, deliberate choices about avoidance strategies within the comprehensive plan are not being made. Just like other choices about specific kinds of land use, decisions about actual adaptation measures are transferred to the decision making process in the detailed planning stage. This reduces the possibility to implement avoidance measures, as already depicted in Figure 1. As an interviewee from the city planning department highlighted, the comprehensive plan is a guiding document, for instance in guiding developers on where to build, but also to point at the challenges in specific areas. The ideas from the comprehensive plan are thus carried through in the development of the detailed development plans.

It should also be noted that the approach to avoid explicit choices about specific kinds of land use in comprehensive plans also reflects current political trends towards liberalisation and an increasing role of private actors, striving for resource efficiency in urban development projects in Stockholm, an issue further elaborated on by Reardon & Schmitt (2013). This reflects recent trends in the practice of spatial planning in Sweden, but also in other Nordic countries (Mäntysalo et al., 2014). Historically, the City of Stockholm has been having a strong position in the process of spatial planning, not only because of the municipal planning monopoly, but also due to the extensive public land ownership (Fredriksson, 2011; Eirini, 2011; Passow, 1970). Recently, there has been a shift going on

towards a more efficient planning process and a changing balance between public and private actors in urban development, with a stronger focus on promoting efficient competition and attempting to attract private developers (Fredriksson, 2011). This is reflected in the revised Planning and Building Act from 2010, which not only intends to make the planning process more efficient, but also to enhance the strategic character of the comprehensive plan (Fredriksson, 2011).

6. Adaptation in Stockholm Royal Seaport

The development of Stockholm Royal Seaport incorporates a transformation of the current harbour area into a dense, mixed urban area with approximately 10.000 new homes and a working environment for 30.000 employees (City of Stockholm, 2010a, p. 53). Ideas to redevelop the existing harbour have existed since at least 1999 when the area was marked as a strategic development area in the former comprehensive plan (City of Stockholm, 1999). The formal political decision making process for the area started in the early 2000s, with the approval of the overall programme by the City Planning Committee in 2003. The first detailed development plans were prepared and ultimately approved in 2008; the detailed development plans for other parts of the area are still being developed. In 2008 the City Council decided to assign a special environmental profile to the area, with large consequences for the rest of the decision making process (City of Stockholm, 2012). It should be noted that the analysed detailed development plans were approved before the decision to assign an environmental profile was taken, making the analysis of other, informal planning documents even more important.

In the latest comprehensive plan, Stockholm Royal Seaport is designated as a strategic area, and as one of the city's environmental profile areas, with high ambitions when it comes to reduction of the emission of greenhouse gases and environmental friendly ways of transport (City of Stockholm, 2010a, p. 53). These ambitions have been substantiated into three environmental targets for Stockholm Royal Seaport: 1) to be free of fossil fuels in 2030, 2) to emit less than 1,5 tonnes of carbon dioxide per person and 3) to be adapted to future climate change, such as increased precipitation (City of Stockholm, 2009b, p. 8). Stockholm Royal Seaport is described as a prototype for sustainable development, taking the lead in starting a transformation to a climate adapted society and to develop new energy- and environmental technology (City of Stockholm, 2009b, p. 6).

In the detailed planning stage, the required detailed development plans for the specific development sites within the area are being developed by the city planning administration, whereas the actual development and building process is being led by the development administration, which is also responsible for the urban design and the infrastructure development. The development and building process is shaped by the environmental profile for the area, creating special conditions under which the different departments within the city administration, academia and building companies cooperate, for instance in

the form of forums and seminars, but also with working groups with representatives from the different departments within the city administration. The project is comparable to Hammarby-Sjöstad, a pilot project for sustainable development in the 1990's. As such, Stockholm Royal Seaport is supposed to become a good example from which other 'regular' urban development projects can learn. The environmental profile creates the incentive to make extraordinary investigations, experiment with novel techniques and break through several habits in urban development.

In the detailed planning stage we were able to identify avoidance as well as minimisation strategies. Different themes are considered to be important in adapting the neighbourhood to the effects of climate change: flood risk, heavy rainfall, heat and drought and ecosystem quality (City of Stockholm 2010b). These aspects are however not prominent in the actual detailed development plans, which can be explained by the fact that the currently valid plans were approved before the area was marked with the environmental profile. From the currently valid plans, only the plan description of Hjorthagen-Norra 1 contains a separate paragraph on dealing with the effects of climate change, referring to an expected sea level rise of 0.5 metres in 2100 and measures taken by the Stockholm Water Company to reduce corresponding risks (City of Stockholm, 2008a).

The other documents that were analysed however give more insight into how climate change adaptation is taken care of in the development of Stockholm Royal Seaport, especially in the formulation of the ambitions in the Vision 2030 (City of Stockholm, 2009b) and in the subsequent detailed elaboration in the Comprehensive programme on Environment and Sustainable Urban Development (City of Stockholm, 2010b). When it comes to actual adaptation measures, the latter document mentions four major issues: 1) rising sea levels, 2) heavy rainfall, 3) heat and drought and 4) ecosystem quality (City of Stockholm 2010b, p. 18f). In order to deal with the issue of rising sea levels, the land is elevated where necessary, adding one meter on top of the already existing flood line used in contemporary developments. In the detailed development plan for Värtahamnen-Värtapiren this aspect is specifically mentioned, in the context of building a new pier that should be built at 2.5 meters above sea level (City of Stockholm, 2009a). This can be considered as a clear minimisation strategy; avoidance would imply that the neighbourhood would not be built in this flood prone area. When it comes to dealing with heavy rainfall, innovative solutions are developed to dispose rainwater by infiltration on site, instead of draining it into sewage systems. To achieve this goal, a combination of green roofs, porous surfaces, innovative water storage techniques and green space is being developed and captured in arrangements between the development department and the developing companies. Additionally, it is necessary to install pumps and systems to drain the water. It is difficult to draw the line here between avoidance and minimisation. On the one hand, the measures incorporate ways to use the infiltration capacity of the soil, but on the other hand minimisation measures are considered

as necessary to reduce vulnerabilities. To deal with the effects of heat waves and droughts, a considerable amount of green space is planned, in conformance to the so called green space index, an index which requires a certain ratio between the amounts of green spaces and built up areas (City of Stockholm, 2011). These green spaces are designed in such a way that the negative effects of climate change can be prevented, for instance by providing shadow, contributing to a high quality recreational space (City of Stockholm, 2010b, p. 19). Furthermore, water ponds, wetlands and innovative techniques for rain water storage are developed, to secure water resources for irrigation purposes during droughts (City of Stockholm, 2010b, p. 19). In the transformation of the area from the current brownfields to a high quality urban neighbourhood, attention is being paid to the soil quality, demanding an environmental quality which does not cause negative effects on human health and the aquatic ecosystem. Furthermore, in the decisions about vegetation types, attention is being paid to its contribution to strengthening the urban ecosystem (City of Stockholm, 2010b). The utilisation of green and blue space can be considered as an avoidance strategy because the natural capacity provided by the biotic processes is used to avoid the occurrence of the urban heat island effect and to create a good micro climate.

The mix of avoidance and minimisation strategies during this stage of spatial planning is surprising, given our earlier assumption that avoidance strategies are difficult during this stage. As we see in Stockholm Royal Seaport, this assumption still holds true for flood risk, but for other effects of climate change, avoidance measures are still possible during this stage. Focusing on the aspect of flood risk, it can be argued that, by building a new urban neighbourhood directly at the Baltic Sea waterfront, the actual vulnerability to flood risk in the area is shaped by the decision to build in this area in the first place. There are however strong economic arguments in favour of the redevelopment of the area, as explained by the representative from the development department, such as the problem of a diminishing importance of the harbour activities and the related brownfields. Soil remediation is a highly cost intensive issue, which can arguably only be financed by increasing land values and transforming the area into a new urban district. The municipal planners from the city planning department emphasise that the development of Stockholm Royal Seaport is first of all a political decision. As they argued, politicians do not want to steer the market, which means that the city develops areas that are deemed to be popular and promise the highest profits – even if they might be under risk of flooding. Nevertheless, they also stressed that the area is very attractive as it allows using existing infrastructure, to make the city denser and to ensure short distances for the residents. Furthermore, the redevelopment supports Stockholm's challenge to house the dramatically increasing population and to resist the related stresses and shortages on the housing market (City of Stockholm, 2010a, p. 24-25).

The representatives from the planning department and the development department explained that the decision to mark the area with an environmental profile has changed the conditions under which the

area is being developed. This decision has had large consequences for the adaptation measures that are being developed. As the interviewees explained, the experimental character of the decision making process enabled the development of innovative measures, especially in the case of dealing with heavy rainfall. They however stressed that these unique conditions will not be possible in regular processes of urban development, due to the resources such a project demands. Furthermore, as they stated, even in this project, the departments involved tended to rely on proven techniques and the institutional conditions are based on these techniques, especially in the case of dealing with heavy rainfall. Moreover, in the case of Stockholm Royal Seaport the City of Stockholm owns the land, which gave the city the opportunity to take the lead in the development process and to put stricter demands on the private developers involved, even though these demands are being compromised by the economic reality of the project, with a strong position for private developers as the main financers of the development (Reardon & Schmitt, 2013). It is questionable if private landowners have similar ambitions when it comes to climate change adaptation, which is supported by Reardon & Schmitt (2013) who also highlight the importance of the political will to use Stockholm Royal Seaport as a flagship project for green urban development.

7. Concluding discussion

In the analysis of both stages of spatial planning in Stockholm, we were able to identify a mix of avoidance and minimisation strategies towards adaptation to climate change. Through an in-depth investigation into the process of spatial planning in both phases, we have come to a more differentiated conclusion on the role of both ways of adaptation in processes of spatial planning. The results show that avoidance measures can still be implemented during the detailed planning phase, the implementation of such measures however depends on the institutional conditions. Generally, even though the difference between avoidance and minimisation is sometimes difficult to define, there is a strong tendency towards minimisation measures, the interviewees for instance often refer to the redevelopment of Slussen as the most important adaptation measure and generally emphasise technical measures to minimise the sensitivity towards the effects of climate change. This faith in technology can lead to neglecting other factors that contribute to vulnerability (O'Brien et al., 2006). Furthermore, the comprehensive plan does not contain specific location choices based on avoidance of possible future vulnerabilities, actual decisions are being transferred to the operational planning stage. The comprehensive plan is strategic with signifiers like 'continue to strengthen central Stockholm' or 'focus on strategic nodes' (City of Stockholm, 2010a). This reflects a trend in strategic spatial planning which is described by Gunder & Hillier (2009) as a trend towards 'empty signifiers' in strategic plans, meaning everything and nothing at the same time, with terms like flexibility, sustainability and growth. Under this trend, it becomes difficult to implement avoidance strate-

gies, because actual decisions about future land use are shifted to an administrative level where minimisation strategies are more likely, unless exceptional conditions like the environmental profile for Stockholm Royal Seaport are created. As also referred to by Measham et al. (2011), in regular spatial planning processes, adaptation is inter alia being constrained by the institutional environment, which is often not suitable to deal with the challenges of climate change adaptation yet. In the specific case of Stockholm Royal Seaport, this difference between a flagship project and regular projects is also supported by Reardon & Schmitt (2013), highlighting that it is important to integrate the lessons from Stockholm Royal Seaport into regular practices of urban development.

From a theoretical perspective, we argue that a relational conceptualisation of the spatial impacts of climate change can potentially lead to a more thorough analysis of how climate change affects relations and processes within society. Such an approach would enable avoidance strategies by identifying and questioning the root causes of vulnerabilities (O'Brien et al., 2007), instead of minimising the consequences of the effects of climate change. We have however also discussed that the spatial challenges of climate change adaptation are usually being described according to essentialist criteria, whereas relational perspectives on the spatial consequences of the effects of climate change are rare. In the practice of adaptation to climate change in spatial planning in Stockholm we also see clear essentialist characteristics in the way climate change is being approached, for instance in the form of risk maps and calculations of potential sea level rise. Altering these practices towards a relational conceptualisation seems unrealistic at the moment, especially because planning practices are still dominated by traditional, essentialist conceptualisations of space (Walsh, 2014). From a practical perspective, we thus argue that it is important to alter practices of adaptation in spatial planning towards a higher prominence of avoidance measures, a strong focus on the effects of climate change during the development of strategic spatial plans and the development of avoidance strategies, before shifting to minimisation. If the right avoidance measures are taken, the necessity for the implementation of the often more cost intensive minimisation measures disappears. Furthermore, avoidance measures are usually more robust than minimisation measures (Roggema, 2009), which is important when dealing with the inherent uncertainties surrounding climate change (Dessai et al., 2009). To transfer this into planning practice, we recommend a hierarchy of the ways of adaptation as a guiding spatial planning principle in decision making about adaptation to the effects of climate change.

8. Final comments

Finally, we propose to reformulate the ways of adaptation as outlined in Figure 1 into the 'adaptation hierarchy', following the principle of the mitigation hierarchy (McKenney & Kiesecker, 2009).. With the adaptation hierarchy, we introduce a normative planning principle that deliberately considers avoidance before minimisation of vulnerabilities to the effects of climate change is considered. In the Swedish context, the adaptation hierarchy can for instance be utilised as an addition to the already existing legal obligation to argue how a detailed development plan deals with the challenges of climate change. By adding the obligation to consider avoidance measures before minimisation measures and to argue why avoidance measures were not viable if minimisation measures are taken, the prominence of avoidance measures can be increased.

The findings from Stockholm show that the potential role of spatial planning in adaptation to climate change is not being fully utilised. While current practices of spatial planning in Stockholm show signs of avoidance strategies, the underlying structures show a tendency towards minimisation strategies. Only in a case where exceptional conditions are created to develop and implement innovative adaptation strategies, like in the example of Stockholm Royal Seaport, existing barriers to the implementation of avoidance measures can be overcome. Especially from a flooding perspective, it is important to take decisions that avoid vulnerabilities, by not building in flood prone areas, as early as possible, preferably in the strategic planning stage. If these decisions are transferred to the detailed planning stage, it is even more difficult to implement avoidance measures, which inherently means a shift towards minimisation measures.

With a focus on avoidance, current and future land use and relations and processes within society should be considered as the cause of sensitivities to the effects of climate change and not as the structures that need to be protected by minimisation measures. Only then, a comprehensive mix of avoidance and minimisation can be found within the context of other social, economic and political processes, surrounding and influencing the actual decision making processes about urban development. With such a focus on adapting to climate change as a relational spatial challenge, the full potential of spatial planning in playing its critical role in adaptation to climate change can be used.

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