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White Paper

Climate Adaptation in the Cross-border Region of Öresund

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Preface

It is with great pleasure that we present a White Paper, which for the first time brings a comprehensive analysis of the common challenges and opportunities that arise in connection with the need for climate adaptation across the Öresund, the strait between Sweden and Denmark.

Greater Copenhagen works together for growth and development in the largest Nordic metropolitan region, with 4.4 million inhabitants in southern Sweden and eastern Denmark - and with the Öresund as an important shared natural resource. As such it has been exciting to follow the work on this White Paper, which is very tellingly based on the ÖReWise bridge-building project.

The project has created an exemplary dialogue between actors on both sides of the strait - regions, municipalities, utilities, companies, and knowledge institutions.

This is a pilot project, which we hope will be one of many in the future, because we believe that through such projects and alliances, we can lay the foundations for future growth and prosperity in our shared border region.

We have a shared ambition for our region to become a global centre for sustainable growth and green innovation, and while this forms the main motivation for this project, the white paper also seeks to encourage cooperation within an international perspective. In this way, experience gained by Greater Copenhagen can be used as a model for developing constructive cooperation in other border regions.

The fundamental aim of the bridge-building project is to gather knowledge about significant common challenges, which can form the basis for a goal-oriented project to strengthen our border-regional cooperation in the field of climate adaptation.

It is greatly important that this project can gather knowledge from the regional level - Greater Copenhagen - link it to the national level in Denmark and Sweden, and subsequently aim to lift it internationally. This is because we can see how this generates many interesting, shared considerations and viewpoints on solutions, which we look forward to seeing realised in concrete and professional collaborations across the Öresund in the future.

Sophie Hæstorp Andersen, Lord Mayor of Copenhagen & Chairman of Greater Copenhagen

Peter Danielsson, Mayor of Helsingborg

Heino Knudsen, Chairman of Regional Council of Region Zealand & Vice Chairman of Greater Copenhagen

Summary

Water knows no boundaries. Nor does it know the border between Denmark and Sweden, which shares many similarities and common issues in this part of the Scandinavian geography. In particular, we share the Sound (Öresund), which is both a protected, valuable marine environment and the terminus of our treated wastewater and much of the rainwater we will have to deal with under more extreme weather conditions in the future.

This white paper presents an analysis of the possibilities of working together on common issues related to climate adaptation across the Sound. It is an output of the Interreg project ÖReWise and based on an analysis carried out in collaboration with the most important actors within climate adaptation around the Sound, especially the municipalities and utilities responsible for planning and executing the large investments that will safeguard our built environment against flooding and other effects of a changing climate.

For Greater Copenhagen alone, estimated investments in climate adaptation of app. € 10bn. in total over the next 30 years is needed. It may end up being higher or lower, depending on various factors, but a very large societal investment is definitely needed for sure – with the risk of a significant carbon footprint due to the large construction activities.

The analysis points to several thematic areas where the will and preconditions are present for building concrete, cross-cutting collaborations of potentially high value.

Analysis of the green growth potential

The large investment needs raise at least two key questions to be addressed: How do we gain most value from the large investments through holistic solutions, and how can we realize the potential for green growth and employment through the export of our solutions?

The following themes address these questions from different perspectives. However, there is also the need for a comprehensive analysis of the holistic, green growth potential of the large investments in climate adaptation; topic that has not yet been addressed independently.

Working with all the elements of the city

Looking at the city, merely 20–25% of its total area is accessible for public climate adaptation investments; the rest is private. We also know that the cost of flood prevention is much lower if we deal with the excess water before it runs from private land onto the public roads and land and down into the drainage system. At the same time, the need for urban development creates fierce competition over how the land should be used. Therefore, an important way forward is to find ways and approaches to use all the elements of the city in a creative way, as well as activate private investment and co-ownership.

Furthermore, the analysis shows that both Denmark and Sweden need to consider how the quality of our surface water is affected by, for example, the combination of a dense city and extreme rain.

Living lab for climate adaptation in Greater Copenhagen

On both sides of the Sound there are many strengths and capabilities, which form a good basis for creating a living lab for climate adaptation. At the same time, there is great interest in exploring the potential value of systematic collaboration in several areas.

Therefore, an investigation should be performed of how these strengths and capabilities can be further linked together in a systematic living lab collaboration, as well as how such a collaboration can be funded.

Data usage and sharing

Complex systems that handle climate adaptation require the gathering and use of a lot of data and thus emphasising the need for digitisation. In general, digitisation and data are needed to plan, manage, and utilise our systems and capacities efficiently; and data is a necessary driver for the development of new solutions.

Specifically, the analysis outlines three focus areas within digitisation and data cooperation. Firstly, the development of the already existing radar data cooperation between Denmark and Sweden, including how radar data can bring value in other areas and contribute to boosting green growth. Secondly, ensuring development of common approaches and solutions for monitoring and managing the many potential climate adaptation solutions in cities, including the interaction between the solutions in the catchment area and our treatment plants. Finally, the implementation and scaling up of sensor systems, which can provide us with new types of valuable data is explored – e.g., real-time measurements of bathing water quality.

In particular, we see a need for the development of common corporation models and operational standards, which are prerequisites for the implementation and scaling of good technical solutions.

Planning for an uncertain future

Currently, planning works with long time horizons and must deal with great uncertainties, although we still work with a 'predict and adapt' approach. This implies that we base our planning efforts on a calculated prediction of, for example, sea level rise and then adapt with the means available today and within a time horizon that is manageable.

We need to find more robust solutions based on multiple scenarios – where we then choose the one that fits with the most scenarios. Therefore, we need to develop an ongoing planning methodology for climate adaptation that can manage multiple scenarios for climate change, urban development and future needs/ costs.

A model for interregional/transnational cooperation

In 2020, Greater Copenhagen adopted a Green Charter, as well as a Memorandum of Understanding for Climate Adaptation, which was established in 2021. This was an initiative set up by Sweden Water Research and The Danish Climate Adaptation Network together with Greater Copenhagen.

Based on the Memorandum of Understanding and the partners behind it, this project was subsequently established with funding from Interreg-ÖKS program.

The ability to collaborate professionally on common challenges across borders holds great potential, and with this project a model for interregional cooperation is tested in practice. This could be further explored and developed into a model for cross-border cooperation that can position Greater Copenhagen as a global role model.

Denmark, Sweden and Öresund

When talking about Denmark and Sweden, we are often preoccupied with the differences, despite there being at least as much in common, which creates a strong basis for cooperation. This is also true for the field of climate adaptation, especially when considering our unique border region across and surrounding the Öresund.

The effects of climate change are impacting both countries, e.g., with rising sea levels, more extreme weather including more rainfall and periods of drought, as elaborated on below.

Despite this, climate adaptation is a relatively new field in both Denmark and Sweden, having only been considered an independent field of work in the last 12-15 years.

Climate adaption is a challenge characterised by the need for cooperation across many fields of study. It is a "wicked problem", which cannot simply be solved by and within one sector. Finally, the high costs of insuring ourselves against the damages of climate change constitute an independent risk and challenge in itself.

Throughout the past two decades, climate adaptation measures have been developed around the world. These initiatives aim to influence human behaviour and decision-making, innovating new technologies and infrastructure through management, governance, and institutional policies, which improve people's access to resources. However, in practice, there is no consensus on what counts as effective adaptation. One reason for this is that initiatives are often proposed and planned, but rarely implemented. Barriers that routinely discourage adaptation efforts include insufficient resources, unaffordable policies, competing or conflicting priorities for action, and uncertainty about future changes.

Impacts of a changing climate

In 2019, the UN Panel on Climate Change published a special report predicting that the global sea level will rise by up to 60 cm by 2100, even if greenhouse gas emissions are halted as supposed in the Paris Agreement.

The UN Panel on Climate Change has also stated that there is now a consensus among world experts that the effects of climate change we are experiencing today are man-made. Only about 3% of the global warming present today can be attributed to natural variations.

If emissions continue, sea levels are expected to rise by double as much, to 61-110 cm. In the long term, the UN report predicts that the sea could rise by between 1 and 5 metres by 2300. These figures are expected to be even larger in the IPCC's new main report, since recent research shows that ice is melting faster in the Arctic and Antarctic than previously thought. This is of course worrying in itself for two countries with long coastlines - and especially worrying for the Öresund region.

The impact of climate change will generally mean more extreme weather. Annually, we will see more rainfall, but summers will largely be drier. However, this does not mean that we will have fewer downpours, as rainfall will be more unevenly distributed. We have already felt the damaging effects of torrential rain in Copenhagen in 2011 and in Malmö in 2014.

We will experience more intense storms and thus more violent flooding from the sea. Some scientists point out that the cost of damage from sea water will far exceed the

cost of damage from large amounts of rain - and once again the Öresund area is at particular risk, as it is home to both major assets and important infrastructure such as bridges, airports, a metro system and wastewater treatment plants.

Temperatures will continue to rise, and especially in the winter months, there will be a noticeable difference, where snow and frost will often be replaced by grey and wet days. Summers will likely have longer periods with heat waves, which in cities can contribute to an overheating, on a level not experienced before – a phenomenon known as the Urban Heat Island effect.

Areas that are currently dry and hot will have recurring problems with heat waves and drought. Climate change will also affect biodiversity and the possibilities for farming and forestry.

The development of societal risks

There are significant geographical differences between the vast and mountainous Sweden and the smaller and flatter Denmark, which also means that both countries will deal with varying risk scenarios.Even within Sweden itself there are large differences between the north and south. In Sweden, ten national risk areas have been identified and ranked based on the probability and consequences of climate-related landslides, erosion, and flooding, see Figure 1 below (reference 1).

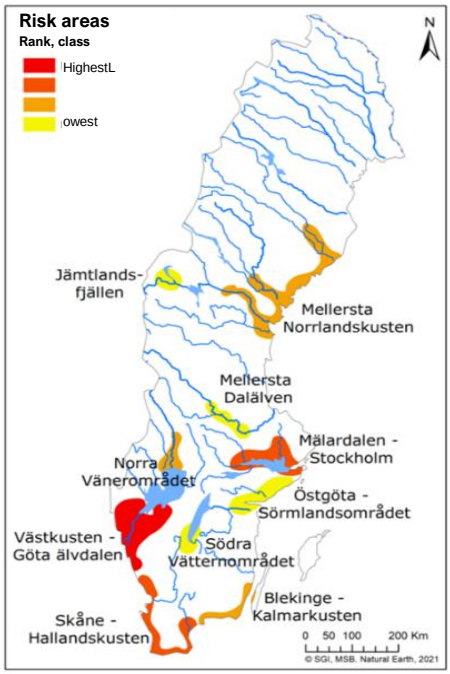

Figure 1. The map shows the ten identified national risk areas for landslides, erosion and flooding ranked according to four classes. Reference 1

In summary, the effects of flooding due to rainfall in urban areas or combined effects of rain and sea are not considered in the above national risk assessments.

Due to Denmark's small size, there are not as many differences as in Sweden. The following is taken from the Danish Emergency Management Agency's "National Risk Profile 2022" (Reference 2); on the next page.

On average, Denmark is only 31 metres above sea level and has around 8,750 km of coastline. Many large Danish cities are located close to the coast, making them potentially vulnerable to flooding from the sea. Denmark is hit almost annually by floods from the sea and storm surges. In the period from 2000 to 2020, for example, 20 events occurred that were of a magnitude that classifies them as storm surges, according to the Danish Storm Council.

However, areas along the fjords in inland Danish waters are often less protected by natural barriers or protection from high tides and thus are more prone to flooding. For example, fjord areas in Funen and Zealand and the eastern fjords in Jutland have been subject to storm surges on several occasions, resulting in major flooding.

In recent years, however, there has been an increased focus on preventing these floods partly due to the implementation of the EU

Floods Directive. As part of this, 14 areas in Denmark with a particular risk of flooding from the sea and rivers were identified in 2018. 12 of these risk areas are located on the coasts or fjords of inland Danish waters, and one risk area is located in the Wadden Sea. In total, the risk areas include a total of 27 municipalities. See figure 2.

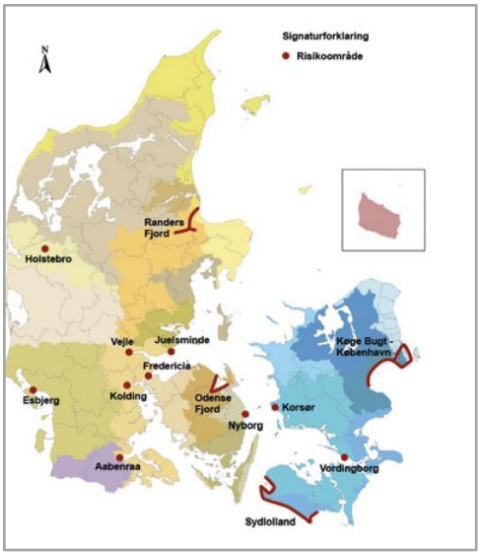

Figure 2. Flood risk areas 2020. Reference 2

From an economic perspective (Reference 3), the central bank of Denmark has estimated that up to 13% of mortgages in Denmark could be exposed to climate risk as a result of flooding in the coming century. In Sweden, the corresponding figure is around 5%. Both examples highlight how regional differences, both geographical and relating to population density, influence the climate risk of the flooding of properties during extreme weather. Southern Sweden and Zealand are the most densely populated areas in the Nordic countries and in Sweden, for example, the total amount of natural damage claims paid to property owners over the last five years is highest in Skåne (Scania) County, which has been most affected by flooding due to specific torrential rainfall events over the years.

The analysis reveals that the geography and threats of climate change are similar on both sides of the Sound, which calls for cooperation between the two countries.

Municipalities and utilities are facing major investment needs

The analysis underlying this White Paper shows that municipalities and utility companies in Denmark and Sweden need to spend at least €10 billion on climate adaptation in the Öresund area over the next 30 years.

This enormous investment need in itself poses some practical challenges in terms of exploiting the limited capacity of the market. Where are all the consultants, planners and contractors needed to carry out the work? How do we effectively communicate and coordinate the efforts of individual cities with those of the utility companies?

At the same time, there is an expectation that efforts should be implemented quickly - so how do we avoid sub-optimal solutions, or parallel development of solutions, where a lack of joint efforts ultimately lead to suboptimal results? Can we work together to find more or less standardised solutions that can achieve more for the same amount of money?

Finally, we must be ready to communicate and support dialogue about this enormous effort, which can easily give rise to concern and dissatisfaction. Construction works, for example, can cause significant disruptions in the urban environment and lead to traffic congestion for long periods of time. These efforts can seem slow and the desired results seem disappointingly far from the present. They may also raise concerns about the possible environmental impact, both temporary or permanent, particularly near vulnerable bodies of water and recipient areas.

Key environmental considerations

The strait of Öresund forms the border between our two countries and the surrounding areas constitute a strong metropolis with 4.4 million inhabitants.

Historically, the strait has developed into an area of marine nature with much to offer its inhabitants in terms of recreation areas, natural habitats, and wildlife. There is considerable physical variation in terms of types of seabed, currents, and depths, which, combined with the fact that trawling has been banned for over 80 years, has provided the natural environment of the strait with quite favourable conditions.

In the Öresund area, from the Køge Bugt/Falsterbo area in the south up to the estuary between Gilleleje and Kullen in the north, 18 different habitat types can be found, while the figure for the entire Kattegat is 15. The Kattegat is the inland waterway with the second highest number of habitat types. The reason for the large number of habitat types in Öresund is mainly due to the influence of brackish water from the south and the saline water from the north.

Together with other distinctive natural features in the form of seagrass beds, eelgrass beds and blue mussel beds, it is clear that the strait is a unique marine area in the Baltic Sea-Kattegat region (Reference 4).

In the December of 2021, the Danish government decided that Öresund should become a marine national park. The agreement states that the parties agree to strengthen nature and biodiversity at sea. To this end, they will make knowledge about the marine environment more accessible. There is currently no demarcation of the park or information about the rules that will apply in the area.

On the Swedish side, there are also proposals for new protected areas in the strait. In 2020, The County Administrative Board of Skåne was commissioned by the Swedish Government to investigate the conditions under which marine areas in the Öresund strait could be protected. This included analysing different forms of protection that would best contribute to a coherent and functional network of protected areas. In general, protection in these areas applies to eelgrass beds, salt marshes and breeding/ farming areas for fish and shellfish

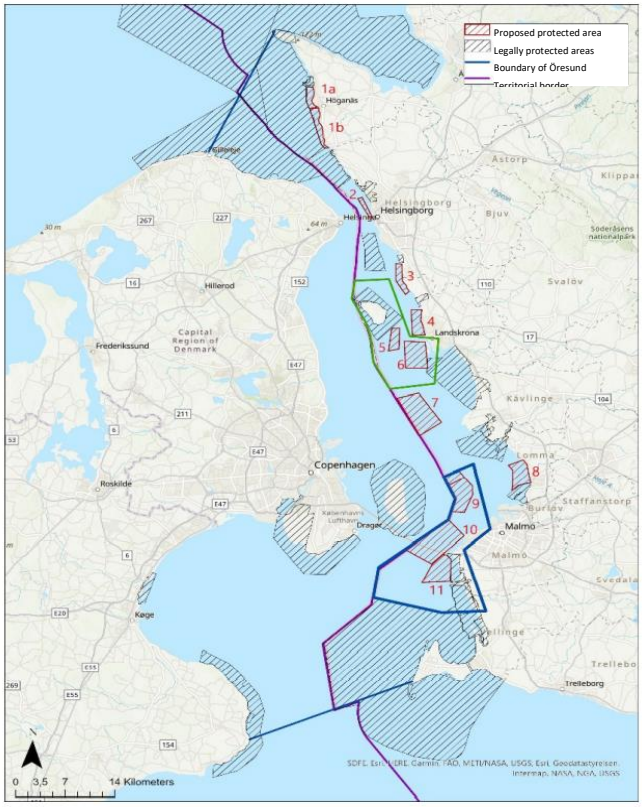

Figure 3. In-depth action plan for possible future marine protection in Öresund in response to the

The word Öresund comes from its presence on a runestone from approx. the year 950: Urasu[n]ti, from the noun -ør(e), 'gravel beach' and the noun sund, meaning strait. (Reference 6).

The northern boundary of the Öresund region is marked by a line going from Gilleleje on the Danish side to Kullaberg in Sweden. The southern boundary crosses from Stevns Klint in Denmark to Falsterbo in Sweden, see Figure 4.

Throughout history, Öresund has been the most important connecting route between the North Sea and the Baltic Sea. With trade and an extensive herring fishery for most of the Middle Ages, a number of significant cities arose here - Helsingborg,

The map on the left shows which protections exist in the Öresund today, as well as the project's future proposals for additional protected marine areas/marine nature reserves (red gridded areas numbered 1-11) (Länsstyrelsen Skåne, 2022).

The shaded "Legal protected areas" along the Swedish coast stem from the Swedish designation of protected areas in the sea off the municipal coasts. The County Administrative Board is the authority, but they rarely say no to municipal proposals.

Together, these protected sites now cover almost 33% of the Öresund area.

Cooperation around Öresund

Copenhagen and later Malmö and Elsinore, all of which were protected by castles.

Öresund is an international strait and the Danish-Swedish agreement from 1979 on territorial waters means that there is open sea immediately north and south of the strait. [1]

In terms of hydraulics, Öresund is one of the connections between the Baltic Sea and the Kattegat. As water flows into to the Baltic Sea from the countries that border it, there is a net exchange of water, leading to a northward flow in the strait approx. 60% of the time.

The current follows the tide, and in Öresund the saltier water from the north meets the fresher water from the south.

There is a threshold between Copenhagen and Malmö (the Drogden-Limhamn threshold) that limits the flow of water, like it

[1] Under the 1999 Access regime, a formation of more than three warships flying the same flag must notify transit through diplomatic channels, submarines must sail on the surface, and all warships must fly the flag of a nation or a navy. Source: Öresund | lex.dk - Den Store Danske

is limited by narrow passage between Elsinore and Helsingborg as well.

Figure 4. Delimitation of Öresund

In recent times, various collaborations have been established across the Öresund, including the Öresund Commission and the Öresund Committee.

The Öresund Commission and Öresund Water Cooperation

The Öresund Commission was set up following a Swedish-Danish governmental agreement in 1974. The agreement required, among other things, that as a minimum, biological treatment be carried out in municipal wastewater treatment plants, and the Commission's task was to oversee these commitments and coordinate research and monitoring activities on the water quality in the Öresund. The Commission was abolished in 1992 and was succeeded by the Öresund Öresund Water Cooperation, a cooperation agreement between the Danish and Swedish municipalities surrounding the Öresund and the County Administrative Board of Skåne. The agreement was signed in 1995 and the aim of the cooperation was to promote a good aquatic environment in the Öresund. At the regional level, the cooperation is a continuation of the Danish-Swedish cooperation, which has existed for over 50 years.

The Öresund Committee

The Öresund Committee was an inter-political organisation for cooperation between politicians from Zealand and Skåne. Established in 1993, the Öresund Committee worked, among other things, to remove border barriers and to strengthen development in the Öresund region. Some of the Öresund Committee's focus areas included infrastructure, culture, and citizen involvement. As of 1 January 2016, the Committee became the Greater Copenhagen & Skåne Committee.

Greater Copenhagen & Skåne Committee

The political cooperation platform Greater Copenhagen & Skåne Committee was established by the municipalities and regions in Skåne and eastern Denmark. Across the 85 municipalities and 4 regions, it works for a committed and action-oriented cooperation to boost growth and create new jobs for the benefit of businesses and citizens.

Cooperation on the Öresund bridge

The construction of both the Great Belt Bridge and the bridge across the Öresund Strait gave rise to major environmental concerns. A so-called net zero solution was required from an environmental perspective, which was successfully achieved for both of the major construction projects.

The environmental authorities were particularly concerned that the extensive excavation and loss of bottom material could lead to permanent damage to the seabed. For this reason, it was required that no more than five percent of the excavated bottom material be spilled into the sea when constructing the Öresund Bridge. This requirement of a maximum of five percent

spillage was respected and the damage to the seabed was small and short-lived. This was continuously documented by monitoring eelgrass and mussels, among other things. It was a solution and methodology that was developed for this purpose, but subsequently successfully exported to other parts of the world.

Monitoring showed that, after a slight decline, all stocks had recovered by the time the bridge opened. Birdlife trends were also monitored. During the construction period, there was one case of a slight decline in the population of breeding eiders on the island of Saltholm, which returned to normal after the Öresund Bridge was completed (Reference 7).

From political visions to joint action throughout the Öresund region

With the establishment of the Greater Copenhagen & Skåne Committee in 2016, the focus became cooperation across the Öresund, especially on growth opportunities and job creation.

With the adoption of the Green Charter by Greater Copenhagen in 2020, the focus also experienced a technical shift. The Charter is the basis for local action on global challenges. It sets the common policy direction and enables Greater Copenhagen's 85 municipalities and 4 regions in Southern Sweden and Eastern Denmark to pursue common interests, contribute locally to the green transformation and take advantage of the coming years' billion-euro green investments to boost growth and job creation. The Green Charter has four thematic areas, including a climate resilient Greater Copenhagen.

As a concrete implementation, a Memorandum of Understanding (MoU) for Climate Adaptation was established in 2021 and signed by a total of twelve key actors on both sides of Öresund in 2021, with three additional parties joining the following year.

Sweden Water Research and the Danish Climate Adaptation Network (DNNK) were - together with Greater Copenhagen - the initiators of this strategic initiative. A steering group with representatives of the co-signatories has met regularly since its establishment to support the work.

Based on the ambitions of this Memorandum of Understanding for Climate Adaptation, and of the partners behind it, a pre-project was established and run by Sweden Water Research and the Danish Climate Adaptation Network with support from Interreg ÖKS.

Basis for future cooperation

Our analysis points to a solid foundation for cooperation across the Öresund. This foundation is based on the fact;

- that Denmark and Sweden share a marine environment which is both a recipient and an important ecosystem with rich ecosystem services, including recreational functions
- that the climate adaptation challenges are very similar in Denmark and southern Sweden
- that municipalities and utilities around Öresund will have to spend large sums on both climate adaptation and protection of the marine environment
- that there are strong research communities around Öresund
- that there are large municipalities and utilities around Öresund, who can both support the cooperation, but are also potential end-users with a high purchasing power
- that there are already institutions that are professional 'lighthouses' in their field with significant capacities that can be built upon
- that a tradition of systematic sharing of technical knowledge and data across the Öresund is missing and needed.

This analysis has led to the identification of specific challenges and potential areas of collaboration in the Öresund region, which are described in the next chapter.

The most important future collaboration areas

This White Paper does not present an exhaustive and complete coverage of all relevant issues but is instead an exploration of the most obvious opportunities for establishing concrete collaborations across the Öresund today.

They are the result of a joint analysis co-produced with stakeholders and based on the needs and planning perspectives of utilities and municipalities, since these are the stakeholders responsible for carrying out the large societal investments in climate adaptation.

This focus is naturally of a practical nature, but in the analysis process certain themes of a more 'philosophical' nature have emerged as well. These have also been included as they bring about a better understanding of the bigger picture, when talking about the very important societal challenge that is climate adaptation.

The following are identified as the most important challenges and opportunities.

Analysis of the green growth potential

Municipalities and utility companies in Denmark and Sweden need to spend at least €10 billion on climate adaptation in the Öresund area alone over the next 30 years. This amount could end up being higher or lower, depending on many different factors. But one thing for certain is that the overall investment needs in terms of climate adaptation in our society are very large.

The figure is calculated by examining the expected costs in Denmark, where the municipalities draw up wastewater plans, which provide a sound basis for prioritizing and planning, what the supplies should budget for.

Figures have been obtained from utility companies along the Öresund, with a population of just over 1.2 million. If this figure is compared to the total population of Greater Copenhagen's Danish part, which is 2.7 million inhabitants (Capital Region and Zealand), the investment amount would be DKK 59 billion - or € 8 billion - for the next 30 years in Greater Copenhagen's Danish part. The figures are calculated for the upgrading of the existing drainage system to meet the climate of the future over a period of 30 years, so that environmental requirements and service targets can be met.

Protection against seawater is a municipal task, and one that has not yet been planned to a degree that would allow for a reasonable estimate of the expected costs. The cost of protection against sea water is therefore not included in the estimate.

Sweden lacks a corresponding analysis and the National Expert Council for Climate Adaptation 2022 (Reference 8) states that there are currently no prerequisites for a traditional cost-benefit analysis of climate adaptation measures on national level. Furthermore, comprehensive analyses of the costs and benefits of climate adaptation need to be carried out where possible, by calculating the socio-economic profitability of measures in different sectors. Analyses should consider how synergies as well as conflicting objectives affect costs and benefits, and also address damages and losses that are difficult to cost out. Furthermore, monitorable indicators to assess both the development of risks and the effects of measures need to be developed.

A general estimate for Sweden was presented in 2016 as part of the Climate Adaptation Report (Reference 9). The work consisted of a survey of Sweden's municipalities, both on their level of risk in relation to climate change and on whether they have made cost estimates for climate adaptation measures (flooding, landslides and erosion).

The total cost of implementing climate adaptation measures in Sweden as a result of a changing climate has been estimated at SEK 137-205 billion. The largest cost item is adoption costs for flooding, primarily flooding from the sea and torrential rainfall.

Measures to protect against 100-year events have been the reference point for the cost calculations. The cost of climate adaptation measures is highest in Svealand (SEK 88-131 billion) followed by Götaland (SEK 47-71 billion) and lowest in Norrland (SEK 2-3 billion).

Götaland has 4.8 million inhabitants and Region Skåne and Halland have 1.74 million inhabitants, which corresponds to 36% or expenditure of SEK 17-26 billion by 2100.

This is equivalent to €1.5 - 2.3 billion - over an 80-year period. To summarise, the effects of flooding due to rainfall in urban areas or the combined effects of rain and sea are not taken into account in the above.

The figures are likely to be underestimated, as these are 2016 prices and prices have generally increased significantly since then. Also, these figures are for utilities only, i.e. for adaptation to rainwater.

Overall, the large investment needs raise at least three issues that need further work. Firstly, how we collaborate on the use of a labour market with limited capacity; secondly, how the large investments can contribute to solving other societal problems such as health and loneliness; and finally, how to utilise the potential for green growth through the export of our solutions.

Working with all the city's elements

The analysis has made clear that Denmark and Sweden share similar challenges, particularly in their cities.

As cities grow, so does the amount of built-up land and the pressure on urban functions and infrastructure - the challenges of finding space for water are only increasing.

An important way forward is to use all the elements of the city creatively and activate private investment and ownership for climate adaptation. Only around 20-25% of the city's land is available for public climate adaptation - the rest is privately owned - and urban development is creating fierce competition over how land should be used. We also know that the cost of managing water is much lower if it is managed before it runs off onto public roads, land and into the drainage system.

Both countries have also turned their attention to blue-green solutions and how their impact can be quantified and integrated into modelling and planning of the overall drainage system. And both countries have fine examples of how to equip the city to hold water like a sponge, the Sponge City thinking, which can be complemented by a Sponge House thinking. Some of the elements are shown in the sketch on the next page, which is a cross-section of the dense city, that is, cities where there is no outdoor space of significance to individual houses.

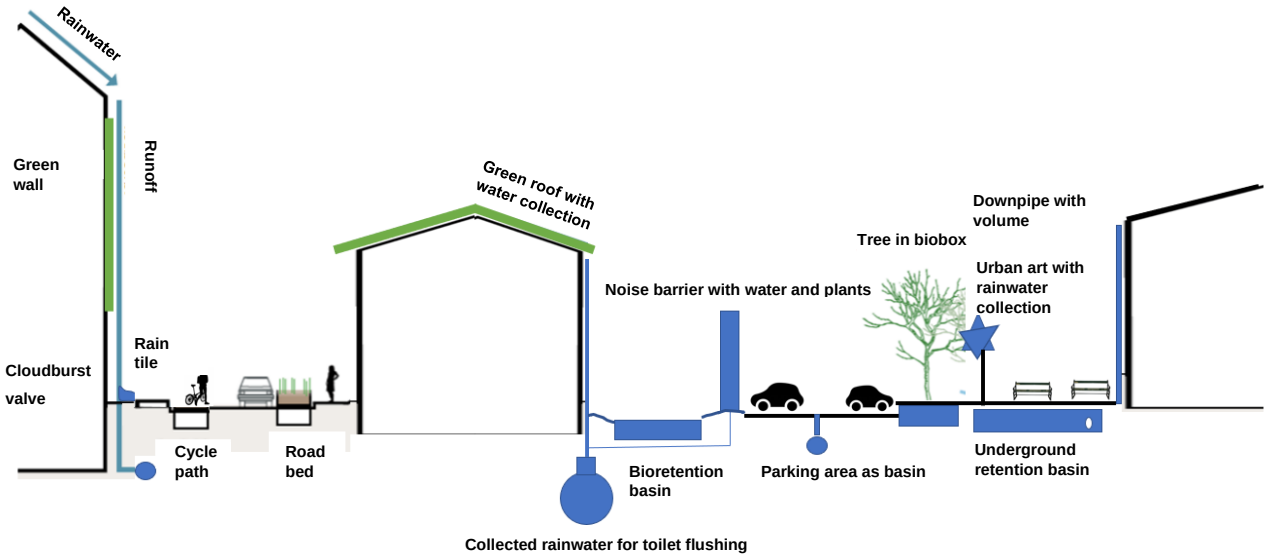

Figure 5. Urban elements that can retain/delay rainwater

Figure 5 shows that there are many elements in the dense city that can help to slow down rainwater flow, thereby creating better conditions for wastewater treatment plants to reduce overflows. These include solutions at the level of private landowners and solutions in the public realm.

The work has also shown that both countries are focused on how polluted surface water running on city surfaces can be managed.

A systematic compilation of the hydraulic effects of the use of urban elements is needed. What do they cost to construct and operate, and what level of protection do they provide? In addition to knowledge of the technical solutions, there is also a need to see them in a systemic context and to define the organisational and economic framework for their implementation and operation.

Finally, we must use all elements of the city with a focus on extending the life of existing infrastructure and minimising the need for new or expanded facilities with large carbon footprints.

Living Lab for Climate Adaption

Climate adaptation is a complex challenge, which can sometimes even have the character of a so-called 'wicked problem'. That is, a problem that is difficult or almost impossible to solve due to incomplete, conflicting and changing requirements.

One approach to tackling such a challenge is to support and develop common understandings, approaches, and collaborations among existing capacities within a defined geography that cover the issues in question. This is precisely the idea of a 'Living Lab' - a coordinated and geographically defined collaboration between independent actors who want to jointly solve a problem that is too complex and resource-intensive for them to tackle individually.

A living lab brings together and creates coherence across the strengths and capacities that exist within the overall problem area, which is the focus of the living lab. It can be specific institutions that provide, for example, demonstration and testing of solutions or exemplary high-level training and dissemination.

They could also be *demonstration sites*, which are exemplary full-scale solutions, whose design and operation are communicated to visiting citizens and/or professionals. They might also be used for testing new technologies and continuous monitoring, providing data to support evidence of their impact or for research and development activities.

In Greater Copenhagen, and especially around Öresund, there are already significant professional capacities, or 'lighthouses', and many potential demonstration sites on which a living lab community in climate adaptation can build upon and further develop.

Figure 6 Examples of existing living lab activities within climate adaptation on both sides of Öresund.

Figure 6 illustrates examples of existing capacities on both sides of Öresund which, among other things, support the development of children's and young people's green competencies, which - together with the training of future green employees more broadly - is one of several essential dimensions that a living lab collaboration within climate adaptation should focus on.

"Young people understand the need for change. What they need is also to know how to do the change. Education should provide them with methods and solutions that work, and with the drive and hope to be innovative for the future"

-Sophie Hæstorp Andersen

Other essential dimensions that a living lab community can focus on are data sharing, governance, new business models, co-creation, showcasing etc.

This section does not present an exhaustive and complete coverage of all relevant topics and issues that can be worked on within the framework of a living lab community but presents some of the most obvious opportunities for establishing concrete collaborations across Öresund today.

The next two topics are examples of issues - ranging from something relatively practical to something more systems-theoretical - that have emerged in the analysis. They are included here to show the range of types of issues that could be dealt with in a living lab.

Use and sharing of data

Stakeholders in the complex work of climate adaptation have expressed the need to be able to share and collaborate on data that provide common pictures of the challenges we face in our shared border region. These include radar-based data for warning, monitoring, and managing extreme precipitation.

Specifically, three tracks emerge that digitisation can readily support in relation to climate adaptation efforts:

- Collecting and utilising radar data
- Monitoring of solutions in the dense city
- The link to and between sensors that can provide relevant data online

But it is important to keep in mind that the value creation is not in the sensors, transmission technology or data management/analysis per se, but in what the data is used for, as illustrated in Figure 7.

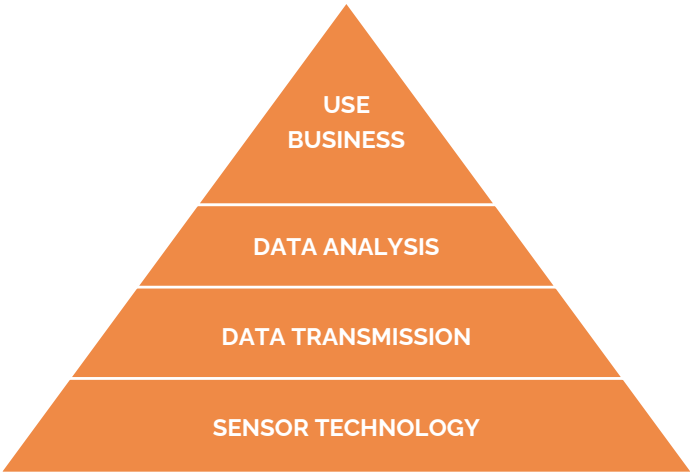

Figure 7. Digitalisation – values is created at the top of the triangle

Planning for an uncertain future

Climate adaptation planning involves the need to plan for actual or expected climate changes and its impacts, while also managing uncertainty. Planning is rooted in uncertainty, and thus this is something that planners deal with on a regular basis. However, the types and complexity of uncertainty associated with climate change require planners to rethink their approaches. Scenario planning, adaptive management, monitoring, and incremental and robust approaches are just some of the tools needed to manage climate adaptation.

In addition, planners need help with presenting the problems of climate change in a way that minimises the aspects of political conflicts in the climate debate. At the same time, support is needed for managing a potentially endless discussion of uncertainty, which can be done by applying uncertainty-reducing techniques and moving to an iterative problem-solving process that aids practical action and capacity building for climate adaptation.

With this approach, we need to develop a planning methodology for ongoing climate adaptation that includes different scenarios for the climate, urban development, and possible consequences/damage costs thereof, as illustrated in figure 8.

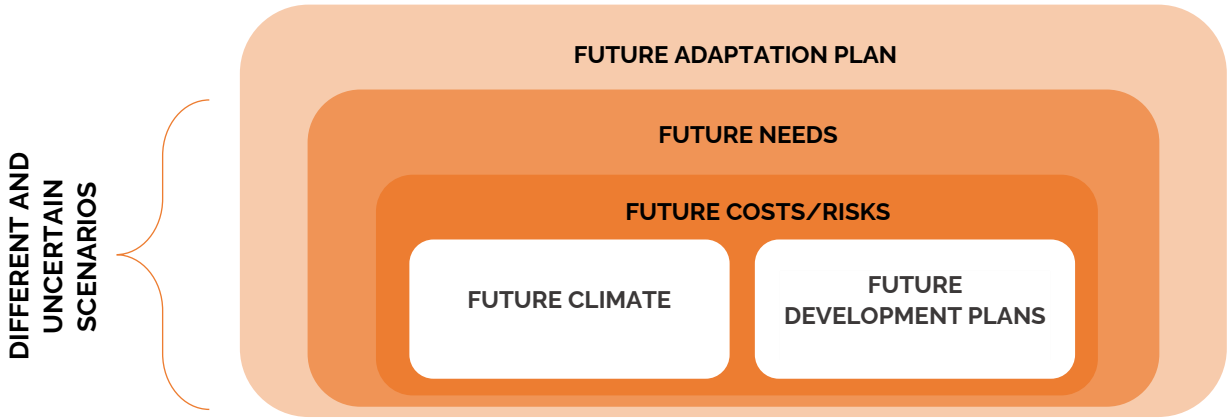

Figure 8. Planning for an uncertain future

Model for cross-border/transnational cooperation

It is important to be able to cooperate on common challenges across regional as well as national borders, especially in a geographical area that shares an aquatic environment or a vulnerable water body such as the Öresund Strait.

The experience gained from the work of creating the basis for, and subsequently implementing, this analysis, outlines a generalisable model for border-regional cooperation. The project is based on a cooperation model, in which cooperation is developed through three conceptual tools.

The three conceptual tools shown in figure 9 are described on the right.

- a Green Charter that provides the basis for local action on global challenges by setting the common policy direction for the area
- a concrete expression of interests in a Memorandum of Understanding, which binds key actors more closely together in a concretization of specific areas of cooperation
- based on the ambitions of a Memorandum of Understanding and the stakeholders behind it, concrete cooperation projects are established that create synergies between the stakeholders' existing or planned activities and the development of their strategies and solutions

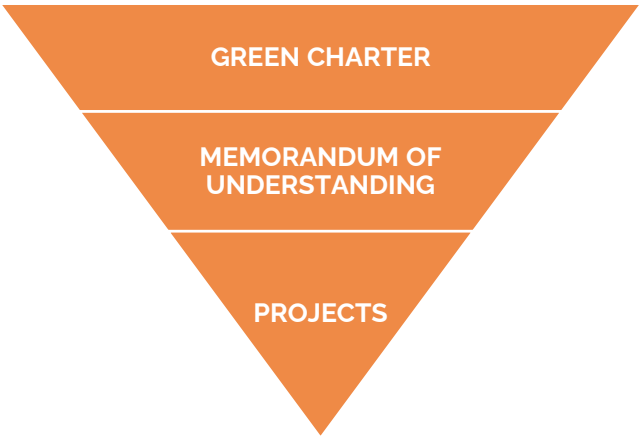

Figure 9. Conceptual tools in cross-border cooperation

Such a model, as shown above, would potentially also be of interest in the rest of the world, where in many places there is a need to be able to cooperate across a river basin or a shared catchment area.

By developing, describing and testing the experiences of other cross-regional collaborations, there is a potential for developing a model that can position Greater Copenhagen as a global exemplar for cross-sectoral water cooperation and resulting green growth opportunities. Below, the model and the work of this project, is compared to the five steps of cross-border regional added value used by Interreg ÖKS.

The establishment of a Green Charter brought the parties together - corresponding to step 1 - with a focus on contributing to the Charter - step 2, (this work stretched from June 2019 to January 2020).

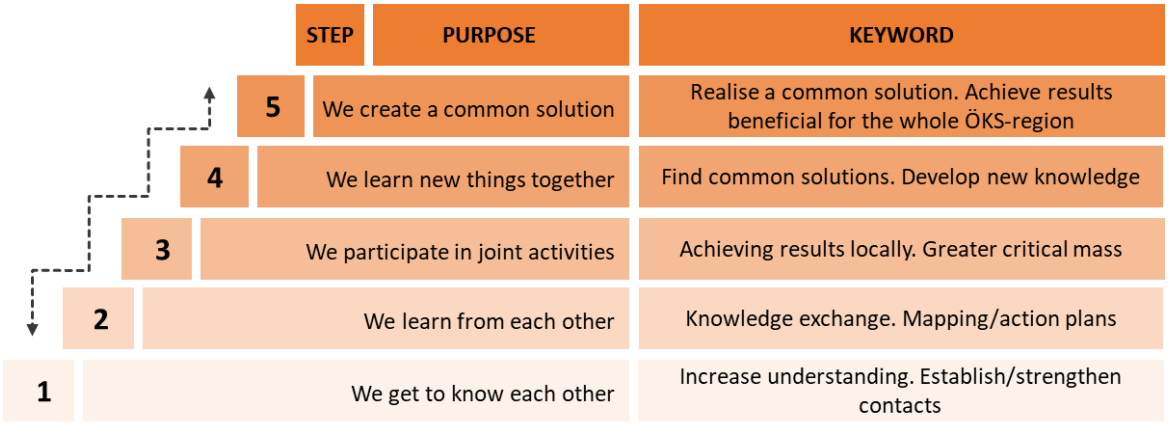

Figure 10. The 5 steps of cooperation with cross-border regional added value from Interreg ÖKS

More stakeholders were then involved in the establishment of a Memorandum of Understanding, which had twelve stakeholders in the beginning, increasing to 15 as of mid-2022, in a process proceeding from spring 2020 to the end of 2020/2021. See Figure 11. This corresponds to stage 3. In parallel to this, partners worked together to establish the first (pre-)project cooperation in spring 2021, which is this bridging project (step 4). The last step in the process is the assembly of a real project coalition among the partners in the Memorandum of Understanding that can realise common and scalable solutions (step 5).

Figure 11. The current partners in the Memorandum of Understanding for Climate Adaption

Postscript

To complement the cooperation model, a mechanism is needed to support effective cooperation, coordination and communication between the different actors and technical lighthouses, as described in section 2.3

We will use this mechanism to work better together across the Öresund - in a common living lab for climate adaptation that supports all the different types of professional collaboration around the complex issues we face.

Co-creation as a working method

This is our methodology section, where we briefly explain how we conducted the analysis while advocating for our methodology as a good approach to co-creating a shared analysis across many stakeholders in a complex problem area.

The analysis in this White Paper is a concentrated presentation of the outcome of a longer process. The aim of the analysis has been to gather knowledge among key stakeholders on the main challenges and potential for the development of a targeted flagship project, with potential themes that could form the basis for cross-border regional cooperation.

The White Paper is therefore aimed at interested parties who want to use it as a starting point for building larger (project) collaborations to solve complex climate adaptation problems in and around the strait. Finally, it is aimed at a wider audience interested in climate change adaptation with an Öresund-oriented perspective.

The starting point for the analysis is the common understanding across all Greater Copenhagen municipalities and regions, initially established with the Green Charter and later further specified with a Memorandum of Understanding (MoU). The MoU brings together the stakeholders behind the Green Charter, who are particularly interested in building cross-community collaborations that can lift the joint effort to create a climate-resilient Greater Copenhagen.

The production of the analysis itself is therefore also an integral part of, and the penultimate step in a working process, with the ultimate goal to establish the concrete collaborations that translate the shared policy objectives into concrete and value-adding actions.

Overall, it represents a methodological approach, constantly focusing on what can be agreed upon and at a pace where everyone can keep up.

The focus moves from overall political ambitions (Green Charter), which can be supported by a more committed group of actors in a Memorandum of Understanding - to the establishment and implementation of concrete cooperation projects.

It is a dialogue-based and iterative process method, initiated by a cooperative circle of actors, who are steadily working on the development of a border-regional/transnational cooperation, and have themselves used the method while it was being developed.

Throughout this process, the White Paper, and its presentation of both findings and methodology, has been informed by discussions at conferences, workshops and dialogue meetings with participants from both sides of the strait, including decision-makers, specialists and experts from municipalities, utility companies, knowledge institutions and businesses.

At the same time, we have sought insight into - and dialogue with - other existing or future projects with a related focus.

Thanks

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