



# Adaptation approaches in Danish municipalities' climate action plans



**CONCITO**

DENMARK'S GREEN THINK TANK

**Realdania**

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## Report

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# Preface

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The world is changing at an ever-increasing pace. Extreme weather events - a consequence of global climate change - are happening more often, and dry spells, intense rainfall and storm surges have had severe impacts in various parts of Denmark in recent years. Climate science tells us to brace ourselves for more and harder impacts in the future.

Denmark, along with many other countries, has been built over many years with a stable climate. Now the climate is changing, and we, as a society, must adapt to the new reality. This report looks at how Danish municipalities are working on climate adaptation.

Realdania works to improve quality of life and benefit the common good by improving the built environment. Achieving this vision requires consideration of how climate change is redefining the rules of the game. We need to develop the sustainable cities and communities of the future by reducing our greenhouse gas emissions and adapting society to climate change. We can only achieve this by thinking holistically and building future cities and communities where citizens and residents thrive.

For a number of years now, Realdania has helped municipalities to plan future sustainable communities and adapt to climate change. This has been through the DK2020 partnership project, for example. The DK2020 project is being funded by Realdania, which, since 2013, has been partnering with C40 Cities to help the world's cities develop and implement ambitious climate action plans. Furthermore, the project has a strong Danish knowledge partner in the Danish think tank CONCITO.

Through DK2020, Danish municipalities have obtained guidance and collaborated on developing local climate action plans that meet the targets in the Paris Agreement. By the end of 2023, almost all Danish municipalities will have prepared climate action plans that meet these targets.

This report reviews municipalities' work on climate adaptation in the DK2020 project. The report looks at the knowledge base municipalities have relied on, and at the targets and actions they have set to adapt to the climate of the future, as well as how their climate adaptation actions can benefit everyone.

The report was prepared by CONCITO and includes recommendations from CONCITO for how climate action planning can be improved across administrative levels in Denmark to bring Denmark closer to climate resilience.

I hope that the report will inspire reflection on our joint task to adapt the Denmark of today to the climate of tomorrow, and I would like to thank the municipalities and experts involved in the project, and not least CONCITO for preparing this report.

**Jesper Nygård**  
CEO, Realdania

# Summary

The ultimate goal of climate adaption is a climate resilient society. This can be achieved by reducing greenhouse gas emissions to halt developments towards uncontrolled climate change, and by implementing practices and policies that develop a more resilient response to climate change and extreme weather. According to the UN Intergovernmental Panel on Climate Change (IPCC, 2022), climate resilience is a society's ability to live with and adapt to the changes and uncertainties that the future brings. This requires a systemic change throughout society, and the change starts with strategic climate action planning across sectors and climate impacts. Local government plays an important role in delivering this change.

The purpose of this report is to provide an overview of the climate adaption action of Danish municipalities and to assess the potential for future improvements to take us closer to a climate resilient future. The report reviews the municipalities' work on climate change adaptation in the DK2020 project<sup>1</sup> and builds on a document analysis of the climate action plans of 96 Danish municipalities, and on the background documents behind DK2020-certification of the municipalities by CONCITO and C40 Cities.

Note that municipalities may have practices and actions that are not reflected in this report because the report was developed on the basis of the documentation provided by the municipalities when they developed their climate action plans. In early 2024, the report was updated to include plans from the remaining six DK2020 municipalities, which was approved at the end of 2023.

<sup>1</sup> DK2020 is a partnership between Local Government Denmark, the five Danish regions and Realdania. CONCITO serves as the project manager and a knowledge partner in the project. C40 Cities, a network of the world's largest and most climate-ambitious cities, is also a knowledge partner in the project.

## Key messages

1. DK2020 has engaged almost all Danish municipalities, from larger cities to smaller urban and island communities. Through DK2020, the municipalities have achieved a more accurate risk assessment in relation to climate change, and they have adopted measures that can ease the consequences of climate change and set goals for a more climate-resilient municipality and society.
2. Extreme weather events such as floods, extreme precipitation, heat waves and droughts increase the municipalities' attention to the need for climate change adaptation. Based on the systemic holistic thinking that is the focal point for the municipalities' DK2020 plans, the risk of both the current and future climate impacts can be addressed in a timely manner.
3. It is important that the climate action plans are continuously revised, and the measures reassessed, so that they can be adjusted in case of new knowledge, new financing opportunities or changes in the political support. There is a need for a comprehensive capacity building, including stronger interaction between research and practice, to support the society's transition to a climate in constant change.



## Overall conclusions

In the DK2020 project, Danish municipalities have developed climate action plans to set strategic goals for climate resilience across sectors and within the geographical boundaries of the municipality. The local knowledge held by municipalities is an important linchpin coupling their climate actions to targets within other municipal governance areas, so that the transition can be understood holistically and in consultation with relevant stakeholders.

Successful climate action requires implementation of actions on an informed basis and aligned with the municipality's existing development strategies and policy agendas. To ensure support, thorough stakeholder engagement and dialogue with affected stakeholders are essential.

The most important conclusions from the report are listed below.

### ***A total of 96 municipalities have developed climate action plans aligned with targets in the Paris Agreement***

Through a voluntary project, Danish municipalities have demonstrated that they are taking climate change seriously. They have done so by adopting climate action plans aiming at emissions neutrality and climate resilience. Through DK2020, a professional network has been established, along with an emerging common language, and this has strengthened the quality of climate adaptation in the climate action plans of Danish municipalities. Political courage at local level and highly dedicated local government officials have impelled a total of 96 municipalities to develop climate action plans aligned with the targets in the Paris Agreement.

### ***Difficult to translate 'climate resilience' into concrete targets***

The pathway to climate resilience should be reflected in municipalities' targets and actions. However, not all municipalities set concrete targets. Some set clear, quantitative goals and deadlines for their actions, while others describe more general intentions. Many municipalities describe an understanding that a goal of climate resilience cannot be defined as final goals, but rather as a continuous process requiring flexible decisions and continuous adjustment of targets and actions. Generally, the concept of climate resilience seems to be difficult to apply in practice.

### ***Follow-up, implementation and impact evaluation could be improved***

As part of their plans, municipalities have described plans for follow-up, and more than 80% have established procedures for revising plans and monitoring actions. However, there is still a need for systematic collection of data on selected indicators, as only around one-third of municipalities use indicators to indicate progress in implementing their climate action plans.

### ***Municipalities are including more climate hazards in their climate hazard assessments than in previous climate adaptation plans***

The climate hazard assessments of municipalities are broader in scope and build further on their existing knowledge basis, including climate adaptation plans, risk management plans and local development plans. The former mandatory municipal climate adaptation plans from 2013-2015 only had to contain a risk assessment for flooding from rainfall, sea level, watercourses and near-surface groundwater. A majority of DK2020 municipalities (80%) now apply a broader approach in their plans, in that they also include warm spells and heatwaves.

The analysis also reveals a correlation between municipalities who report they have experienced extreme-weather impacts from cloudbursts, watercourse flooding, storm surges, heatwaves and drought, and municipalities who include these climate hazards in their risk assessment.

### ***The approach by municipalities to value-at-risk assessment and overall impact assessment differs considerably***

Municipalities have freedom of methodology when developing their DK2020 plans. Their choice of method depends on locally embedded knowledge, experience from past events and the use of publicly available data and tools. The differences in methodological approach mean there is great variation in the actual content in climate impact assessments of how the climate impacts municipalities' vulnerable systems, assets and groups. Municipalities use monetary valuation for flood events more than for other climate risks. They often focus on buildings and critical infrastructure but have difficulties determining the monetary value of cultural and natural assets, and these are therefore often omitted from calculations.

### ***Municipalities' plans vary in format, scope and in their description of concrete action***

Municipalities tend to develop stronger climate action plans when they can find inspiration from the work of other municipalities. This became evident during the DK2020 project as the experience of other municipalities and their approved plans became available to those still in the process of developing their plans. Furthermore, municipalities develop stronger plans when they have previous experience from developing risk management plans and/or have previously participated in climate adaptation development projects. As with risk assessments, municipalities with previous experience with local climate-induced events have more actions aimed at preventing similar events in the future. Municipalities' climate action plans primarily include actions aimed at flooding and they have less focus on dry spells, heatwaves and drought.

The plans primarily focus on measures and construction projects related to rainfall and sea level flooding. Municipalities have fewer construction projects, master plans and sketch projects, etc. related to high groundwater levels, heatwave and drought in particular. There is also a general trend that municipalities need to prepare multiple analyses and pre-analyses as part of their planned work on climate adaptation, and this suggests that municipalities recognise the need to continuously learn more about how to concretise actions and how to apply new knowledge.

Municipalities make use of different climate adaptation approaches but not all of them indicate what approaches and strategies they use. Although 16% of municipalities refer to the Dynamic Adaptive Policy Pathways (DAPP) method to some extent. This does not mean that other municipalities have not applied other, similar methods, approaches and strategies, it is just not clear from the material we reviewed, particularly with regard to seawater actions.

### ***Climate change adaptation should be considered in the context of the place and the people affected by climate change***

The extent to which municipalities engage citizens and how they approach stakeholder engagement differ. Municipalities make use of various engagement approaches in their internal as well

as their external stakeholder engagement, for example hearings, citizens' meetings, information material, workshops as well as digital platforms, apps and climate ambassadors. Internally in municipalities, developing the plans involve in particular administrations responsible for technical/environmental works and for planning, as well as emergency response and preparedness. Externally, work on the plans involves in particular utility companies, citizens, neighbouring municipalities and community councils. These stakeholder engagement activities have mainly taken place in connection with planning and project work prior to, and as the basis for, the DK2020 plan.

Some climate change actions cut across municipal boundaries or can potentially be incorporated with other projects by other municipalities. One third of the plans involve neighbouring municipalities in planning work. Municipalities that also develop risk management plans pursuant to the EU Floods Directive more commonly than other municipalities involve their neighbouring municipalities in actions targeting coastal areas. This also applies to municipalities that have participated in development projects, and river basin projects in particular.

### ***Climate change adaptation should be better integrated with other municipal work and ensure benefits locally***

Municipalities highlight the benefits of climate change adaptation at various levels in order to incorporate climate change adaptation in municipal agendas. In identification of benefits, most municipalities highlight the benefits of adaptation action for nature and biodiversity, as well as for leisure and recreation. Less than half of municipalities highlight health and synergies with greenhouse gas emission reductions, and even fewer municipalities highlight business development, tourism, security and other agendas.

A majority of municipalities refer to their municipal development plans, wastewater management plans, emergency response plans and previous climate adaptation plans. Referring to other municipal sector plans is less common among the municipalities, as is referring to their planning strategy for the wider local government policy agenda.

### ***Municipalities have taken the first important steps towards adaption to a future climate***

It is not possible to combine the climate change adaptation measures of all municipalities in the same way as their emissions reduction targets can be combined to provide a total figure to measure progress towards climate resilience to extreme weather and other climate changes.

This makes it difficult to assess whether relevant challenges are being overlooked in the municipalities' climate action plans, and to determine how the municipalities assess whether their climate action is enough to ensure climate resilience.

Overall, there is still a need for new knowledge and broad expert involvement to describe the real challenges facing municipalities, and to develop specific solutions. Therefore, CONCITO has prepared a number of recommendations to address the challenges identified in this report.

## **Recommendations**

The climate change adaption outlined in the climate action plans of Danish municipalities shows that municipalities have taken the first important steps to assess their local risk profile and to identify the actions needed to become more climate resilient. However, there is still a need for uniform approaches and methods in climate change adaptation planning, as well as a clear and common language for this.

Without a common language and uniform methods, it is difficult to assess whether the combined plans and actions of all municipalities are enough to ensure the climate resilient society we are striving for. Establishing a better foundation is no simple task. For this reason, CONCITO has prepared a number of recommendations to bring Denmark closer to climate resilience.

The recommendations in this section are based on results from the analysis, as well as on interviews and outcomes from workshops with municipalities and experts. Finally, they are based on CONCITO's expert knowledge from the DK2020 project. Among other things, the recommendations draw on a report by CONCITO from 2017 on

[resilience in the climate change adaptation plans of municipalities](#). The report included 16 recommendations, all of which, unfortunately, remain relevant today to some degree or other.

The recommendations in this report cover climate change adaptation action broadly, from planning to implementation, including evaluation on progress and impacts. The target group includes central, local and regional governments, as well as knowledge institutions, researchers, consultants, etc. The recommendations have been divided according to the overall topics of the analysis.

### **The pathway to climate resilient municipalities**

We need clear directions for how to become a climate resilient society. A common language is needed, along with clear and unambiguous framework conditions and an efficient system to drive implementation and progress.

CONCITO recommends that:

- **A common language and a positive vision for a climate resilient society needs to be created**

The term 'climate resilience' can be a positive term for our common future and the transformation needed for society. Clear objectives for how society should manage the consequences of climate change can support this transformation. A common picture of the future can also be a guide for politicians when making difficult, long-term decisions, whether at local, regional or central government level.

Therefore, the Climate Alliance,<sup>2</sup> in cooperation with relevant stakeholders, should work with central government to establish a common language and goals for Danish efforts to increase the climate resilience of all parts of society across sectors.

- **Central government need to set the overall and long-term strategic framework for Danish climate change adaptation action across sectors**  
Climate change adaptation should be a

<sup>2</sup> The Climate Alliance is the continuation of the DK2020 project. The focus of the Climate Alliance is on implementation of, and follow-up on, climate action plans.

high-priority item on the agenda across policy areas, as climate change will affect all of society's functions, identity and structures. This can be achieved through broader integration of climate change adaptation into policies and legislation. Denmark could benefit from looking at the most [recent guidelines from the European Commission](#). These include clear recommendations for how Member States can develop strategic plans and set goals for all sectors, monitor continuously and evaluate actions. Central government should ensure greater coordination between ministries<sup>3</sup> to ensure a more accurate risk profile across sectors and at the same time be able to manage conflicting concerns in legislation and regulations. This applies in particular for holistic actions aimed at Danish coasts and river basins.

- **The plans of municipalities should be monitored closely and continuously to ensure progress in implementation and revision of targets** Municipalities should prioritise monitoring developments to ensure continuous progress towards meeting their goals for climate change adaptation. Goals can be made more measurable so that clear indicators can be set up. There is potential in establishing a common monitoring system<sup>4</sup> to support local decision-makers and monitor overall developments across all municipalities. Such a system should also contribute to competence building in municipalities and to improving municipalities' own monitoring efforts to help them demonstrate that they are reducing risks in the municipality. Inspiration should be drawn from international experience and there should be systematic knowledge generation and knowledge sharing between actors and countries.

### Holistic climate risk assessments

There is a need to understand the complexity of the effects of climate change. We need to develop our methods so that risk assessments take account of this complexity.

CONCITO recommends that:

- **Methods should be developed to assess consequences for vulnerable systems across sectors** Decisions regarding climate change adaptation action must be supported by reliable data and up-to-date research. Relevant central government authorities, including within transport, building and construction, agriculture and health, should collaborate with researchers and knowledge institutions to help identify particularly vulnerable systems in need of adaptation. This knowledge should be targeted at municipal stakeholders to inform their planning of the society of the future. Moreover, it is important that tools to assess flood risks are based not only on monetary values. Understanding of vulnerability should be broader, so that natural and cultural assets and health consequences, for example, are included in analyses more consistently.
- **More knowledge needs to be acquired about risks and the consequences of drought, warm spells and heatwaves** Climate research within these areas and in a Danish context should be strengthened considerably. Central government and other public authorities and institutions should prioritise monitoring and researching all relevant climate risks, including the effect of rising temperatures on the aquatic environment and the effect of warm spells and heatwaves on vulnerable population groups. These efforts should take place continuously as we experience more frequent climate events and as climate science provides us with better projections and knowledge about consequences for systems and sectors in society. Experience with risk assessment of drought, warm spells and heatwaves, in particular, must be collected and made available to municipalities.
- **A better understanding of the consequences of extreme and compound flood events needs to be gained** Compound weather events are not represented in central government tools

<sup>3</sup> The government's proposal for [Climate Change Adaptation Plan 1](#) from 23 October 2023 proposes setting up an inter-ministerial committee of civil servants, the aim of which includes managing conflicting concerns.

<sup>4</sup> A common monitoring system developed through the Climate Alliance (a continuation of the DK2020 project) focussing on implementation and development. CONCITO is a knowledge partner in development of the system.



and data today. This makes it difficult for municipalities to include such events in their assessments. Extreme events that occur very rarely and compound events can cause extensive damage, even though they are not as likely to occur as a 20-year event, for example. Therefore, knowledge and tools are needed to assess the most extreme events and compound events. This will help provide municipalities with an accurate local risk profile, even if concrete actions need not necessarily be aimed at these extreme events.

- **Uncertainty and range of outcomes in climate models and calculations be integrated in decision tools, so that underlying choices and exclusions become more transparent**

There is plenty of scientific data available to decision-makers and stakeholders in Denmark. However, there are difficult (political) choices hidden away in calculation models and tools applied to make risk assessments. Decision-makers should be made more aware of the assumptions on which they base their difficult (and expensive) decisions. Competence building is therefore needed in the use of data and tools and in how to deal with uncertainties and outcome ranges in climate change scenarios, as well as how impact assessments can more systematically include impacts on the municipality's services, assets and vulnerable population groups. Furthermore, central government tools need to be better coordinated. Today, they differ too much on parameters such as climate change scenarios, time horizons, and the extent to which they show uncertainty ranges, etc.

- **Continued bridge building between science, experience and policy development needs to be ensured to create the right long-term solutions**
- There should be more systematic inclu-

sion of new knowledge and existing experience in authorities' planning efforts, and there should be closer collaboration between researchers, knowledge institutions, decision-makers and local stakeholders. There is inspiration to be gained in experience from previous development projects, including Realdania's *Byerne og det stigende havvand*, Capital Region of Denmark's *Klimatilpasnings på tværs* and Central Denmark Region's *Coast 2 Coast Climate Challenge*.

### **Ambitious risk management**

The approach to climate change adaptation action must be holistic and far-sighted to eliminate the risk of overlooking sectors and areas or choosing solutions that work today but that restrict possibilities for deploying appropriate adaptation solutions in the future. A clear and predictable financing framework is needed to accelerate implementation and deployment.

CONCITO recommends that:

- **Climate change adaptation solutions should be selected on the criterion that they do not restrict any possibility to choose an alternative strategy in the future**
- Major investments in climate change adaptation should be coupled with long-term planning of land use in areas where adaptation is needed. There should be more focus on how to apply flexible approaches to adaptation planning. National and international experience with risk management of flood events should be brought into play and made more applicable in municipal planning<sup>5</sup>. Flexible solutions should also be made more concrete with regard to other hazard than flooding, including for drought, warm spells and heatwaves. There should also be a clear indication of how to balance emergency management, protection measures and social resilience.
- **Municipalities' plans must take more account of the need for climate adaptation action within the geographical boundaries and functions of the municipality and not just with regard to areas over**

<sup>5</sup> For an example of how to strike such a balance with regard to coastal protection, see *Vejviser til helhedsorienteret risikostyring af oversvømmelse* (guide to holistic risk management of flood events by Danish Coastal Authority, 2021).

### which the municipality has authority

Most of the actions in the climate action plans of municipalities pertain to areas where the municipality has a clear ownership, authority or facilitator role. However, just as municipalities should assess their emissions reductions relative to emissions within their geographical boundaries, municipalities' climate adaptation should cover impacts and consequences for the entire municipality. Climate adaptation action by municipalities should cover a greater number of activities and should support all relevant stakeholders in the municipality, including businesses and agriculture, as these are not being addressed sufficiently in current plans.

- **Local planning needs to include stricter requirements for avoiding development and vulnerable land use in flood-prone areas**

Uniform guidelines are needed for urban development and land use change in municipalities in areas vulnerable to climate change. Guidelines should be aligned so that municipalities are not left with difficult decisions with respect to balancing business and urban development with climate adaptation considerations, as this may lead to undesirable competition between municipalities if developers are not faced with the same requirements across municipalities. Therefore, the Planning Act and planning provisions should be updated, so that the general principles for development and construction in flood-prone areas are determined at central government level. Concrete solutions and land-use decisions should still be a matter for local government, however.

- **Available financing sources should be made clearer so that projects by municipalities and other stakeholders do not run aground**

A more stable and predictable financing framework is needed for climate adaptation. The degree to which municipalities indicate specific financing sources for their climate adaptation actions differs depending on the hazard source. Municipalities was more specific with regard to rainfall management in particular. The legislation is clear in this area, in

that it places responsibility with wastewater companies and stipulates a financing model through water taxes. However, for coasts and watercourses for example, the utility principle applies, and this means that the property owners and stakeholders assessed to benefit from a solution are required to finance the solution. They can obtain co-financing from the municipality and/or central government, but these sources of co-financing are currently unclear. For example, the national one-year funding pool for coastal areas<sup>6</sup> lacks transparent allocation criteria. Central government funding for climate change adaptation could focus on innovation, so that central government funds are not spent exclusively on local problems but also contribute to overall capacity enhancement.

- **New funding opportunities, private as well as public, needs to be identified and made practicable for municipalities, citizens and other stakeholders**

The Danish financing model and incentive structure should be reviewed. Financing and insurance schemes exist, but these should be examined to determine whether they encourage or impede proactive adaptation, by citizens in particular. Furthermore, the Danish natural hazards scheme should be updated as the climate changes. For example, should the scheme, which is financed through fire insurance policies, also pay for storm surge damage in the future? This could create the wrong incentives with regard to redevelopment in particularly vulnerable areas where alternative approaches and strategies should be encouraged instead, including making changes to land use and avoiding redevelopment. Here, financing models from other countries could serve as inspiration.

### Relevant climate change adaptation for all

Climate change adaptation should be an integral part of all municipal agendas. This calls for local engagement and increased awareness among citizens about the inevitable challenges associated

<sup>6</sup> The government's proposal for Climate Adaptation Action Plan 1 from 23 October 2023 proposes to continue the funding pool for coastal areas with DKK 150 million in 2024.

with a changing climate.

CONCITO recommends that:

- **Municipalities should integrate climate change adaptation across all their agendas**

Municipalities can include other priority agendas in their climate adaptation work than they do today. For example, they can integrate benefits in concrete projects. Therefore, municipalities should give higher priority to climate adaptation action as a cross-cutting topic throughout their administration and ensure alignment with the overall goal of enhanced climate resilience. This requires breaking with the silo mentality in local government administration. Some of the municipalities in the DK2020 project managed to do this in their efforts to reduce greenhouse gas emissions.

- **The potential for more synergies between emissions reduction and climate change adaptation needs to be realised**

To capitalise on the political momentum in the green transition, efforts to link emissions reductions and climate change adaptation should be maintained. Many municipalities would not have prepared new climate action plans for climate change adaptation had it not been for the DK2020 project. Continuing with common plans or common processes for evaluation and revision is therefore essential. This should also be included in the work by the Climate Alliance. Furthermore, there is time and money to be saved by en-

gaging external stakeholders and designing specific projects in which synergies between emissions reductions and climate change adaptation secure more value for money.

- **Local stakeholders should be included more in climate adaption planning in order to ensure better and locally informed solutions**

There should be more systematic inclusion of the stakeholders most affected by climate change, as well as of the stakeholders who will have to live with the solutions. This is a time-consuming task for municipalities and it may entail long appeals proceedings. However, previous experience can serve as inspiration for clear guidelines on <sup>7</sup> when and how best to include relevant stakeholders.

- **Citizens needs to be made more aware of the impact of climate change and their own possibilities for action**

There is a general need for targeted information to citizens and other civic stakeholders about the consequences of climate change for everyday life and in extreme weather events. It is essential to build social resilience. Information campaigns should focus on providing an accurate risk profile, the possibilities for action by those affected by climate change, including citizens' own responsibilities with regard to managing risks, as well as what they can expect from local emergency and response services and other local authorities.

<sup>7</sup> See for example the following handbook on stakeholder identification and climate adaptation with co-benefits, etc.: *Aktørkortlægning og værdiskabende klimatilpasning - nye metoder til strategisk planlægning* (Quitau et al, 2022).

# 1. Introduction

## A burning platform - climate change in Denmark

Because of rising global temperatures, the stable environment and temperatures the Earth has experienced for the past 10,000 years will be no more. Even with accelerated emissions reductions and increased adaptation, the price of irreversible climate change will increase significantly in the future (IPCC, 2022). This is the main reason why we need to adapt, but it is difficult to predict what we need to adapt to.

Higher temperatures, more rainfall and more extreme weather events in general are the new norm in Denmark. Global warming is happening now: the average temperature in Denmark has increased by about 1.5°C since the 1870s, and it is expected to continue to increase even more up to 2100 and for a long time after (Danish Meteorological Institute (DMI), 2023).

According to the Danish Meteorological Institute's Climate Atlas (2023), Denmark will experience ever more prolonged heatwaves, warmer summer nights and fewer frosty days with temperatures below freezing. The rise in temperatures will also change the precipitation patterns we know today. Annual precipitation in Denmark has already increased by around 100 mm over the past 100 years. There will be more winter precipitation, more intense cloudbursts, and more frequent rain events up to the year 2100. The mean sea level is increasing and will continue to do so far into the future. This will result in far more storm surges than we see today. A storm surge statistically occurring every 20 years today will likely occur about every other year towards the end of the century, if global greenhouse gas emissions follow a middle-of-the-road scenario (SSP 2-4,5) (Danish Meteorological Institute (DMI), 2023).

The society we live in today has been built in a stable climate. Achieving the goal of climate resilience described in the Paris Agreement will require formidable change.

## Climate action plans aligned with targets in the Paris Agreement

In 2015, Denmark signed the Paris Agreement. The agreement obligates countries to carry out ambitious climate action to pave the way towards net-zero emissions and enhanced climate resilience (UN, 2015).

C40 Cities, an international network of cities, has developed a climate action planning framework that is compatible with the Paris Agreement and is used by some of the largest and most ambitious cities in the world. The DK2020 project marks the first time C40 Cities' international standard, *The Climate Action Planning Framework (CAPF)*, has been further developed for use by municipalities and smaller towns.

The project has allowed Danish municipalities to meet international best-practice standards for climate action and develop ambitious local climate action plans to pave the way for net-zero emissions within their physical municipal boundaries by 2050 and also demonstrate how they will adapt to climate change.

DK2020 is a partnership between Local Government Denmark, the five Danish regions, and Realdania. CONCITO is the project manager and a knowledge partner in the project. C40 Cities is also a knowledge partner in the project. The objective of the partnership is to establish a common framework and to support Danish municipalities in developing climate action plans compatible with the Paris Agreement. The first 20 Danish municipalities joined the DK2020 partnership in 2019. A further 44 municipalities joined in November 2020, and 31 more during 2021. These municipalities are referred to as pilot municipalities, first-round municipalities and second-round municipalities, respectively, depending on when they entered the partnership.

By the end of 2023, a total of 96 Danish municipalities are expected to have prepared C40 Cities-approved climate action plans compatible with the Paris Agreement. This includes the 95



municipalities under the DK2020 project and the City of Copenhagen, whose climate action plan was previously certified by C40 Cities.

CONCITO and the consultancy firm NIRAS have analysed the climate adaptation actions in the DK2020 plans of the municipalities. The data basis includes the climate action plans of 90 municipalities, as well as the background documents behind DK2020-certification of the municipalities. Municipalities may have other practices and actions than those included in this analysis, as the analysis is based on the documentation available in connection with development of the climate action plans. All municipalities were given the possibility to receive a written validation of the document analysis. Furthermore, interviews were conducted with ten representative municipalities. In addition to the analysis, in June 2023 a 'next-practice' workshop was held with the participation of municipalities and knowledge experts. The purpose of this workshop was to identify common experience and prime the ground for recommendations.

This report was updated in early 2024 to include plans from the remaining six DK2020 municipalities, which was approved in the end of 2023. The report and appendices was published again in a final, updated version.

### Good plans and effective implementation

DK2020 is based on C40 Cities' climate action planning standard. This standard sets out what, as a minimum, a climate action plan should include.

A good plan shows the path to a climate resilient society, just like a GPS shows the route from point A to point B. This does not mean that municipalities need a good climate action plan to carry out good climate adaptation. Using the same analogy, this corresponds to driving from point A to point B without a GPS. Choosing this strategy could lead to a good trip, but there is a risk of going to point C and D before getting to point B or not reaching point B at all. This is a risk in particular if you have never driven the route before.

In this context, a good climate action plan for climate adaptation is based on an assessment of all relevant climate impacts (flooding, warm spells/heatwaves, drought and wind) followed by a prioritisation of focus areas. A good plan sets clear goals and sub-goals and describes how to achieve

these goals through concrete actions. A good plan defines indicators for the impact of actions once they have been implemented. To ensure the plan is implemented, a good plan must also describe how actions will be financed, and it must include follow-up on the implementation of these actions to ensure that goals are met.

In other words, a good plan provides a total overview of expected risks and the municipality's goals and actions related to climate adaptation. These are often spread out across various municipal plans.

Furthermore, DK2020 has a requirement for wider benefits, in that implemented climate actions should, as far as possible, harmonise with other societal needs and not lead to inappropriate derived consequences.

### Benefitting from the experience of others

Climate adaptation is an ever-changing research and knowledge field. This report is not the first to review the work of Danish municipalities and attempt to establish a framework for future discussions or provide recommendations for future work.

Researchers, government agencies, initiatives at local and regional government levels and by think tanks and other knowledge institutions in Denmark have contributed the knowledge and experience base upon which municipalities base their climate action planning. This knowledge and experience also forms the basis for the discussions and recommendations in this report.

In recent years, a number of ambitious collaboration projects have managed to build a bridge between science and local climate adaptation stakeholders. These projects have been funded by philanthropic foundations, regional governments, central government agencies, and institutions supported by EU funding schemes, for example.

In Realdania's project on cities and rising sea levels, *Byerne og det stigende havvand*, selected municipalities worked on new, innovative and holistic solutions to protect cities against flooding in the short term, while also planning for long-term needs (Realdania, 2023). As an additional outcome, the project published a useful reference book on sea level rise, *Den lille blå palør* (Wiberg et al., 2023).

With its project about who should pay for climate adaption projects, *Klimatilpasnings på tværs*, the Capital Region of Denmark has contributed research into contribution models that provide new knowledge about when it is appropriate to apply the utility principle (Fryd et al., 2021).

Central Denmark Region's *Coast to Coast Climate Challenge* project worked broadly with climate adaptation over six years across the region. Projects and extensive experience harvested throughout the period have meant increased implementation and knowledge-building locally (Nielsen and Wejs, 2023). Aalborg University developed methods for stakeholder identification and climate adaption with co-benefits exemplified through three concrete cases (Quitzaeu et al, 2022).

Through the *C5a* EU Interreg Programme, the Danish Coastal Authority and Central Denmark Region have prepared a guide to holistic flood risk management. The guide describes a 12-step

method for holistic flood management planning. The guide refers directly to requirements in the DK2020 project.

Danish climate adaption action also draws on international players. C40 Cities, in particular, has played a crucial role in the DK2020 project. Furthermore, the European Environment Agency (EEA) has published several relevant reports on the European risk profile and damage estimates across Europe (EEA, 2022).

This summer (2023), the European Commission published new guidelines on the strategic planning of climate change adaptation (European Commission, 2023a). These still need to be translated into a Danish context.

In other words, there is no shortage of inspiration to draw on; the examples mentioned above are far from an exhaustive list. The next step is to apply this enormous knowledge base in practice.

## 2. Framework conditions for climate adaptation in municipalities

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This report describes municipalities' work on climate adaptation via plans and their underlying documentation in the voluntary DK2020 project. Although the project is voluntary, Danish municipalities are subject to certain fixed national framework conditions for their climate adaption work.

Climate adaptation in Denmark is often associated with water management, and existing legislation about the role of municipalities in planning and performing climate adaptation is primarily linked with water management. Regulations pertaining to flood management have not been consolidated as coherent legislation. It is a highly complex field because climate adaptation relates to many different legislative areas, including the EU Habitats Directive and the EU Water Framework Directive, Danish building regulations, the Danish Water Sector Reform Act, and there is currently no consistent, holistic approach across legislation (Basse 2022).

This chapter briefly describes the most important legislative and administrative framework conditions that Danish municipalities are subject to in the area of climate adaptation planning. The description is not exhaustive.

### National strategies and plans

The government's national strategy for adaptation to climate change from 2008 had a broad focus on climate hazards and threats in various sectors. The strategy included initiatives for targeted information campaigns, a research strategy, and a cross-sectoral coordination forum for climate adaptation tasked with ensuring concerted efforts between public authorities (Danish government, 2008).

The first national climate adaptation plan was adopted in 2012 and focussed exclusively on flood management, in particular from cloudbursts (Danish government, 2012). The plan focused on overall planning as well as on local development plans, and it included about 64 initiatives.

In step with this, as part of the 2013 budget agreement, the Danish government and Local

Government Denmark decided that Danish municipalities were to prepare climate adaptation plans. These municipal climate adaption plans were developed and adopted in the period 2013 to 2015. There has been no central government requirement for municipalities to update these municipal climate adaptation plans.

The municipal climate action plans from 2013-2015 focussed on managing flooding from rain, the sea and groundwater. The Danish Nature Agency (now under the Danish Environmental Protection Agency) published guidelines for mapping flood risks, defining, prioritising and financing local solutions. Furthermore, the municipalities were to set climate adaption targets, all in the context of municipal development planning (Danish Nature Agency, 2013).

All Danish municipalities prepared plans, but with very varying levels of detail in risk mapping, etc., and only half of the plans included an action plan with concrete initiatives. Furthermore, not all municipalities stipulated guidelines for developments in risk areas in their municipal development plan (Danish Environmental Protection Agency, 2017).

In October 2023, the government presented its proposal for Climate Adaption Action Plan 1, which includes nine initiatives: continuation of central government engagement in erosion protection along the Danish West Coast; state aid to particularly exposed coastal regions, including a one-year extension of the funding pool for coastal areas of DKK 150 million; structural changes to address challenges associated with high near-surface groundwater levels by giving municipalities real authority and allowing wastewater utility companies to establish public climate adaptation solutions in areas with sewers; establishment of an inter-ministerial committee of civil servants tasked with focussing on long-term climate adaptation action; launch of a number of analyses, including to identify the national need for investment in climate adaptation and identify how other EU Member States administrate nature and environmental legislation on climate adaptation; and make it easier for municipalities to imple-



ment major coastal protection through new models for organisation of the coastal protection area (Ministry of Environment of Denmark, 2023).

### **Flood and erosion mapping in municipal development plans**

The Danish Planning Act and spatial planning are important tools when considering climate adaptation action for new and existing land areas. Municipalities consider climate adaptation in their municipal development plans by describing guidelines and deciding the framework for spatial planning, and they also have some authority to stipulate requirements for climate adaptation in local development plans.

The Planning Act was amended in 2018 to the effect that municipalities can now prevent damage from flooding and erosion through spatial planning initiatives. With the amendment, municipalities are now required to identify flood-prone and erosion-prone areas in their municipal development plans in connection with urban development planning, especially when planning technical installations, land-use changes, etc. Municipalities must assess the possible need for actions aimed at flooding or erosion within areas covered by the relevant local development plan. The individual local authority is responsible for assessing the possible consequences of flooding or erosion and for weighing these consequences against other considerations, such as financial concerns, pollution risk, and environmental and health concerns, etc. (Housing and Planning Agency, 2021). This means that municipalities are not obligated to set up strict requirements if local, political sentiment says otherwise.

In 2022, climate considerations were included in the objects provisions of the Planning Act on a par with considerations for the environment, nature, economic growth and development. The rules concerning adaptation measures now allow municipalities to impose requirements for the establishment of adaptation measures outside areas covered by the individual local development plan before approving the use of buildings and other construction. This will allow for greater possibility to develop flood-prone areas (Ministry of the Interior and Health, 2022).

### **Implementation of the EU Floods Directive and transfer of authority for coastal protection**

The EU adopted the Floods Directive in 2007 as a result of extensive flooding in several places in

Europe (EU, 2007). Denmark has implemented the Floods Directive through the Danish Flood Risk Act, which includes requirements for evaluation and management of risks of flooding from the sea, inlets, lakes and watercourses. The Flood Risk Act operates with three steps: 1) central government identifies flood risk areas, 2) central government maps flood hazards and risks in the identified areas, and 3) the relevant municipalities prepare risk management plans for the identified risk areas (Danish Coastal Authority, 2023). Today, the Act covers 14 designated risk areas spread across 27 municipalities, and these municipalities are required to prepare risk management plans. A municipality's risk management plan takes precedence over the municipal development plan, and thus the municipality's sector plans as well. Therefore, the framework for the risk management plan will affect other risk planning by the municipality (Housing and Planning Agency (discontinued), 2022); (Danish Coastal Authority (2023).

In September 2018, the competent authority for coastal protection was transferred from the Danish Coastal Authority to the municipalities. The objective of this change was to make it easier to apply for permission to establish coastal protection. The individual local authority is therefore responsible for approving or rejecting applications from property owners or homeowners' associations to establish coastal protection (Danish Coastal Authority, 2018).

Municipalities play another important role with regard to situations with municipal joint projects. In these situations, they can file coastal protection cases for coastlines to ensure coordinated and consistent coastal protection. In their decisions pursuant to the Coastal Protection Act, local authorities can order owners of real property who obtain protection or other benefits from the measure to participate in paying for the measure. Municipalities determine the contribution distribution model and the size of individual contributions. They can also contribute to paying for the project as property owners themselves, or if the project results in co-benefits for the municipality's citizens in general. It is up to the individual municipality to assess whether it is relevant for the municipality to contribute (Danish Coastal Authority, 2019).

### **Collaboration between municipalities and utilities on rainwater management**

Municipalities collaborate closely with utility



companies on rainwater management. This applies in particular with regard to developing and implementing the municipal wastewater management plan.

The legislative framework for financing wastewater management services has been amended several times. In 2014, it became possible for wastewater companies to finance climate adaptation projects through their price caps, but only for the part of the project that pertains to near-surface water runoff, via the so-called co-financing rules (Water Division, 2015).

In 2021, the rules concerning financing of climate adaptation by wastewater companies were amended. This change introduced a new way in which to finance climate adaptation beyond the normal level of service. To justify financing services beyond the normal level, a climate adaptation project must be appropriate from a socio-economic and business economic perspective, relative to the chosen service level. The decision about appropriateness is set out in the municipal wastewater management plan.

The 2021 legislative amendment also meant that wastewater companies can now carry out projects outside areas with sewers in situations in which this makes for a cheaper solution than the traditional, technical solution that would otherwise have been chosen. Furthermore, the amendment put climate adaptation on an equal footing with utility companies' other activities and made climate adaptation subject to the efficiency requirement (Danish Environmental Protection Agency, 2022).

In future, municipalities and wastewater companies will most likely have to work together to manage high groundwater levels in areas with sewers. It is anticipated that a future legislative amendment will make municipalities the authority responsible for managing high near-surface groundwater levels, as well as allow wastewater companies to establish public climate adaptation solutions where socio-economically viable.

This was announced in the government's Climate Change Adaptation Plan 1 (Ministry of Environment of Denmark, 2023).

### **Municipal authority for all watercourses**

Municipalities are the competent authority for all types of watercourses. These include open as well as culverted watercourses, channels and drains, etc. The individual municipality is responsible for maintaining all public watercourses, as stated in the watercourses regulations. As the authority for watercourses, municipalities are also responsible for issuing permits for watercourse restoration, etc. Individual landowners are responsible for maintaining watercourses on their land if properties located upstream do not have the possibility to dispose of their water (Danish Environmental Protection Agency, 2023).

### **Municipal extreme weather emergency preparedness**

The municipal emergency preparedness service is the primary body responsible for response efforts in extreme weather situations, but the Danish Emergency Management Agency will provide personnel and special equipment if necessary. The municipal emergency preparedness service typically lies with the local fire service, and this can be a voluntary or a municipal service, including a municipal service outsourced to a private sector entity. With regard to injury and damage to people, property and the environment, the emergency preparedness service is tasked with providing appropriate preventive, mitigating and remedial response efforts. Municipalities must plan emergency and preparedness response on the basis of an assessment of local risks, and the response must be described in a municipal emergency preparedness response plan. This plan must be revised at least once during each municipal election period (Danish Emergency Management Agency, 2023; Klimatilpasning.dk, 2023).

# 3. The pathway to climate resilient municipalities

The ultimate goal of climate adaptation is a climate resilient society. However, climate resilience is not a state but a continuous process. The goal of climate resilience should be the overarching framework setting the direction for how municipal practices and policies become more resilient in their response to climate change and extreme weather events. This chapter looks more closely at how municipalities have set goals for climate resilience and climate adaptation.

The society we live in has been built in a stable climate. Achieving the goal of a climate resilient society requires formidable change. According to the IPCC (2022), the route to a climate resilient society requires that we make changes to our fundamental values, world views, ideologies, social structures, political and economic systems, and power relations. Climate resilience therefore goes beyond just dealing with extreme weather events. Rather, climate resilience requires that we completely transform society to a way of liv-

ing that respects the planetary boundaries and addresses the changes in natural processes that we have already caused (see text box 1). These are changes that all of us will be impacted by and will have to live with in future.

Danish municipalities may already have set out climate adaptation targets in their municipal development plan and in their local development plans for how new buildings and any changes to the use of existing buildings should relate to flood and erosion risks. DK2020 municipalities are required to set goals for their overall climate adaptation action, including for areas outside their own planning and development tasks. They are required to set an overall goal of climate resilience and to indicate milestones or sub-goals guiding the municipality towards climate resilience (by 2050). Furthermore, municipalities must have a process in place for how to follow up on their planned goals and actions.

## Text box 1: Definition of climate resilience and climate adaptation

There is no single definition of **climate resilience**, and the general concept of resilience has changed in recent years. Whereas previously the concept focussed on a society's ability to restore the status quo, today focus is rather on society's ability to live with and adapt to the changes and uncertainties that the future brings. Resilience is now understood more as the capacity to navigate the unpredictable, to be flexible and innovative, and to be able to adapt in response to crisis situations (Rockström et al., 2023).

The UN Intergovernmental Panel on Climate Change (IPCC) defines resilience as the capacity of social, economic and ecosystems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation (IPCC 2022, Annex II).

**Climate adaptation** (or climate change adaptation) is therefore a subset of climate resilience. Adapting to climate change can be defined as taking action to prepare for, and adapt to, current and expected future impacts (European Commission, 2023b). The IPCC distinguishes between human and natural systems. Human systems can adjust in order to moderate harm or exploit beneficial opportunities, while for processes in natural systems, human intervention may help facilitate needed adjustment to expected climate (IPCC 2022, Annex II).



## Municipalities' targets and follow-up

### Difficult to translate 'climate resilience' into concrete targets

The general understanding among municipal employees working with climate adaption of what constitutes a climate resilient society is that it is a society able to manage the unpredictable, that is able to manage extreme events, or that has considered or responded to various climate risks (CONCITO, 2023b).

Figure 1 shows examples of municipal employees' descriptions of what climate resilience means to them.

The pathway to climate resilience is different from municipality to municipality. Goals and milestones are determined on the basis of the local context as well as current and expected climate risks. This means that it is not possible to combine the targets of all municipalities in the same way that their emissions reduction targets can be combined to provide a total figure.

### Climate resilience and climate adaptation targets vary with regard to how concrete they are

The DK2020 project does not specify in any clear terms what is entailed in setting targets for climate resilience.



Figure 1: How municipalities understand climate resilience. Statements collected during a workshop with municipalities and knowledge experts in June 2023. Prepared in collaboration with NIRAS.

Some municipalities focus on the concept of climate resilience from an overall perspective, while others choose to break down targets and milestones into concrete topics. Some municipalities set clear, quantitative targets and deadlines for their actions, while others describe more general milestones for action. **A total of 63% of municipalities indicate a deadline for when the municipality must be climate resilient, and a majority indicate 2050 as the target year.** However, several municipalities have indicated in interviews that it is important to also look beyond 2050. Climate adaptation is not something that we can fix but something that we will have to work on continuously for an indefinite period of time (municipalities #3 and #8, Annex 2).

Municipalities mention other quantitative parameters than a target year. **13% of municipalities indicate events (e.g. a 20-year event), and 18% indicate a specific water level.**

Municipalities set targets within a broad array of topics in their climate adaption plans. **Not surprisingly, as many as 88% of municipalities include water management.** Other common topics included are: drought (53%), climate resilience (48%) natural assets (40%), urban planning (40%) and recreation (39%). Other climate hazards apart from flooding and drought include heatwaves (39%), warm spells (28%), wind (16%) and erosion (16%). Figure 2 illustrates the most common topics in municipal climate adaption targets.

Figure 2: Most common topics in municipalities' climate adaption targets and milestones. The larger the font, the greater the number of municipalities that include the topic in their plans. Colours are not significant.



Although the targets cover a broad array of topics, there is no systematic approach to ensuring that the municipality includes all important as-

pects of the resilience concept, including ensuring an appropriate emergency response and systemic and continuous improvement of practice and legislation. However, targets must reflect the risk assessment the municipalities have conducted (see chapter 4). The figure shows that all climate hazards are represented, but not all municipalities have included all relevant hazards as part of their targets.

### ***Around one-quarter of targets define protection and/or service levels***

Targets in DK2020 plans do not have to be concrete with regard to protection and service levels, and far from all municipalities set protection and/or service levels for targets in their DK2020 plan. **27% of municipalities indicate service and/or protection levels.** 20% of municipalities indicate protection levels for defences against high sea levels. **The protection levels for seawater range from spot height 1.7 to spot height 3.48. Spot height indicates the height above sea level in metres.** By far the majority of the protection levels have been set for specific areas. Three municipalities have set service levels for targeted rainwater management, and one of these municipalities refers to the Service Level Executive Order, while another indicates a protection level of 10-cm inundation depth in a 100-year event. With regard to watercourse flooding, two municipalities indicate protection levels in the form of a 100-year rainfall event in 2048 and a protection level for spillways of a spot height below 2.68, respectively. One municipality has a service level for energy consumption for cooling during heatwaves and warm spells. Concrete protection levels are most common among municipalities that have risk management plans and municipalities that have participated in development projects within climate adaption. This seems to indicate that these municipalities have come further with concretising projects.

However, this does not mean that municipalities that have not indicated protection and/or service targets generally fail to consider this aspect. They may have considered such aspects in sector plans instead. It may often be justified (and legitimised by law) to choose different protection and/or service levels for different areas and projects in the municipality on the basis of the specific lifetime and resilience needs of the building project in question or based on a cost-effectiveness perspective.



**A few municipalities have clear indicators for follow-up on planned actions**

The purpose of targets in municipalities' plans is to help ensure that, over time, actions implemented can be compared with the original target, so that it can be assessed whether more actions are needed and/or whether the targets should be revised. When targets are less concrete, it is more difficult to measure whether municipalities are succeeding in meeting their ambitions. **More than 80% of municipalities consider follow-up on their DK2020 plan, both follow-up in the form of revision of the plan after 4-5 years and in the form monitoring concrete actions in the plan.** However, three of the pilot municipalities do not indicate whether the monitoring described in their climate action plans also includes climate adaptation.

**83% of municipalities include ongoing follow-up on progress with actions in their plan, and 14% monitor climate developments** such as specific events, measurements of near-surface groundwater, high-water events along coasts, etc.

Far fewer municipalities use indicators in their monitoring. Monitoring can be defined as continuous, systematic collection of data about selected indicators. Indicators (often quantitative) indicate progress with implementation of the climate action plan and its impacts/effects. Examples of indicators are number of climate adaption projects carried out, number of metres of sewers sealed, or number of overflows into natural areas. **Only 32% have specific indicators for climate adaptation.** However, the number of municipalities that include indicators increases from the pilot municipalities to rounds 1 and 2 municipalities later in the project.

Based on the indicators described in their plans, it appears that municipalities have difficulties defining actual indicators. Many of the indicators are in reality targets that cannot be sufficiently measured. Many targets in the plans could be made more measurable and then transformed into actual indicators. For example, one municipality sets specific targets for biodiversity, but

sets no indicator. However, in this case, an indicator can be derived from the target: *number of newly planted trees of native species.*

The municipalities' non-measurable 'indicators' can be reworded as: *number of metres of sewers sealed, number of drought and heat events, number of reports to an emergency crisis unit, number of flood reports from citizens, number of stakeholders involved, number of satisfied stakeholders, number of actions implemented, number of areas with separate sewer systems, etc.*

**Summary of targets and follow-up**

Becoming climate resilient and preserving important societal functions, identities and structures require major societal change across all sectors (IPCC, 2022). It is difficult to set targets for climate resilience, as the concept has not been clearly defined in a Danish context. The EU has set a clear goal of climate resilience by 2050 (European Commission, 2021) and increased climate resilience is central to the Paris Agreement (UN, 2015). Even so, the Danish government has yet to consider a concrete climate resilience target.

It is an overwhelming task for Danish municipalities to define concrete targets covering all of their geography and across sectors. However, municipalities have the local knowledge and potential to couple their actions to other targets within other municipal governance areas, so that the transition can be understood holistically and in consultation with relevant stakeholders. However, this also means that it is not possible to combine the climate adaption targets of all municipalities in the same way that their emissions reduction targets can be combined to provide a total figure.

There is a major potential in improving how municipalities follow up on their plans, including following up on whether their targets and actions are sufficient. It would also be beneficial to create a common framework for following up on progress in implementation of actions and for measuring the effect of this.

# 4. Holistic climate risk assessment

The purpose of carrying out climate risk assessments is to provide municipalities with an overview of current and future climate-related hazards that may have consequences for the municipality. This chapter analyses how municipalities have carried out climate change risk assessments, including how broad and deep their assessments are, as well as how well-documented and transparent their risk analyses are.

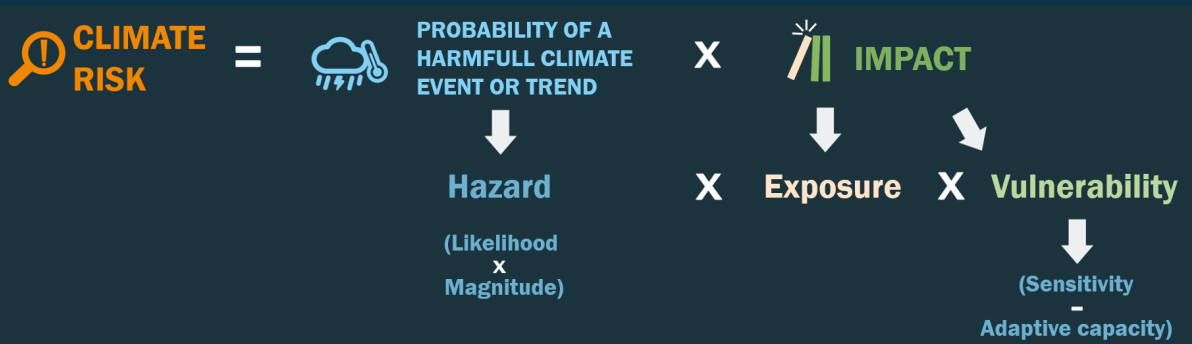
Now and in the future, Danes will have to consider a number of climate hazards due to altered weather conditions. More specifically, this includes altered precipitation patterns with more intense cloudbursts in summer and more *rainfall* in winter. Furthermore, some places will experience higher *near-surface groundwater* levels, and the altered precipitation patterns will affect the water level in *watercourses*. The *sea level* will rise and, as a consequence, storm surges will oc-

cur more frequently. Altered *wind* patterns also constitute a hazard that could change with climate change but there is no clear trend for this in a Danish context. Higher temperatures will lead to more *warm spells and heatwaves*, and a combination of altered precipitation patterns and rising temperatures may cause longer and more frequent periods with *drought* (Danish Meteorological Institute (DMI), 2023).

To provide the municipality with an accurate risk profile, risks should be assessed as a whole, in terms of risks from flooding as well as risks from heat, drought and wind and across all the municipality's exposed systems, assets and population groups (see text box 2). A climate risk assessment can also help municipalities prioritise between actions, thus creating transparency in the decisions.

## Tekstboks 2: Definition af klimarisiko

Klimarisiko (climate risks) kan defineres som skadelige klimabetingede hændelser, der har en negativ indvirkning på samfundet. Faren (hazard) er sandsynligheden og udbredelsen af den truende hændelse og påvirkningen (impact) heraf (også omtalt som konsekvensen), er et resultat af samspillet mellem farerne og det, der bliver omtalt som udsathed og sårbarhed. Udsathed (exposure) udgør de elementer, der er til stede i berørte områder, herunder borgere, flora og fauna, bygninger eller infrastruktur, og sårbarhed (vulnerability) beskriver modstandsdygtigheden eller manglen på samme af disse udsatte elementer over for faren. Mennesker kan derfor blive udsat for de samme potentielle skader ved en klimafare, men ikke alle er sårbare på samme måde. Samspillet mellem disse komponenter bestemmer klimarisikoen (C40 Cities Climate Leadership Group, 2021).



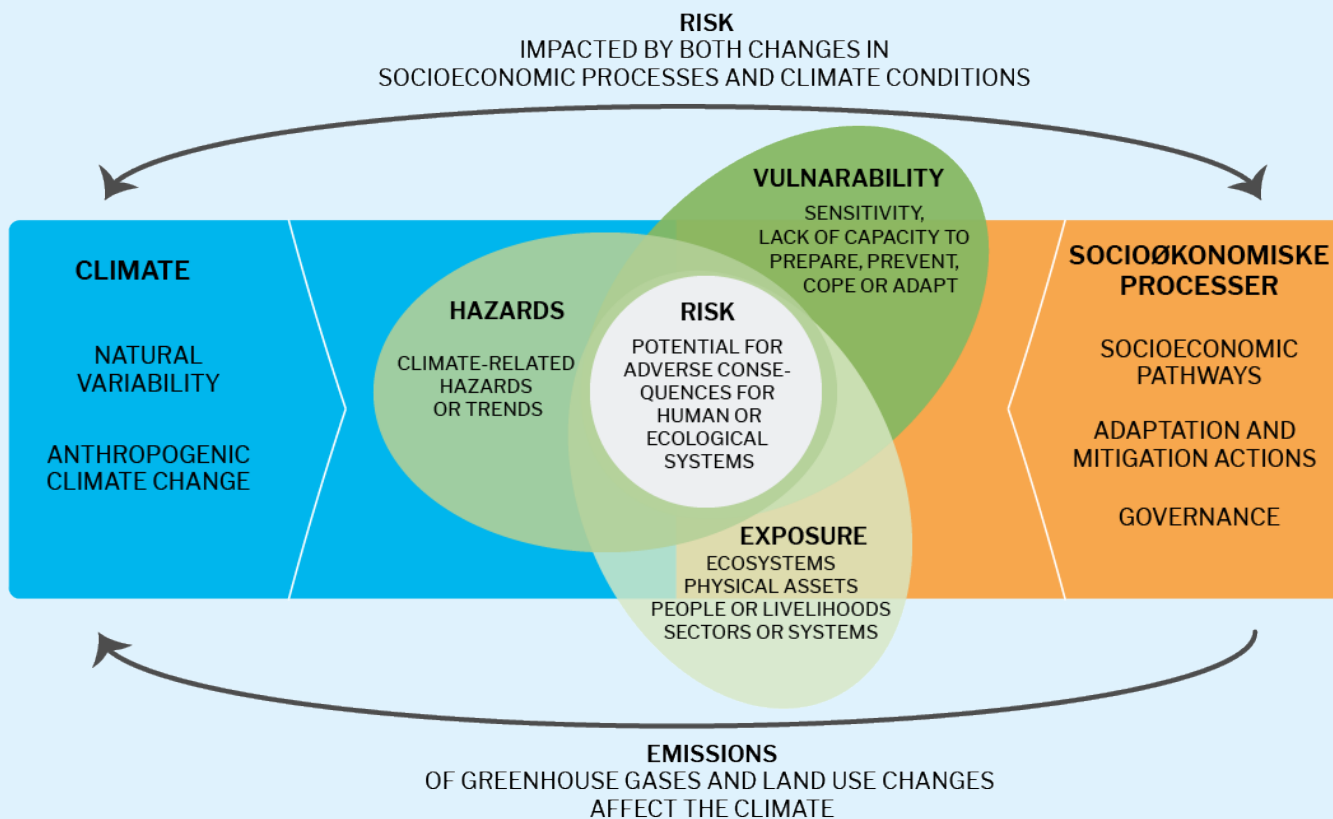


Figure 3: The risk is made up of the likelihood of extreme weather events occurring; the systems, assets and people that could be exposed to serious consequences of the event, and how vulnerable these systems, assets and people are. The hazard is influenced by natural processes as well as by the extent to which the climate is influenced by the level of greenhouse gases in the atmosphere. The latter depends on implementation of international climate pledges as well as on implementation of pledges locally. The figure has been adapted from IPCC (2014) and UNDRR (2022).

The probability of extreme weather events occurring depends on natural processes as well as on the extent to which the climate is influenced by greenhouse gases in the atmosphere. The latter depends on implementation of international climate pledges as well as on implementation of pledges locally. Figure 3 illustrates the relationship between risks, climate and socio-economic processes.

The IPCC’s climate scenarios and the derived regional and local models are the basis for the projections of meteorological and hydrological data used by municipalities in their identification of climate hazards and overall risk assessment. There is a wide range of outcomes in the IPCC’s climate projections, but these projections are the best available, and projections provide an overall indication of the climate future. However, the wide range of outcomes makes it difficult to predict *which* climate changes to adapt to.

The Danish central government recommends using two scenarios from the IPCC that are best es-

timates of the greenhouse gas emissions that will influence climate change. Choosing between the two scenarios should depend on planning horizon and resilience requirements. The two scenarios are the middle-of-the-road ‘RCP4.5’ scenario and the high-emissions ‘RCP8.5’ scenario. They are based on the IPCC’s scenarios from 2013 (Danish Meteorological Institute, 2018).

Most climate adaption planners choose a series of specific weather events within a scenario and use these as the basis for their risk assessment. A frequently used tool to calculate flood risk is an estimate of total costs and damages broken down by a number of events and calculated as expected annual damages. Calculations of economic damages can be an effective way to determine flood risk if the calculations include valuation of all of the municipality’s relevant assets, including natural and cultural assets.

The most popular tools typically do not include *all* possible outcomes in the climate change scenarios, nor do they include the most extreme

events (low-likelihood- high-impact events). This can lead to false certainty, because the most extreme events, although they are not very likely, are extremely costly. The European Environment Agency has estimated that more than half of damage costs between 1980 and 2020 came from only three percent of the total number of extreme weather events (EEA, 2023). In other words, the trend is that rare extreme events can have very serious consequences.

However, compound events can also cause extensive damage and currently it is difficult to predict and estimate the overall consequences of these (Danish Meteorological Institute, DMI, 2022). According to the Danish Meteorological Institute (DMI, 2022), there is a great need to find out more about extreme events with more than one weather event striking at the same time, such as the combination of long periods of rain in the winter and storm surges from the sea. Therefore it is understandable that the municipalities do not include these in their climate risk assessments.

## Municipalities' climate risk assessments

### *Municipalities include more climate hazards in their climate hazard assessments than previously*

Central government required municipalities to identify climate risks in their municipal climate adaptation plans from 2013-2015 on the basis of flood maps and assets maps, primarily for building assets or building damage (the Danish Nature

Agency, 2013). Since 2018, there have also been requirements for identification and designation of flood-prone and erosion-prone areas in the municipal development plan (Housing and Planning Agency, 2022). In the DK2020 project, there has been a requirement for a broader risk assessment, which, besides flooding also includes warm spells, heatwaves, drought and wind, and which includes a broader impact assessment.

By far the majority of Danish DK2020 municipalities have drawn up a broad risk assessment. In general terms, a risk assessment entails examining the probability and scope of a threatening event and the impact of this on societal functions (see more in text box 2).

**The analysis shows that all municipalities work with rainfall and all the coastal municipalities work with sea level rise.** Generally, there is a strong focus on flooding, and the municipalities are increasingly considering risks such as rising groundwater levels, drought, warm spells/heatwaves and wind. There has been a clear trend from the pilot municipalities' plans (pilot municipalities) to the last municipalities' plans (round 2) with respect to which hazard sources municipalities include. This applies in particular to drought, heatwaves and wind between the first pilot municipalities and the next round of municipalities (round 1).

Besides flooding, warm spells and heatwaves, 55% of municipalities mention wind and 31% erosion as sources of hazard. Two municipalities also mention landslides and another municipality describes saltwater intrusion and biological hazards (illness/pests) (see figure 4).

## Climate hazards identified

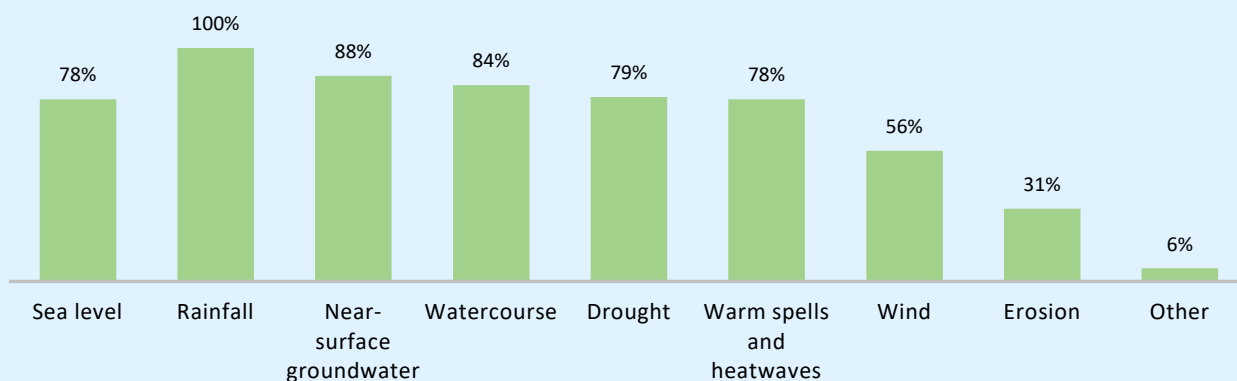


Figure 4: Percentage shares of climate hazards included in DK2020 plans.



Municipalities in DK2020 address all climate hazards. This is an improvement from the municipal climate adaptation plans in 2013, which only identified flood hazards. However, not all DK2020 municipalities have had access to useful data and the accessibility of data has varied greatly across the DK2020 project's lifetime. This may explain the difference in the content of municipalities' climate hazard assessments.

One municipality stated in an interview in connection with the analysis (Annex 2) that *"We would not have prepared a risk assessment for drought and heatwaves if it had not been for DK2020. But it's good that we did"* (municipality #1).

Overall, the municipalities' climate hazard assessments are broader in scope than their existing basis. However, some municipalities have not had resources for, or have not prioritised, comprehensive identification of risks, but work more on the basis of experience. For example, one municipality said: *"We haven't identified risks in the way they propose. We haven't identified risks in any structured or functional way. We said we can look at the blue spots on the flood map and that's what we've done. [...] We never thought that it would be worthwhile [to do as they propose]. We can very quickly see what the problems are, and decide whether we're going to do anything about them. It's a very simple approach and we've been allowed to do it like this"* (municipality #6, Annex 2).

**Previously experienced events mentioned in the plans vary in format, scope and in the degree to which events are described in detail**

The analysis examined events experienced locally in the municipality, events outside the municipality and national weather events mentioned in the municipalities' plans.

**With regard to cloudbursts, local, regional and national events are described in 36% of the municipalities' documentation**, i.e. around two-thirds of the municipalities do not consider historical weather events in their plans. Categorising according to the types of municipality used by Statistics Denmark, metropolitan municipalities (67%) and capital municipalities (55%) mention cloudburst events. Fewer mention cloudburst events in commuter municipalities (37%), rural municipalities (29%) and provincial municipalities (19%). Around less than half of the municipalities

which mention cloudbursts mention the major cloudburst in Copenhagen on 2 July 2011.



Figure 5: Most commonly mentioned storms and storm surges (indicated by the year of the event) in municipalities' plans. The larger the year, the more municipalities include the event in their plan. With regard to specific storms, 12 municipalities mention the storm in 1872, nine mention the storm 'Bodil' in December 2013, one municipality mentions the storms in 1902 and 1904, three mention storms in the 1980-90s (1981, 1984, 1990, 1991 and 1999). Other storms mentioned are storms after 2005. Storm years mentioned in addition to the ones referred to above include: 2005, 2006 (3 municipalities), 2007, 2011, 2012, 2015 (2 municipalities), 2016 (3 municipalities), 2017 (6 municipalities), 2018, 2020, 2021, 2022 (4 municipalities).

**Historical local watercourse flooding events are mentioned by 24% of the municipalities.** By type of municipality, this breaks down as follows: provincial municipalities (19%), commuter municipalities (22%), rural municipalities (26%), capital municipalities (27%) and metropolitan municipalities (33%).

**Local high near-surface groundwater level events are mentioned as a local challenge by 28% municipalities.** By type of municipality this breaks down as follows: commuter municipalities (21%), rural municipalities (23%), capital municipalities (33%) and metropolitan municipalities (35%). Municipalities fail to indicate a year for groundwater events. However, twelve municipalities indicate that it is a current problem.

**Storms and storm surges are mentioned in the plans of 51% of coastal municipalities.** Storm surges are mentioned most by rural municipalities (45%), after which come provincial municipalities (38%), capital municipalities (32%), metropolitan municipalities (33%) and commuter municipalities (33%). With regard to specific

storms, **12 municipalities mention the storm in 1872, nine municipalities mention the storm 'Bodil' in December 2013.** See figure 5.

With regard to local storm surge events, there are differences as to whether or not municipalities have drawn up risk management plans. **62% of municipalities with a risk management plan mention local events, while 39% of coastal municipalities without a risk management plan mention local events.**

Heatwaves and droughts are relatively new to municipalities' climate adaptation planning. **37% indicate historical weather events related to drought, and the majority of these municipalities refer to the drought in 2018.** Provincial municipalities in particular, but also commuter municipalities and rural municipalities, mention local drought events. These are all municipalities that generally have more agriculture than capital and metropolitan municipalities. **Warm spells and heatwaves are mentioned to a far lesser degree, and only 8% of municipalities refer to previous events of this type.** However, more metropolitan and capital municipalities mention local events of this type.

Thus, it seems from the plans that drought is considered a problem in the countryside, while heat is considered a problem in the large cities.

The analysis also reveals a correlation between municipalities which refer to specific climate-hazard-related weather events and the municipalities which include these climate hazards in their risk assessment.

#### ***No consistent use of climate scenarios and time horizons between municipalities' plans***

**Municipalities primarily use the RCP8.5 scenario.** There is no consistent trend in what climate scenario municipalities use for the various hazard sources. The RCP8.5 scenario is used in particular for hazard sources sea level, drought, heat and wind. **Rainwater stands out, in that 24 municipalities use other types of scenario for this hazard source.** These include mainly climate parameters in the Danish Water Pollution Committee's publications on rainwater management. Some municipalities indicate having applied IPCC climate scenarios that are more than 15 years old. Eight of these municipalities indicate having used the A1B climate scenario, and some indicate A2, A1-3 (IPCC scenarios from 2007) or SRES

(2000). A few municipalities state that they have used the most recent IPCC scenario, SSPS-8.5. As of March 2023, the Danish Meteorological Institute's (DMI) Climate Atlas only includes data for seawater based on this scenario. With regard to watercourses, nine municipalities indicate having used other climate scenarios, namely the scenarios they have used for rainwater. Furthermore, a single municipality indicates having used the climate parameter stated in publication 28 from the Water Pollution Committee.

**The time horizon applied by municipalities in their climate hazard assessments depends on the climate hazards they describe, but most of the municipalities use the year 2100 across hazards.** The difference is particularly great between 'old' sources of hazard related to water and 'new' sources of hazard related to drought, heat and wind. This could be because the tools available to the municipalities use different time horizons and different scenarios. For example, the Danish Meteorological Institute's (DMI) Climate Atlas uses the time horizon 2071-2100, as opposed to 2120 in the Danish Coastal Authority's Coastal Planner. With regard to sea level rise, 16 municipalities use other time horizons, and of these 12 use the year 2115, two use the year 2110, one uses the year 2112 and another the year 2122. The municipalities that use 'alternative' time horizons are primarily the municipalities that have risk management plans. The difference in the use of time horizons suggests that municipalities use their own calculations, or that they use older versions of the national planning tools.

#### ***There are large differences in how municipalities have made use of national tools and external consultancy in their preparation of risk assessments***

Denmark has good, digital mapping tools and data covering the whole country. An analysis was therefore made to determine the degree to which municipalities use these publicly available tools. The [Climate Atlas](#) tool provides an authoritative data set for climate change indicators. [HIP](#) displays data and model calculations of near-surface hydrological conditions, including projections for near-surface groundwater and water flow in watercourses. The [Coastal Planner](#) tool provides a national risk map of Danish coastal areas up to 2120, supplemented by suggested strategies and proposals for concrete ways to manage flood



### Use of publicly available climate adaptation tools

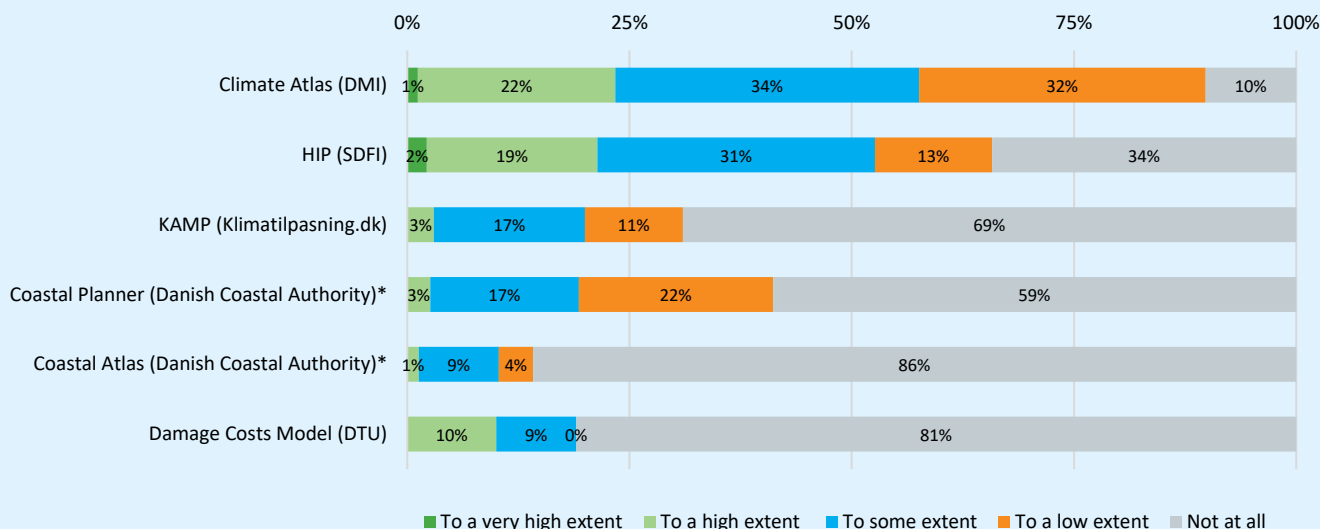


Figure 6: The climate adaption tools most commonly used by municipalities that are freely available through government platforms or from other public stakeholders. \*Percentages for Coastal Planner and Coastal Atlas are percentages of the total number of coastal municipalities.

and erosion risks. The [Coastal Atlas](#) WebGIS tool contains information on coasts and the climate. [KAMP](#) is a screening tool that compares selected national data, calculations and projections and it is aimed in particular at planning and environmental works in local government. The [Damage Costs Model](#) can be used to calculate the costs of flooding. This tool has been developed collaboratively between the municipalities of Funen, GeoFyn, the Technical University of Denmark (DTU), LNH Water, AestasGIS and Local Government Denmark.

**The analysis shows a tendency for plans to lack transparency about underlying data and about the tools or methods used to process data.** The two publicly available tools referred to most by municipalities are the Climate Atlas and HIP, which around 20% of the municipalities say they use to a high extent or to a very high extent. In addition to freely available tools, around 40% of the municipalities use data from Scalgo and from local hydrodynamic calculations to a high extent or to a very high extent. Other government tools, such as the Coastal Planner and KAMP, are both used to a high or to a very high extent by 22% of municipalities. Figure 6 provides an overview of the extent to which municipalities have used government and other freely available tools (includes only the most popular of these) in their identification of climate hazards.

Municipalities’ transparency with regard to data sources improves over time in the project period

(from pilot to round 2 municipalities). Because municipalities use very different data sets, tools, models and calculation assumptions, it is very difficult to compare their assessments. This is complicated further by the fact that many municipalities use external consultants/consultancy services. However, documentation by consultants is generally more transparent. That municipalities prepare their own assessments or outsource these to an external party is not, in itself, a problem. However, it is important that knowledge remains within the municipality organisation and that it is transparent.

Spending on consultants and consultancy services differs from municipality to municipality. As it is not clear from the municipalities’ material who has entirely or partially prepared the risk analysis, the percentage is assessed based on the 57 municipalities that have validated the document analysis. **Municipalities’ risk assessments have been prepared by the municipality itself (46%), in collaboration with a consultant (35%), by a consultant alone (14%) or by/in collaboration with a utility company or others (5%).** Based on a qualitative assessment, it appears that tools and results are difficult for municipalities to apply in practice, regardless of whether these stem from consultants or government tools. One reason could also be lack of resources or competences in municipal administrations, which could explain why only half of municipalities prepare risk assessments themselves.

### ***Around one-quarter of plans do not consider uncertainty in their calculation basis***

The analysis looked at whether municipalities' climate adaptation plans consider uncertainty. Considering uncertainty is important because climate data and climate scenarios operate with statistical intervals and are subject to considerable uncertainty. This also applies for the tools used by municipalities in their hazard, value-at-risk and risk assessments, and, by extension, the results they arrive at in these assessments. **72% plans consider uncertainty, which means that around one-quarter of municipalities do not consider uncertainty.**

It is important to note that not only climate science and climate scenarios are subject to uncertainty. There is an equal amount of uncertainty, or even more uncertainty, linked to developments in society, and in land use, for example. It is far from certain that we will be living in the same way or on the same areas in future.

Even if predicting societal developments is subject to uncertainty, municipalities have room to manoeuvre *today* to avoid future vulnerable land use, e.g. for housing. By planning with a long time horizon and considering more flexible or resilient land use, municipalities can plan more resilient actions when a new town is to be sited or existing areas are to be converted (see chapter 5).

### ***Great variation in the actual content in climate impact assessments of impacts on municipalities' vulnerable systems, assets and population groups***

The impact assessment is the part of the risk assessment in which the exposed systems, assets and populations are assessed in relation to their vulnerability. In this way, the total risk can be assessed. See text box 2 on the definition of climate risk assessment.

There is a great difference in impact assessments from municipality to municipality, depending on the source of hazard, including whether qualitative or quantitative assessments are prepared. Many municipalities use damage models or value-at-risk assessments for flooding, as the majority of municipalities also used this method in climate adaptation plans from the period 2013-2015. **The analysis shows that 67% state that they have**

**assessed damage from climate impacts in monetary values for flooding from rainfall, watercourses and the sea.** The municipalities have not yet come very far as regards value-at-risk assessment of near-surface groundwater, drought and heatwaves. Value-at-risk assessments are not mentioned at all in 4% of the plans, but there is a progression from the early (pilot municipalities) to the last group of municipalities (round 2 municipalities), all of which have prepared either a quantitative or a qualitative impact assessment.

The analysis also shows that the municipalities in the Capital Region of Denmark use value-at-risk in DKK to a greater extent, while the municipalities in Region North Jutland and Central Denmark Region more commonly apply points or point DKK, where the latter is a qualitative valuation in DKK, even though there is no actual monetary value available. Four municipalities use other values, including weighting in percent or exclusively qualitative descriptions.

Looking more closely at what municipalities include in their damage calculations, just over one-half of the municipalities have included buildings and critical infrastructure in their value-at-risk assessment. Other categories relatively often included in the assessments are utilities, nature and agriculture, while cultural landscapes, preservation-worthy buildings and ancient monuments occur to a lesser degree. This may be because 67% of municipalities state their values in DKK as described above.

Since it is more difficult to set monetary values on culture and ancient monuments, for example, these are often omitted from the calculations. In certain cases, ancient monuments, preservation-worthy buildings and cultural landscapes may be considered as cultural heritage, and damage to this may entail the loss of invaluable assets. Other small categories used in the analyses include pollution, vulnerable groups, including hospitals, institutions and prisons, recreational areas, tourism, loss of ability to work, emergency services, health, wind turbines and cemeteries. This means that not all municipalities prepare very extensive impact assessments, and perhaps they are overlooking relevant challenges associated with the climate hazards identified. In many cases this may result in an incomplete risk profile.

Compared with previous climate adaptation



## Vulnerable groups in climate adaptation plans

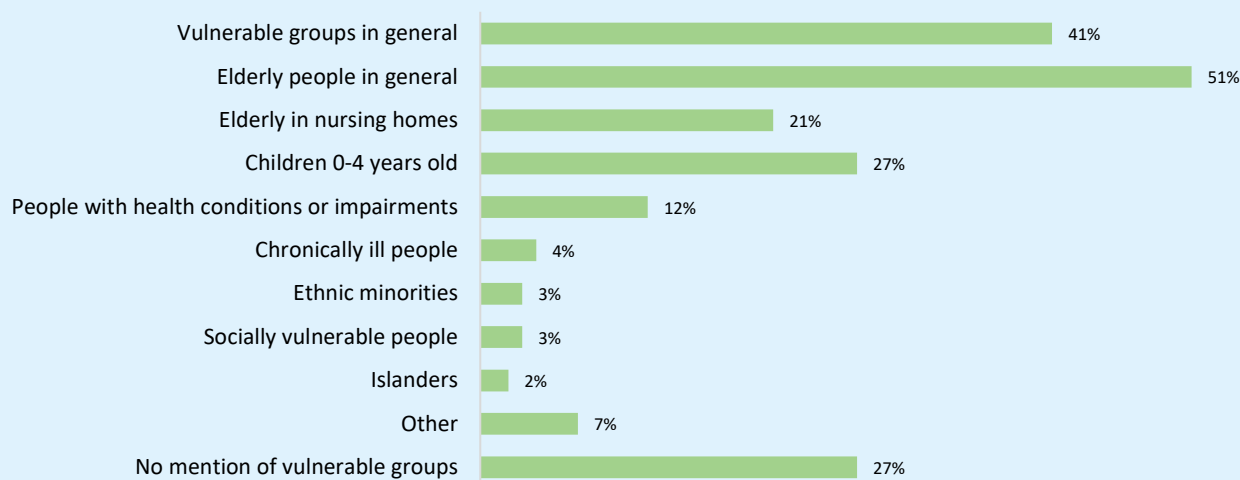


Figure 7: Indication of vulnerable groups in plans (%). Other groups include hospital patients, prison inmates, persons with hard outside physical work, rehabilitation homes and homes for adult patients under the care of mental services, etc.

plans, DK2020 plans more often contain an assessment of whether there is an equal allocation of benefits and equal access to these benefits. This means that many municipalities have considered whether specific groups in society are vulnerable to weather events (see figure 7).

There is more focus on the elderly and children in relation to warm spells and heatwaves, and generally the elderly and children represent the majority of the vulnerable groups. Socially vulnerable, and ethnic minorities are less prominent, even though they may have difficulty obtaining information and warnings via the usual information channels.

**As there is not a great deal of experience in the evaluation of vulnerable groups, the analysis also shows that there has been a learning process from the early municipalities (pilot) in DK2020 to the latest approved municipalities (second round), such that only 43% of the pilots consider vulnerable groups against 80% of first round municipalities and 90% of second round municipalities.**

There are regional differences, and the Region of Southern Denmark, the Capital Region and the Central Denmark Region indicate the greatest number of vulnerable groups. There are also differences between urban and rural municipalities, where commuter and rural municipalities have the greatest weight of elderly, while capital municipalities refer to the socially marginalised and

ethnic minorities in their plans.

### Summary of climate risk assessments

The approach by municipalities to value-at-risk assessment and overall impact assessment differs considerably. Far from all municipalities are transparent in documentation of their risk assessments. This lack of transparency makes it difficult to assess whether relevant challenges are being overlooked.

Focus should also be on whether policymakers feel sufficiently informed to make difficult decisions on the basis of the knowledge base behind the overall risk assessment and prioritisation of actions, as climate risk assessments are, by nature, built on a partly uninformed foundation due to uncertainty in climate projections and uncertainty regarding how society will develop and future land use. This makes it a very difficult communication task for municipalities. It is important to maintain the complexity, as not doing so would undermine the accuracy of the risk profile, but it is also possible to establish good climate adaptation on uncertain data.

The tools applied by municipalities in hazard, value-at-risk and risk mapping often form the basis for the policy measures adopted. Therefore, it is inappropriate that calculation models contain difficult (political) choices that are often hidden from decision-makers. Uncertainties and outcomes ranges are inevitable in work on climate

adaptation and they should be managed openly through political priorities and decisions. If they are hidden away in calculations and models, decision-makers will not be aware of the assumptions behind their difficult (and expensive) decisions.

Overall, there is a need for broad expertise to describe the real challenges facing municipalities. An example of this is that, in their risk assessments, municipalities find it difficult to assess how drought, heatwaves and warm spells will affect housing, infrastructure, and production land such as agriculture and forestry. This requires systematic incorporation of new knowledge internally in the municipality and knowledge from institutions and authorities.



# 5. Ambitious risk management

Assumptions for climate adaptation are constantly changing as knowledge about the effects of climate change is updated. But lack of knowledge must not delay action, as major and long-term investment today requires timely decisions, despite the uncertainty in municipalities' risk profiles. However, this creates a risk that under- or over-investment in climate adaptation may lead to necessary additional investment or unnecessarily high levels of protection (Haasnoot et al, 2019). This calls for a balanced approach to climate adaptation, and municipalities face this balancing act in their DK2020 plans when they have to define concrete actions. Therefore, this chapter examines and discusses municipalities' actions and plans as a whole.

Overall, it makes sense to start with climate adaptation approaches we can be most certain will reduce the risk, rather than starting with expensive and less flexible solutions. When managing flooding from the sea, it is possible to set up a number of overall climate adaptation approaches according to Jørgensen et al (2022): avoid, retreat, accommodate, protect and see what happens, see figure 8. The *see what happens* approach can only be recommended if the approach is applied while monitoring the situation regularly and not locking more investments in risk zones, e.g. construction of new residential areas in low-lying areas.

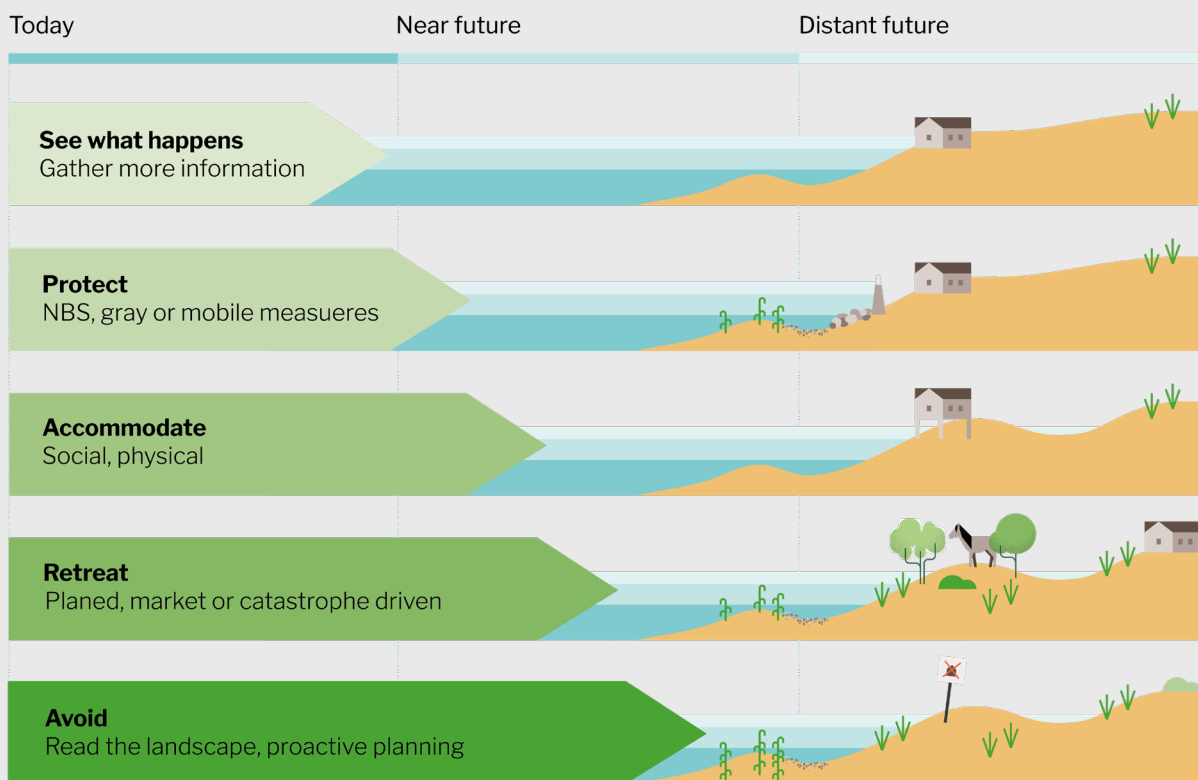


Figure 8: Risk management, here seen for flooding from the sea, should be planned on the basis of a long time horizon. The headlines indicate the overall approaches, and the sub-headings indicate the different methods to do it. Above all, one should avoid building in low-lying and flood- and erosion-prone areas, unless one deliberately works with an expiration date for the construction. If one has already built, choose an approach where one has the opportunity to change course as new knowledge and political opportunities emerges. Over time, vulnerable areas can be restored by retreating from flood prone areas to the benefit of the coastal zone so that the sea and indigenous nature can spread further inland over time. It is also an option to design our homes and infrastructure so that we learn to live with water by accommodating it. Protection against rising sea levels may be necessary, but also potentially a short-term solution, with expensive reinvestments or unforeseen damages once the security levels of the solutions are exceeded. By letting things be without initiating efforts, one indirectly accepts what might happen in the event of a storm surge. Prepared by CONCITO (2023c) and adapted from Jørgensen et al (2022).

The approaches were originally described with respect to managing rising sea water levels (IPCC, 1990), but they are also useful for adaptation to flooding from extreme rainfall, watercourses and high groundwater levels (Doberstein et al., 2019).

The same philosophy could be applied for other climate risks, although the measures will be different. Similarly, planning could include assessing which measures are appropriate now, in 2050, and in 2100 before deciding whether the choice of measures now will block other measures in the future. Below is a rough idea of how the above approach to risk management could be transferred to other climate risks.

For managing risks associated with warm spells and heatwaves, as well as wind and windfall, actions include emergency initiatives (*accommodate and protect*), construction standards (*avoid, accommodate and protect*), maintenance of buildings and appropriate nature and forestry management (*accommodate, protect and retreat*).

For managing risks associated with drought, the approach mainly entails understanding and management of the water cycle, and how risks to nature, urban nature and production land such as forest and agriculture can be mitigated. Nature-based or technological solutions could be used to deal with drought, for example by storing or managing water (*accommodate and protect*). Changing cultivation of crops/plants or more efficient irrigation could also be considered (*accommodate*) as well as taking land out of production (*retreat*).

In the Netherlands, the Dynamic Adaptive Policy Pathways (DAPP) method is used in overall prioritisation of coastal protection. The method entails climate adaptation in phases or modules, with timely allocation of resources. This can avoid over- or under-investment (Haasnoot et al., 2019). The method has been tested in a number of municipal projects in Denmark, and the Danish Coastal Authority (2020a) recommends that the principles behind DAPP be deployed to manage flood risks and climate adaptation.

Overall, it is important to consider whether flexible solutions could be appropriate for climate adaptation. For example, the dynamic adaptive method could have good potential in relation to flooding in Denmark, and should be included more in risk management of other hazard sources and sectors in the future. However, there is a need for more research across risks and to create a common language for this.

## Municipal actions and plans in general

### *The municipalities' DK2020 plans have different formats and scopes*

There is great freedom of methodology in the DK2020 project, and this means that the final material from the municipalities has many different terminologies and formats. The climate adaptation elements in DK2020 work for the individual municipality are made up of one or more (climate) action plans, background documentation and various technical annexes.

**The majority of municipalities (40%) have carried out an overall climate action plan, including emissions reductions and climate adaptation; 22% have prepared a separate DK2020 climate adaptation plan with a concrete action plan as well as background documentation; 14% of municipalities have drawn up a climate action plan under which they have committed to subsequently prepare a supplementary climate adaptation plan.** Three municipalities have structured their DK2020 climate action plan according to the DK2020 project's reporting framework: the CAPF reporting form (C40 Cities' Climate Action Plan Framework). The 20 pilot municipalities are not included in the above partitioning.

### *The plans have most actions aimed at flooding and fewest actions aimed at dry spells, heatwaves and drought*

There is wide variation in municipalities' choices for what the plans are to cover, and what actions are to be highlighted in the plan.

Figure 9 shows the percentage of actions within each climate hazard used by the municipalities in their DK2020 plans. **All municipalities have actions within rainfall and/or general water management in their plans. A total of 97% of coastal municipalities have actions within risk management of sea level rise. Two-thirds of municipalities have actions within high groundwater levels and a quarter for watercourses. Around half of municipalities have actions for warm spells and heatwaves, as well as droughts.**

There is a clear trend from the early pilot municipalities in the project to the later rounds in the project (rounds 1 and 2) with regard to warm spells and heatwaves as well as droughts. **Municipalities with actions for warm spells and heatwaves amount to 19% of the pilots, 55% of round 1 and 71% of round 2 municipalities. The**



### Initiatives distributed by climate risks

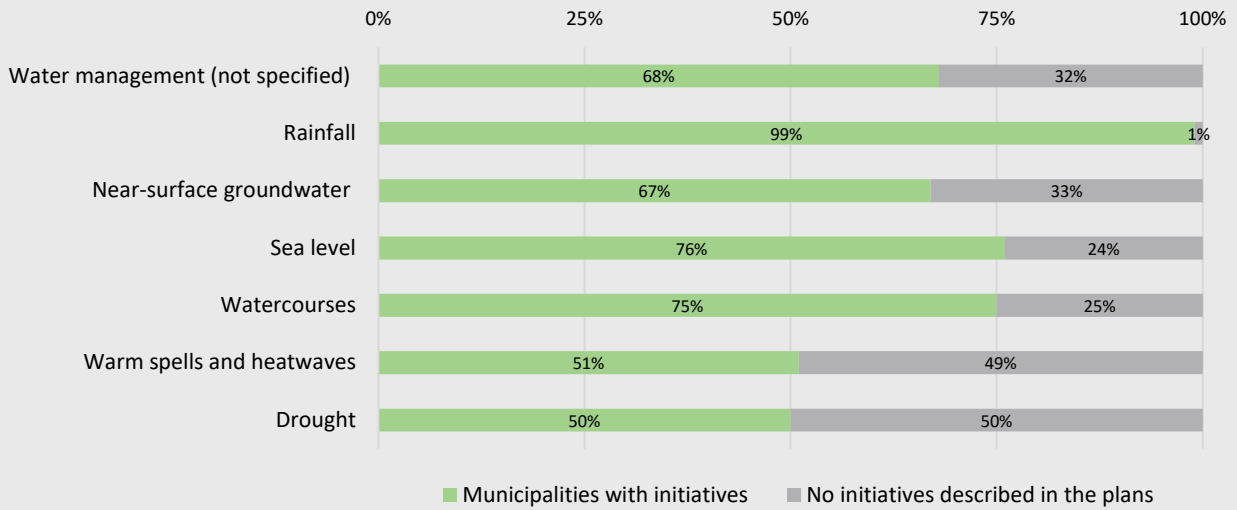


Figure9: Percentage of actions within each climate hazard used by municipalities in their DK2020 plans.

same trend applies for drought, with 33% of the pilots, 48% of round 1 and 68% of the last round having actions for drought.

The analysis has examined what concrete actions municipalities use, from policies, principles and plans, analyses and pre-analyses, master plans and sketch projects, to construction projects and actions related to communication and stakeholder engagement (see figure 10).

Construction projects and specific measures related to flooding from rainfall and sea level are most common in the plans. It is also clear that Danish municipalities have less focus on construction projects, master plans or sketch projects

ects with respect to high groundwater levels, heatwaves and drought. For all risks, there is a general trend that many municipalities need to prepare multiple analyses and pre-analyses as part of their planned climate adaptation work. It is positive that the municipalities recognise the need to become more aware of the problems and implement measures, but it is also important to follow up on how this new knowledge is being brought into play as new targets and actions.

This is not surprising that municipalities can be more specific about projects for rainwater management. In this context, legislation and financing are far clearer, and it is an area in which the municipalities already have experience, for ex-

### Climate adaptation action areas

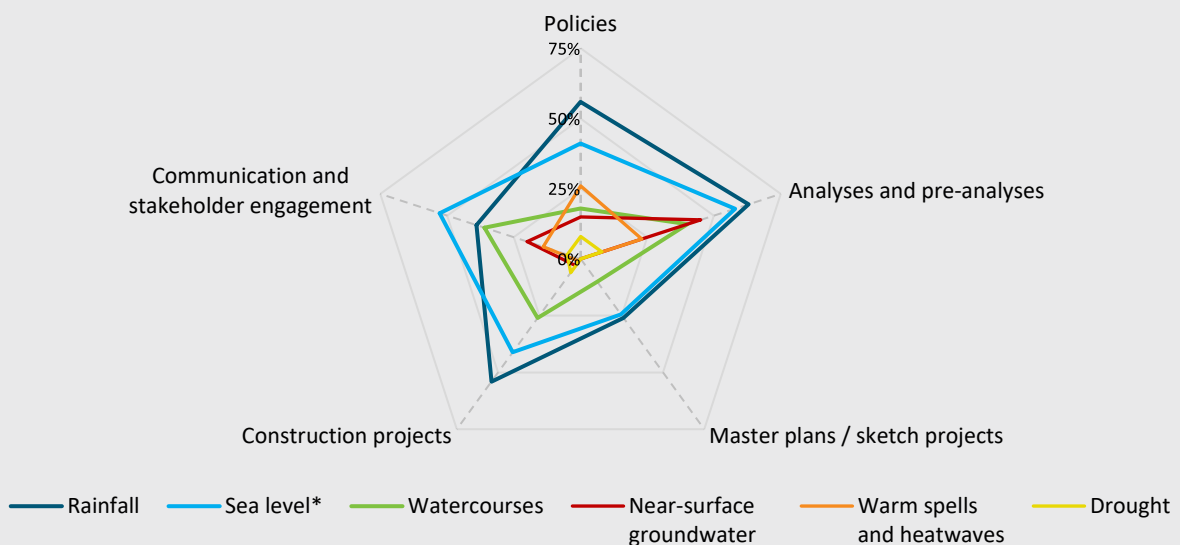


Figure10: Municipalities' actions, broken down as policies, principles and plans, analyses and pre-analyses, master plans and sketch projects, construction projects, as well as actions related to communication and stakeholder engagement. The colours indicate against which climate hazard the action is aimed. \*Actions for seawater show the percentage of coastal municipalities.

ample through collaboration with wastewater companies. For the sea, watercourses, and in particular high surface groundwater levels, Danish legislation is more likely to expect that property owners themselves plan and finance solutions. With regard to communication and stakeholder engagement, most actions are for sea level rise. This may be because the Coastal Protection Act expects municipalities to facilitate joint municipal coastal protection processes for citizens. For risk management of warm spells/heatwaves and drought, there are no concrete construction or master-plan actions.

The other observation in the review of the plans is that municipalities that have experienced local cloudbursts have more measures to address flooding from rainfall. The same applies for near-surface groundwater and drought, while this trend is slightly less clear for sea level and watercourses. **Overall, the analysis indicates that the municipalities that have experienced local events (flooding, drought, heatwaves) have more actions within the relevant hazard source than municipalities that have not experienced local events.**

#### ***Measures applied in climate action plans to manage climate risks***

**The five most common measures for rainwater management** are separate sewer systems (50%), retention basins (43%), buffer installations (large plants 41% and smaller installations 37%), information and dialogue (37%) as well as emergency flood channels (29%).

**For near-surface groundwater, the most common measures mentioned in the plans** are information and dialogue (29%), use of near-surface groundwater (9%), ditches (5%), system drainage/third line (8%) and groundwater drains (6%).

**For risk management of seawater in coastal municipalities, the five most commonly mentioned measures** are dykes (47%), information and dialogue (49%), warning and response (35%), sluices (21%) and quay walls (19%).

**With respect to watercourses, 75% of Danish municipalities refer to actions**, although only around 53% of plans mention concrete measures. Measures most commonly mentioned are water retention in wetlands (30%), upstream buffers for urban areas (27%), information and dialogue (16%), warning and response (14%), and dykes

(10%).

**For risk management of warm spells and heatwaves, 51% of municipalities mention actions**, although only a few mention concrete measures. This is a relatively new hazard in a Danish context, but concrete measures in municipalities' plans include warning and response (19%), information and dialogue (11%), trees in towns and cities (11%), green infrastructure and open urban design (9%), and green roofs and facades (6%).

**Actions to manage drought are mentioned by 50% of the municipalities**, although only a few concrete measures are described in the plans. Measures linked to warning and response (18%), information and dialogue (17%), seasonal correction by retaining winter precipitation (7%), update of data for improved assessment of abstraction permits (6%) and hosepipe bans (3%).

**Nature-based solutions are mentioned in 25% of the plans.** However, municipalities may use nature-based methods that are not mentioned as such in their plans.

#### ***The plans are stronger when municipalities have previous experience from developing risk management plans and/or have previously participated in climate adaptation development projects***

The analysis shows a clear relationship between experience and the quality of climate action plans. There is a general progression in climate action plans from pilot to round 1 and often to round 2 municipalities with respect to both the scope and the level of detail in the plans. There is also a higher quality on several parameters for municipalities that have prepared risk management plans under the EU Floods Directive as well as for municipalities that have participated in development projects within climate adaptation.

42% of municipalities make no mention at all of participation in development projects. Municipalities in Central Denmark Region refer to development projects within climate adaptation to the greatest extent, and they mention in particular the Coast-to-Coast Climate Challenge LIFE project.

Not surprisingly, there are more projects for sea level rise and watercourses in municipalities with risk management plans. These municipalities also have a larger proportion of policies, princi-

ples and plans, as well as analyses for heatwaves than the other municipalities. **There are regional differences, particularly regarding drought, for which 42% of the municipalities in Central Denmark Region mention analyses within drought, compared with 30%, 27%, 24% and 23%, respectively, of municipalities in the North Denmark Region, the Capital Region, Region Zealand, and the Region of Southern Denmark.** This is because, among other things, Central Denmark Region prepared a drought map for the Region's municipalities in connection with DK2020.

**Flexible approaches do not yet characterise municipalities' plans to any great extent**

Municipalities use different climate adaptation approaches, and there are large differences in whether they mention their approaches and strategies in their plans. The above-mentioned dynamic adaptive method is particularly interesting to investigate, as this has been an important part of Realdania's *Byerne og det stigende havvand* project (on towns and rising seawater) in which 18 coastal municipalities participated (Realdania, 2023). **16% of climate action plans mention the dynamic adaptive method directly.** Another concept of risk management that is also used in the *Byerne og det stigende havvand* project (towns and rising seawater) is multi-layered safety. This entails having a plan B, C or even D. **One municipality mentions multi-layered safety.**

However, this does not mean that the remaining municipalities do not apply similar methods or strategies. The methods are just not mentioned directly in their plans or background material. Generally, it is difficult to compare across municipalities because the approaches of different mu-

nicipalities depend on the site-specific climate risks, historical developments and other local conditions.

For sea level rise, many different measures are used for concrete actions. There have been attempts to classify the various measures within the five approaches outlined in the beginning of this chapter in order to examine the extent to which avoid, retreat, accommodate, protect and see what happens, respectively, are applied in the municipalities' plans. Figure 11 shows the number of municipalities using measures within the five approaches. *Avoid* covers measures to keep areas free of construction. *Retreat* includes measures to move away from the sea and make space for coastal meadows (avoid coastal squeeze for natural heritage). *Accommodate* covers overall measures to invite the water in and more concrete solutions such as building on stilts, higher plinth elevations and pontoon bridges. *Protect* covers dykes, raising quay walls and sluices against elevated sea levels, reinforcing moles, cliff and bluff protection, stone reefs against erosion, nature-based protection against rising sea levels, local protection of buildings, e.g. bulkheads etc. as well as mobile solutions. *See what happens* in this context covers municipalities which do not directly state measures within the four other approaches, but instead are awaiting more analyses or knowledge before taking decisions.

**The majority of coastal municipalities work on protection (73%) against and/or addressing (11%) increasing seawater levels.** Around one-sixth have no specific measures in use via plans, and are leaving things be while they collect more knowledge and data. Avoid and restore are only applied as specific measures to a small extent at present.

**Risk management of sea level rise in coastal municipalities**

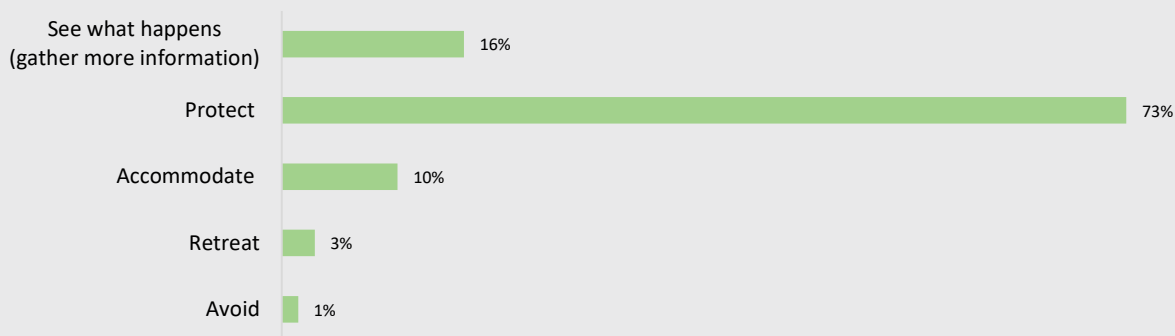


Figure 11: Number of municipalities using measures for sea level rise within the five approaches: avoid, restore, address, protect and leave it be. Percentages are indicated on the horizontal bars.



Even though the restore approach is only applied as a measure for seawater in two municipalities, relocation of construction is mentioned in about 11% of the plans. Relocation may be necessary in places that are either too expensive or too difficult to protect. Therefore, it is interesting to note that retreat or relocation is beginning to appear in climate adaptation plans.

**Sources of financing and allocation of personnel resources are difficult to compare between municipalities**

The analysis has not examined the number of actions in the plans, as these vary greatly from plan to plan and the number does not necessarily indicate the scope of work. This also means that the analysis cannot reveal anything about how many of the respective actions in plans are financed. However, the analysis has examined the type of financing used by the municipalities.

Not all plans consider financing for concrete actions. 65% of the plans, corresponding to 62 municipalities, consider financing at action level, and 41% of the plans, corresponding to a total of 39 municipalities, consider financing at a general level and only indicate possible sources of financing for efforts overall.

Of the 62 municipalities which stated financing at action level, figure 12 provides an overview of the sources of finance and whether or not the financing has been allocated.

The percentage of financing stated at action level increases from the early pilot municipalities to the next round of municipalities and thus follows the same trends mentioned earlier in the analysis, including that municipalities in later rounds draw up more concrete plans. The qualitative assessment from the review of the plans is that full financing, across all sources of hazard, is stated for only a very small number of actions. The stated actions are primarily financed by the municipalities and utility companies, i.e. via taxes and charges. This is also where funds have actually been allocated, while private and government financing has not been allocated to the same extent. On the basis of a qualitative assessment, this may also indicate that there is uncertainty as to whether national funds and government financing are available for projects realised locally.

The majority of municipalities have allocated personnel resources to some extent, whereas the financing for analyses, sketch projects and construction has to be found with the respective project owners.

Sources of financing for concrete initiatives among 56 municipalities

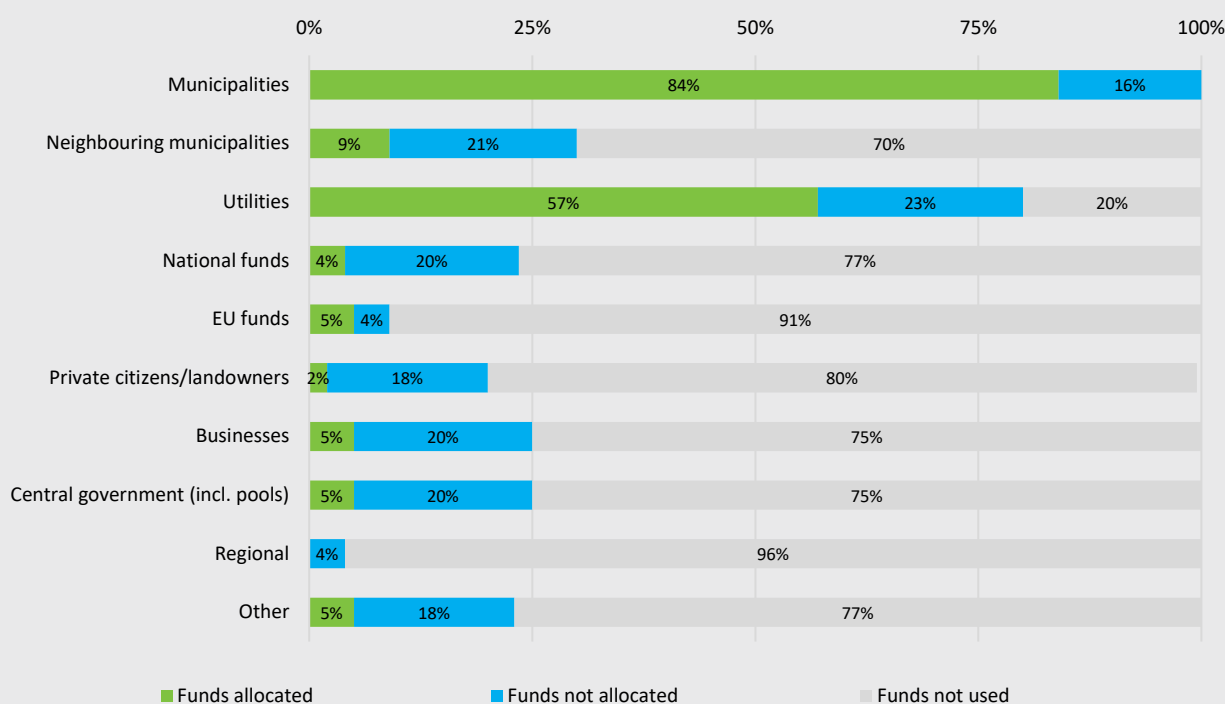


Figure 12: Overview of the sources of finance and whether or not the financing has been allocated for the 56 municipalities which stated financing at action level.



The analysis shows that **80% of the municipalities have documented that personnel resources have been allocated, while 20% have not done so**. DK2020 requires municipalities to indicate future needs for personnel resources, and the analysis shows that there has been an improvement, particularly from pilot to round 1, with regard to whether municipalities indicate and allocate personnel resources to climate adaptation.

### ***Summary of municipal actions and plans overall***

Municipalities' plans vary in format, scope and in the degree to which actions are concretized. Municipalities tend to develop stronger climate adaptation plans as the experience of other municipalities and their approved plans became available through the project period, including descriptions of financing. Furthermore, municipalities develop stronger plans when they have previous experience from developing risk management plans and/or have participated in climate adaptation development projects. Municipalities that have experienced local climate-related events have more actions aimed at preventing similar events in the future.

There is wide variation municipalities' choices for what actions the plans are to cover, and what is to be highlighted in the plans. Municipalities apply different measures and the plans have most construction projects and measures related to flooding from rainwater, followed by seawater

and watercourses. With respect to warm spells and heatwaves as well as drought, around half of municipalities have actions, but few describe concrete actions. Most of the actions in municipalities' plans cover the areas in which the municipality has a clear owner, authority or facilitator role, and the municipalities do not, to any great extent, identify the measures necessary for external stakeholders, including establishment of partnerships.

The municipalities currently have to room to manoeuvre to avoid future vulnerable land use. They can do this by planning with a long time horizon and considering more flexible or resilient land use when a new town is to be sited or existing areas are to be converted. A flexible approach should increasingly be included in the management of flooding and other sources of hazard. With regard to flooding, there is a huge potential in sharing existing Danish experience in the use dynamic adaptive methods.

It is difficult to compare municipalities' approaches to climate adaptation and there is no common language for how to ensure that they fully examine whether the climate risks they have assessed are relevant to act on. Therefore, it is not possible to assess whether actions by the individual municipality together create increased climate resilience. For this reason, there is a need for more research in the future, across risks and sectors, to create a common language for this.

# 6. Relevant climate adaptation for all

Climate change affects society in a broad sense, and therefore solutions should also be with both internal and external partners. Engagement across sectors and stakeholders is therefore an important element in DK2020. Engaging the local community will increase understanding of the risks and identify appropriate solutions that can be accepted locally. Similarly, integration of climate adaptation with other sectors creates synergies and wider benefits for the local community and the political foundation of climate adaptation action. This chapter describes how the municipalities have considered internal and external engagement, as well as the wider benefits included in climate adaptation action.

Climate adaptation projects have significant potential for creating benefits for small towns, in cities and in the countryside if they are integrated with other societal considerations and opportunities. Projects must address wider aspects than just the technical. Benefits are generated by a local or societal impact that is meaningful for the rel-

evant location, and for the relevant stakeholders (Quitze et al, 2022). Climate adaptation requires massive investment in the future, and there is a need for integration with other benefits in projects to create synergies across sectors.

Climate adaptation must not be an isolated task and it must be coordinated internally with other related policy areas such as actions for greenhouse gas reduction, health, mobility, schools and leisure, recreational land use, biodiversity initiatives, and sustainable development. Integrating different agendas can help retain the political foundation necessary to maintain focus on action in the future and create a common (climate) narrative across sectors.

This applies in particular to the synergy between greenhouse gas reduction and climate adaptation, which is an important element in DK2020. There are several interfaces between these measures, and when concrete actions are to be implemented, the same policy areas and stakeholders often have to be engaged (see figure 13).

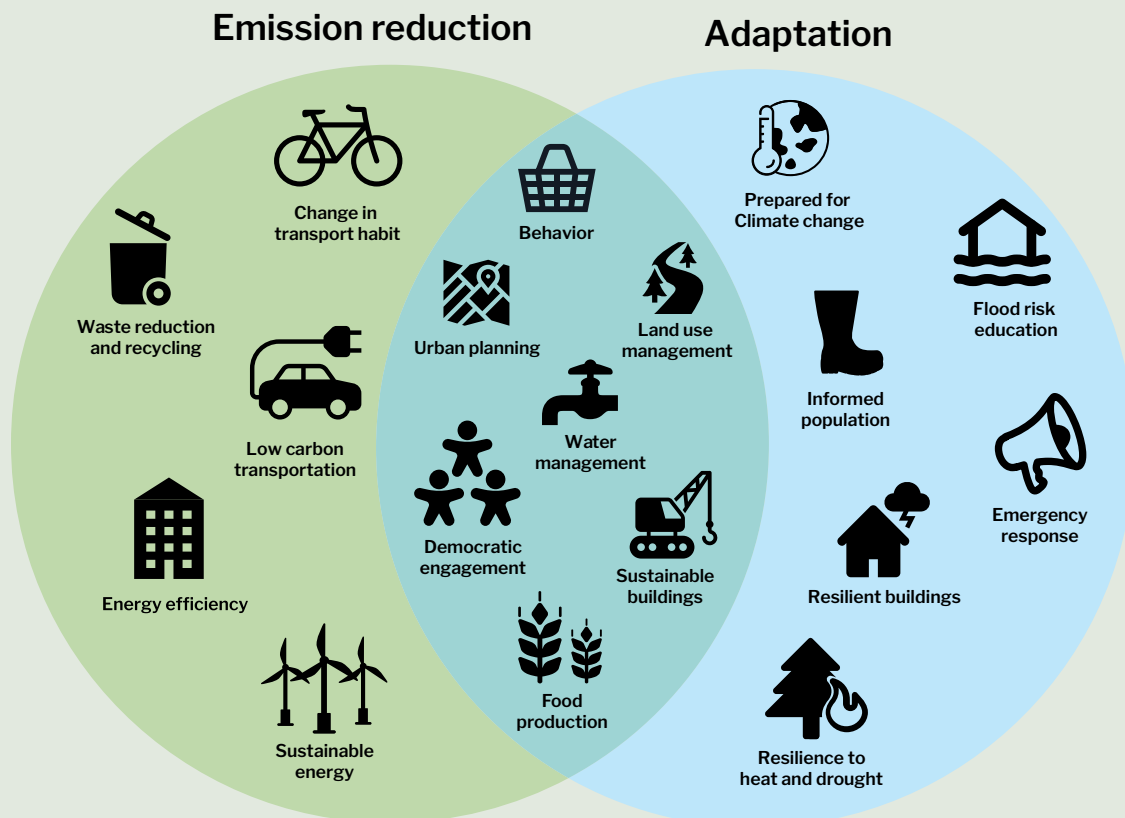


Figure13: Synergy between greenhouse gas reduction and climate adaptation in areas within the geographical boundaries of a municipality in situations when coordinating actions can help both agendas politically. An integrated approach can also help ensure that significant stakeholders are effectively engaged in the overall planning.



Therefore, climate action should be a joint effort that includes both reduction and adaptation ambitions. For example, synergy effects between greenhouse gas reductions and climate adaptation for land use can be created by coordinating set-aside of carbon-rich organogenic soils with water retention from watercourses in wetlands. By prioritising appropriate restoration areas, setting aside organogenic soils can reduce emissions of greenhouse gases *and* reduce the risk of flooding.

External engagement of the local community is important to design the best possible adaptation solutions and to ensure acceptance of the projects among citizens and other relevant stakeholders in the local community. Citizens, businesses and other stakeholders have local knowledge and expertise regarding the characteristics of the local area, and this can contribute to the development and quality assurance of adaptation solutions (Uittenbroek et al., 2019). Engagement also strengthens support and acceptance of the projects established in the citizens' local area (Uittenbroek et al., 2019; Agger and Hoffmann, 2008). *How* the external stakeholders are engaged may be crucial to secure an acceptable solution with local support. Engagement based on dialogue and mutual exchange of views can create mutual understanding between citizens, who are experts on the area they live in, and civil service officials,

who have the technical expertise. This will increase citizens' understanding of decisions and enhance the degree of responsibility and joint ownership of actions (Jæger et al., 2012). On the other hand, engagement that builds on one-way communication and information, in which citizens play a more passive role, can feel alienating and there is a risk that citizens will experience *pseudo-engagement* (Møller-Hansen, 2010; Agger and Hoffmann, 2008).

In DK2020, the municipalities have to anchor their action with internal and external stakeholders. *Internal* engagement in the municipality is seen as an opportunity to create interaction with ongoing and future actions. *External* engagement aims to ensure that all relevant stakeholders are heard, and that climate action gives maximum benefits and minimum negative derived impacts.

## Municipal engagement and wider benefits

*The degree of engagement of external stakeholders varies*

**The municipalities indicate in their plans and background material that they have a high degree of engagement of utility companies (90%) and secondly the public in general (65%).**

### Stakeholder engagement

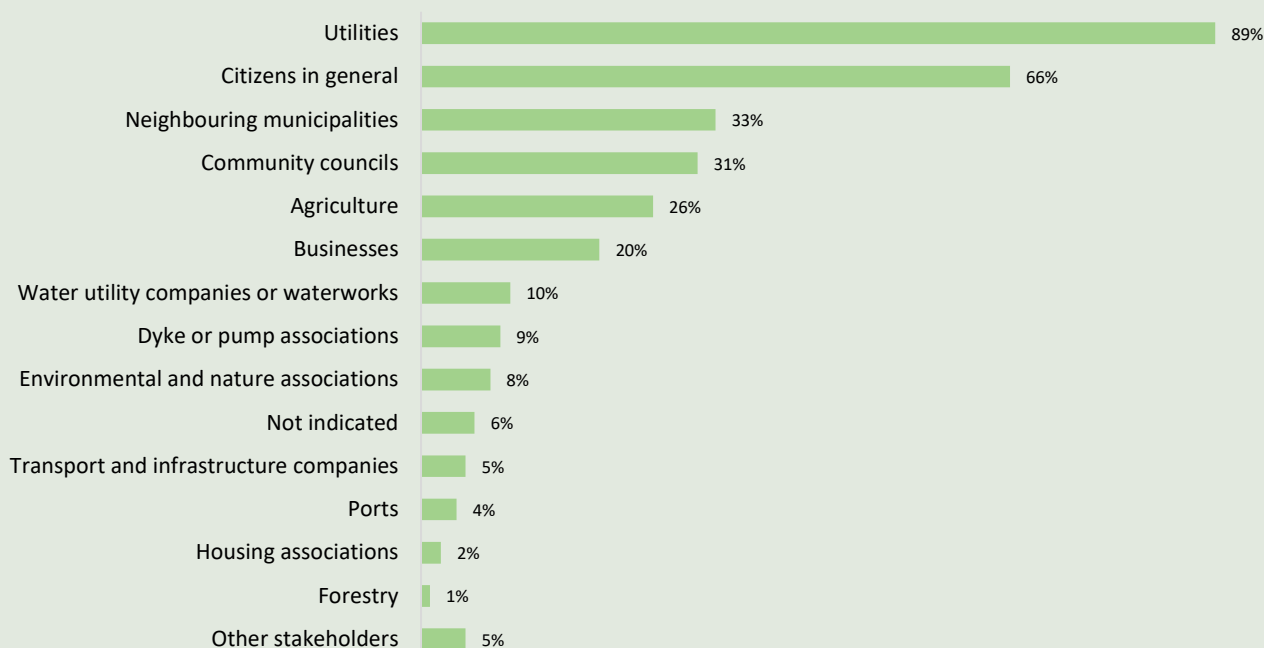


Figure14: Engagement of external stakeholders. 'Other stakeholders' includes the construction sector in one municipality and a few municipalities engage local associations, youth councils and educational organisations, as well as national institutions such as the Geological Survey of Denmark and Greenland (GEUS), the Danish Agency for Data Supply and Infrastructure (SDFI) and the Danish Coastal Authority.

33% engage neighbouring municipalities, 33% community councils, 27% agriculture and 19% businesses. Forestry, water utility companies or waterworks, dyke or pump facilities, environmental organisations and nature associations, transport and infrastructure companies, ports and housing organisations are engaged to a lesser degree (see figure 14).

Other stakeholders include the construction sector (in one municipality) and (in a few municipalities) local associations, youth councils and educational organisations, as well as national institutions such as the Geological Survey of Denmark and Greenland (GEUS), the Danish Agency for Data Supply and Infrastructure (SDFI) and the Danish Coastal Authority.

Further to this, the municipalities have worked with different types of engagement for external stakeholders (see figure 15).

**There is particular focus on hearings (34%), citizen meetings (47%), information material (29%), workshops (27%) and meetings with external stakeholders (29%).** Fewer use direct dialogue, digital platforms and questionnaires. Other types of engagement used include climate citizens' panels, green ambassadors, citizen labs, report a flooding event and various app solutions. It is interesting that the most common actions by municipalities (citizen meetings and consultations) are characterised by one-way communication, at which citizens are often merely informed and consulted, although they do not actively contribute to the process. On the other hand, use of dialogue and participation-promoting types of engagement, with focus on mutual knowledge exchange and meaning-making, is more limited. For example, only few municipalities use climate citizens' panels, citizen labs, and dialogue, which are types of engagement that activate citizens more and allow them to influence projects.

**Municipalities highlight the wider benefits of climate action at different levels**

The DK2020 plans have to consider wider benefits, set goals for these, and describe how actions in the plans can help to achieve these benefits. The objective is for these goals to contribute to cementing climate action as an integral part of a municipality's agenda and mobilise resources across the administration to achieve common gains. In this way, a municipality can create a cohesive climate narrative in its climate action.

Identification of wider benefits can therefore potentially achieve more value for the same monetary investment.

**The most frequently mentioned wider benefits from climate adaptation are nature and biodiversity, as well as leisure and recreation, and 84% and 68% of municipalities mention these, respectively. Next come health benefits (45%), synergy with greenhouse gas reduction (39%), business development (15%), tourism (15%) and security (8%).** Fewer municipalities mention wider benefits related to urban development, schools and education, the social area, communities, sustainability, food, innovation, the aquatic environment, cultural heritage and multifunctionality.

**Internal engagement of the municipal organisation**

The analysis examined which administrative areas the municipalities mention as being engaged internally in the municipal organisation (see figure 16).

Internally in municipalities, developing climate adaptation plans/documents involves in particular entities responsible for technical/environmental works and for planning, as well as emer-

**External engagement approaches**

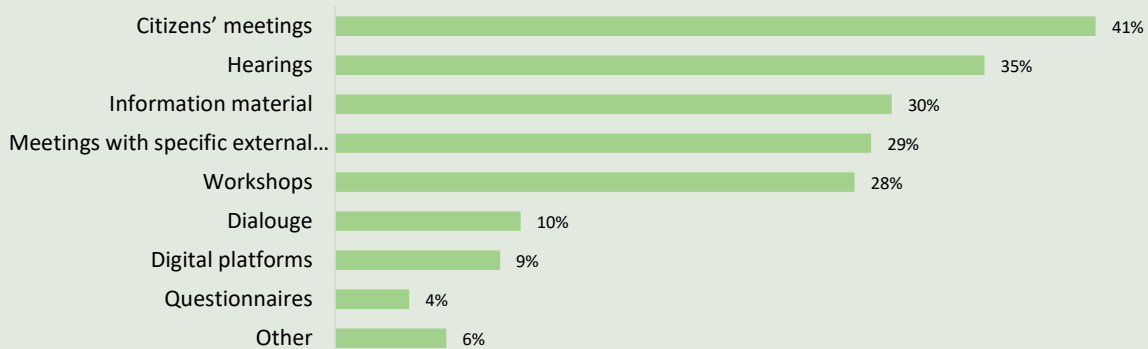


Figure 15: Types of engagement in the municipalities' DK2020 material.



### Internal engagement across administrative areas in the municipality

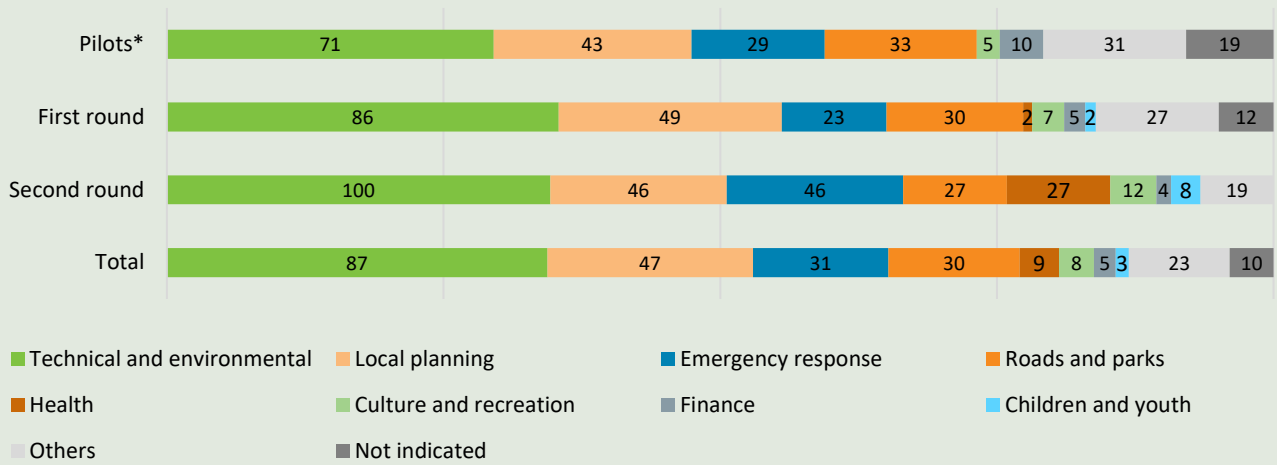


Figure 16: Internal engagement of the municipal organisation in each round in the project. As a percentage per administrative area. Other administrative areas include business services, the social area, procurement departments, green transition and IT/data/digitisation. \*Pilot municipalities including the City of Copenhagen.

gency response and preparedness. Roads, health, culture, and children and youth departments are less engaged. The analysis shows that there has been a development from pilot municipalities to round 2 municipalities, all of which engage internal partners. Furthermore, health departments are much more likely to be engaged in municipalities that have drawn up plans later in the project. These stakeholder-engagement activities have mainly taken place as preparatory planning and project work prior to, and as the basis for, the DK2020 plan.

### Internal engagement and links to other plans in the municipality

It is important for overall climate adaptation (and greenhouse gas reduction) that these actions are incorporated in the municipality’s other planning. The analysis therefore examined what other municipal plans are referred to in the DK2020 climate adaptation documents (see figure 17).

**92% of the municipalities refer to the municipal development plan, 88% to the wastewater plan and 69% to another climate adaptation**

### Relationship to other municipal plans

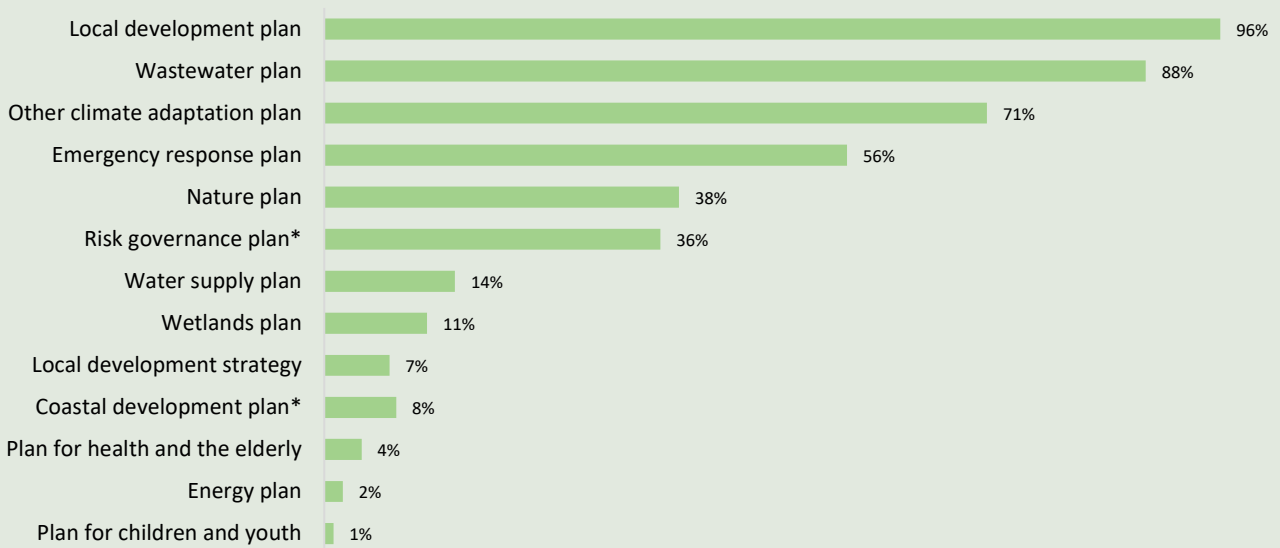


Figure 17: Other municipal plans referred to in DK2020 climate adaptation plans (multiple responses possible). \*As a percentage of the total number of coastal municipalities.

**plan (including climate change adaptation plans from 2013-2015).** Slightly more than one-half of municipalities refer to the emergency response plan, and several municipalities include a nature plan (40%) and coastal municipalities include risk management plans (33%). 20% of municipalities mention water utilities plans, 10% river basin management plans and 7% refer to the planning strategy. A small number of municipalities integrate climate adaptation in sector plans such as an energy plan, plans for children and youth, etc. Individual municipalities refer to watercourse regulations, action plans for the protection of groundwater, the regional development strategy, as well as a number of thematic plans such as the area development plans for watercourses (e.g. Gudenåen, Ryå, Harrestrup å, Skive å), urban development plans, climate plans (CO<sub>2</sub>), strategies for land use, etc.

**Many municipalities refer to their climate adaptation plans from 2013-2015.** An aggregation of municipalities' climate adaptation plans from 2013-2015 (1st generation plans) shows that **only 11 out of the 98 municipalities updated their climate adaptation plans prior to the launch of the DK2020 project in the individual municipality.** Of course, it is possible that some municipalities postponed updating plans in order to link with DK2020, but nevertheless it is notable how few of the municipalities updated plans at their own initiative. Some municipalities continued work on sector plans and specification plans, but none of these resemble a strategic plan for climate adaptation.

One municipality stated: ***“Had we not been part of DK2020, we would not have had a new climate adaptation plan. It has triggered greater political awareness”*** (municipality #8, Annex 2).

#### **One third of the plans engage neighbouring municipalities**

Water knows no municipal boundaries and coastal stretches run across municipalities. It has therefore been examined whether, and in what contexts, neighbouring municipalities are engaged. 33% of the plans mention directly that neighbouring municipalities have been engaged. **Of the municipalities which engage neighbouring municipalities, 19% do so for coastal stretches, 26% for river basins and 5% for wastewater catchment areas.**

Engagement of neighbouring municipalities with regard to wastewater catchment is only among capital municipalities. Capital municipalities generally have a significantly lower geographical size than other Danish municipalities, and wastewater companies are typically responsible for stormwater drainage systems for more than one municipality and/or systems are connected or dependent on each other across municipalities and possibly across wastewater companies.

Municipalities that also develop risk management plans more commonly than other municipalities engage their neighbouring municipalities in actions targeting coastal areas. This also applies to municipalities that have participated in development projects. This is particularly evident with respect to river basins.

#### **Summary of engagement and wider benefits**

Climate adaptation should be considered in the context of the place and the people affected by climate change, and in the context of the solutions chosen. Although municipalities have engaged a large number of stakeholders and taken several approaches, there is a huge potential to improve both internal and external stakeholder engagement.

Moreover, it is important to ensure that climate adaptation actions are coordinated with other related policy areas and priority agendas in the municipality. Climate change strikes very broadly, and therefore solutions will also range broadly in collaborations across all sectors and authority areas. If different agendas and wider benefits are not incorporated in projects, municipalities could miss opportunities for interplay between actions. Identification of wider benefits can therefore potentially achieve more value for the same monetary investment. Moreover, municipalities should consider how to engage external stakeholders in the local community, so that they ensure actual dialogue, mutual knowledge exchange and support for local actions. There is potential in supporting municipalities in their work on internal and external cooperation in the next revision of climate action plans.

Some climate adaptation actions cut across municipal boundaries or can potentially be incorporated with other projects by other municipalities. This applies in particular to projects in river basins, where municipalities located upstream can facilitate the task of the flood-threatened munic-

ipalities located downstream. However, municipalities with adjoining coastlines can also benefit from common projects, as in Køge Bugt Strandpark.

Only 11% of municipalities have updated their climate adaptation plans from 2013-2015. Therefore, it is important that, in the same way as greenhouse gas reduction, climate adaptation is followed up regularly through monitoring, evaluation and revision of the plans. There may be a risk of losing knowledge and experience if ongoing updates are not ensured, as was seen in some municipalities after the 1st generation of climate adaptation plans.



# 7. International perspectives

Climate zones move, and climate challenges that were previously talked about in southern Europe are now knocking at doors in Denmark. Through the DK2020 project, Danish municipalities have drawn up plans based on international standards for climate action plans compatible with the Paris Agreement.

The project has given municipalities a solid foundation to inspire other municipalities across the world. However, there is still a lot to learn from other countries and international collaboration. Denmark also has a unique opportunity to streamline its actions with the European climate adaptation agenda.

## What can other countries learn from DK2020 and Danish actions?

The DK2020 project is based on international experience through the C40 Cities network. By taking outset in international experience, Denmark now has a map of municipalities that have taken the first steps towards developing Paris Agreement-compatible climate action plans. DK2020 has engaged urban, rural, coastal, inland and small-island municipalities. Therefore, CONCITO and the partners in the project have extensive experience in mobilising preparation of climate action plans that are compatible with the Paris Agreement for both large cities and small urban communities.

It is unique that a philanthropic initiative through Realdania has managed to mobilise an entire country to draw up climate plans. It has not been possible for the authors to find similar initiatives abroad with the same scope. It would be interesting to examine in more detail the mechanisms that have been instrumental in encouraging almost all municipalities to join the DK2020 initiative. Nevertheless, it shows that the climate is such an important agenda locally, that there is

more local political willingness and courage to support municipal climate efforts than previously.

Furthermore, one of the requirements for developing a good plan is a solid knowledge-based foundation for decisions. Denmark is at the forefront in accessible and open data with a high level of detail, and Denmark has good public screening and decision-making tools for flood mapping. This is relevant for other countries throughout the world, and Denmark has a good export potential in this context.

## What can Denmark learn from other countries?

**Climate adaptation is closely linked to spatial planning and with the climate change facing Denmark,** some (difficult) choices have to be taken as to whether exposed areas should be protected against flooding, returned to nature or otherwise be made more resilient.

For example, Denmark can look to the Netherlands and Dutch experience with dynamic adaptive planning that has also been introduced in a Danish context in Realdania's programme *Byerne og det stigende havvand* (Realdania, 2023). The Netherlands is comparable with Denmark in many ways in relation to climate adaptation, although Denmark has a longer coastline, which to a higher degree than in the Netherlands is dominated by exposed dynamic coasts. Denmark has not yet implemented measures to deal with water to the same degree as the Netherlands. Denmark must, however, consider seriously whether climate adaptation should be carried out in the same way as in the Netherlands, which, to a large extent is protected by large technical installations with dykes, sluices and pumps, or whether Denmark should focus more on nature-based solutions, and/or leave nature entirely to its own devices in some areas. Nevertheless, there are

many specific solutions and approaches to inspire Danish municipalities. The dynamic adaptive method can also be included in further planning of climate adaptation in Denmark (Danish Coastal Authority, 2020b).

**Nature-based solutions (NBS)** have been defined by the International Union for Conservation of Nature (IUCN, 2020) as “*actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature.*” Nature-based solutions to societal problems such as climate-related flooding are therefore solutions based on nature’s own functions, and include, for example, wetland restoration. Norway and Sweden have embraced this concept to a higher degree than Denmark. Norway even has an explicit statutory requirement in some planning guidelines to consider the use of NBS. The other Nordic countries sometimes use other terms than NBS in their policies and guidelines, for example ‘blue-green infrastructures’, ‘restoration’ or ‘ecosystem services’ (Sandin et al., 2022). Denmark lack addressing biodiversity and the dynamic adaptive method in climate adaptation and does not use the term nature-based solutions. However, it is a general trend among all of the Nordic countries that nature-based solutions is only sparsely addressed (Gram-Hanssen, 2023).

**Financing** is already a great challenge today, and the need for investment in construction projects will only increase in step with future climate change. Furthermore, the scale of extensive, sometimes irreparable, damage will also increase as temperatures increase. The IPCC report on impact, adaptation and vulnerabilities confirms that climate adaptation action up to the present has been incremental and sometimes even *mal-adaptive* - in other words poorly planned investments that will be difficult and expensive to rectify (IPCC, 2022).

There is a need to improve adaptation financing and infrastructures for financial incentives across the Nordic countries (Gram-Hanssen et al., 2023). Denmark is strong in some areas, including in particular with regard to climate adaptation actions targeting rainwater management, which can be financed through taxes and charges by wastewater utility companies.

The storm surge in October 2023 and the government’s presentation of its Climate Action Plan 1 (Danish Ministry of Environment, 2023) spurred media coverage about the need for multiannu-

al pools or permanent national funds to finance climate adaptation (see for example CONCITO ). The government and private stakeholders must work together to close the financial gap between the adaptation measures needed and the funding available. This calls for an examination of international experience with both governmental and non-governmental financing.

CONCITO (2017) has presented several financing models from the United Kingdom, the Netherlands and the US that remain relevant as inspiration for all of Denmark.

**Heatwaves and droughts are new challenges** in a Danish context. Northern Europe has an increasing need for cooling solutions, for example in light of a new study from the University of Oxford (Miranda, et al., 2023). This study emphasises that relative change in the number of unpleasant warm days will be most prominent in Northern Europe, with Denmark in a ninth place. This will cause major adaptation challenges in regions that, traditionally, have not been at all prepared for challenges with more warm spells and heatwaves (Miranda, et al., 2023). The increasing need for cooling globally led the UNEP to launch the *Cool Coalition* initiative in 2019. Cool Coalition is a multi-stakeholder global network aiming to reduce the need for mechanical cooling; to promote a shift to low-emissions cooling and cooling based on sustainable sources; to improve the efficiency of cooling; to protect vulnerable people with no access to cooling; and to leverage cooperation between different actors to achieve greater collective impact (Cool Coalition 2022). This initiative is worth monitoring to forge the best and most efficient solutions when warm spells and heatwaves occur in a Danish context.

Denmark can also learn from neighbouring European countries with regard to working with climate hazards such as heatwaves and droughts. There is much to learn from central and southern Europe. For example, Paris prepared an urban heat plan using blue and green structures for cooling that can be planned in parallel with climate adaptation in a Danish context as well. There is also experience from southern Europe and the US on agricultural production in periods with little precipitation.

**Citizens and property owners**, according to international literature, are the primary stakeholders for implementing adaptation, and in a review study of 1,682 scientific articles on stakeholders’ role in climate adaptation Petzold et al. (2023) find some interesting patterns regarding stake-



holders and the roles they perform. The strong evidence for citizens and property owners as primary stakeholders for actual adaptation is in line with previous research, which concludes that adaptation is often a highly localised phenomenon, with a tendency to autonomous and incremental adaptation (Petzold et al 2023).

Engagement of different stakeholders and citizens is repeated across all climate adaptation plans. As described in Chapter 6, the most common engagement approaches are classic hearings and meetings, which are often based on one-way communication, or place citizens in a passive role. There is already good experience in the area in Denmark, see for example Hoffmann et al. (2015) for examples within climate adaptation, and besides this there are other, more inclusive, traditions abroad, e.g. in the US.

**Danish national adaptation planning overall should be seen in the context of the EU climate change adaptation strategy and guidelines for Member States' climate change adaptation strategies and plans**

The European Commission has prepared a single European strategy on adaptation to climate change with a common vision for the EU to become a climate resilient society by 2050 (European Commission, 2021). The objective of the

strategy is for the EU to meet the targets of the Paris Agreement to strengthen capacity to manage climate-change impacts through adaptation and greater resilience, and it should be seen in the context of European Climate Law (EU, 2021), which builds on the Paris Agreement. The common European adaptation strategy puts into words the scope and complexity of strategic work towards a climate-resilient Europe. The strategy requires a broad systemic understanding when implementing climate adaptation policy and that such implementation should be integrated with other European Green New Deal initiatives.

In 2023, the European Commission presented guidelines for preparing national adaptation strategies and plans. These guidelines aim to make sure that adaptation is a top priority on the political agenda (European Commission, 2023). It is anticipated that Member States will adopt an interdepartmental approach to designing policies for climate adaptation. This should be by breaking down the silo structure between governmental sectors and by developing a clearly worded policy cycle with ongoing monitoring and evaluation of all adaptation actions. In DK2020, the Danish municipalities have built up experience with these principles on which to build further. The government should aim to prepare the next national climate adaptation plans in line with these frameworks, in the same way as the municipalities.

# Literature

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## ANNEXES

**Annex 1:** Document analysis: Analysis of DK2020 climate adaptation plans prepared by NIRAS in collaboration with CONCITO for Realdania, October 2023. *Citation: Wejs, A. 2024. Indholdet i DK2020 klimatilpasningsplanerne - Dokumentanalyse. NIRAS. CONCITO.*

**Annex 2:** Insights from qualitative interviews. Behind the municipalities' DK2020 climate adaptation plans. NIRAS in collaboration with CONCITO for Realdania, September 2023. *Citation: Wejs, A., Olsen, C.H., Eriksen, M.H. 2023. Bag om kommunernes DK2020 klimatilpasningsplaner - Indsigter fra kvalitative interview. NIRAS. CONCITO.*

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