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Scenarios of Future Land Use in Denmark

How to accomondate goals for climate change mitigation, the aquatic environment, and biodiversity

Published April 2024

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1

Danish Council on Climate Change: main conclusions

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Biodiversity and the aquatic environment should guide spatial planning

- Biodiversity and the aquatic environment must be conserved in specific areas in Denmark to yield the greatest benefits for society. However, for climate change mitigation, the location of forest planting is not as crucial – the important aspect to meeting climate goals is to increase forestation regardless of where the forest is located.
- When land use is planned with biodiversity and the aquatic environment in mind, significant climate gains are also achieved. This means society can advantageously coordinate land use based on biodiversity and aquatic environment goals. The designation of areas should be done centrally but implemented locally.
- The timing of initiating individual measures on land use also has significant importance in achieving synergy between different policy areas. This means that the efficiency of transition measures depends on how quickly they are initiated and implemented and not only on the type of transition elements and their location.

Danish Council on Climate Change’s main conclusions

Biodiversity and forests should occupy more of the landscape

- Currently, agriculture covers the majority of the Danish landscape. This provides a certain level of economic activity and employment in the sector but also puts pressure on the climate, the aquatic environment, and biodiversity.

- The analysis shows that the goals for climate change mitigation, the aquatic environment and biodiversity can all be achieved if the area used for agricultural production is reduced by approximately one-third, and at the same time, more unmanaged forests are created in the existing production forests.

- Agriculture and the food industry do not necessarily need to occupy less space in the national economy if the sectors can successfully transition towards a greener future.

Danish Council on Climate Change's main conclusions

The costs of a coordinated effort for climate change mitigation, the aquatic environment, and biodiversity are modest.

- From a societal perspective, the lost earnings in agriculture and forestry are relatively modest when the objectives are to be met. When land use is planned with a focus on achieving biodiversity and aquatic environment goals, the total direct costs amount to approximately DKK 2.8 billion annually in terms of lost revenue. The DKK 2.8 billion primarily stem from reduced food production and reduced amounts of feed for livestock production.
- At the same time, a significant climate benefit of almost 7 million tonnes of CO_2 equivalents per year is achieved. This corresponds to a total direct cost of approximately DKK 400 per tonne of CO_2 equivalent. Additionally, the significant societal benefits of an improved aquatic environment and increased biodiversity are not included, which would reduce the costs from a societal economic perspective if they were included. Likewise, the cost estimations in the analysis do not include the increased recreational opportunities in nature that might arise from land-use changes, which, if included, would also reduce the costs from a socio-economic perspective.

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2

What we have done

The analysis focuses on climate change mitigation, the aquatic environment, and biodiversity...

- The Danish Council on Climate's analysis tackles three major climate, environmental, and nature-related challenges that Denmark faces in the coming years:
  - **Climate change mitigation.** To limit greenhouse gas emissions in accordance with the goals of the Climate Act.
  - **Aquatic environment.** To limit the loss of nitrogen to the inland Danish waters achieving good ecological status
  - **Biodiversity.** To make room for diverse biodiversity in line with the EU's strategy that 30 pct. of the land area should be protected nature with no production activities.

... and how they are best solved together

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Three scenarios in the analysis

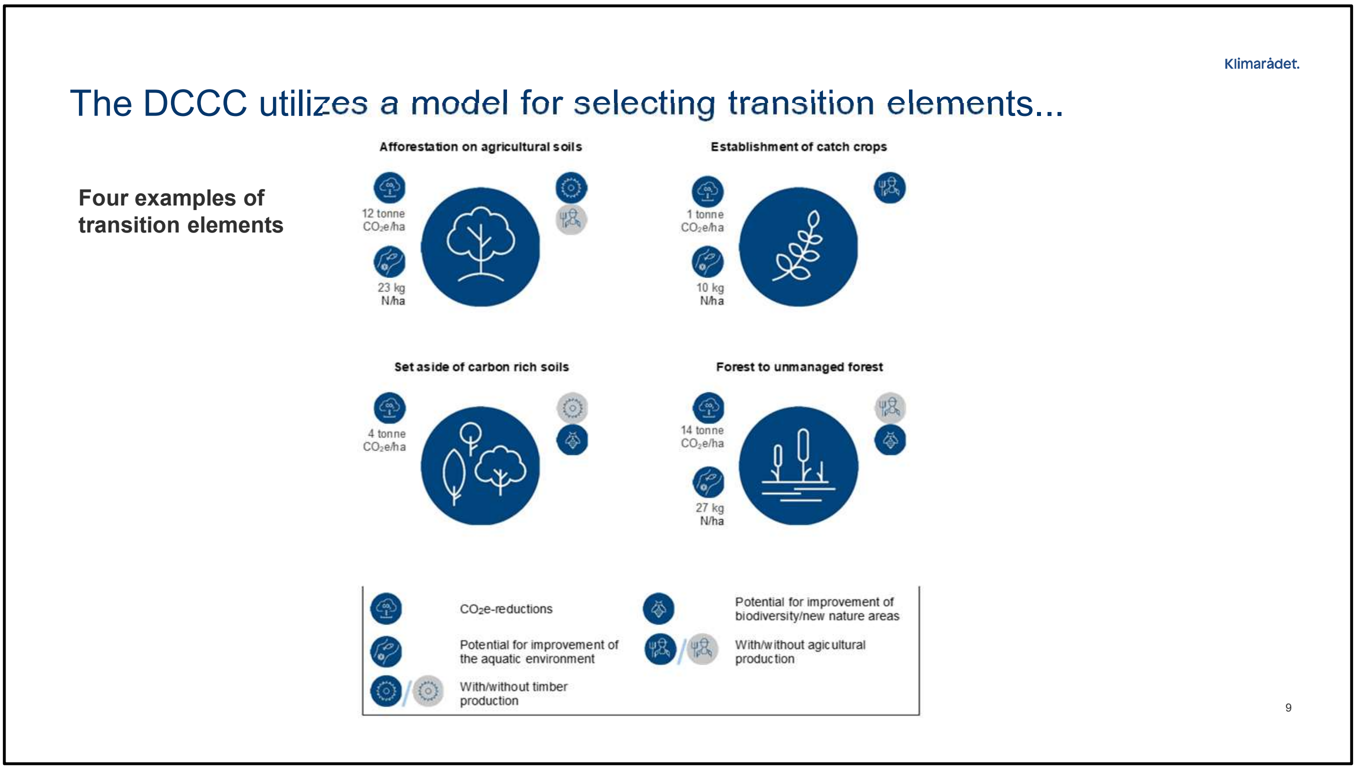
Scenario	Description
Climate scenario	Net-zero emissions from the areas
Climate and aquatic environment scenario	Climate and aquatic environment objectives along with goals for afforestation and unmanaged forest
Biodiversity and aquatic environment scenario	Biodiversity and aquatic environment goals along with goals for afforestation and unmanaged forest

8

The three scenarios in the analysis

Note:
Afforestation and unmanaged forest are included in both the climate and aquatic environment scenario and the biodiversity and aquatic environmentscenario as goals. Additionally, they are also transition elements that the model can choose to fulfil the goals.

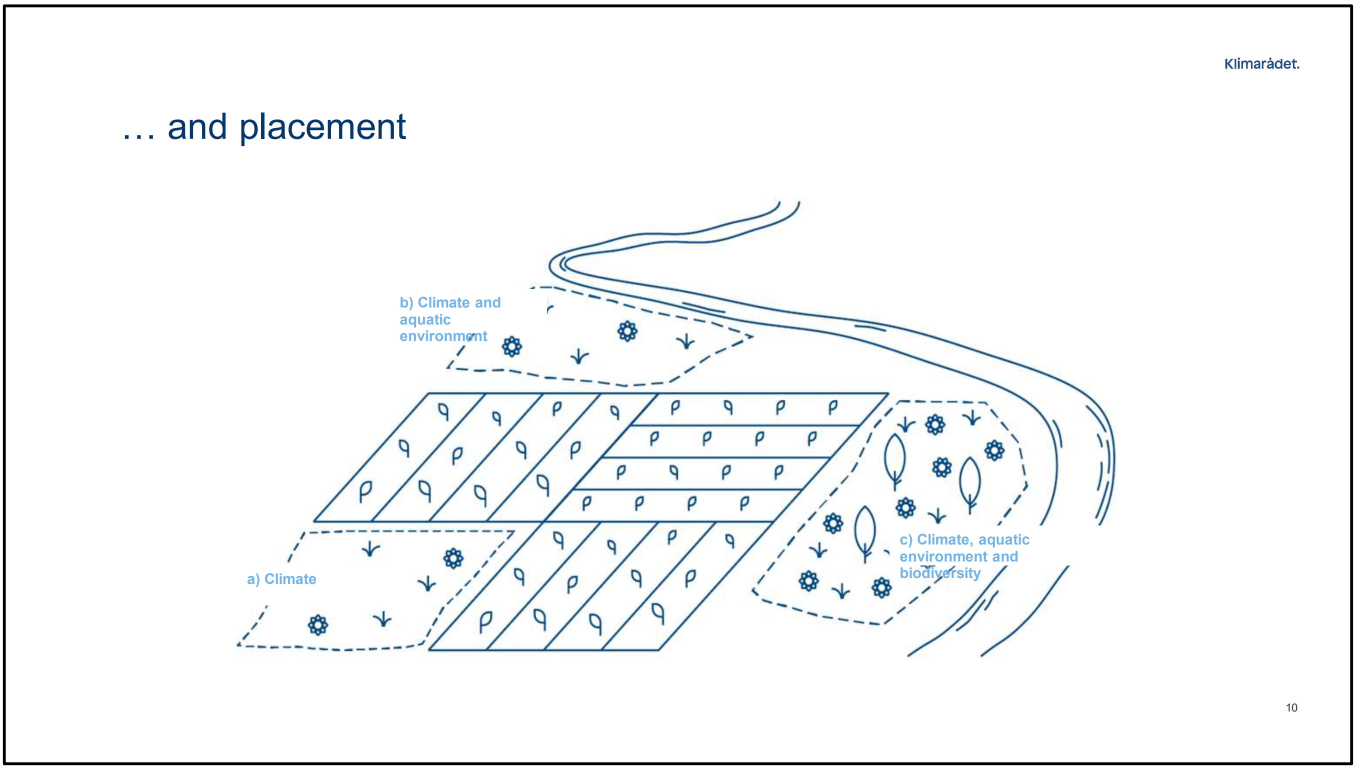
Source: The DCCC.



Four examples of how different transition elements contributes to different policy areas

Note:
Changes in land use, called transition elements in this analysis, can, for example, include the establishment of catch crops, afforestation, designation of unmanaged forest areas or the conversion of carbon-rich soils to wetlands. Note that, while afforestation and designation of unmanaged forest are goals in themselves, they are also classified as transition elements in the TargetEcon model, used in this analysis, when their effect on other goals is to be estimated.

Source: The DCCC.



Coordination of transition elements creates synergy effects between different policy areas

Note:
Example of the transition element ”conversion of agricultural land to area with no production”.
a) If used on location a: Only climate effect, as the placement give no effect on the aquatic environment nor biodiversity.
b) If used on location b: Climate effect and effect on the aquatic environment, as the geographic placement ensure an effect on the aquatic environment as well.
c) If used on location c: Effect on both climate change mitigation, the aquatic environment and biodiversity as the geographic placement also ensures an effect on biodiversity.

Source: The DCCC.

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3

More space in the landscape is needed for biodiversity, protection of the aquatic environment, and for afforestation.

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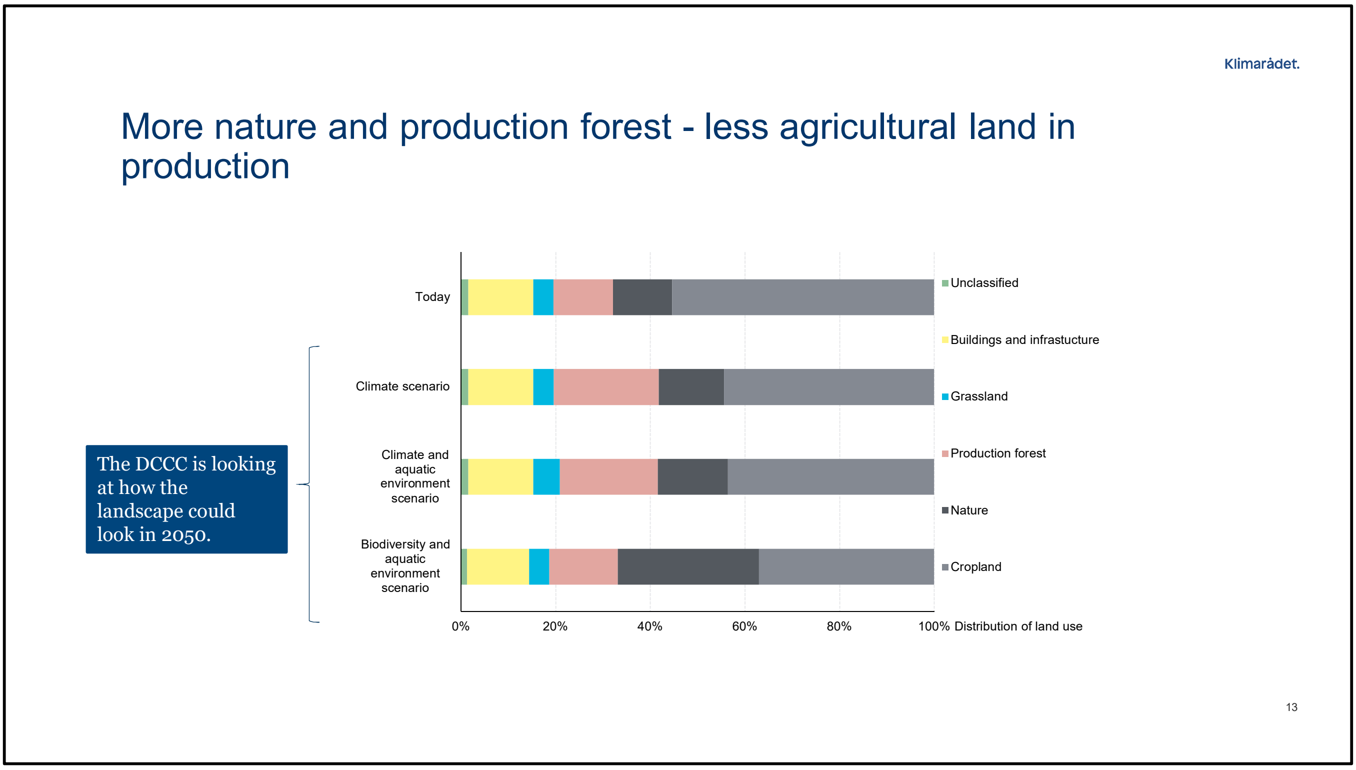
The analysis uses a net-zero target for land-based emissions of greenhouse gases

- As an illustrative target, the DCCC analysis uses a goal of ensuring emissions from Danish land area are net-zero by 2050. This corresponds to a reduction of 6.5 mil. tonnes CO2e in 2050 compared to today. This is based on the Danish Energy Agency's *Climate Status and Projection 2023*. Thus, it is not a politically adopted climate target.
- Denmark has an overall net-zero target for all greenhouse gas emissions in 2050 under the Climate Act, but the target is not distributed across sectors. However, it is likely that the land sector will need to contribute negative emissions in 2050. This is because Danish land areas have significant potential to sequester carbon in forests and soils.
- The net-zero target for land-based emissions set out in this analysis can therefore be seen as a minimum requirement for emissions from land use. In a forthcoming analysis, the DCCC will examine the need for carbon uptake in forests and soils in connection with national climate goals.

12



Danish land use distribution today and in 2050 in the three scenarios of the analysis

Note 1:
The Danish Biodiversity Council has estimated that 1.6% of Denmark's area is protected today. The 1.6% is included in the category "Natural areas, rivers and lakes including unmanaged forest".

Note 2: Unclassified denotes areas for which the datasets used do not contain information about land use.

Source: The DCCC and Biodiversitetsrådet, *Mod robuste økosystemer – anbefalinger til en dansk lov om biodiversitet,* 2023.

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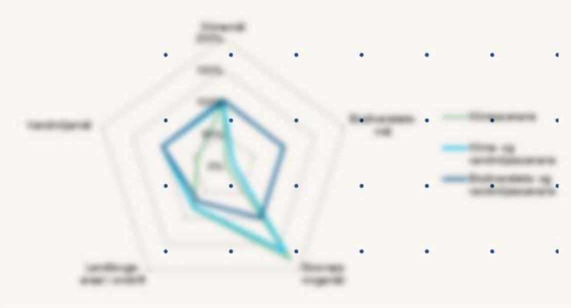
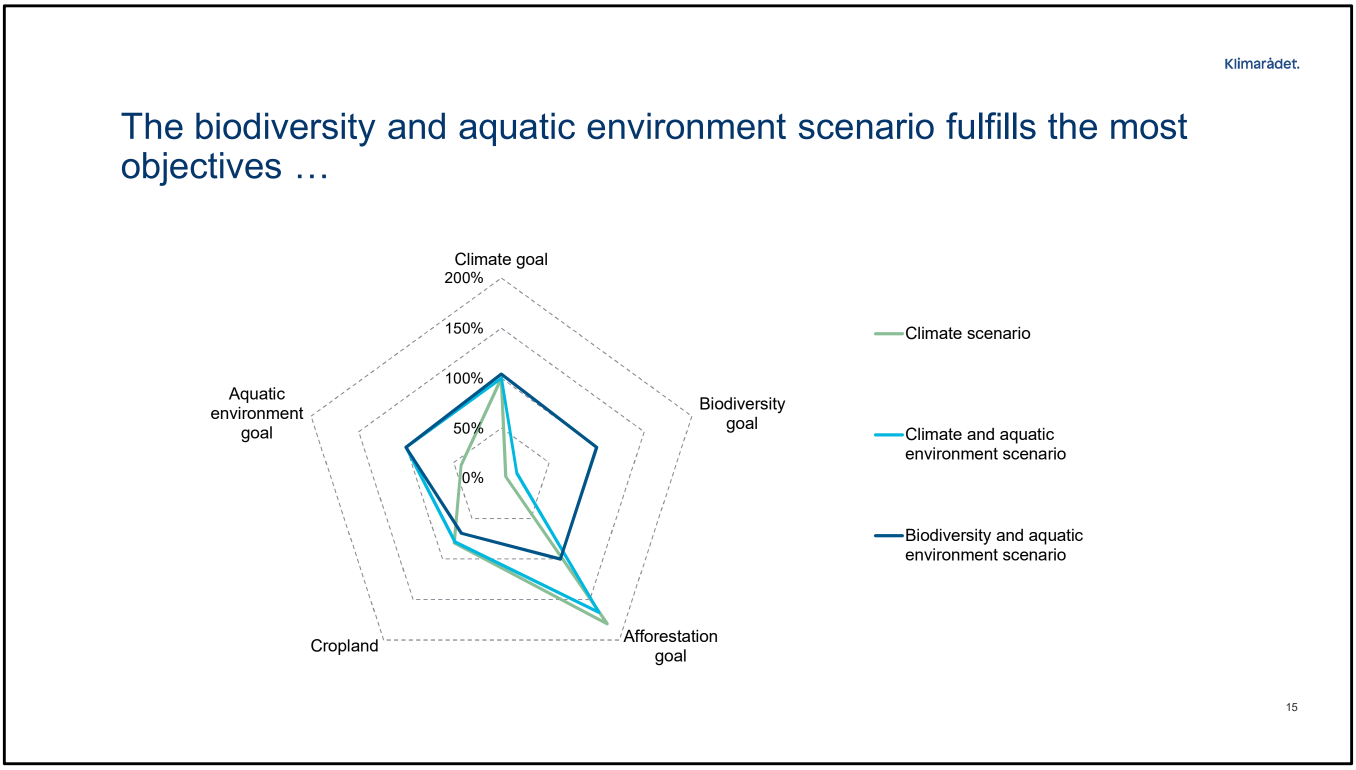
4



Biodiversity and the aquatic environment should guide spatial planning



Comparison of the three scenarios in the analysis across goals and changes in agricultural and forestry areas

Note 1:
The biodiversity goal is the area that is taken out of production in the scenario and is located within the designated biodiversity area. With an allocation of 30 percent of Denmark's area, equivalent to 1.26 million hectares, 623,228 hectares of land currently in intensive agricultural or forestry production would need to be taken out of production. The percentage is calculated in relation to the 623,228 hectares.

Note 2:
The aquatic environment goal is measured as the reduction in nitrogen emissions contributed by the scenario, out of a target in the aquatic environment plans of 12,955 tonnes of nitrogen.

Note 3:
The percentage contribution to the climate goal is calculated based on the number of tonnes of CO_2e contributed by the scenario in 2050 compared to an

emission of CO_2e from the areas in 2050 of 6.5 million tonnes of CO_2e. The climate goal is used as an illustrative goal for the areas.

Note 4:
Cropland is the proportion of agricultural land that remains under cultivation compared to the agricultural land in cultivation today. Thus, for example, in the climate scenario, 80 percent of agricultural land will still be under cultivation.

Source: The DCCC.

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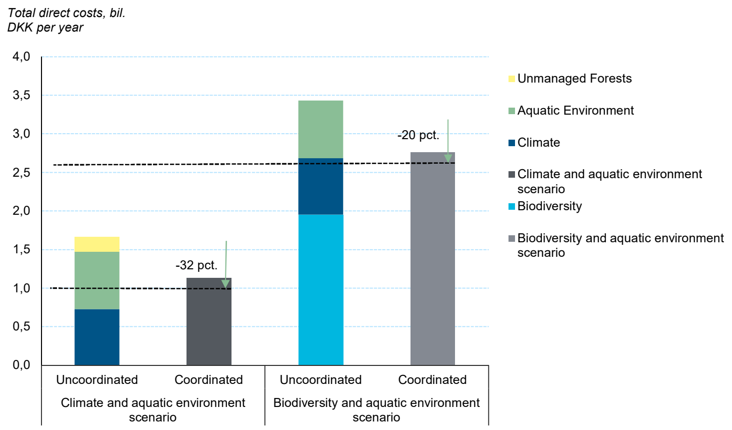
… and the costs are modest



	Total direct costs	Total direct costs per tonne CO_2e
	Million DKK	DKK per tonne CO_2e
Climate scenario	728	110
Climate and aquatic environment scenario	1,137	176
Biodiversity and aquatic environment scenario	2,761	409

16

Comparison of Costs with and without coordination of objectives for climate and aquatic environment scenario and the biodiversity and aquatic environment scenario

Note 1:
The figure shows the cost of meeting the objectives for climate change mitigation, the aquatic environment, biodiversity, forest expansion, and unmanaged forest individually. In column 1 and 3 the costs shown are for the example where the policy areas are uncoordinated, while the policy areas are coordinated in the columns 2 and 4.

Note 2:
The results are based on model runs of the different scenarios, allowing for a comparison of the individual objectives.

Source: The DCCC

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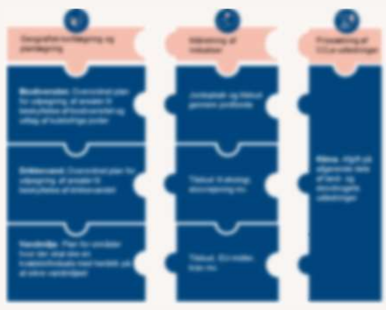
6



Regulation of the areas should be based on three pillars.

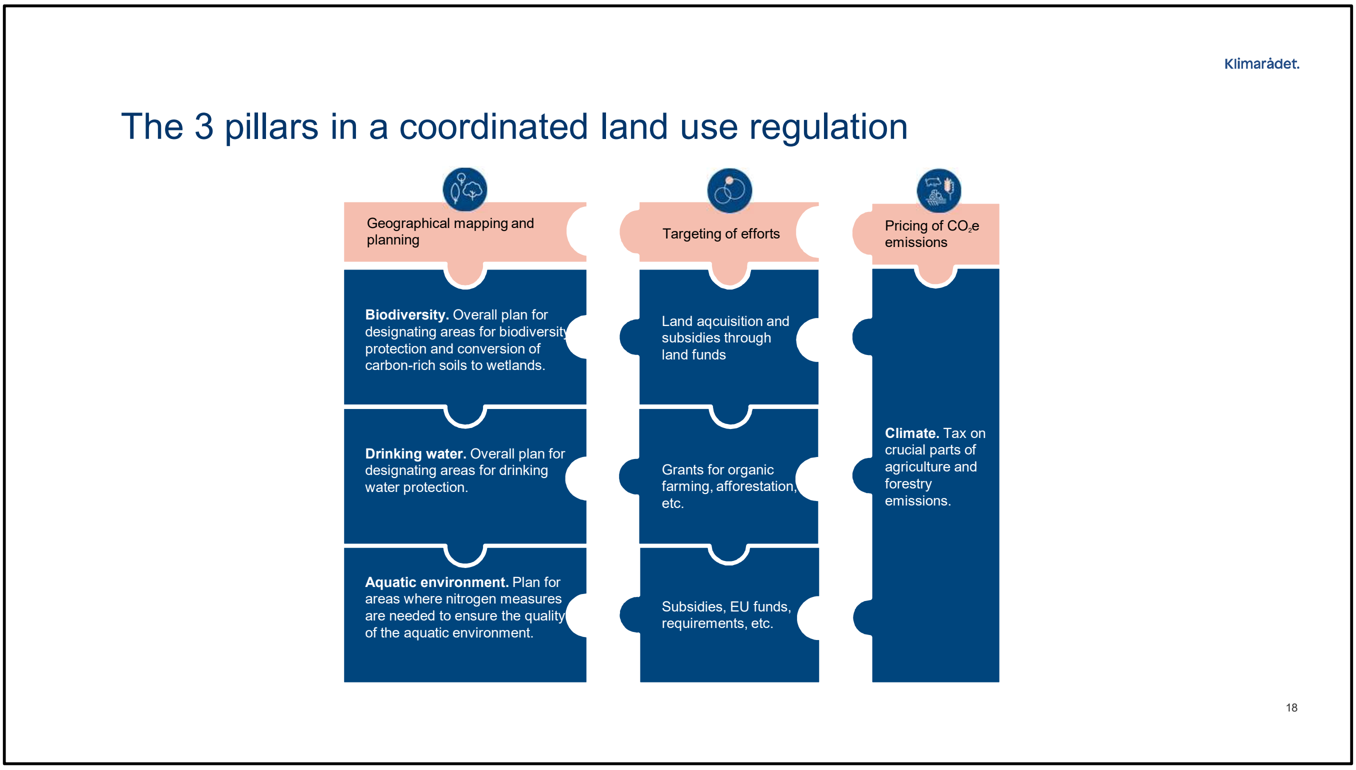


Illustration of a possible architecture for comprehensive regulation of land use

Note:
This is far from the first time that significant changes are needed in the management of Denmark's land area. The land ownership reforms at the end of the 18th century marked the beginning of major and decisive changes in ownership and property structure in agriculture, which still leave their mark on the landscape today. The many different desires and political objectives for the Danish land area mean that the Danish land area must undergo yet another major change. This DCCC analysis shows that the key to fulfilling these political objectives in a meaningful way is efficient and coordinated planning.

Source: The DCCC

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First pillar: Designation of areas

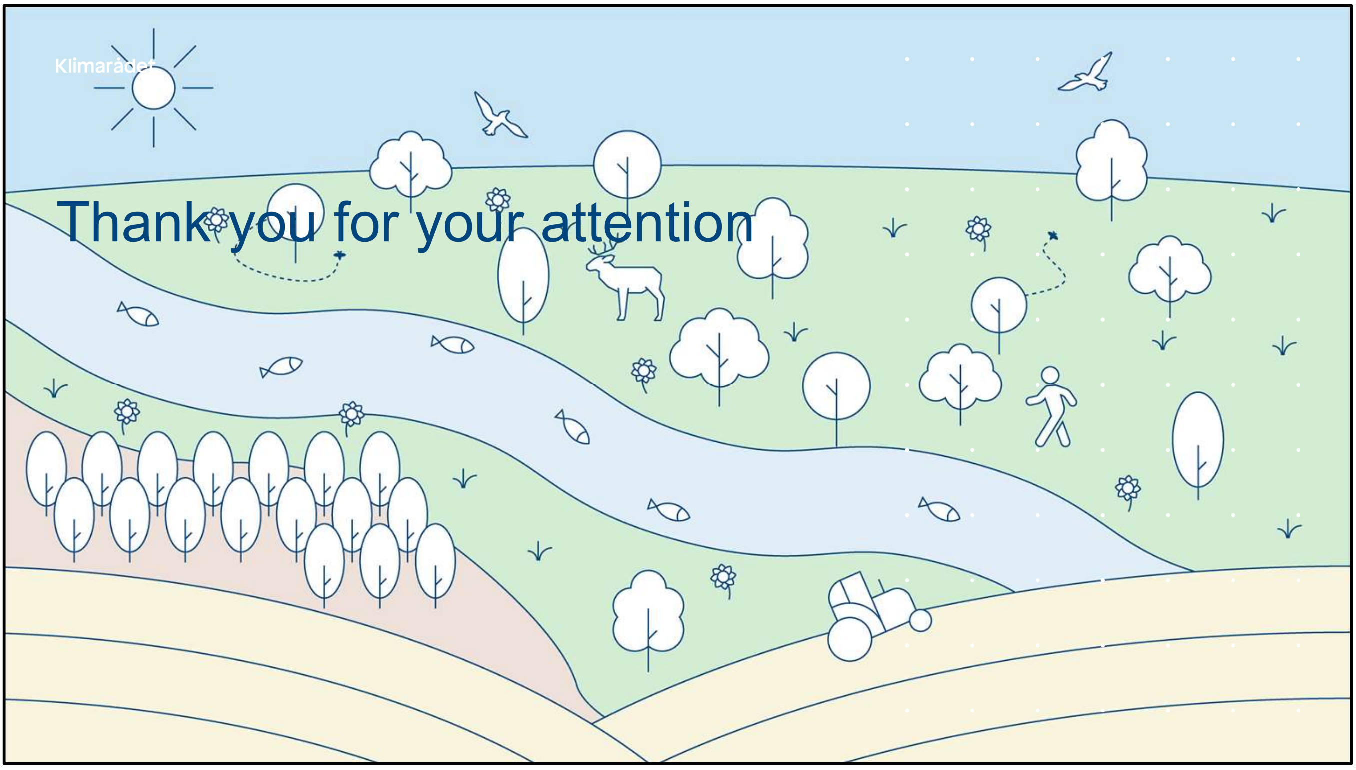
- Considerations such as the aquatic environment and biodiversity require geographic focus.
  - The Danish Environmental Protection Agency has designated areas that are particularly critical to the aquatic environment,
  - but a similar designation for biodiversity is lacking.
  - A targeted effort to enhance nature and wildlife requires the designation of coherent areas that have special value for this purpose.
  - Therefore, the government should ensure that areas reserved for biodiversity are designated promptly to allow for comprehensive spatial planning

Second pillar: Targeted efforts

- The designated areas should form the basis for targeted efforts to promote the desired land use for the benefit of, among other things, the aquatic environment and biodiversity. This can include schemes that promote afforestation or coherent natural areas through subsidies, auction schemes, or better coordination among different types of land funds.
- The schemes should reward efforts where synergies are greatest. For example, forests should be planted especially where this also benefits the aquatic environment. Many of these elements already exist in current regulations and should be continued and strengthened. It is also important that the schemes are designed to encourage prompt action.
- This is a comprehensive coordination task for the relevant authorities. It's not an easy task. But this makes it even more important to get started quickly.

Third pillar: Greenhouse gas tax

- In February 2024, the Expert Group for a Green Tax Reform presented models for how emissions from agriculture and land use can be effectively taxed. Although coordination of land efforts is important, the DCCC sees no hindrance to implementing one of the expert group's models as soon as possible.
- A tax on emissions from agriculture, especially livestock and fertilizers, will promote structural change and more efficient land use with less feed production, more afforestation, and conversion of carbon-rich land to wetland areas.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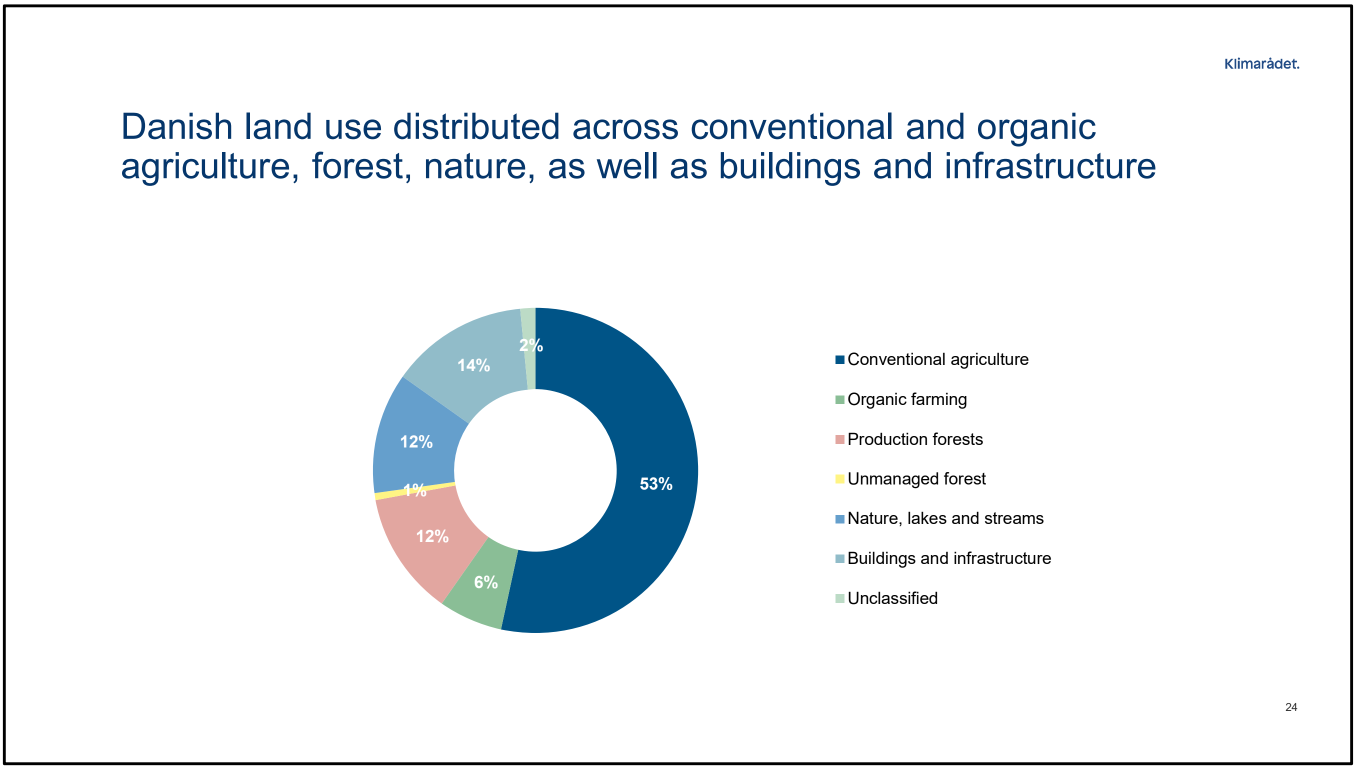
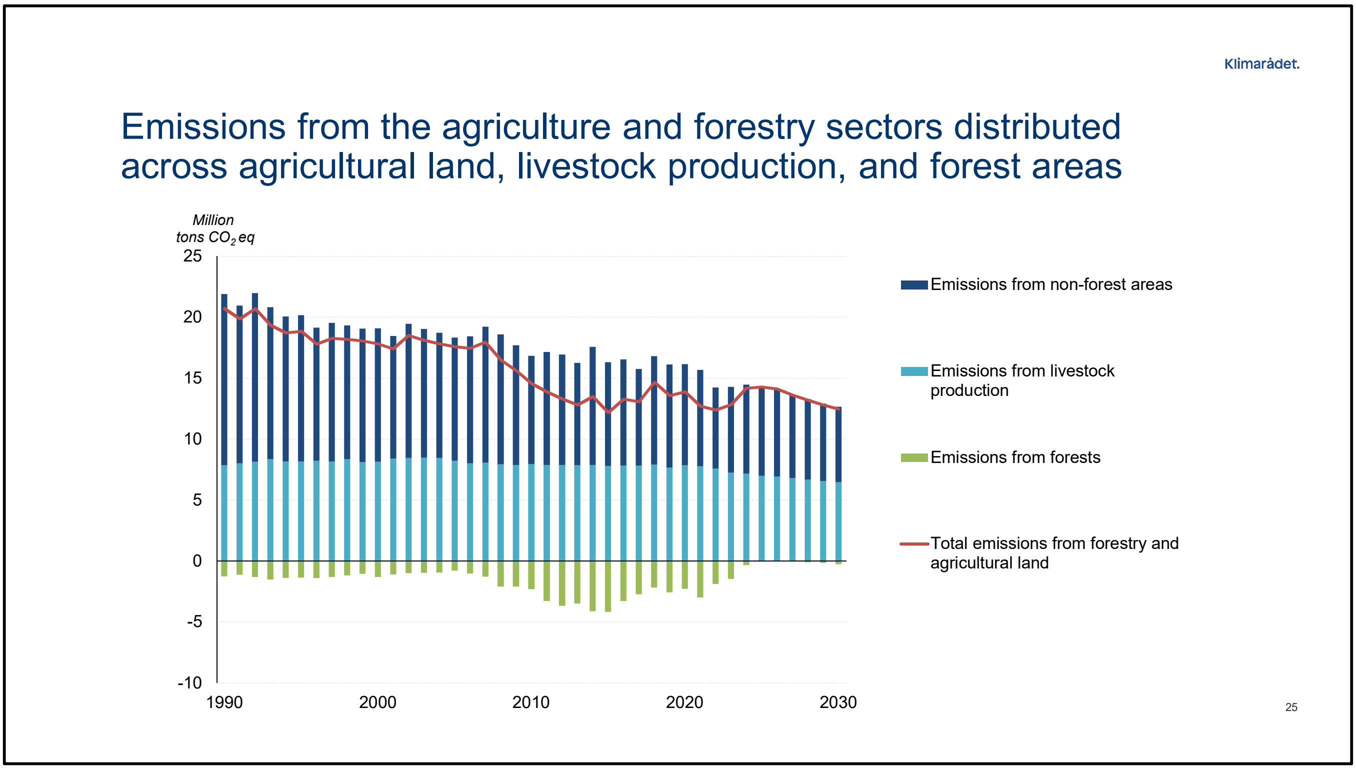


Land use in Denmark today divided into categories

Note 1:
The Danish Biodiversity Council showed in 2023 that 1.6% of the Danish land area can be classified as protected nature according to the definition in the EU's biodiversity strategy. This area is primarily found in the categories of unmanaged forest and nature, lakes, and streams.

Note 2:
Agricultural activities take place on a significant portion of the areas that are categorized as nature in the figure.

Source:
Levin, G., Technical documentation of the method for elaboration of a land-use and landcover map for Denmark, 2019, Aarhus Universitet.
Nord-Larsen, T., Johannsen, V. K., Riis-Nielsen, T., Thomsen, I. M., Bentsen, N. S., & Jørgensen, B. B., Skovstatistik 2021, 2023



Emissions from the agriculture and forestry sectors distributed across agricultural land, livestock production, and forest areas

Note 1:

The figure shows historical Danish emissions and the expected emissions up to 2030 based on current policies. The last historical year is 2021.

Note 2:

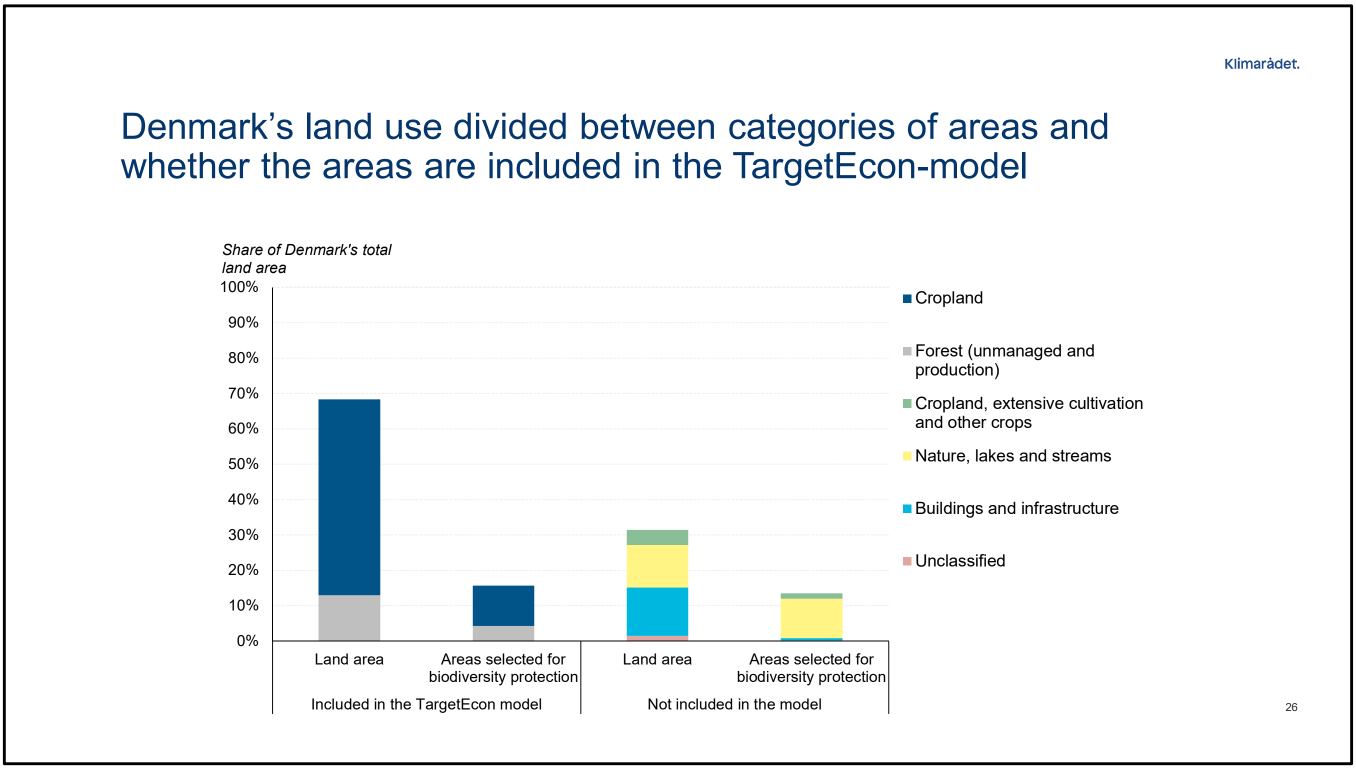
Emissions from the areas are adjusted with the latest revision of Denmark's total area of carbon-rich soils and the expected changes to the soils' emission factors. The procedure follows the method described in DCCC publication *Status Outlook 2024.* Emissions from the areas include nitrous oxide emissions associated with fertilizer application.

Note 3:

Emissions from the forests are negative due to a net absorption of CO2 in the forests.

Souce:

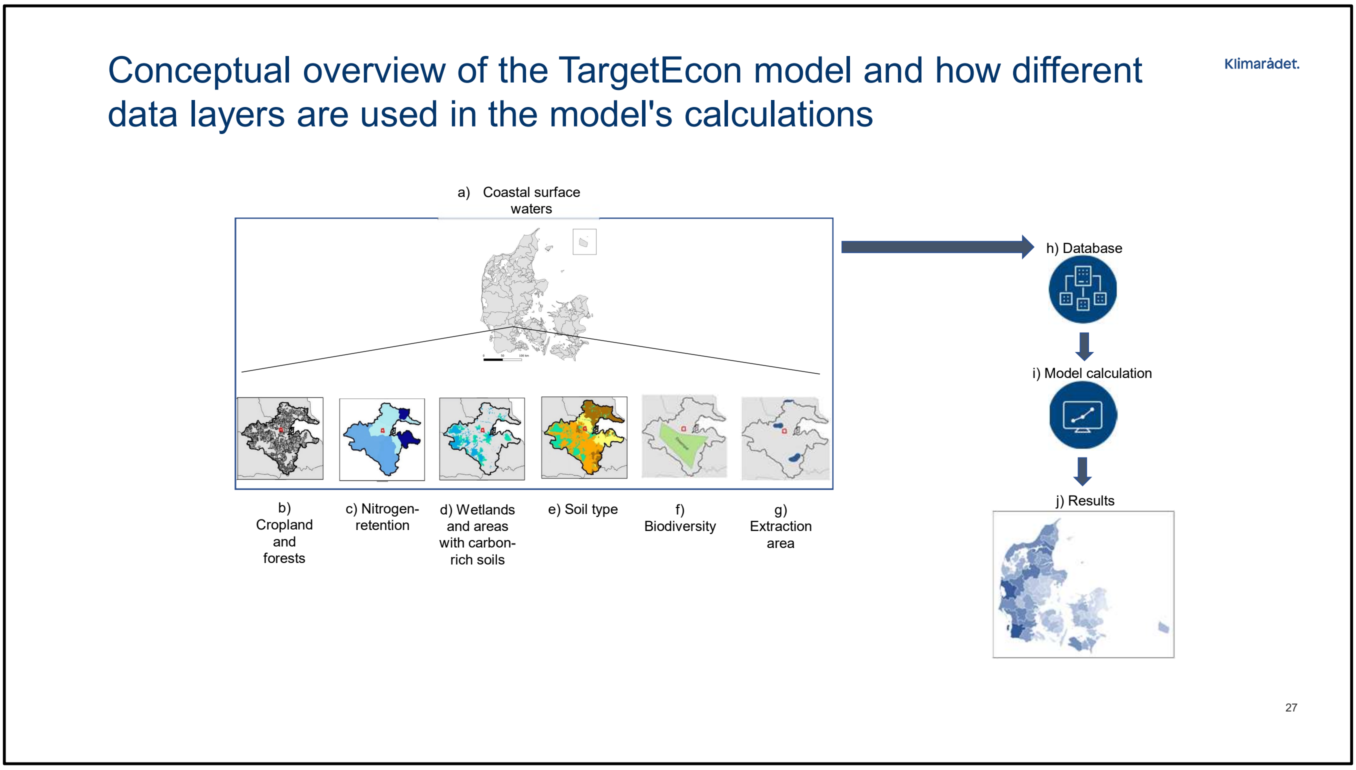
Klimarådet, *Statusrapport 2024 (https://klimaraadet.dk/en/report/status-outlook-2024),* Energistyrelsen, *Klimastatus og -fremskrivning*, 2023.



Denmark's land use divided between categories of areas and whether the areas are included in the TargetEcon-model.

Note:
The figure shows how the biodiversity area is distributed inside and outside the model. The biodiversity area is designated by the Danish Biodiversity Council for the DCCC for use in this analysis.

Source:
Biodiversitetsrådet, Mod robuste økosystemer – anbefalinger til en dansk lov om biodiversitet, 2023.
Levin, G., Technical documentation of the method for elaboration of a land-use and landcover map for Denmark, 2019, Aarhus Universitet



Conceptual overview of the TargetEcon model and how different data layers are used in the model's calculations

Note:
The figure shows how various data contribute to a database. The TargetEcon model extracts data from the database to perform a series of calculations, resulting in a final map. The different elements of the figure are described here:

Map (a) shows how Denmark is divided into coastal water catchment areas. These catchment areas pertain to the fulfillment of the EU Water Framework Directive, where each coastal catchment area has a nitrogen reduction target. There are a total of 108 coastal water catchment areas in Denmark.
Map (b) and (c) illustrate how a coastal water catchment area is divided into cropland and forests (b) with different nitrogen retention (c). Cropland and forest areas represent the smallest level in the model (the red square in the map). Nitrogen retention is a term used to describe the soil's ability to retain nitrogen from reaching the aquatic environment. The nitrogen retention indicates how much nitrogen is retained during transportation from the field to the sea. For instance, if the retention is 70%, it means that 30% of the nitrogen emitted from

the field ends up in the coastal water catchment area. Each field is assigned the retention applicable to the area in which it is located.
Map (d) and (e) illustrate how wetlands and carbon-rich soils (d) and soil type (e) are linked to the fields and forest areas. This information is known only for a larger area than the field (as seen in the red square) in the figure.
Map (f) illustrates the designation of contiguous areas with biodiversity potential. These areas are identified by the Danish Biodiversity Council and include areas that could be part of a comprehensive designation of 30% of Denmark's land area for protection of biodiversity. The area is only illustrated with a green figure as an example and does not represent a final designation.
Map (g) shows the extraction areas for drinking water supply, which together cover a total area of approximately 840,000 hectares, of which 430,000 hectares are included in the TargetEcon model with varying sizes.
Database (h) illustrates how all data, both field- and forest-specific and all other information, are stored in a database from which the TargetEcon model retrieves information for calculation **(i)**. If one imagines that all the maps are layered on top of each other, they could be used to provide comprehensive information on specific fields and forest plots.
Model Calculation (i). Based on knowledge of the individual field and forest plot, the TargetEcon model finds the most cost-effective solution for the areas by choosing between different transformation elements that can contribute to various policy goals.
Results (j) show how the model delivers results that can be divided by, for example, municipalities, as illustrated.

Source:
The DCCC based on Termansen m.fl. 2023a and b and Hasler m.fl., 2022.
Termansen, M., Hasler, B., Levin, G., Filippelli, R., Lundhede, T., Strange, N., Nainggolan, D., Blads, J. og Zandersen, M., *National arealforvaltningsmodel for vand, klima, biodiversitet og friluftsliv*, 2023, Københavns Universitet.
Termansen, M., Filippelli, R., Hasler, B., & Pedersen, M. F., *Udtagning af lavbundsjorde: Analyse af mulige synergier med andre miljø- og naturmål*, 2023, Københavns Universitet.
Hasler, B., Filippelli, R., Levin, G. og Nainggolan, D., *Økonomiske konsekvensberegninger for vandrammedirektivet i 2027*, 2022, Aarhus Universitet.

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Elements of transformation in the model divided into temporary and permanent changes

Elements of transformation for agricultural and forest areas	
Temporary change	**Permanent change**
1. Catch crops	8. Permanent withdrawal of land for grass
2. Intermidiate crops	9. Permanent withdrawal of land for biodiversity purposes
3. Early seeding	10. Afforestation
4. Reduced use of nitrogen fertilizer	11. Converstion of carbon-rich land (flooding and permanent grass)
5. Marginal zones	12. Restoration of wetlands
6. Multi-annual energy crops	13. Mini-wetlands
7. Temporary land withdrawal	14. Convert existing production forest to unmanaged forest

28

Elements of transformation in the model divided into temporary and permanent changes

Note 1:
Permanent withdrawal of land for biodiversity purposes involves areas where all production ceases, and the vegetation is allowed to, for example, regenerate into forest or develop into a wetland.

Note 2:
With the chosen model, it has not been possible to incorporate afforestation on carbon-rich soils, as there is considerable uncertainty about the effect.

Source:
The DCCC based on Termansen, M., Fillippelli, R., Hasler, B., Levin, G., Lundhede, T. og Gyldenkærne, S., Scenarier for Klimarådets rapport: Dokumentationsnotat, Københavns Universitet, 2024

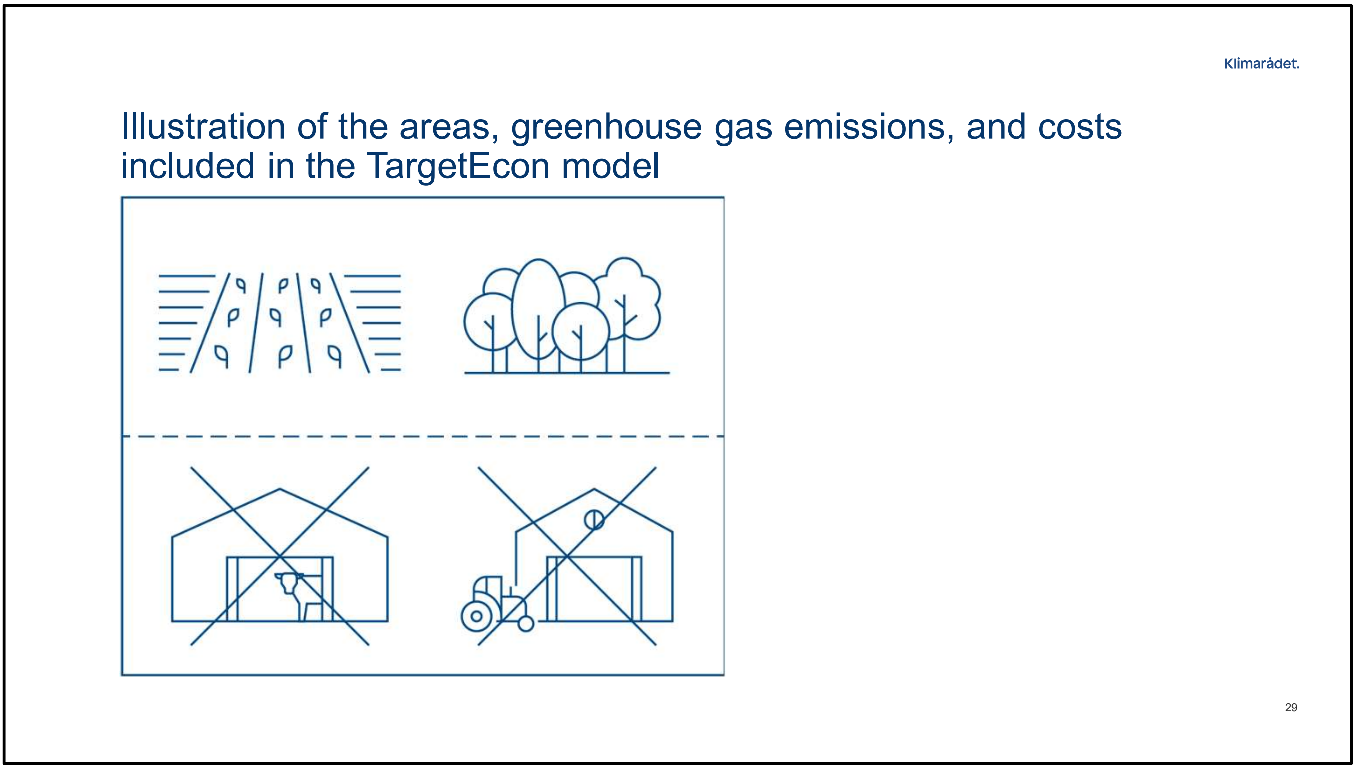

Illustration of the areas, greenhouse gas emissions, and costs included in the TargetEcon model

Note 1:
Greenhouse gas emissions: The model only includes effects directly related to the production areas. This applies to greenhouse gas emissions, but also to costs, nitrogen emissions, etc. This means that, in broad terms, the model takes into account greenhouse gas effects resulting from: 1) carbon stocks, 2) nitrous oxide emission from plant residues and fertilizers, and 3) emission of methane from carbon-rich soils.

Note 2:
Areas: The areas in the TargetEcon model include all Danish agricultural land in rotation. These are areas where crops are produced and where soil is regularly tilled. The agricultural areas in the model account for nearly 2.4 million hectares. This corresponds to 92.8 percent of the total Danish agricultural area and 55 percent of Denmark's total area. The agricultural areas that are extensively cultivated are not included in the model. In addition, the model includes all areas with production forests as well as unmanaged forests. In total, the forested area covers over 0.5 million hectares and represents 13 percent of Denmark's

area.

Note 3:
Costs: The costs assessed in the analysis are referred to as direct costs. They consist of the lost income from a change in land use and are based on current prices for inputs, capital and labour, food, and timber products. Prices are market prices and adjusted to 2023 price levels. The costs are assumed to be externally given and thus do not account for the potential impact of changed land use on food prices or wage levels in agriculture. Land conversion results in societal benefits that are not subtracted from the costs in this analysis. The potential benefits are associated with the altered cultural landscape, including benefits such as an improved aquatic environment, the recreational value of unmanaged forests and other natural areas, and increased biodiversity. All these benefits have a socio-economic value that would significantly reduce the total costs if included.

Source: The DCCC

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The three scenarios of the analysis, with area planning from today towards 2050 and focus on synergies between policy goals

Scenarios \ Targets	Greenhouse gas emissions reduction target (Mil. Tonnes CO_2e)	Nitrogen emissions reduction target (Tonnes Nitrogen)	Area reserved for biodiversity target (Hectares)	Afforrestation target (Hectares)	Unmanaged forests target (Hectares)
Climate	6.5				
Climate and aquatic environment	6.5	12,955		250,000	61,445
Biodiversity and aquatic environment		12,955	623,228	250,000	61,445

30

The three scenarios of the analysis, with area planning from today towards 2050 and focus on synergies between policy goals

Note:
The 623,228 hectares area reserved for biodiversity is elsewhere in the report referred to as approximately 630,000 hectares.

Source:
Vandområdeplanerne 2021-27, Regeringsgrundlag 2022 – Ansvar for Danmark, Aftale om grøn omstilling af dansk landbrug 2021, Aftale mellem regeringen og Radikale Venstre, Socialistisk Folkeparti, Enhedslisten og Alternativet om: Finansloven for 2021, EU's Biodiversitetsstrategi for 2030.

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Results: climate, aquatic environment, biodiversity and costs in 2050 for the three scenarios in the analysis

Scenarios / Results	Greenhouse gas emissions reduction	Nitrogen emissions reduction	Area reserved for biodiversity	Total direct costs	Total direct costs per tonne CO_2e
	Mil. Tonnes CO_2e	Tonnes Nitrogen	Hectares	Mil. DKK	DKK per tonne CO_2e
Climate	6.5	9,466	30,187	728	110
Climate and aquatic environment	6.5	15,831	100,214	1,137	176
Biodiversity and aquatic environment	6.8	17.087	623,228	2,761	409

31

Results: climate change mitigation, aquatic environment, biodiversity and costs in 2050 for the three scenarios in the analysis

Note 1:
The area reserved for biodiversity is calculated as the area that, in each scenario, is taken out of agricultural and forestry production and falls within the Danish Biodiversity Council's proposal to designate 30% of the land area for biodiversity. For the biodiversity scenario, it is the entire area in the Danish Biodiversity Council’s map that is withdrawn from forestry and agricultural production.

Note 2:
The 623,228 hectares area reserved for biodiversity is elsewhere in the report referred to as approximately 630,000 hectares.

Note 3:
The reduction in nitrogen emissions includes local overachievement of the nitrogen emissions reductions required for fulfilling the water framework directive in several places in Denmark. Any overachievement does not contribute to the nitrogen target, as the nitrogen target has a narrow geographical focus where nitrogen savings in one place cannot substitute for emissions in another.

The contribution of the scenario to the target can be read in slide 33.

Source:
The DCCC
Termansen, M., Fillippelli, R., Hasler, B., Levin, G., Lundhede, T. og Gyldenkærne, S., *Scenarier for Klimarådets rapport: Dokumentationsnotat*, Københavns Universitet, 2024.

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Results: Changes in agricultural and forestry areas in 2050 for all three scenarios in the analysis

Scenarios / Results	1) Agricultural land set aside for nature and afforestation	2) Agricultural lands with temporary changes	3) Afforestation on agricultural lands	4) Production forest converted to unmanaged forest	5) Total area with changes in land-use
	Hectares				
Climate	474,587	425	449,747	35,840	510,851
Climate and aquatic environment	509,080	165,518	414,471	61,490	728,360
Biodiversity and aquatic environment	760,730	125,903	250,000	166,650	1,053,283

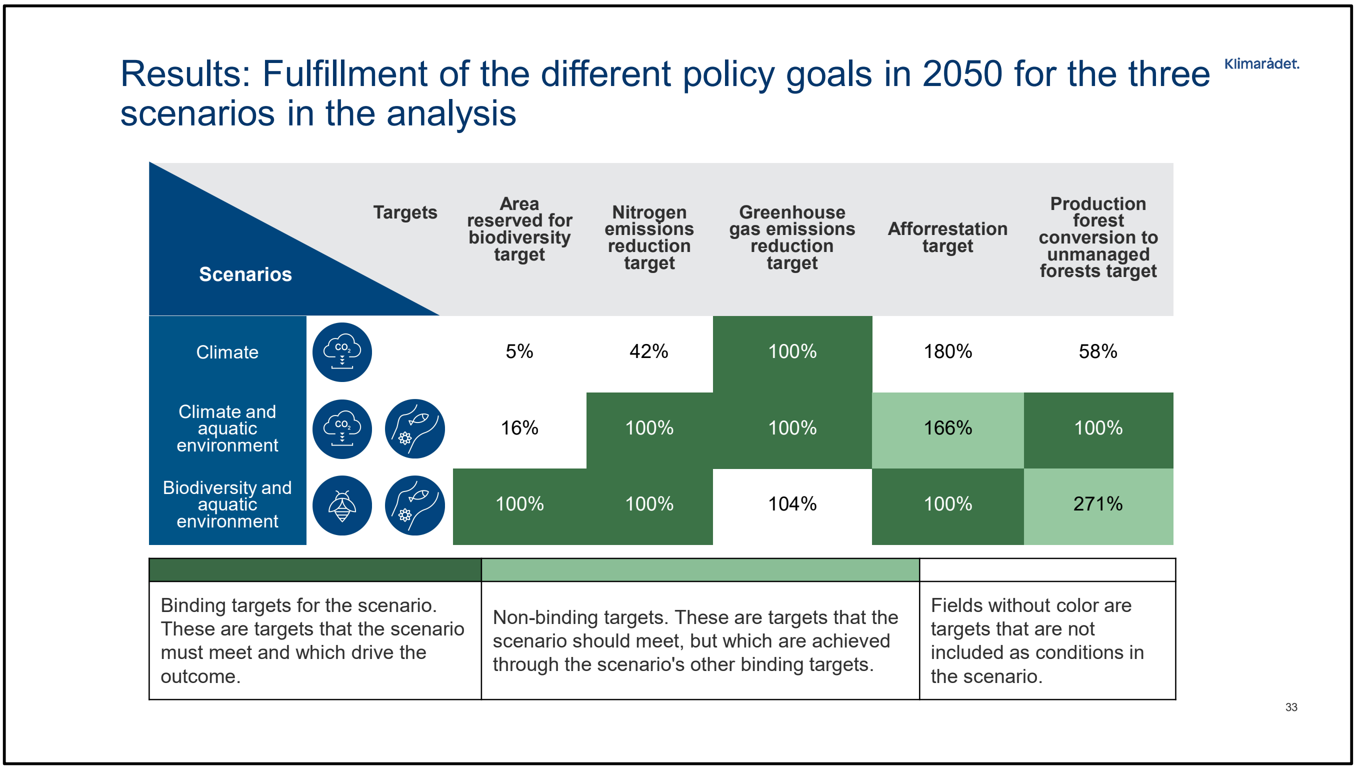
32

Results: Changes in agricultural and forestry areas in 2050 for all three scenarios in the analysis

Note 1:
The total area with changes in land-use encompasses all areas where there is a change in land use. This include all changes on both agricultural and forestry lands, including temporary changes such as the establishment of cover crops and permanent changes such as forest restoration and the conversion of existing production forests to untouched forests. The area with changes is obtained by adding up columns 1, 2, and 4.

Note 2:
In the biodiversity and water environment scenario, 760,730 hectares of agricultural land are converted to nature and afforestation. Currently, agriculture covers approximately 2.4 million hectares, which means that about one-third of the total agricultural area is taken out of agricultural production.

Source: The DCCC



Results: Fulfillment of the different policy goals in 2050 for the three scenarios in the analysis

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Scenarios / Targets	Area reserved for biodiversity target	Nitrogen emissions reduction target	Greenhouse gas emissions reduction target	Afforrestation target	Production forest conversion to unmanaged forests target
Climate	5%	42%	100%	180%	58%
Climate and aquatic environment	16%	100%	100%	166%	100%
Biodiversity and aquatic environment	100%	100%	104%	100%	271%

Binding targets for the scenario. These are targets that the scenario must meet and which drive the outcome.	Non-binding targets. These are targets that the scenario should meet, but which are achieved through the scenario's other binding targets.	Fields without color are targets that are not included as conditions in the scenario.

33

Results: Fulfillment of the different policy goals in 2050 for the three scenarios in the analysis

Note 1:
The biodiversity target is based on the designation of 623,228 hectares, which are currently in intensive agricultural or forestry production, to be taken out of production. The percentage is calculated relative to these areas. Thus, a percentage of 10% indicates that 62,322 hectares are taken out of production. In the biodiversity and water environment scenario, all 623,228 hectares are taken out of production, which corresponds to 100%.

Note 2:
The nitrogen emissions reduction target is based on the fulfillment of the Water Framework Directive with a reduction of 12,995 tons of nitrogen.

Note 3:
The climate scenario fulfills 42% of the water environment target of 12,995 tons of nitrogen. This is because only 5,486 tons of nitrogen out of the 9,466 tons of nitrogen indicated in Table 4.2 (slide 31) contribute to target fulfillment, as the

fulfillment has a narrow geographical focus.

Note 4:
The greenhouse gas emission reduction target is calculated as the reduction in greenhouse gas emissions achieved in 2050 in each scenario relative to areduction of 6.5 million tons of CO_2e. The 6.5 million tons of CO_2e correspond to the emissions from the areas reaching net zero in 2050.

Note 5: The targets for forest restoration and untouched forest are the scenarios' contributions to a forest restoration target of 250,000 hectares and a target for converting 61,445 hectares of existing forest to untouched forest.

Source: The DCCC.

Klimarådet.

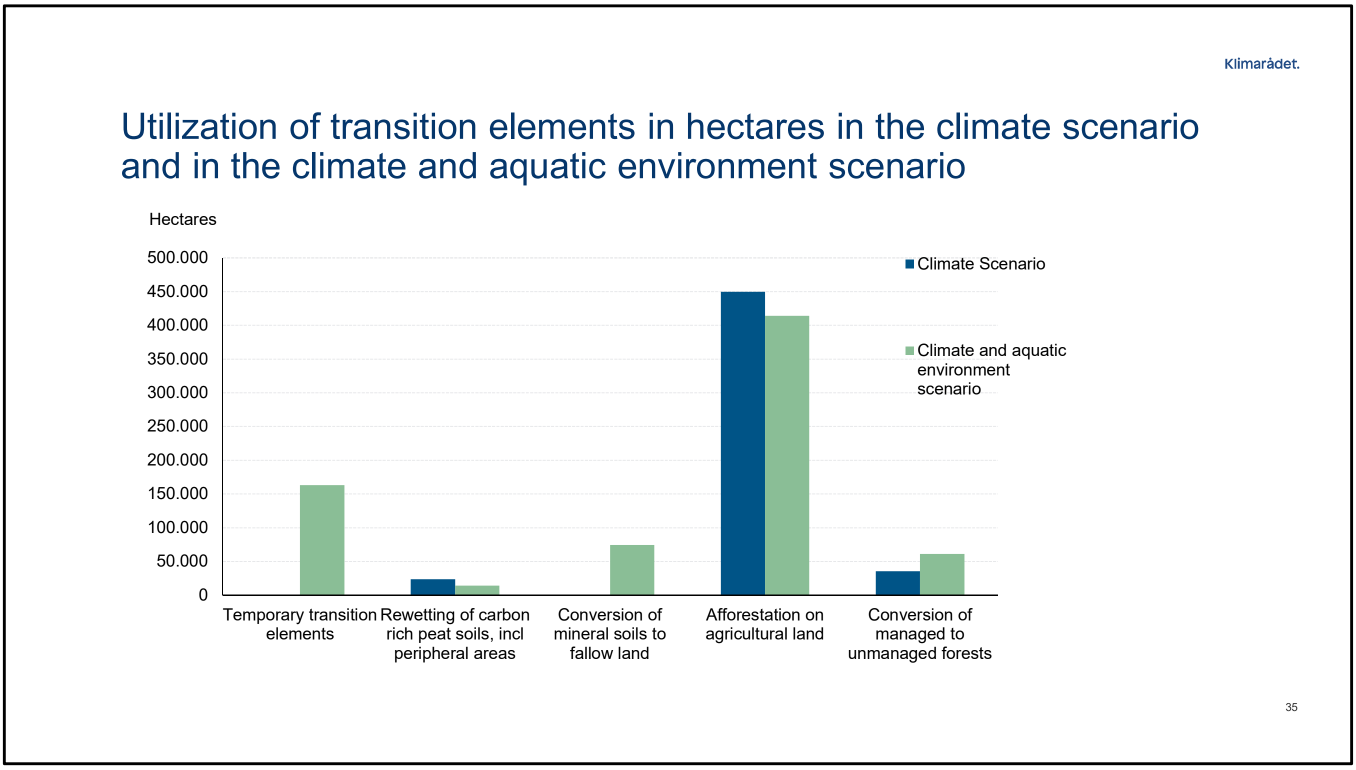
The distribution of areas within the Biodiversity Council's allocation of 30% protection of the land area

	Area distribution within the biodiviersity allocation			Area distribution in Denmark	
	Area, hectares	Share of Denmarks area	Share of biodiversity area	Area, hectares	Share of Denmarks area
Forest (managed and unmanaged)	185,903	4.3%	14.7%	562,406	13.0%
Arable land under cultivation	492,729	11.4%	39.0%	2,391,943	55.4%
Arable land extensively cultivated and with other crop varieties	69,918	1.6%	5.5%	186,772	4.3%
Nature, lakes and water courses	477,758	11.1%	37.9%	520,275	12.0%
Urban areas and other developed land	23,965	0.6%	1.9%	592,106	13.7%
Area not classified	11,960	0.3%	0.9%	66,636	1.5%
Total	1,262,233	29.2%	100%	4,320,138	100%

34

The distribution of areas within the Biodiversity Council's designation of 30% protection of the land area.

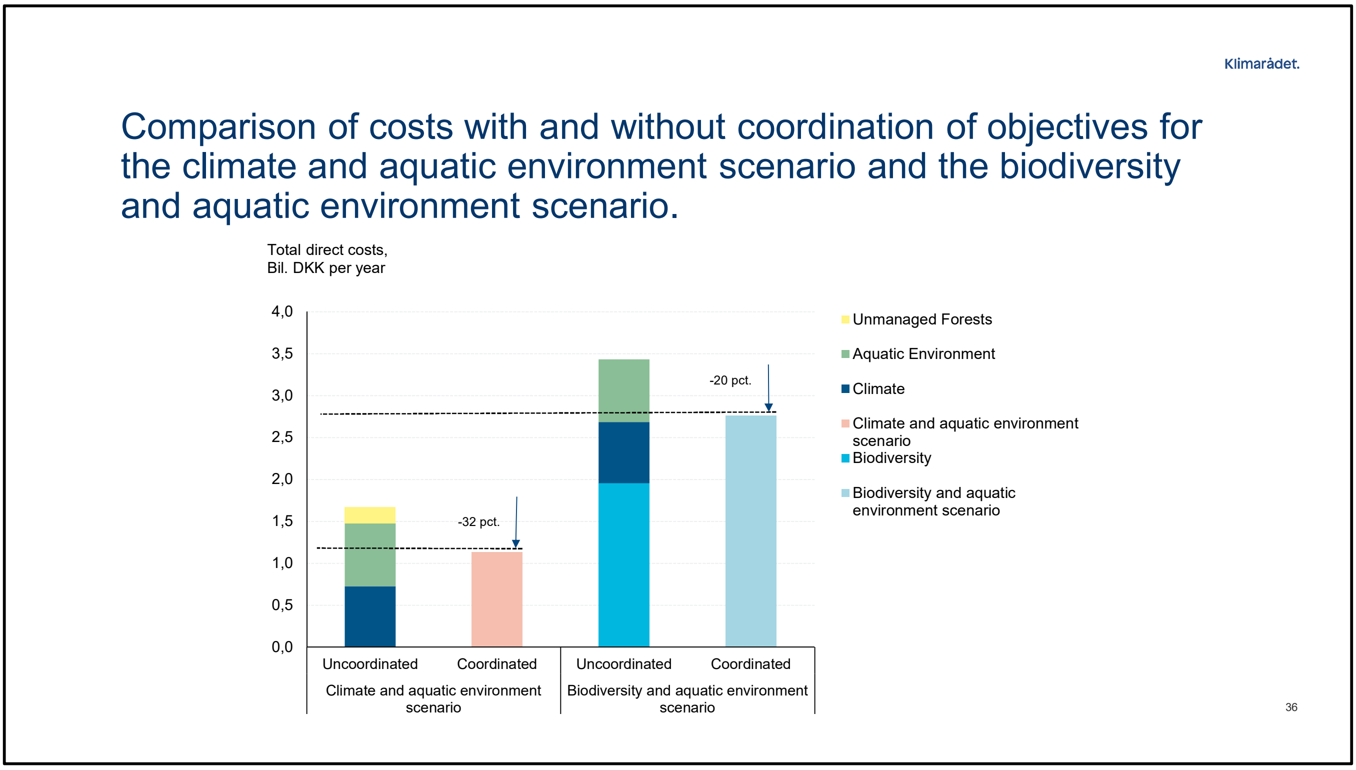
Source:
Biodiversitetsrådet 2023 and calculated based on Basemap03.
Biodiversitetsrådet, *Mod robuste økosystemer – anbefalinger til en dansk lov om biodiversitet*, 2023.



Utilization of transition elements in hectares in the climate scenario and in the climate and aquatic environment scenario

Note:
Temporary transition elements include cover crops, catch crops, early sowing of crops, reduced use of nitrogen fertilizers, energy crops, buffer zones, and temporary conversion of cultivated mineral soils to fallow land.

Source: The DCCC.

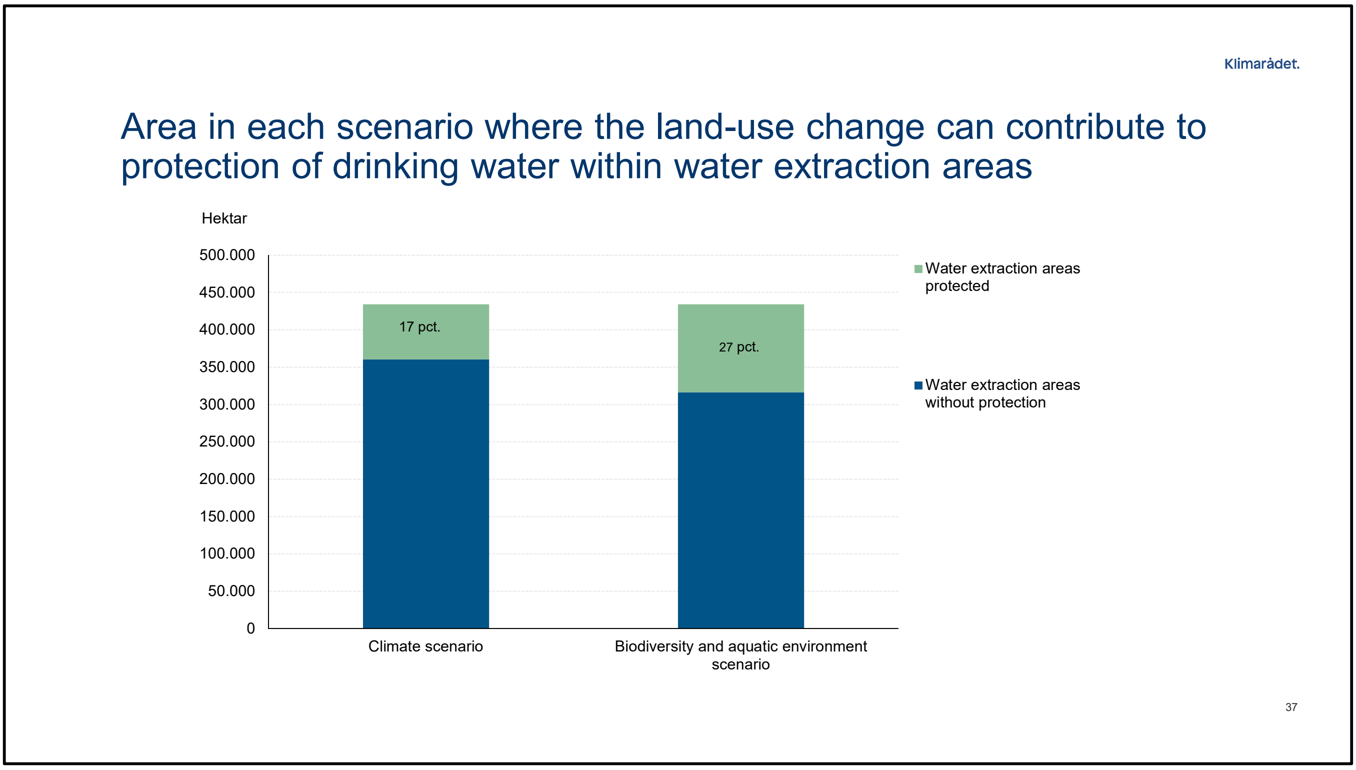


Comparison of costs with and without coordination of objectives for the climate and aquatic environment scenario and the biodiversity and aquatic environment scenario.

Note 1:
The figure shows the cost of meeting the objectives for climate change mitigation, the aquatic environment, biodiversity, forest expansion, and unmanaged forest individually. In column 1 and 3 the costs shown are for the example where the policy areas are uncoordinated, while the policy areas are coordinated in the columns 2 and 4.

Note 2: The results are based on model runs of the different scenarios, allowing for a comparison of the individual objectives.

Source: The DCCC.

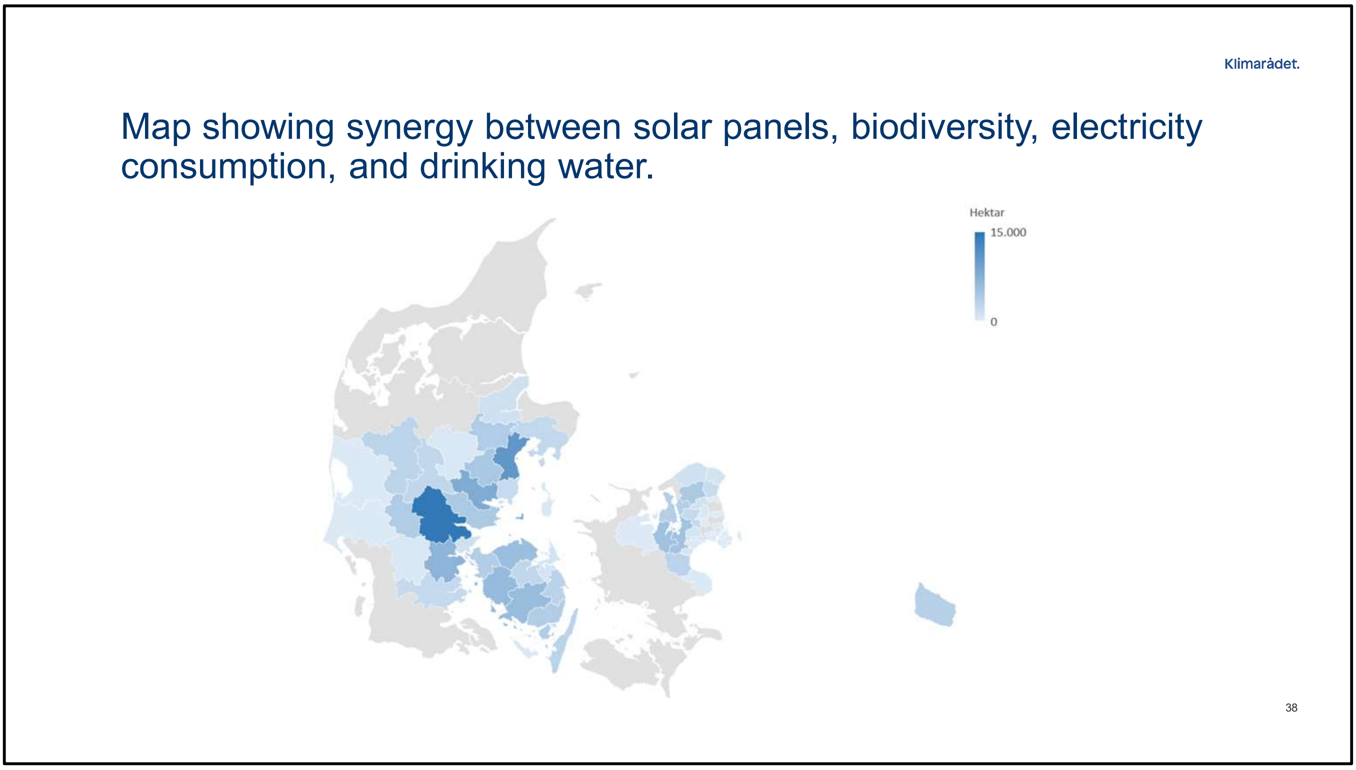


Area in each scenario where the land-use change can contribute to protection of drinking water within water extraction areas

Note 1:
The areas that can contribute to the protection of drinking water are all agricultural lands previously cultivated and areas where new forests are established.

Note 2:
Results for the climate and aquatic environment scenario, where climate and aquatic environment objectives are coordinated, are missing. It has not been possible to perform this calculation.

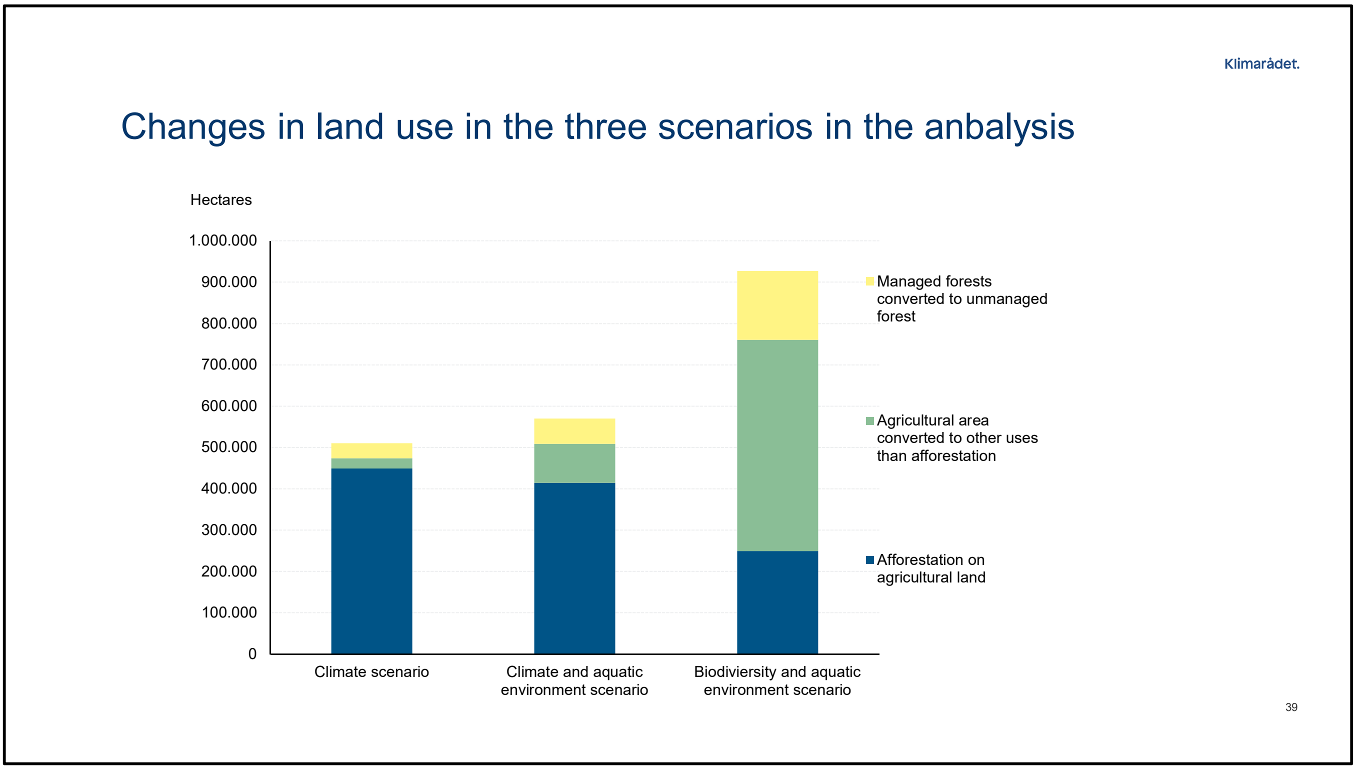
Source: The DCCC.



Map showing synergy between solar panels, biodiversity, electricity consumption, and drinking water

Note:
The map shows the hectares of agricultural land in each municipality where the Danish Biodiversity Council has not highlighted specific conservation interests, where drinking water is extracted, and where electricity consumption exceeds production.

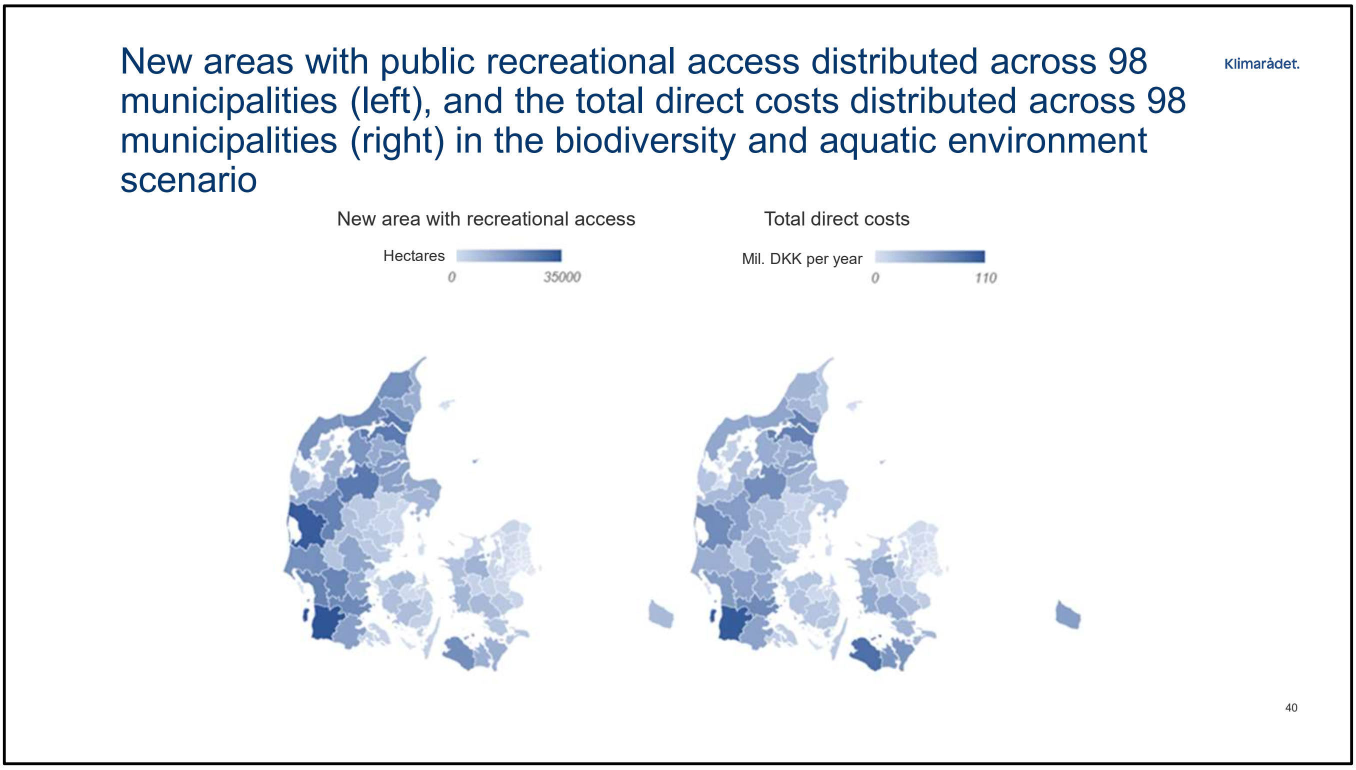
Source: The DCCC.



Changes in land use in the three scenarios in the analysis

Note:
Denmark's total area is 4.3 million hectares, of which agricultural and forestry land currently comprises approximately 3.2 million hectares

Source: The DCCC.



New areas with public recreational access distributed across 98 municipalities (left), and the total direct costs distributed across 98 municipalities (right) in the biodiversity and aquatic environment scenario

Note 1:
The map on the left shows changes in public access to nature distributed across municipalities. The land changes included as recreational are the establishment of new production forests, permanent fallowing of mineral-rich and carbon-rich soils, and new nitrogen wetland areas. Unmanaged forests are not shown, as they do not create new areas with recreational access.

Note 2:
The maps do not indicate where the precise efforts should be made but illustrate where in the country the recreational benefits have the potential to be greatest.

Source: The DCCC.

Klimarådet.

The area of carbon-rich soils projected for both historical and future years (without conversion schemes)

	Area of carbon-rich soils, hectares					Change per year, hectares	
	1990	2022	2030	2040	2050	2022-30	2030-40
Cultivated land 6-12% OC	75,897	28,217	19,571	13,865	8,159	-1,081	-571
Cultivated land >12 pct. OC	52,502	10,741	9,726	8,870	8,014	-127	-86
Permanent grass, 6-12% OC	36,038	43,000	33,834	26,710	19,585	-1,146	-712
Permanent grass >12 pct. OC	48,636	34,844	33,246	31,913	30,580	-200	-133
Total	213,073	116,802	96,377	81,357	66,338	-2,553	-1,502

41

The area of carbon-rich soils projected for both historical and future years (without conversion schemes)

Note:
Projection until 2050 is based on the Climate Council's own calculations using the same trend as in the period 2030-2040.

Source:
Gyldenkærne, S. og Callisen, L.W., *Notat om emissionsestimater for organiske jorder historisk (1990-2022) og i fremskrivningen (2023-2040),* 2024.
Beucher, A., Weber, P.L., Hermansen, C., Pesch, C., Koganti, T., Møller, A.B., de Carvalho Gomes, L., Greve, M. B. og Greve, M. G., *Updating the Danish peatland maps with a combination of new data and modelling approaches*, 2023, Aarhus Universitet.

Klimarådet.

Development in carbon-rich soils in the TargetEcon-model in 2030 and in 2050

	2022	2030	2050
	Hectares	Hectares	Hectares
<6 %	2,255,766	2,265,428	2,278,551
6-12 %	30,592	21,946	10,533
>12 %	11,987	10,972	9,261
>6 %	42,579	32,918	19,794
Total	2,298,345	2,298,345	2,298,345

42

Development in carbon-rich soils in the TargetEcon-model in 2030 and in 2050

Note 1:
The area in 2050 is projected using the same depreciation factor as for the period 2030-2040.

Note 2:
The TargetEcon model only includes areas under cultivation. The numbers in the table are therefore only comparable to the rows in the table in slide 41 with cultivated land. However, the numbers are not completely comparable as different base maps have been used.

Source:
Calculation of areas based on Levin 2019 and Beucher m.fl., 2023.
Gyldenkærne, S. og Callisen, L.W., *Notat om emissionsestimater for organiske jorder historisk (1990-2022) og i fremskrivningen (2023-2040),* 2024.
Beucher, A., Weber, P.L., Hermansen, C., Pesch, C., Koganti, T., Møller, A.B., de Carvalho Gomes, L., Greve, M. B. og Greve, M. G., *Updating the Danish peatland maps with a combination of new data and modelling approaches*, 2023, Aarhus Universitet.

Klimarådet.

Delimitation of the analysis in relation to goals, considerations, and other types of land use

Objectives and considerations analysed in high detail in the analysis	Objectives and considerations treated in less detail in the analysis	Land use types and issues not addressed in the analysis
• Greenhouse gas reductions on land areas	• Protection of drinking water	• Settlement and infrastructure
• Fulfilment of the EU Water Framework Directive	• Doubling of the organic area	• Climate adaptation
• EU target for protection of biodiversity in 30 percent of Denmark's land area	• Placement of solar energy parks	• Raw material extraction
• National goal for afforestation	• Food production	• Discharge of chemicals into the aquatic environment
• National goal for conversion of existing production forests to unmanaged forest		• Loss of phosphorus to the aquatic environment
		• Recreational areas
		• Onshore wind farms
		• Use of marine areas

43

Source: The DCCC.