Introducing the scenarios

Four scenarios used in the DBT project on Ocean Rise.

Most of us regard the debate on climate change and global warming as something abstract, lying far out in the future. Something that only experts and environmentalists are concerned with. But the fact is that global warming is already noticeable, and there is more and more evidence that the changes are not random variations. Global warming can already be measured, and it expresses itself by trees blooming earlier and migratory birds returning earlier from their winter homes.

These trends will probably intensify in the coming decades and other indications will appear. Denmark's Meteorological Institute has calculated that the yearly average temperature in Denmark in 100 years might be 3 to 5 °C degrees higher than the average for the years 1961-1990. We will have hotter and drier summers but wetter winters. Precipitation will be more concentrated and intense than we are used to. The oceans around us will rise, first very slowly and later faster. This – almost all meteorologists agree – will happen even if we eventually begin to reduce global emissions of greenhouse gases.

Global warming will gradually affect many areas of our society and as a result we will be forced to deal with many new problems. Here though, we have decided to focus on how global warming and especially the coming rising waters in the Danish oceans will affect valuable nature areas and the surrounding countryside.

According to the UN Intergovernmental Panel on Climate Change, the ocean will rise between 15-85 cm during the years 1990 - 2100, mainly due to the heating of the waters, but also because of the increasing melt from glaciers and icebergs. How much the temperature and sea level actually do rise will depend upon how we deal with the emission of greenhouse gases into the atmosphere in the next century.

It is very difficult to calculate how much the water level will actually rise. We have therefore chosen - as a starting point for the scenarios of the future - to place ourselves between the two extremes, namely at 50 cm. This is what a new report from the Academy of Technical Sciences, named "Effects of climate changes", says we should plan for.

It is inevitable that a 50-cm rise in the oceans will affect many Danish nature areas. A large number of our untouched areas are preserved as EU habitats and lie near coasts and streams. These areas might come under pressure or entirely disappear as the ocean gradually rises. In the coming decades we will therefore have to take a position on to how to deal with these changes.

We could, for example, take small, careful or even drastic measures to protect tourist and business interests in coastal areas, or to protect special landscape features against the rising waters.

Another option is to try to protect the natural environment in a way that lets low-lying biological habitats wander into new areas gradually, as the waters rise. This would require, for example, that all low-lying areas close to wetlands would gradually be excluded from other uses, such as farming, housing, etc.

The scenarios of the future included here suggest possible choices for local planning in Denmark - with all the uncertainties that are inevitable when trying to visualize development as far as 100 years in the future.

The scenarios are built around imaginary interviews held 100 years from now, with persons who are closely connected to the described areas. It is important to note that the remarks of both the journalists and interviewees are intended to shed light on various aspects of future developments and not to imply that the local newspapers or interest groups have certain fixed opinions. In the interest of simplicity, we have chosen to present four scenarios, even though many more possibilities exist. The purpose of the scenarios is to clarify the advantages and disadvantages of various future strategies and to inspire a local debate about a future where the oceans are a half meter higher.

Source material for the scenarios
Except for the report from the UN Intergovernmental Panel on Climate Change, and the report ” Effects of climate changes – adjusting in Denmark” from the Academy of Technical Sciences, the scenarios are based on conversations with a large number of Danish scientists and technicians working in the field. The consequences of the different strategies in the scenarios should not be regarded as scientific truths, but rather as qualified guesses to developments which include a great many uncertainties.

Do nothing scenario

Næstved – scenario 1

Description of scenario

The scenario is based on the idea that there are no special regulations such as coast protection or dikes to combat the threats caused by a rising ocean. This means, for example, that buildings, summerhouses, etc., in low-lying areas near the fjord will eventually be demolished and the land abandoned.

The scenario mainly describes the potential problems for all affected groups if nothing is done to counter the development. Affected groups include summerhouse owners and the tourist centre on Enø, and other persons – including farmers - with low-lying property along the fjords.

Picture of the future

I - your correspondent from the South Zealand local newspaper - have been invited on a balloon trip over one of the most beautiful landscapes in the area - Karrebæk and Dybsø fjords. The balloon skipper is the chairperson of the local conservation society, Birgit Laursen. We start from a hilltop near Svinø beach and the plan is to let the southern breeze carry us up over the fjord to a field slightly west of Næstved. The weather is glorious this June day in 2104 – it's only 25 degrees and a few cumulus clouds dot the clear sky.

We rise slowly up over Svinø beach and Dybsø fjord stretches out under us. On the left we can see that Dybsø and its shallow tidal meadows are partly under water. I ask Birgit Laursen how the rising ocean has changed the fjord.

"So far we haven't seen any great change", she says. "If we look down at Dybsø to the left, we see that the tidal meadows near the fjord are very wet and have lots of ponds and farms, and it doesn't take much to flood them. The lowest part of Dybsø's meadows and Enø's tip are already completely flooded at normal high tide".

"What about Dybsø fjord?"

"Conditions there are actually quite good", says Birgit Laursen. "The water quality has been improving slowly, even though there were some problems about 30 years ago, when heavy winter rains increased the leaching of nutrients. But after a while, it looked like the various water control measures had an effect. But it's still going to be a long time before the water quality is satisfactory."

We floated slowly towards Vejlø with the southern end of Enø down towards the west.

"Has the rising ocean broadened the channel between Enø and Dybsø?" I asked.

"Yes it has", says Birgit Laursen. "It has actually meant that the water rotation in the southern part of Karrebæk fjord, called Krageholms stream, has become larger. So even though the southern part of Enø and some of the tidal meadows near the fjord are partly flooded, the increased water rotation has improved water quality."

“But hasn’t the rising ocean affected some of the summerhouses on Enø?”

“Yes, they have had their problems. Under normal conditions things are still very good, but now almost every year the water rises over the old dikes and floods the low-lying summerhouse area, holiday centre and the road that joins the rest of Enø’s summerhouse area with Karrebæksminde. It’s difficult to insure the most vulnerable buildings, and some owners are thinking of abandoning their homes. So far it hasn’t been possible to reach agreement about expanding or heightening the dikes, but that might soon happen. They also have problems with the beach. It has been badly eroded in the last decades, so there isn’t much left of what was once a great beach for swimming.”

“Are there other areas around the fjord that have problems?”

“There are a few houses close to the fjord that are in trouble, and there is also some farmland here and there that has been abandoned - especially in the southern part of Gavnø and between Appenæs and Vejlø. On the other hand, it looks like the dam at Nylands marsh will hold out for quite a while.”

“Can you say anything about what the rising ocean has meant to nature in general?”

“It’s difficult”, says Birgit Laursen. “What has had the greatest effect is the change in precipitation. I’ve read that in the middle of the 21st century there were major problems with the water quality in Karrebæk fjord in the area that is most affected by the Sus river. The Sus is strongly influenced by the increase of nutrients washed out from farmland due to the heavy rains we sometimes get in the winter. But just like Dybsø fjord, it’s getting a little better, even though it will be long before we are satisfied with Karrebæk fjord. We think there is still too much fertilizer being spread over the farmlands, and it all runs off into streams and wet areas. ”

“It sounds like you are dissatisfied with developments in general?”

“That’s pretty true. By not doing anything about the change in climate - which has been the political position up till now - problems have arisen on all fronts. Everyone who is touched by the rising ocean is dissatisfied and demanding that some sort of position be taken on how to deal with the issue in the future. And this applies to conservationists, tourist organisations and farmers as well.”

“So in that regard there is no conflict of interests?”

“Not yet, but it’s sure to come when we have to decide how to deal with this area in the future. Priorities will have to be set, and that’s bound to create problems for some of the involved parties.”

“How do the conservationist groups see the future?”

“What we worry about most is that the wet areas along the fjord will gradually flood and the farmers will try to protect their land by building dikes against the rising ocean. If they are allowed to do that, the biological habitats which are destroyed by the rising

waters won't be able to wander into new areas. The tidal meadows on Enø and Dybsø are also in danger of completely disappearing as the coast erodes. And this is something we can see today, especially on Enø common where the beach wall is already very low."

The interview came to an end at that point, as we slowly descended and landed on a field just east of Næstved.

Summerhouse scenario

Næstved – scenario 2

Description of scenario

The scenario assumes that efforts are being made to protect the existing summerhouse area, tourist centre and beach on Enø by expanding and heightening the existing Enø dikes.

The scenario describes the potential conflicts that can arise from this expansion, and focuses on the attitude of summerhouse owners towards the visibility and financing of the dikes.

Picture of the future

In 2021 the decision was made to expand and heighten the dikes around the low-lying summerhouse areas and holiday centre on Enø. It was also decided to reinforce the coast along the summerhouses and beach. The decision was taken after strong pressure from the Karrebæksminde tourist organization and the affected homeowner organisations, after low-lying areas had been flooded several years in a row because the dikes could not contain the waters.

Now 75 years have passed since the dikes were extended and the water level has risen considerably in the meantime. We are visiting Gustav Egedam, chairman of one of the homeowner organisations with properties behind the dikes, to ask whether people are satisfied with the situation now that the dikes are completed.

"Naturally we are happy to have the dikes", says Gustav Egedam, "but there were also a number of negative effects. And not everyone was happy about the expansion. Especially owners whose houses lay a little higher but nevertheless had their view of the fjord spoiled were against the dikes. There was also some grumbling about the summerhouse owners having to pay a large part of the cost of expanding and maintaining the dikes."

"You mentioned the view? – There were people whose view of the fjord was spoiled?"

"Yes, there were", says Gustav Egedam, "Especially those whose houses were closest to the fjord and bay. They were, of course, unhappy about losing their view and in the long run were also afraid that their houses would fall in value, which is what actually

happened. There is now a big price difference between houses situated close to the dikes and in the other low-lying areas, and houses on the higher parts of Enø."

"Did the discussion about the view influence the height of the dikes while they were being built?"

"Yes, there was, as far as I know, a lot of discussion about how high the dikes should be, and most people felt that it would be sufficient to raise the existing dikes by a half meter, to save the view and keep costs down. But in hindsight it would have been wiser to have built higher than the 2.2 meters which we ended with as a compromise. They should have listened to the city authorities who said the dikes should be at least 2.6 meter high to ensure them against future floods."

"Yes – because now there are problems again?"

"That's right. Two years ago we had a period with strong northwest winds, which then changed to northeast and pushed the water in the Bay of Finland back in here, causing it to flow over the dikes. It gave us a bad scare, and the experts say that the water is continuing to rise, so this is not the last time it happens."

"And there were problems getting rid of the water?"

"Yes, the problem is that the lowest areas are now below the normal high tide level, so the water that comes in has to be pumped out again. And of course that makes it difficult to dry out the area after flooding. Now they are saying that it can be necessary to install a permanent pump station to keep the area dry in the future. And who is going to pay for it?"

"Does that mean that it was the wrong decision to extend and raise the dikes?"

"Certainly not. If that hadn't been done, the ocean and fjord would have gradually swallowed up the summerhouse area, so despite all the problems, I can't see any alternative. If the summerhouses and beach had not been protected, then I think Karrebæksminde would have gradually declined as a holiday area. But many people regret that we did not take the full step and protect the dikes for the future so that we don't have to go through the whole process again."

"Yes, because it will soon be necessary?"

"There's no doubt about it, but the question is whether the city will pay a considerable share of the expense once again."

With these words I thanked Gustav Egedam and thought about the uncertain future facing some of Enø's summerhouse owners.

Restoration of nature scenario

Næstved – scenario 3

Description of scenario

The scenario describes a situation where the wishes of conservation groups are given highest priority. This means that wherever possible, existing wet areas and meadows are expanded to include new land as waters rise, giving biological habitats a chance to move and adjust to new circumstances. It can also mean restoring dammed and drained areas around the fjord to their natural state.

The scenario describes the potential consequences and conflicts – mainly with regard to farming – that might arise by focusing on the interests and values of nature groups in the area. There can also be conflicts between local and state bodies if the area is given the status of a national park.

Picture of the future

It's an early April morning, very early for a late-riser such as your correspondent. The time is 6 a.m, the place is a bird-watching tower in Nylands marsh and I've joined ornithologist Morten Høegh to talk about birds and nature. After having stood quietly for a while, admiring the sunrise over the fjord, I force myself to break the silence and ask Morten Høegh what this large nature area can offer ordinary people who may not want to get up at 5 a.m. on a cold April morning to see the sunrise and bird migration.

"It's actually hard to answer that in a few words", says Morten Høegh, "there are many ways to enjoy nature the whole year round. To start with the most obvious, there are about 20 bird towers and shelters scattered around the fjord where people can observe birds without disturbing them. There is an extensive trail system for short and long hikes and bike trips, and there are several camping grounds where you can spend the night in your tent. And of course there are hotels and pensions."

"Does the area get many visitors?"

"It's very popular. After Karrebæk, Dybsø fjord and the Svinø area were given the status of national park 40 years ago, the facilities for guests were increased and improved and the number of visitors rose accordingly. We get tourists from the south who return year after year just to enjoy our fantastic nature. So even from a narrow economic point-of-view, the project hasn't been so bad."
"How did the area get national park status?" I asked.

"We have to go further back", says Morten Høegh. "I think that it was almost 100 years ago that people began seriously discussing how to deal with the rising ocean waters. With an eye on a very successful nature restoration project on Svinø, it was decided to pay special attention to nature interests in the area. People began to learn how to diminish the discharge of nutrients into the fjord, and how to allow biological habitats to wander in response to rising waters. That led to the idea of giving the whole territory national park status, first and foremost in order to formulate an overall development plan for the entire unique fjord area."

“And one of the results has been the nature restoration project here in Nylands marsh?”

“It’s probably the most spectacular result of the decision to prioritize conservation interests in Karrebæk and Dybsø fjord. It took a long time to work it out, but the result is a very fine area with new, shallow wetlands; these include extensive wet and dry meadows where the grass has been cut back to prevent overgrowth by reeds. More water birds are attracted to the area, and we have great flocks of geese which feed in the meadows in the winter and rest here during migration.”

“But this is not the only place where changes have been made?”

“No, but it’s the place where changes are most visible. In addition, a number of meadows have replaced intensively cultivated land, and new woods have grown up while old woods are left to decay undisturbed. All in all, this has led to a decline in nutrient excess in most waters of the fjord. Only streams flowing from the Sus river still have problems, due to the leaching of nutrients higher up in the river system.”

“What have the farmers around the fjord said to this serious interference in their use of the land?”

“Of course there have been conflicts. In the first phase the groups behind the park were able to achieve cooperation, mainly because people became involved in the project and weren’t forced to accept it. On the other hand, progress was slow, and there were some who wouldn’t participate. The problems came when the national park project was established and the state entered the picture. This caused some people to feel that decisions were forced upon them and they began to resist.”

“What was the consequence of that?”

“It meant that the project at first was quite unpopular because people could not foresee the consequences, and because the state expropriated some properties which lay in the way. As a result, some years passed before the project was really accepted locally.”

“Is it mainly the birdlife which has benefited from the restoration of nature?”

“Probably. In addition to ducks, geese and water birds, we have many birds of prey. We usually have at least two pairs of breeding white-tail eagles and different kinds of hawks, such as the northern harrier and the marsh harrier. We also have rich animal life in the area.”

“Does it mean that all other interests had to give way to the nature project?”

“You can’t put it so simply. Of course the farmers had to give up some land, and it’s taken time to sort it all out. But the natural environment and the varied animal life attract many tourists, also outside the usual high season.”

"Has it been possible to combine growing tourism with demands for large protected areas?"

"It depends upon whom you ask. Many people think we could attract many more tourists if we allowed more hotels in the national park. But this would cause some persons who come seeking peace and quiet and untouched nature to go elsewhere. The question is what form of tourism people want. I think that most local people are satisfied with the situation as it is."

Large dike scenario

Næstved – scenario 4

Description of scenario

The scenario describes the possible consequences of building a dam on the low part of Enø out towards the sea and from the tip of Enø over the fjord to Vejlø woods. A lock would also be built at Karrebæksminde canal, so the water level in the fjord can be regulated and the fjord can be totally closed when the water rises.

The scenario describes the possible consequences and conflicts of interests in damming Karrebæk fjord. Here mainly summerhouse and tourist interests play a roll, but farmers would also oppose conservation groups in the area.

Picture of the future

It is 1 May, and I – your correspondent from the local newspaper – am taking a bike ride with nature guide Karsten Mørkhøj. The purpose is to celebrate the 50th anniversary of the inauguration of the nature trail around Karrebæk fjord. Much of the trail system skirts Karrebæk dam, which was completed about 10 years before the trails were established. We pause in the middle of the dam where it divides Dybsø from Karrebæk fjord to drink a toast in honour of the anniversary and talk about what the dam and trails have meant for the area.

"Is it true that the decision to build the dam was the subject of serious criticism at the time", I ask Karsten Mørkhøj.

"It certainly was", answers Karsten Mørkhøj. "If you look in the library's online archive, you'll find at least 5,000 references and I think five or six books about the dam. The powerful nature organisations - led by conservationists and ornithologists - strongly opposed the plans and warned that the project might have unforeseen consequences."

"Then why was the decision made after all?"

"It was mainly the tourist and business interests who pushed the decision through. Tourism had been steadily increasing throughout the 21st century, and there was fear that the rising water level would reduce tourism around Karrebæksminde because of

the growing risk of floods in low-lying areas of Enø. We should also remember that tourism gained an increasingly greater economic importance throughout the 21st century for the entire country. Furthermore, landowners with property along the fjord, in particular what was then the Gavnø estate, had a clear interest in the dam to prevent flooding of low-lying fields."

"Did the dam have the unforeseen consequences that were warned against?" I asked.

"Yes, I should say so. To start with, it went exactly as the critics warned. The added flow of nutrients from the Sus river meant a worsening of water quality, which wasn't particularly good to begin with. This attracted large swarms of mosquitoes, which made it necessary to keep the Karrebæksminde locks open except when the water level was high. This was certainly not good advertising and actually resulted in a decline of tourism for many years – just the opposite of the original intention."

"What consequence did that have?"

"At first there were angry demands to demolish the whole dam. But we know how hard it is to get people to admit their mistakes, so the dam remained."

"But the situation today is nowhere near so bad?"

"It's become much better. Today the fjord functions as a fresh water lagoon and the water quality is quite good. But it's been difficult to limit the flow of nutrients from the Sus. If you see the matter from the positive side, you could say that it turned out to be a great advantage for the Sus river system because we were forced to deal with the discharge of nutrients into the whole river system."

"It sounds like it was quite a big job?"

"It certainly was. There were many conflicts and we couldn't take action locally because it concerned the whole Sus valley. A lot of money was paid in compensation to all the farmers who had to let their land along the river and fjord lie fallow. Some of them were persuaded to switch to ecological farming, which helped. It took many years to get it all sorted out, and even more years before it was possible to see true improvement in the fjord's water quality."

"It's evident that tourism has returned. Haven't new holiday cottages and many hotels been built in the last few decades?"

"Yes. I don't think the area has ever had so many tourists as now. Partly because we benefit from the climate change which causes intense heat around the Mediterranean in the summer. It's become so that anyone who can afford to escapes to the north during holiday. And we can offer all sorts of fun: the man-made beach on the fjord is good for kids, and there's sailing and fishing in the fjord. "Put and take" fishing is very popular, especially with the many German tourists. There are all sorts of wonderful ways of enjoying the natural environment around Dybsø fjord. Today, the fjord, the whole Svinø area and Avnø are known for their unique natural environments."

“Could you simply say that there has been a happy marriage between tourism on one side, and nature on the other?”

“I don’t think everyone would agree with that. I doubt that the conservation groups are as pleased about developments as the tourist organisations and businesses. It’s true that many tourist attractions have been established around Karrebæk Fjord, but at the same time a lot natural beauties have been lost. Many people are especially unhappy that Gavnø is turning into a sort of Disneyland with a big hotel, museums, theme park and much more. On the other hand, it’s a fact that the development in tourism, especially after the natural environment in Karrebæk fjord came under control, has significantly improved the area’s economy.”

With these words I continue my trip with Karsten Mørkhøj around the fjord.

Explanation of map - Næstved

Three water level lines are drawn on the map: ”Average tide level in 100 years”, ”Current 50-year event” and ”50-year event in 100 years”. The map assumes that in 100 years the ocean will have risen a half meter.

Average tide level in 100 years

The line shows where the high tide will be twice daily in 100 years. The line is 0.64 meter over the Danish Vertical Reference (DVR). This figure is calculated by the Danish Meteorological Institute and the Administration of Navigation and Hydrography, and based on the current average tide level, to which we have added a half meter.

Be aware that this is an average, and the tide also depends upon astronomical conditions. Variations in the high water level are also influenced by changes in wind and weather. The high tide will therefore occasionally rise higher than the line shows.

Current 50-year event

The line shows the high tide level that statistically can be expected at 50-year intervals – upon extreme high tides that are assumed to occur at least once in a 50-year period. The line is 1.40 meter over the DVR. This figure comes from the Danish Costal Authority, which regularly makes risk assessments based on local water level measurements throughout the country.

50-year event in 100 years

The line lies 1.90 meter over the DVR. This figure is based on the current 50-year event, to which we have added a half meter.

Be aware that these figures include a number of uncertainties!

Even though the tide line is drawn on the map by means of the most precise height measurements that the National Survey can provide, the measurements can be imprecise and local persons can probably reveal some inaccuracies. Likewise the level

of the landscape will change over the next 100 years. In some places, deposits of materials will cause the surface to rise, while erosion elsewhere will lower the surface.

Wind and precipitation also strongly affect the water level and as storms and rain are expected to increase in strength and concentration, the frequency of extremely high water will probably increase. The Academy of Technical Sciences predicts in the report ”Effects of Climatic Changes” that high tides in 100 years will reach the level of the current 50-year event (the blue line) about once a year.

High tide varies so much that the line for ”Average tide level in 100 years” is almost the same as the current, biological limit for salty tidal meadows. In 100 years this limit – if everything else remains the same – will be at the level of the ”Current 50-year event”. In some meadows, however, the level will not rise so much because material deposits will cause the terrain to grow higher.

The map suggests how the coast might look in 100 years.
The map has been prepared by the Danish Hydraulic Institute (DHI) with data provided by the National Survey.