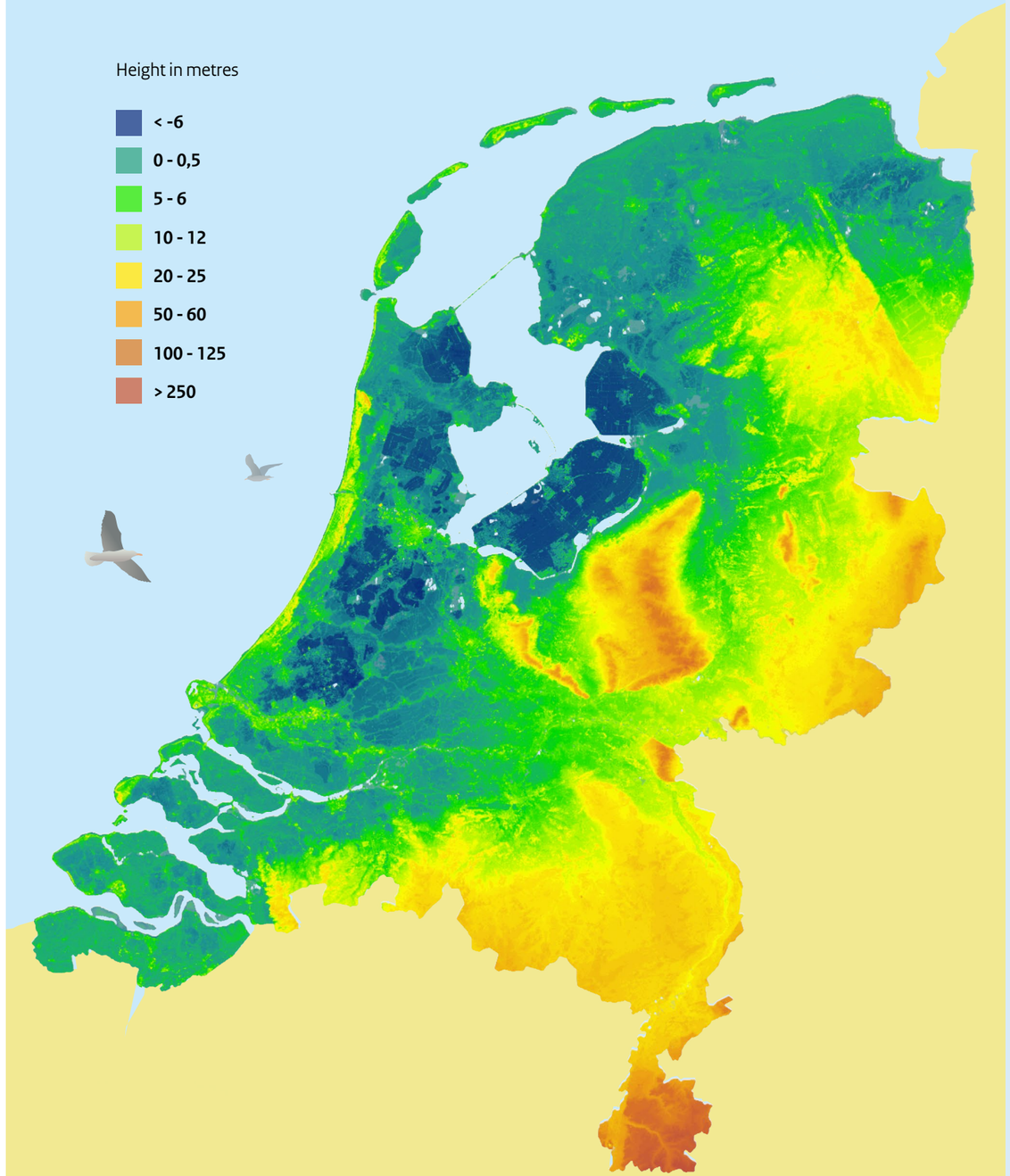
Ministry of Infrastructure
and Water Management

Sea-level rise in the Netherlands



Sea-level rise in the Netherlands

A large part of the Netherlands is below sea level. This makes our country vulnerable to accelerating sea-level rise. At the same time, we are protecting ourselves against high water levels in our rivers, like the Rhine and the Maas, which flow towards the sea through the low-lying delta. Over the centuries, the Netherlands has become ever better at protecting itself against water. Even before the beginning of our era, terps were created to allow people to live safely near high water levels. Subsequently, the construction of levees and dams (which started about a thousand years ago) made it possible to keep larger areas dry.

And yet, not a century passed without the country being hit by floods. Time and again, new measures were taken to protect the country against high water levels. Over time, this resulted in an ingenious system of levees, dams, dunes, flood barriers and pumps which today make the Netherlands one of the best-protected deltas in the world.

The current Dutch water safety policy regulates in detail who is responsible for what and what requirements are imposed on the flood barriers used. In addition, money has been set aside for the longer term to ensure that these flood barriers can be maintained and reinforced. After all, it is of crucial importance for the Netherlands to keep focusing on flood protection, also in the future, not least because climate change and the associated sea-level rise, as well as the expected increase of river discharges, will pose new challenges for the Netherlands in the longer term. We are taking stock of those challenges – and how we can address them – by means of the Sea-Level Rise Knowledge Programme.

Delta Programme: In the Netherlands we deal with water together

In the Netherlands, central government, provincial authorities, local authorities, water authorities and other organisations collaborate, under the banner of the Delta Programme, to meet the water-related challenges facing the Netherlands both now and in the future.
This collaboration focuses on three pillars:

Water safety

Water safety concerns the reinforcement of dunes, levees and other flood barriers, sand replenishment on the coast, and the creation of more room for rivers. These measures reduce the likelihood of flooding.

Sufficient freshwater

Ensuring that there are adequate supplies of freshwater – both now and in the future – is an important objective, especially with a view to periods of extreme drought and increasing salinisation.

Spatial adaptation

In many places, our spatial planning is intended to ensure that we can handle the extreme effects of climate change – heat, drought, disruption due to high water levels, and the effects of flooding – also if these extremes occur more often and become even more intense in the future.

Working on water safety

In the Netherlands, the requirements which flood barriers must meet have been established using a risk-based approach. The most stringent requirements apply in places where the consequences of floods (i.e. number of victims and scale of the damage) will be greatest. These requirements have been legally formalised. It has been agreed that all flood barriers must meet these statutory requirements by 2050.

Once every 12 years, there is an assessment of whether a barrier is still compliant. If a barrier no longer meets the requirements, or if such non-compliance is imminent, the barrier will need to be reinforced. For this purpose it will be included in the so-called Flood Protection Programme.

The Flood Protection Programme keeps the Netherlands safe

The Flood Protection Programme (HWBP in Dutch) focuses on the reinforcement of levees which do not meet the statutory requirements. Until 2050, this concerns the reinforcement of nearly 1300 kilometres of levees and nearly 500 locks and pumping stations. The Flood Protection Programme is an ‘evolving programme’ and also includes knowledge development and innovation projects. Plans are made for six-year periods, while also looking ahead at the six years after that. If it is necessary from a safety point of view to urgently reinforce a flood barrier, this will be included in the schedule without delay. When a barrier is no longer compliant, the relevant management authority will take measures to protect the hinterland, for instance by monitoring the barrier extra closely in times of high water levels and being prepared to take emergency measures. When a flood barrier is reinforced, account is taken of the climate change that is expected in the future. This ensures that the barrier will continue to be compliant until the expected end of its useful life (i.e. the period for which it has been designed).

Climate change

The current strategy for water safety in the Netherlands will be sufficient to handle the consequences of climate change and sea-level rise until at least 2050. Experts agree that with this strategy the Netherlands can deal with a sea-level rise of up to 1 metre. For the longer term, however, the rising sea level poses new challenges for the way in which the Netherlands approaches water. With a view to the uncertainties of the period after 2050, it is important to make investments now to increase our knowledge and adapt where necessary.
In this way the Netherlands can anticipate the future sea-level rise.

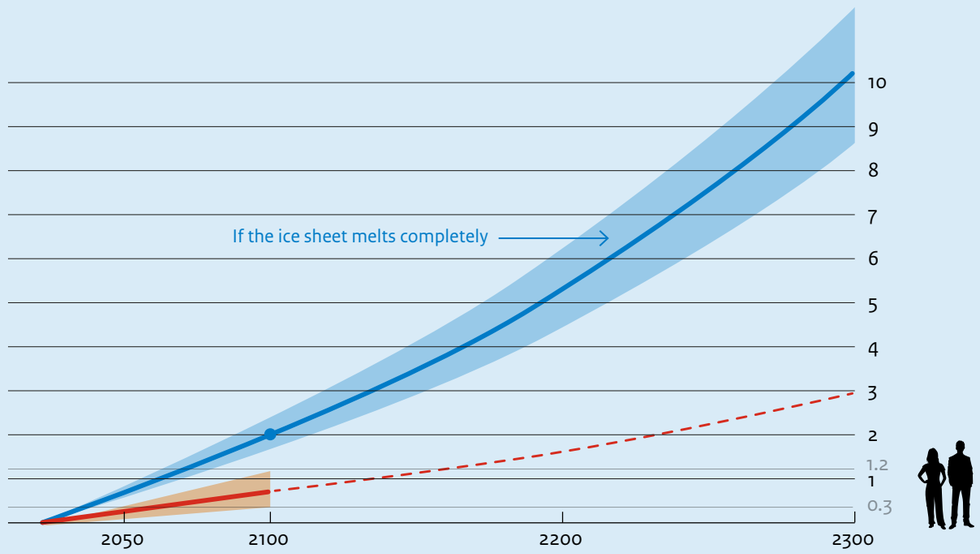
With the current strategy the Netherlands can deal with a sea level rise of up to

1 metre

(until at least 2050)

Sea-level rise scenarios

By how much the sea level will rise and how quickly this rise will occur is uncertain and strongly depends on how global warming develops. In its ‘Climate Signal ‘21’, the Royal Netherlands Meteorological Institute (KNMI) has calculated a bandwidth for sea-level rise on the Dutch coast based on several different scenarios. For the year 2100, this bandwidth ranges from 0.30 to 1.2 metres (with the latter being the worst-case scenario).
In addition to the scenario calculations, which use greenhouse gas concentrations, a so-called ‘low-probability, high-impact storyline’ has been drawn up in line with the IPCC reports. For this it was assumed that carbon emissions will continue to grow at the current level and that the melting of the Antarctic ice sheet into the sea will accelerate. If the ice sheet melts much faster, we may already face a sea-level rise of 2 metres by 2100, and of more than 10 metres by 2300.



Relation between the Sea-Level Rise Knowledge Programme and the Delta Programme

The strategies of the Delta Programme keep our feet dry and ensure that enough freshwater is available in the Netherlands. The Delta Programme focuses on the period up to 2050, with a forward view to 2100. The Sea-Level Rise Knowledge Programme is intended to find out what is needed after 2050. The focus is on 2100, and the Programme looks ahead towards 2150 and 2200. The Sea-Level Rise Knowledge Programme provides knowledge which can be used to adjust the strategies of the Delta Programme (where necessary) at the time of the next six-yearly review in 2026.

Sea-Level Rise Knowledge Programme

To investigate the challenges posed by a rising sea level in the longer term, the Dutch Minister of Infrastructure and Water Management and the Delta Programme Commissioner gave the green light to the Sea-Level Rise Knowledge Programme in 2019. This Knowledge Programme gathers and shares knowledge on the following topics:

- How much of a sea-level rise can we expect, and when? Plus, how can we monitor the development of the sea-level rise properly?
- What does sea-level rise mean for our current water safety system, and how much longer can we keep using our current policy and system for water safety, the sandy coast and freshwater?
- What can we do if our current policy and system for water safety, the sandy coast and freshwater is no longer adequate?
- What steps can we take now to keep the Netherlands liveable and safe in the long run as well?

Sea-level rise and Antarctica: What can we expect, and when?

The speed at which the sea level will rise in the future is highly uncertain. The melting of the Antarctic land ice in particular will be decisive for the sea-level rise to be expected on the Dutch North Sea coast after 2050. Therefore, the Sea-Level Rise Knowledge Programme is following the research into the situation on Antarctica closely.

For the purpose of the Sea-Level Rise Knowledge Programme, KNMI is conducting additional research that contributes to the development of climate scenarios to be published by the institute in 2023.

To adequately anticipate a possible acceleration of the sea-level rise, we need to detect such an acceleration in a timely manner. For this reason, developments around the world, on Antarctica, in the North Sea region and on the Dutch coast are monitored closely.

For how long can the Netherlands keep using its current approach?

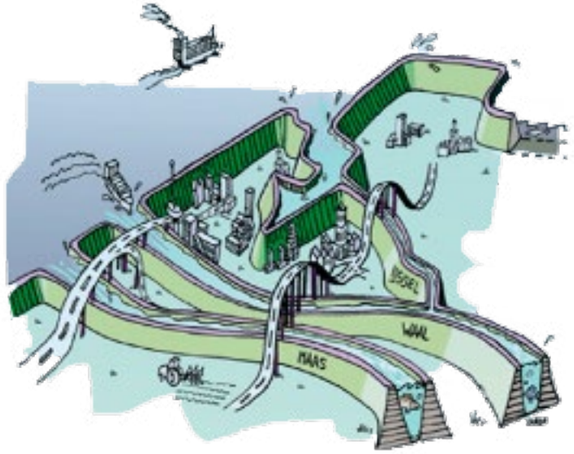
In the Sea-Level Rise Knowledge Programme we are trying to find out for how long we can keep using the current strategies that require ever stronger barriers to protect us against floods, to maintain our sandy coast and to have adequate supplies of freshwater. For these three topics the Knowledge Programme calculates what the effects are of sea-level rises of 0.5, 1, 2, 3 and 5 metres. These calculations demonstrate until what level it will still be possible and affordable to stick to our current strategies. In addition, the Knowledge Programme addresses the effects of changes to the water system on other functions.

For these three topics the Knowledge Programme calculates what the effects are of different sea level rises.

Options for the long term

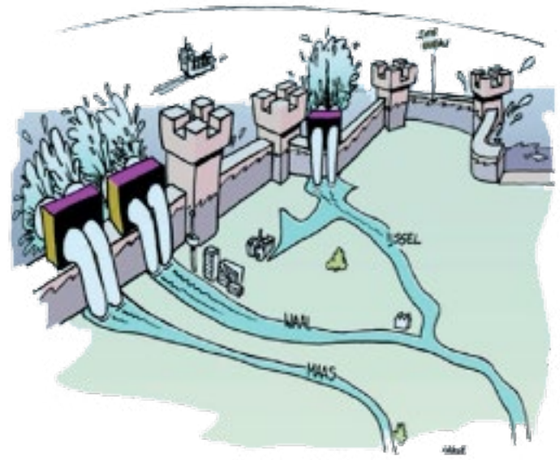
Besides on the tenability of the Netherlands' current strategies, the Knowledge Programme also focuses on options for the long term. What alternatives will be available to us when the current strategies for water safety, the sandy coast and freshwater are no longer adequate or become unaffordable? And how promising are these options, for instance in terms of the availability of materials, technical requirements and affordability? The Knowledge Programme explores these alternatives based on four solution strategies (> *include visualisations of the possible solutions*): **protection-open**, **protection-closed**, **seaward**, and **flexibility**.

Protection-open



In the '**protection-open**' solution strategy, the rivers will to have open connections to the sea. If the sea level rises, this means that the sea moves increasingly inland via the rivers. This will result in the need to elevate the flood barriers along the rivers, for example.

Protection-closed



The '**protection-closed**' solution strategy involves reinforcement of the coast and closing-off of estuaries. In this case the rivers will no longer flow into the sea freely, and it will be necessary to pump river discharges into the sea. In addition, more room will be needed for temporary storage of river water.

Seaward

The **‘seaward’** solution strategy involves the development of a new coastline in the sea, as well as the creation of additional room for the storage of river discharges.

Flexibility

Finally, the **‘flexibility’** solution strategy means that the influence of the sea moves increasingly inland, that certain areas of the Netherlands are faced with flooding and salinisation more often, and that we must adapt our land use accordingly. Examples of such adaptation measures are building floating homes, creating terps, or constructing dikes around residential areas, possibly in combination with increased development of higher areas of the Netherlands.

What do we need to enable our society to withstand the possible consequences of sea level rise?

communication

participation

governance

transition management

Implementation issues: How can we get this done?

Finally, the Knowledge Programme investigates how we can take the right steps to keep the Netherlands liveable and safe. What do we need, in terms of communication, participation, governance and transition management, to enable our society to withstand the possible consequences of sea-level rise?

What will we do with that knowledge? Looking at options for the future

The Sea-Level Rise Knowledge Programme runs from 2019 to 2026. The insights gained through the Programme will be used to adjust our current policy where necessary. The Netherlands is not making any big decisions yet and has not yet chosen a specific solution strategy for the long term. This will not be necessary for a while; the Netherlands is still in control with regard to water safety. The Knowledge Programme is intended to help us prepare for the future. The knowledge gained will be used to identify so-called ‘adaptive policy pathways’. These pathways show us when we will need to take action and what the possible options are in those cases, so that we will know when to prepare concrete decisions in the future. For now, the aim is to understand what we need to do (and shouldn’t do) at present to keep promising options open for the future. This means, for example, that in current spatial development projects we already need to take account of the space that may be needed in the future to reinforce levees or to create extra room for our rivers.

This is a publication of

The Sea-Level Rise Knowledge Programme:
Ministry of Infrastructure and Water Management
and the Delta Programme Commissioner.
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