waddenacademie

Climate change in the Netherlands

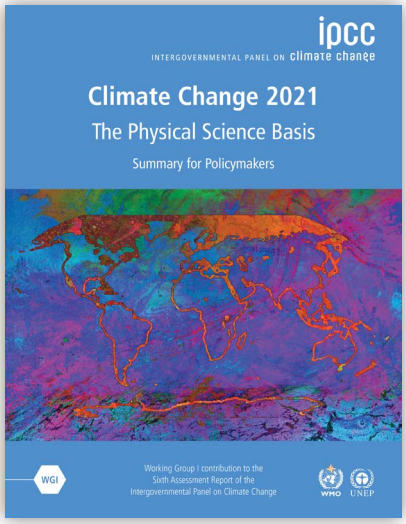
Facts, trends and developments relevant to the Wadden Sea region

INTRODUCTION

Warmer water, more erratic precipitation, rising sea level; climate change is creating great challenges for man and nature in the Wadden Sea region. In the past two years, the Wadden Academy has focused on the sea level rise (2020), the impact of climate change on migratory birds (2020) and the Wadden ecosystem (2021). The administrative aspects and dilemmas arising from climate change have also been addressed by the Wadden Academy (2020).

Two recent reports provide a new interim view on climate change in the Netherlands and around the Wadden Sea:

- *Sixth Assessment Report (6th AR) of the Intergovernmental Panel on Climate Change (IPCC, part of UN) – Working Group 1: The Physical Science Basis*
- *KNMI Klimaatsignaal '21. Hoe het klimaat in Nederland snel verandert.*

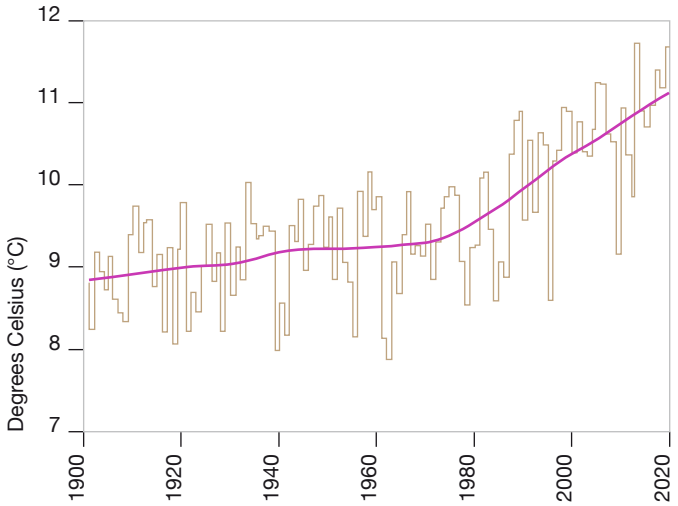


KNMI (The Royal Netherlands Meteorological Institute) translates global climate developments, as described by the IPCC, into developments in the Netherlands. In 2023, KNMI will publish the formal and more regional translation for the Netherlands based on more detailed data and models.

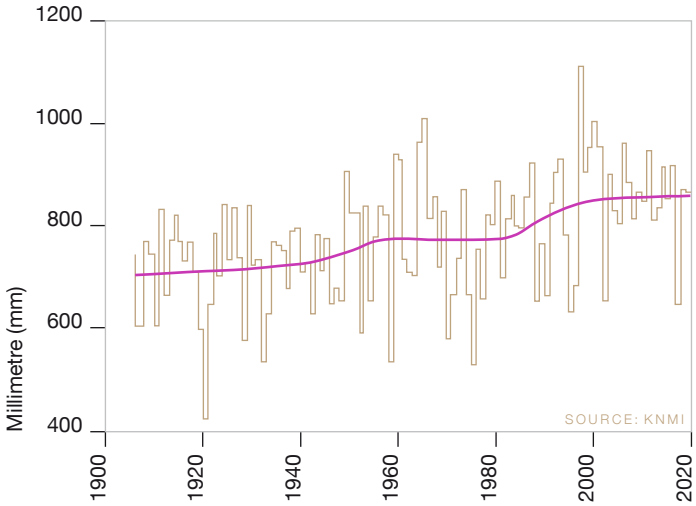
This fact sheet will allow us to briefly summarise and explain the most important changes in the climate in the Netherlands. Where possible, we briefly reflect on the significance for the Wadden Sea region. We not only examine the Wadden Sea region itself, but also developments in Arctic areas, because these areas play an important role in the annual migration patterns of migratory birds that use the Wadden Sea as a foraging station.

1 Changes and trends in the Dutch climate during the period 1901-2020

Annual average temperature since 1901



Annual precipitation since 1906



- The annual average **temperature** has increased by 2.3°C in 120 years.
- Incoming **solar radiation** has been increasing by 3% every 10 years since 1990, mainly due to a decrease in cloud cover.
- Annual **precipitation** increased in the past. Since 2000, this net trend has ceased. There is, however, a strong seasonal effect: precipitation has increased in summer and winter but this effect is compensated by a decrease in spring and autumn.
- The maximum **precipitation deficit**, or drought during the growing season, increased by 8% every 10 years in the period 1991-2020. In particular, there is more evaporation in spring.
- The annual average **wind speed**, as measured on land, has decreased since the 1990s by an average of 2% every 10 years. The highest hourly average wind speed per year has also decreased.
- This decrease is probably partly related to more building development and therefore a greater 'roughness' of the land surface that inhibits the wind. Data for the Dutch coastal zone are missing and for the North Sea (station K13 in the North Sea) there is no clear trend in strength or direction.

Wadden Sea region: more southern species in warmer Wadden Sea

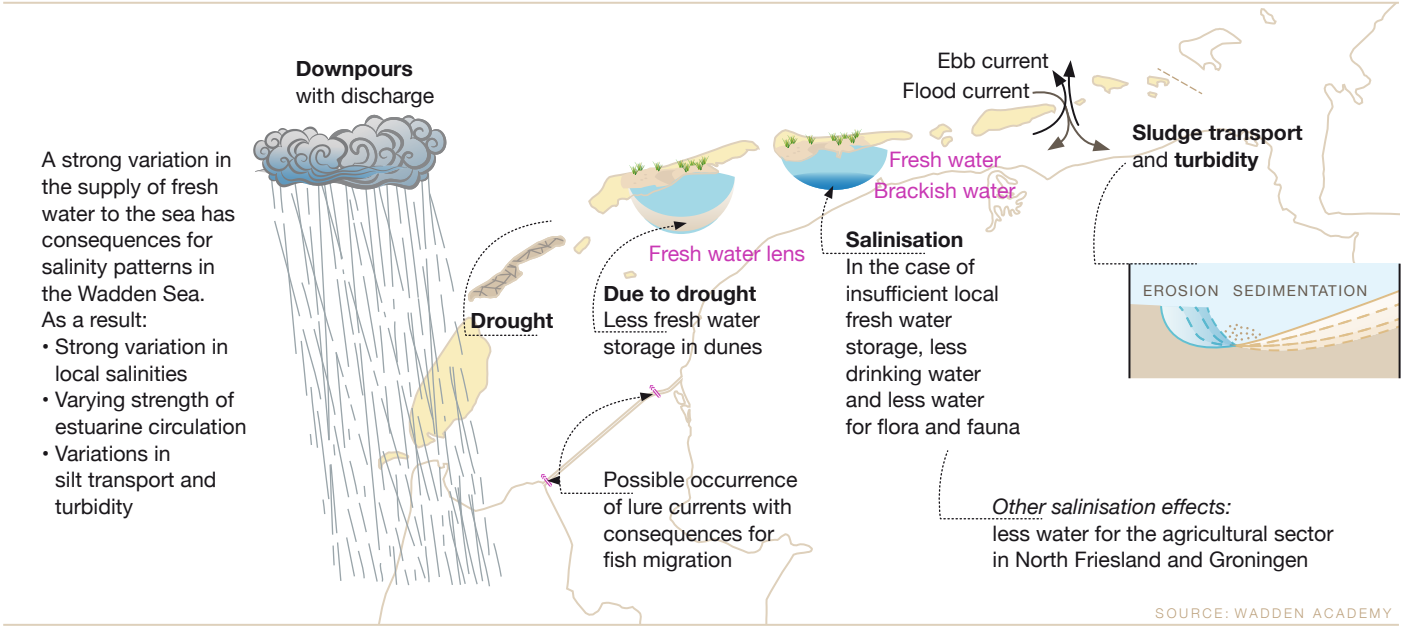
The air pressure pattern over Europe has been changing for the last century and a half. While the air pressure over the Mediterranean has increased, it is decreasing north of Scandinavia.

As a result, we increasingly have westerly winds and a decrease in easterly winds in the winter. This explains to a small extent the warming in winter over the last 60 years.

In the Wadden Sea region, this affects both flora and fauna. For example, the water temperature in the Wadden Sea also rises with the air temperature, which means that species that previously only occurred further south can now settle in the Wadden Sea. Species that were already here can also survive further north, provided that there are suitable habitats.

Extremes in heat, drought and precipitation caused by climate change

Fresh water surpluses and shortages due to extreme weather



- Owing to the warming, more and more moisture is entering the atmosphere. As a result, **extreme showers will increase**, including in the Netherlands. During the period 1951-2020, the absolute amount of moisture in the air increased by 8%. This trend seems to have slowed somewhat in recent years, due to the drying out of the land.
- **Air humidity** in the Netherlands in summer is expected to rise by 3 to 7% per degree temperature increase (global average).
- Over the last 30 years, **extreme showers have become even more extreme**. The most extreme showers, which occur at most once every 10 years, are now dropping 10 to 15% more precipitation. Since 2000, showers with rainfall intensities of more than 40-50 mm/hour have also become more frequent. Models show that especially the heaviest showers (precipitation > 50 mm/hour) tend to intensify.
- In 2018, 2019 and in the spring of 2020, the Netherlands was faced by **extreme drought**. In all cases, there was a so-called 'blockade': a stable and persistent high-pressure area over our part of Europe, with sunny, dry and warm weather.
- Drought is the sum of evaporation and precipitation. In the past century, both potential evaporation and precipitation have increased. In summer, however, evaporation exceeds precipitation, leading to **a precipitation deficit** . Dry periods during the growing season in the Wadden Sea region cannot be directly attributed to climate change.

Wadden Region: capricious supply of fresh water
Downpours alternating with drought have consequences for agriculture, drinking water and also ecology. For the agricultural sector, the risk of salinisation increases when not enough fresh water is stored in the soil. A strong variation in the supply of fresh water to the sea also has numerous consequences for the saline Wadden Sea: strong changes in local salinity, varying strength of the estuarine circulation (flow patterns that occur due to the density differences between fresh and salt water), variations in silt transport and turbidity, the presence or absence of fresh water lure currents attracting migratory fish from the salty sea to the rivers, ...
On the Wadden Islands, drought will also affect the local fresh water storage in the dunes. This affects the drinking water supply and water availability for flora and fauna.

2 Global and regional climate projections

The future of the climate depends very much on the extent to which mankind will be able to limit the emissions of greenhouse gases. The general trend is for more rapid warming over land than over the oceans.
The front runner is the Arctic, where the strongest temperature increase is taking place. Globally, extreme heat will become more common, while the probability of extreme cold will decrease.
If the Paris Climate Agreement is implemented, global temperatures between 2081 and 2100 are expected to rise by 1.8 °C compared with the pre-industrial era, with a range between 1.3 and 2.4 °C. This range corresponds to a more sustainable scenario of the so-called *Shared Socioeconomic Pathways*. In an unsustainable development – where greenhouse gas emissions continue unabated – the global temperature could rise to 4.4°C (3.3-5.7°C).

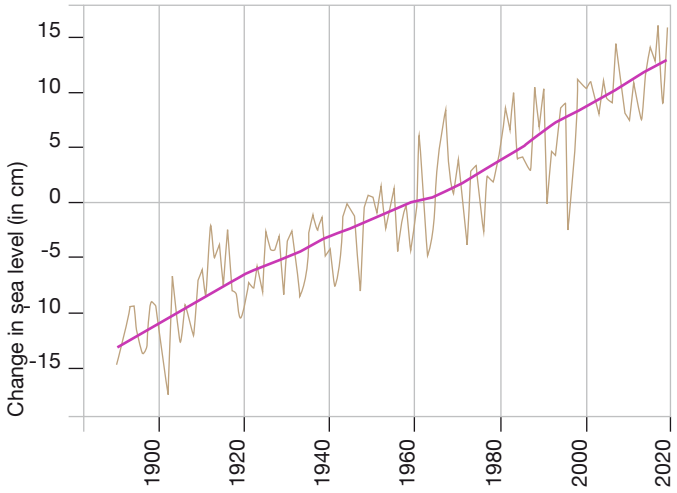
3 Rise in sea level

- The average **global sea level rise** between 1901 and 2018 was about 20 cm.
- Recently, there has been an **acceleration in global average sea level rise**. In the period from 1971 to 2018, the rate was still 2.3 mm/year (1.6-3.1). Calculated over the period 2006 to 2018, the increase has reached 3.7 mm/year (3.2-4.2). Converted, this means that every ten years the sea level rise accelerates by 1 mm/year. Based on the above, the sea level rise from 3.7 mm/year in 2018 will increase to 4.7 mm/year by 2028.
- For the Dutch coast, the **net sea level rise** between 1901 and 2018 was about **1.8 mm/year**. This includes subsidence. In total, the sea level in that period rose by 22 cm. So far, no acceleration of the sea level rise has been seen in our region.
- The melting of land ice on Greenland may actually cause the sea level **to fall** slightly in a wide arc around Greenland. This is because the melting of the land ice also changes the gravitational field around Greenland, causing the ice on Greenland to pull less hard on the water and the water to 'move away' from Greenland. This effect is even noticeable off our coast.

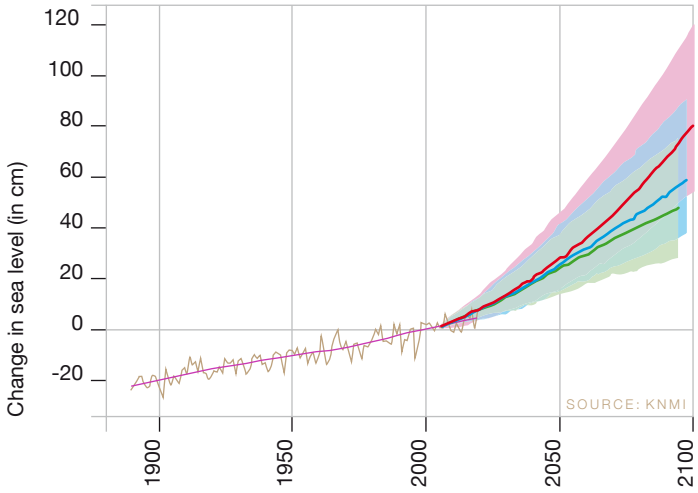
Conversely, melting ice on the other side of the world, in Antarctica, will hit us twice as hard. Between 1971 and 2017, **melting land ice around the North Pole**, including on Greenland, contributed 20% to global sea level rise.

- According to the KNMI scenarios, by 2020 we should expect a **sea level rise of 4.9 mm/year for our coast** (range 2.3-7.6). This is clearly more than the trend measured since 1993 of approximately 2.8 mm/year (1.2-4.2). The difference between the KNMI projections and the actual measurements is mainly due to the regional meteorological and oceanographic conditions in North-West Europe, including the North Sea area. Since 1993, the trend has therefore deviated from the long-term average (Since 1901: 1.8 mm/year versus 2.8 mm/year recently), but according to KNMI this is not yet a significant difference.
- Wind may cause the highest water level to rise: the so-called **water surge**. Model calculations for the period 1991-2020 and projections for the period 2071-2100 show that in both periods there was and will be no effect of wind on the highest water levels. In the measured period, there was a slight decrease in water accumulation, but this decrease was not significant in practice. However, in the future, the highest water levels will increase as the average sea level rises.
- In a scenario with continued high greenhouse gas emissions ('SSP5 8.5'), a **sea level rise of one metre** will be achieved somewhere between 2090 and 2140.

Sea level rise along the Dutch coast: annual measurements and trend according to the Sea Level Monitor



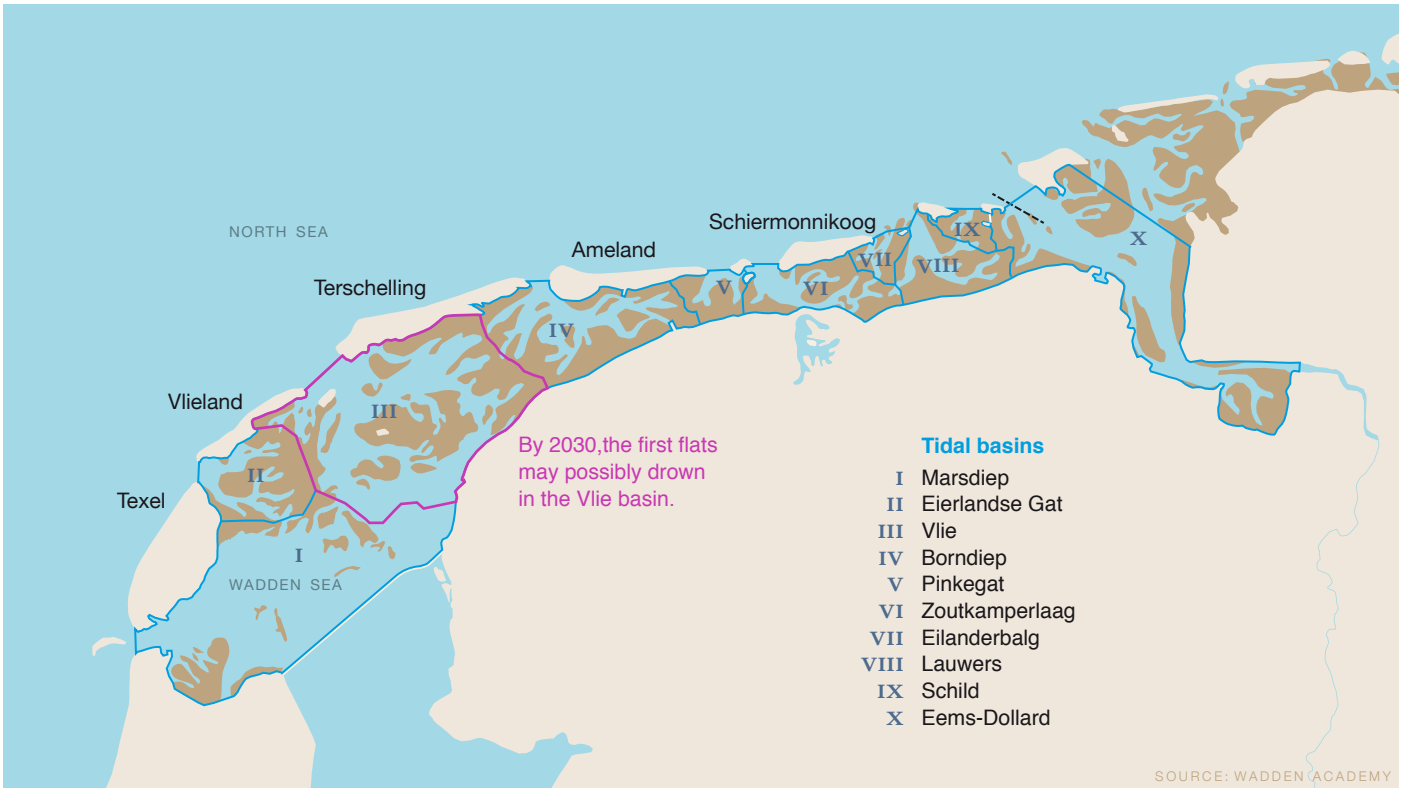
Sea level rise along the Dutch coast, predictions up to 2100 based on different scenarios



Sea Level Monitor trend
Sea Level Monito
SSP5-8.5
SSP2-4.5
SSP1-2.6
(SSP = Shared Socio-Economic Pathways)

Measured and predicted sea level rise along the Dutch coast up to 2100 based on different greenhouse gas emission scenarios. The lines represent the median value: 50% of the predictions have either a higher or a lower value. This spread is represented by the bandwidth.

Channels and flats in the tidal basins of the Wadden Sea



Wadden Sea: fewer tidal flats

In the Wadden Sea, accelerated sea level rise mainly affects tidal flats, mudflats and salt marshes. The more the sea level rises, the shorter the flats run dry. This will have a major impact on the habitats of plants and the foraging behaviour of animals. Whether and when tidal flats really do 'drown' also depends on growth, due to natural deposition of sediment. As long as flats 'grow' in line with the sea level, they continue to run dry. Based on existing models and current insights, it is conceivable that around 2030 the sea level in the tidal basins of the Vlie (western Wadden Sea) will rise faster than the tidal flats grow.

4 Climate development in the Arctic

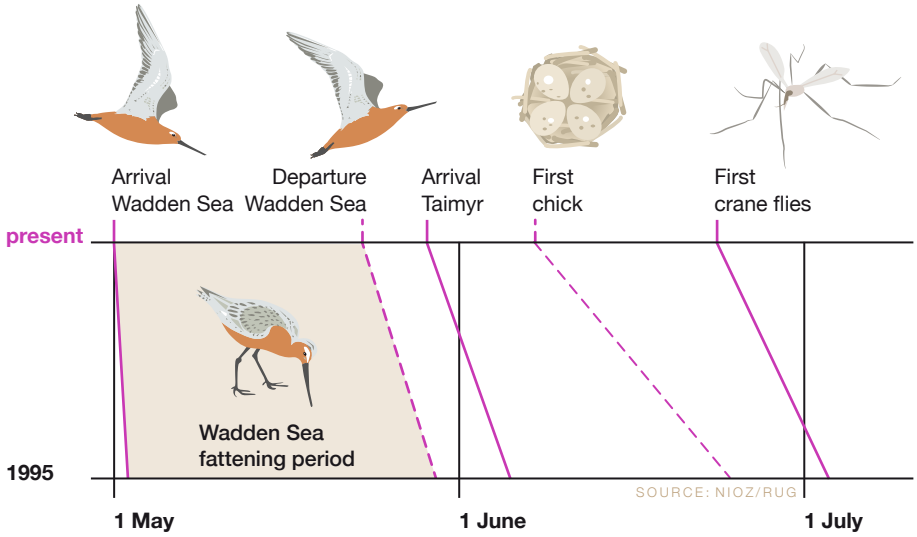
Effects of climate change on the lifecycle of the bar-tailed godwit 1995 - present

Crane flies (food) are emerging from the soil earlier and earlier

So in order to provide enough food for their young, the bar-tailed godwit has to arrive increasingly earlier in the Arctic breeding area (e.g. Taimyr).

However, the birds hardly ever leave their wintering areas any sooner

As a result, they have less and less time to 'refuel' adequately in the Wadden Sea 'intermediate refuelling station'



- The temperature in the Arctic is rising two to three times faster than the global average. Over the **last 40 years**, **the area has warmed by 2°C**, with regional peaks of 6°C, as measured on Spitsbergen.
- Satellite observations show that **sea ice coverage** (in km^2) has decreased by 40% in late summer since 1979. The volume loss of sea ice (in km^3) is determined mainly by a rapid decrease in ice thickness; this decrease explains 60-65% of the loss in ice volume in the Arctic.
- Less floating ice and therefore more open water boosts the evaporation of water. The warming of the atmosphere also transports more moisture to the Arctic regions, which **increases precipitation**.
- Arctic regions have permanently frozen soil, the permafrost, with only the top layer thawing in summer. The **permafrost** is expected to **largely disappear** due to warming. The thawing and subsequent bacterial decomposition of plant remains in the soil will release large quantities of greenhouse gases – mainly carbon dioxide and methane – into the atmosphere, further aggravating the greenhouse effect.

Wadden Sea: more urgency for migratory birds
In winter, warming ocean water releases heat into the cold atmosphere, making winters in Arctic regions considerably warmer. This has considerable impact on the ecology. The habitats of plant and animal species will disappear as the tundra becomes wetter and greener and the winter snow melts away ever earlier. The migration and breeding behaviour of birds are already indicating a mismatch. As birds would have to arrive in their breeding areas earlier and earlier in order to benefit from insects that are appearing ever earlier, they have less and less time to fatten up when they migrate, for example in the Wadden Sea.

ACKNOWLEDGEMENTS

We want to thank Jan Rozema and Peter Siegmund (KNMI) for a substantive check of the fact sheet.

REFERENCES

Hoekstra, P. and C.J.M. Philippart. (ed.), 2021. Climate change and ecology. Position Paper Waddenacademie en Omgevingsberaad Waddengebied, 202101.

KNMI, 2021. Klimaatsignaal'21. Hoe het klimaat in Nederland snel verandert. KNMI, De Bilt, 72 pp.

Philippart, Catharina J.M., Kees Bastmeijer and Piet Hoekstra, 2020. Fastening our Wadden Sea seat belts. Protecting Natural Values in times of rapid climate change. An essay on Climate Change.

Common Wadden Sea Secretariate (CWSS), Annual report 2020, 411.

Reneerkens, J., 2020. Climate change effects on Wadden Sea birds along the East Atlantic flyway. Position Paper Wadden Academy, 202002.

Van den Hurk, B and Tj. Geertsema, 2020. An assessment of present day and future sea level rise at the Dutch coast – Zeespiegelstijging langs de Nederlandse kust en de regionale bestuurlijke consequenties.

Waddenacademie, position paper 202005.

SOURCE REFERENCE

Figures on page 2 and 5: KNMI Klimaatsignaal '21 Hoe het klimaat in Nederland snel verandert

Figures on page 3 and 6: Wadden Academy

Figure on page 7: Rakhimberdiev *et al.* (Nature Communications, 2018)

AUTHORS

Piet Hoekstra and Katja Philippart

EDITOR

Rob Buiter

ILLUSTRATIONS

Erik Visser – RaafWes

GRAPHIC DESIGN

BW H ontwerpers

Fact sheet 2022-01

Published by the Wadden Academy

CONTACT

Klaas Deen
Wadden Academy secretary
+31 (0)58 233 90 31
E klaas.deen@waddenacademie.nl
www.waddenacademie.nl

The basic funding of the Wadden Academy originates from the Wadden Fund.

waddenacademie