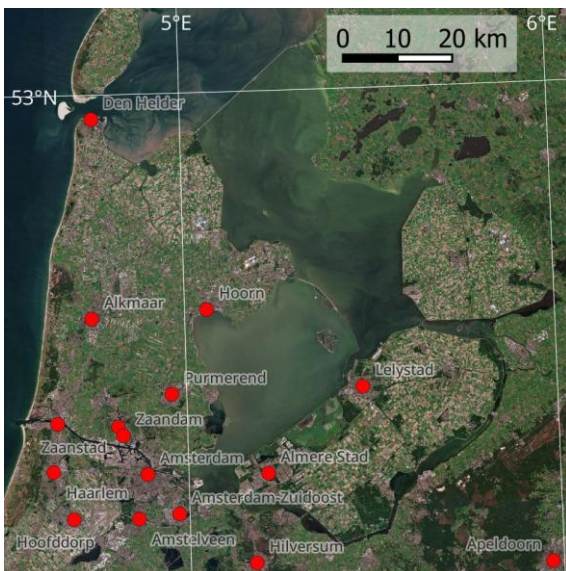


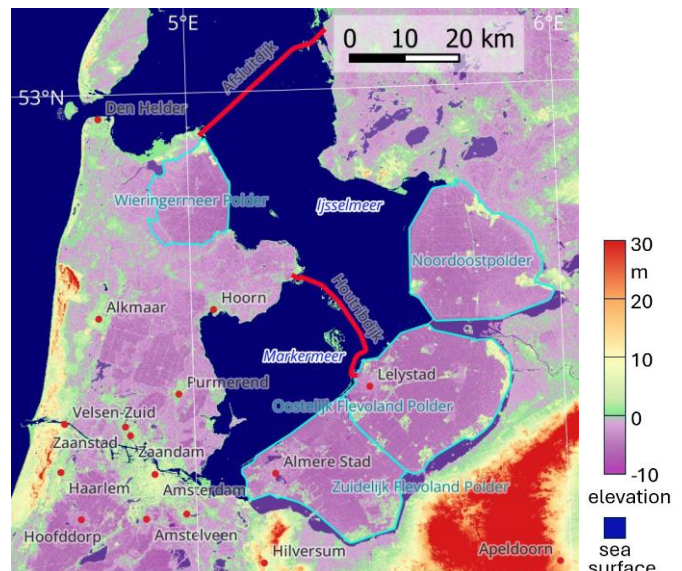
Argon, 1964-08-21



Landsat5, 1989-05-23 (overlay: polders and dams)



Sentinel-2, 2024-08-12



Digital Elevation Model (SRTM; overlay: polders and dams)

Before the 20th century, the IJsselmeer did not exist. Instead, there was the Zuiderzee, a saltwater inlet connected to the North Sea. During storms, water from the sea often flooded the surrounding towns and farmland. After a disastrous flood in 1916, the Dutch government approved the **Zuiderzee Works**, an ambitious plan led by Cornelis Lely to protect the region from flooding and to increase food security by creating new farmland.

The first major step was the construction of the **Afsluitdijk**, completed in 1932. This dam separated the Zuiderzee from the North Sea, transforming it into a freshwater lake now called the IJsselmeer.

After the Afsluitdijk was completed, engineers began draining sections of the IJsselmeer to form **polders**, areas of land reclaimed from the water. These polders are surrounded by dikes and kept dry using pumping stations. Four major polders were created: **Wieringermeer** (1930), **Noordoostpolder** (1942), **Oostelijk Flevoland** (1957), and **Zuidelijk Flevoland** (1968) with the city of Almere, one of the fastest-growing urban areas in the Netherlands. The creation of Flevoland, the newest Dutch province, is a direct result of these reclamation efforts. Currently about 9000 km<sup>2</sup>, more than one fourth of the area of the Netherlands, lies below sea level.



Although the Dutch have managed water for centuries, climate change brings new challenges to the region. Rising sea levels put increased pressure on coastal defences, including the Afsluitdijk, which has recently undergone major reinforcement. Another concern is subsidence, the gradual sinking of reclaimed land. As the polders compact over time and groundwater levels fluctuate, maintaining proper drainage becomes increasingly expensive.

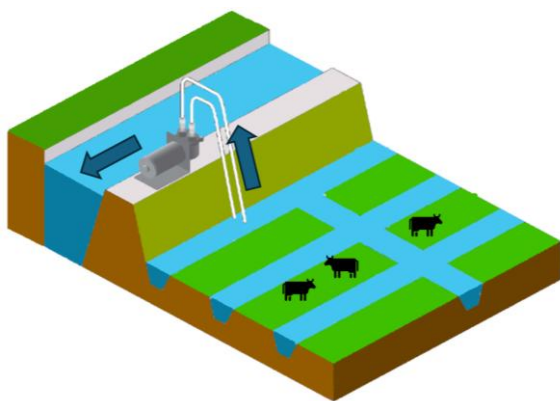
To address these issues, engineers and planners are exploring adaptive solutions such as flexible water-level management, nature-based flood defences, and continued use of advanced monitoring systems, including satellites, to guide decision-making.

## Exercises

### • **Satellite Maps:**

- Look at the satellite image maps and discuss the changes that occurred in the region between 1964 and 1989 (note: the 1964 image was taken by Argon, a US reconnaissance satellite).
- Comparing these two satellite images, try to identify factors influencing their information content. Think e.g. about spectral properties (bands) and spatial resolution (level of detail).
- Focus on the land reclamation areas and compare with the dates of creation of the polders. Which of them was under construction in 1964?
- Have a look to the 2024 Sentinel-2 image. Can you identify additional changes?
- Using the overlay of the polder areas, try to estimate the areas gained by the projects.
- Look at the Elevation Map (lower right). Large areas outside the polders lie below sea level. How is this possible? Think about dikes – where would you place them?

## Additional Material



*Schematic view of a polder. From areas below sea level water is pumped up to canals flowing to the sea (based on a drawing by Mic Greenberg).*



*Aerial view of the Afsluitdijk (MD van Leeuwen/CC BY-SA 3.0)*

## Links and Sources:

- [https://www.esa.int/ESA\\_Multimedia/Images/2024/12/The\\_Netherlands\\_from\\_Sentinel-1C](https://www.esa.int/ESA_Multimedia/Images/2024/12/The_Netherlands_from_Sentinel-1C) - Sentinel-1C radar satellite image highlighting the landuse pattern in the IJsselmeer region.
- [https://www.esa.int/Applications/Observing\\_the\\_Earth/Envisat/Satellites\\_keep\\_an\\_eye\\_on\\_Dutch\\_dikes](https://www.esa.int/Applications/Observing_the_Earth/Envisat/Satellites_keep_an_eye_on_Dutch_dikes) - report on the use of satellite data to support monitoring of dikes.
- [https://www.esa.int/Applications/Observing\\_the\\_Earth/Copernicus/Sentinel-1/Mapping\\_that\\_sinking\\_feeling](https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-1/Mapping_that_sinking_feeling) - report on the use of radar satellite data to monitor subsidence in the IJsselmeer region.

