Water transport networks in a changing climate

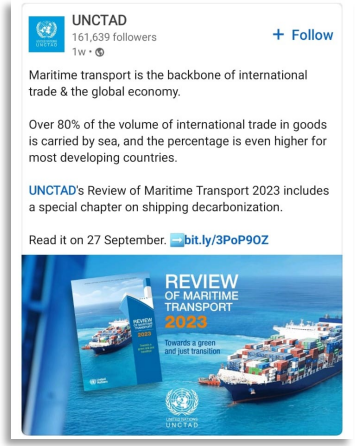
Supply chain disruption, an underestimated climate impact?

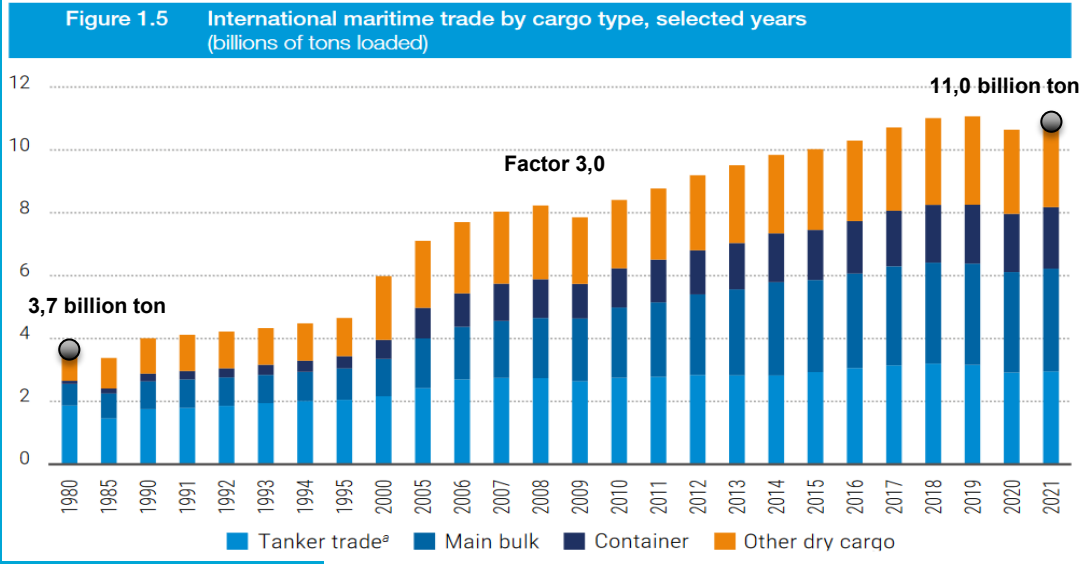
prof. dr. ir. Mark van Koningsveld

TU Delft – professor Ports and Waterways
Van Oord – program director corporate innovation
TS Water & Maritime – government appointed academic representative for water (captain of science)

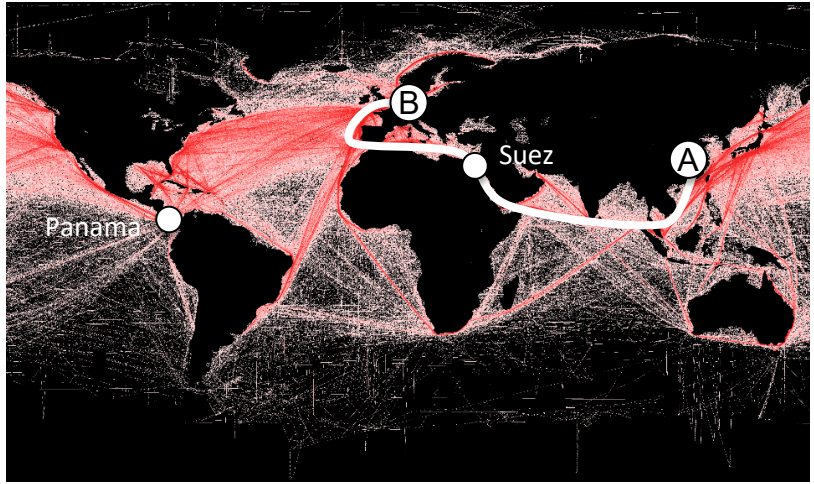
According to UNCTAD/RMT/2023:

"Over 80% of the volume of international trade in goods is carried by sea, and the percentage is even higher for most developing countries."



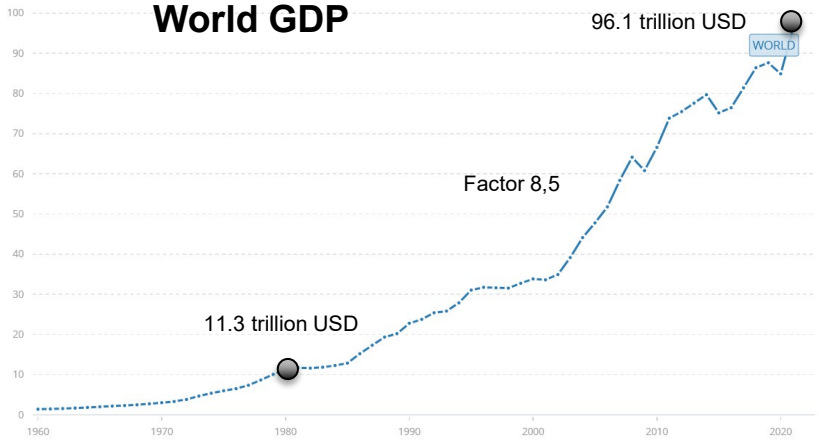


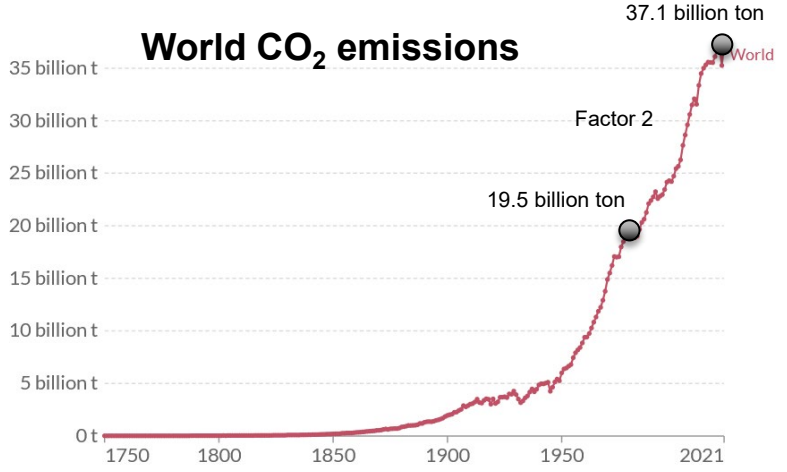
Source: UNCTAD/RMT/2022



Present-day commercial shipping routes by B.S. Halpern (T. Hengl; D. Groll) is licenced under CC BY-SA 3.0

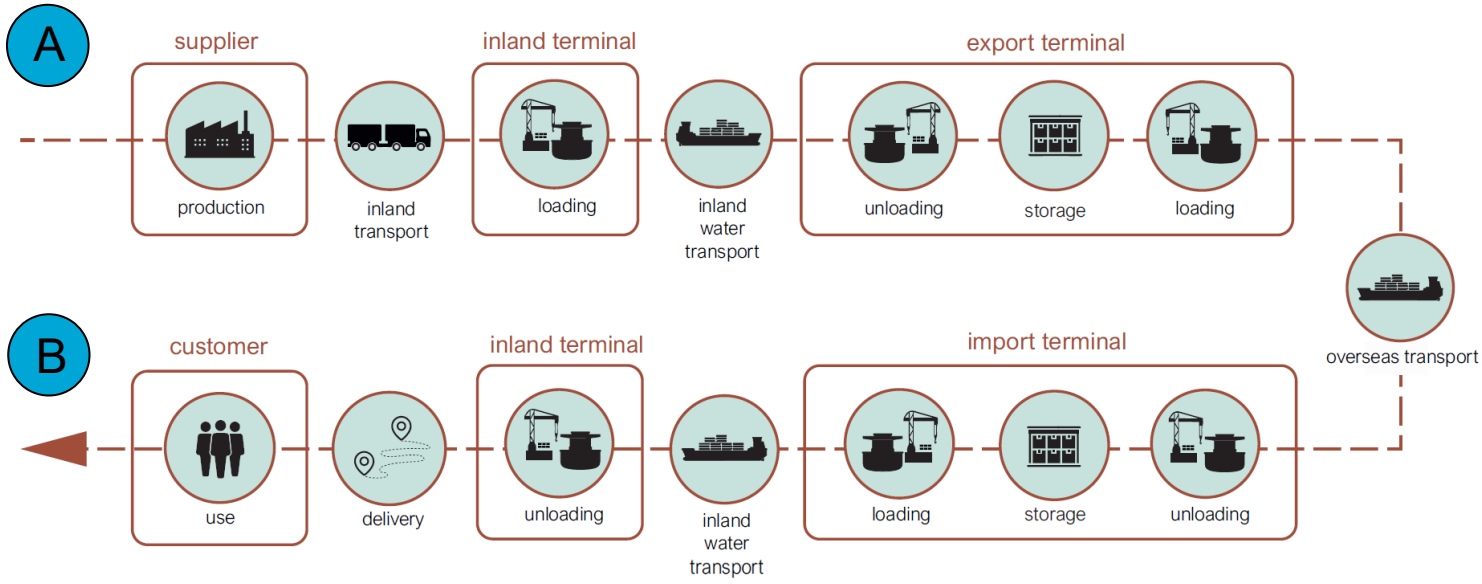
Figure 1: Aerial photographs of some of the world's largest port cities: Rotterdam, Singapore and Shanghai. Left column, view in 1984 (earliest available image); right column, view in 2022. Source: Google Earth.

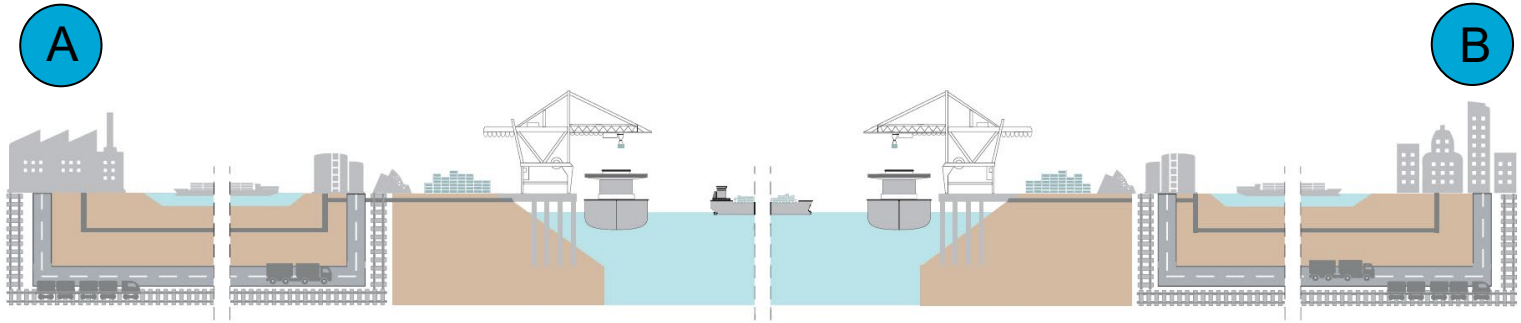




Waterborne supply chain

Physical environment





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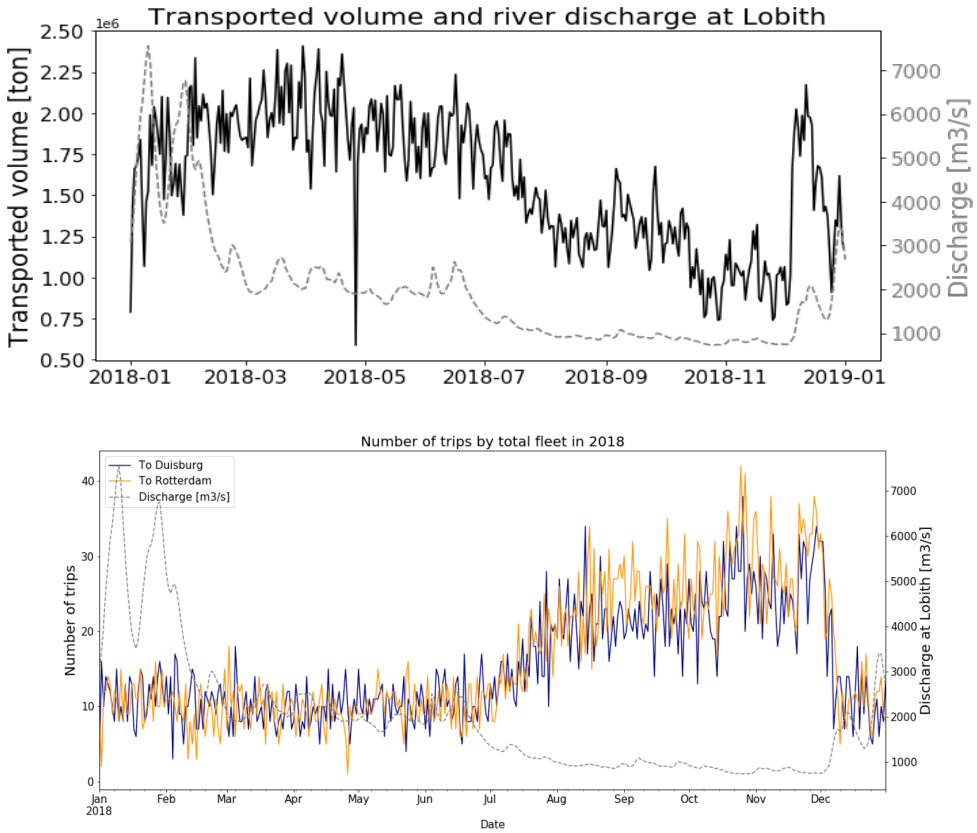
River Rhine

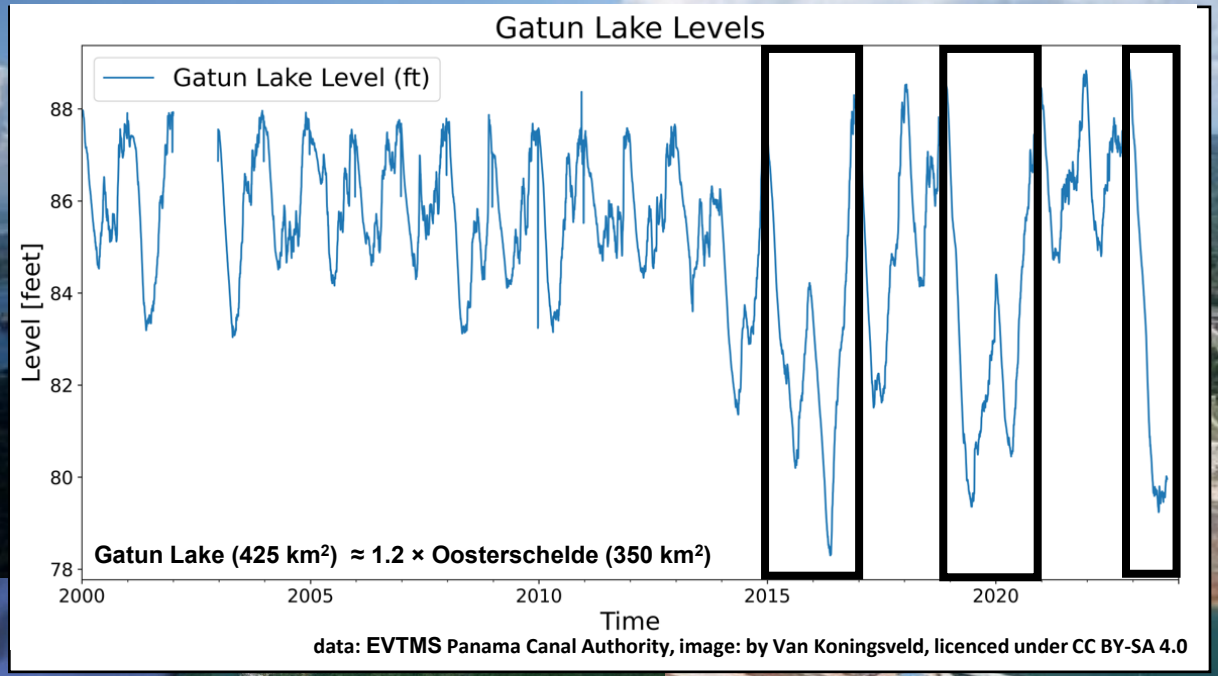
- In **2018 extreme drought** caused the **discharge** at Lobith to be **below ALD (1020 m³/s) for 124 days**
- Vessel operators needed to **reduce cargo load** to avoid running aground
- Reduced loads mean **more trips are needed to move the same amount of cargo**
- Despite the increased number of trips, the **total transported amount of cargo declined**
- German research estimates that **tangible losses from extreme weather** events amounts to **at least EUR 80 billion since 2018**
- We need to **simulate** what is likely to happen **in order to formulate rational policies**



source: https://www.waterschaprivierenland.nl/droogte

Panama canal

- The Panama Canal handles between 13,000 and 14,000 transits per year (**app. 40 ships per day**)
- The region is increasingly confronted with droughts, putting pressure on the use of fresh water (**drinking water vs shipping**)
- The PCA can take various measures, e.g., fixed and variable freshwater **surcharges** (up to 10%), official **maximum drafts** (neopanamax, panamax), fixed number of **transit slots**
- In 2022, an **average of 40 ships** passed through the canal each day. In 2023 this has been **lowered to 32 to save water**.
- The **limits on daily vessel transits and drafts** are set **to continue for another 10 months**, officials announced in August 2023.

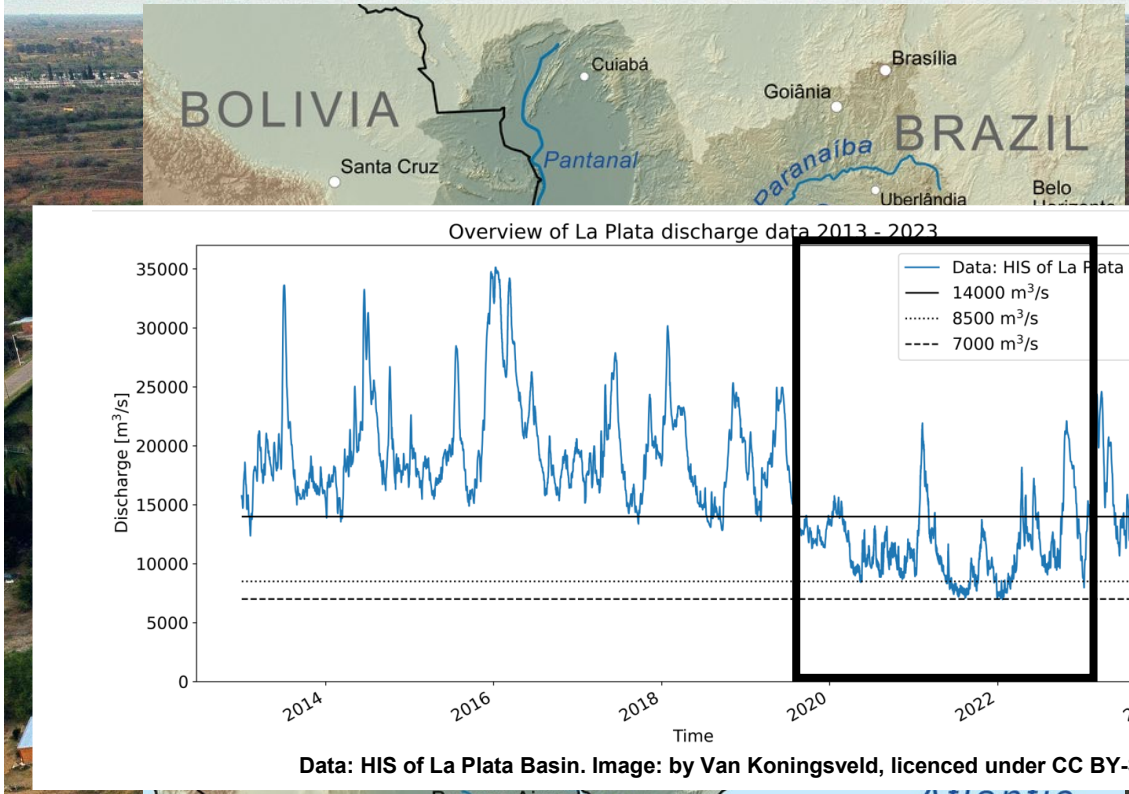


data: EVTMS Panama Canal Authority, image: by Van Koningsveld, licenced under CC BY-SA 4.0

New Agua Clara locks
US DOT
licenced under CC0 1.0

Paraná river

- The Paraná has recently suffered severe droughts. The river is the **key waterway for the export of grains and soy** from South America via Rio de la Plata.
- Since **mid 2019** continuing drought has caused the river discharge to drop from a ‘normal’ minimum of **14,000 m³/s** to just **7,000 m³/s**
- The low water levels are causing problems for **hydroelectric energy** production. Towns along the river are struggling to get **fresh water** and **catch fish.**
- Waterborne transport is hampered as **ships are not able to load up fully** in case they run aground, and **cargo has to be rerouted**



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ITALY'S PO DELTA'S RACE AGAINST A CHANGING CLIMATE

August 15, 2023
Topic: Natural disaster
Tags: #Italy, #Fisheries, #climate change, #drought
Located: Italy
by: Vittorio Torsello

REPUBLISH THIS ARTICLE

The Po River of Italy winds its way through a fragile region deeply impacted by climate change – the Mediterranean. As its waters wane, a compelling call to action emerges, urging innovative responses to the increasingly capricious nature of weather.

As the sun sets, its rays cast vibrant shades of yellow across the vast expanse of the Po Delta, highlighting the rice plant roots that float in the scarce water that lingers in the canals.

Elisa Moretto, a rice farmer from Italy's Veneto region, carries a family heritage linked to this crop, as depicted by a family photo proudly displayed in her shop. Each year, her farm, situated 20 kilometres from the Delta, cultivates 46 hectares of five distinct rice varieties.

The climate instability in the small Po Delta region is exacerbating vulnerability among farmers.

UK river levels already at record lows forecast to be 'devastated' by dry spring

Campaigners say government and water companies have not done enough to conserve water supplies

The River Wye at Hereford, which is very low after a dry winter. Photograph: Steven May/Alamy

River levels across the UK have been at record lows and are likely to be "devastated", as new data forecasts broadly dry weather until at least May.

Campaigners have said the government and water companies have not done enough to conserve water supplies by building reservoirs and fixing leaks, as months of low rainfall could cause some areas to run out of water.

CHRIS BARANIUK SCIENCE 14.03.2023 11:00 AM

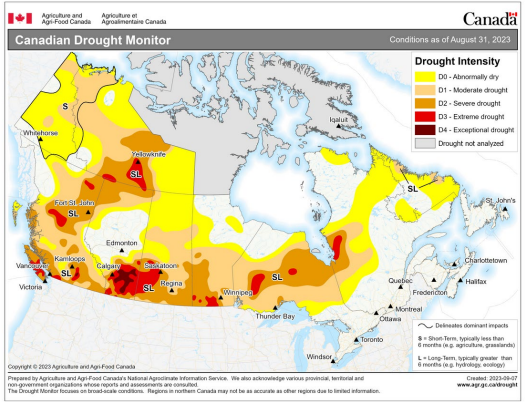
Europe Is Drying Up

After unusually low amounts of rain and snow this winter, the continent faces a severe water shortage.

PHOTOGRAPH: MATTHIEU RONDEL/BLOOMBERG/GETTY IMAGES

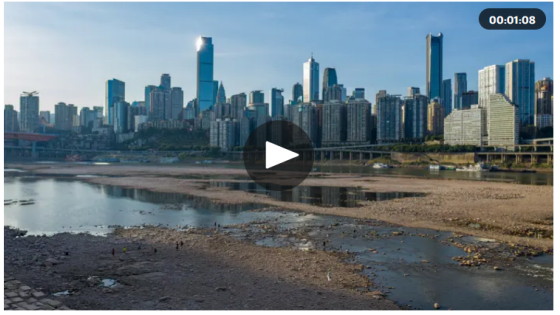
The European Drought Observatory tracks indicators of drought across the continent, including from satellite measurements, and suggests that vast regions are far drier than they should be. "Honestly, all over Central Europe, this issue, it's a widespread problem," says Carmelo Cammalleri at the Polytechnic University of Milan.

Current drought conditions



China drought causes Yangtze to dry up, sparking shortage of hydropower

Nationwide alert issued with south-west especially badly hit, as major companies forced to suspend work



China: world's third largest river dries up in drought – video

A record-breaking drought has caused some rivers in China - including parts of the Yangtze - to dry up, affecting hydropower, halting shipping, and forcing major companies to suspend operations.

A nationwide drought alert was issued on Friday as a long-running and severe heatwave in China's heavily populated south-west was forecast to continue well into September.

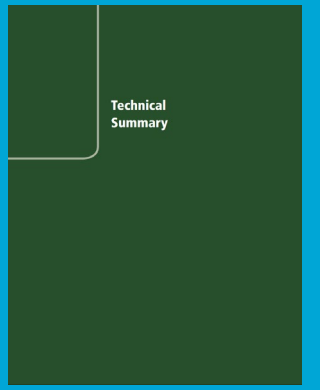
News / Drought threatens return of shipping disruption on US waterways

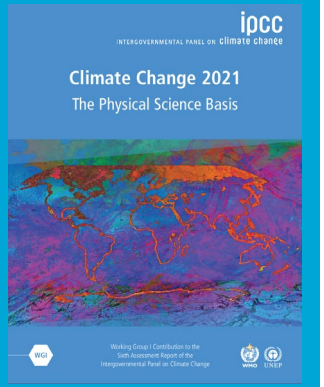
Water levels on the Mississi
rate – near the city of Cairo,
one week and experts predi
end of the month.

On the Mississippi, the wate
Louis area, and about six fe

Such declines would push b
barges may run aground an

By Ian Putzger, Americas correspondent 21/07/2023





IPCC's AR6 Reports

According to the IPCC AR6 Technical Summary report:
https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_TS.pdf

'Human influence on the climate system is now an established fact' (p.41)

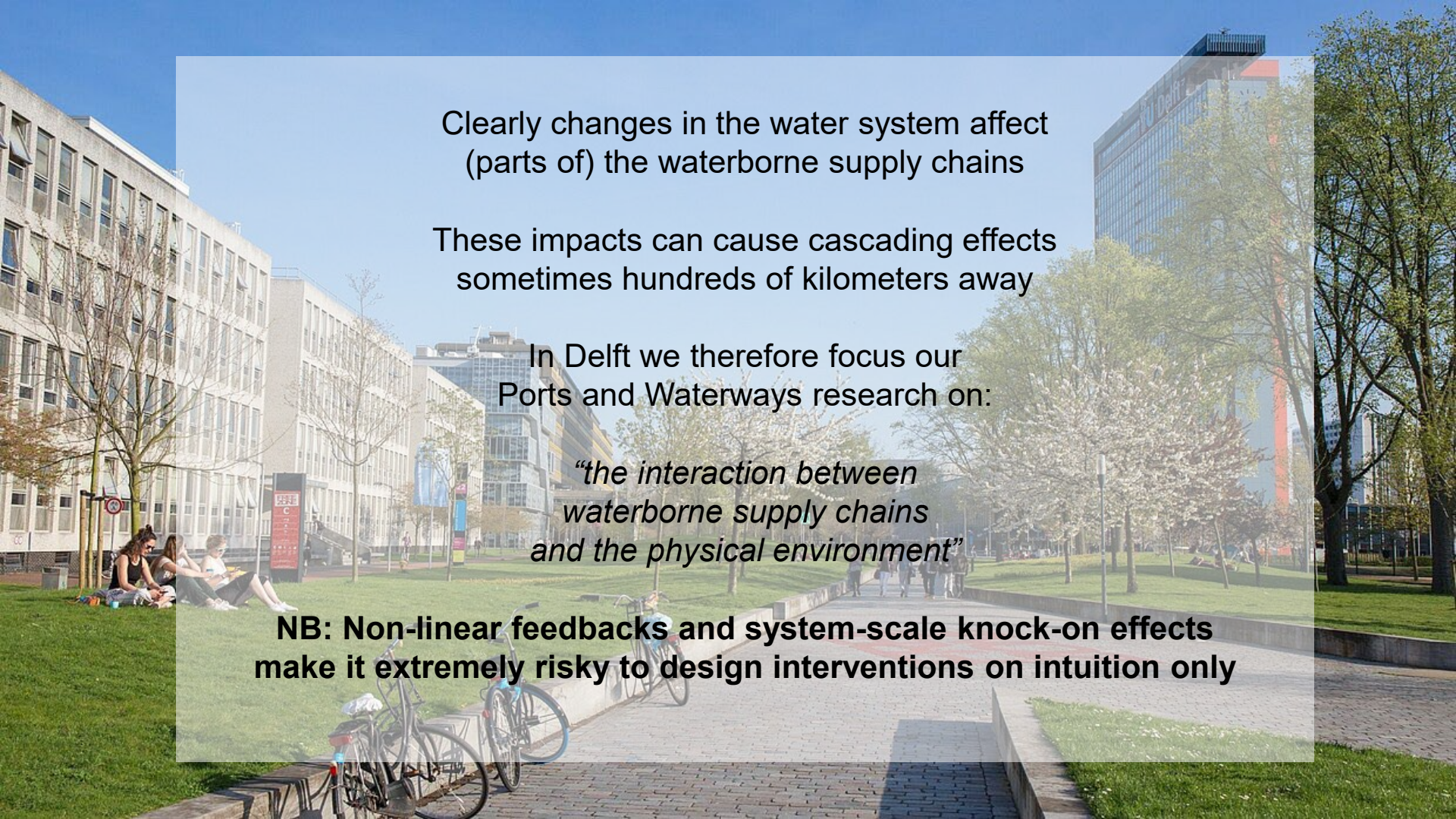
*"**Global water cycle:** The AR5 assessed that anthropogenic influences have likely affected the global water cycle since 1960. The dedicated chapter in the **AR6 WGI (Chapter 8) concludes with high confidence that human-caused climate change has driven detectable changes in the global water cycle** since the mid-20th century, with a better understanding of the response to aerosol and greenhouse gas changes. The **AR6 WGI further projects with high confidence an increase in the variability of the water cycle in most regions of the world and under all emissions scenarios.** (Box 17 TS.6)"* **(p.42)**

*"**Extreme events:** The AR5 assessed that human influence had been detected in changes in some climate extremes. A dedicated chapter in the AR6 (Chapter 11) concludes that it **is now an established fact that human-induced greenhouse gas emissions have led to an increased frequency and/or intensity of some weather and climate extremes** since 1850, in particular for temperature extremes. **Evidence** of observed changes and attribution to human influence **has strengthened** for several types of extremes since AR5, **in particular for extreme precipitation, droughts, tropical cyclones and compound extremes (including fire weather)**. (Sections TS.1.2 and TS.2.1, Box TS.10)"* **(p.42)**

Searching for words like '**ports**', '**waterways**', '**water transport**' and '**logistics**' returns **zero hits** in both the "Technical Summary" (112 pages) and the full report on "The Physical Science Basis" (2409 pages)

There is a lot of attention for the impact of shipping on the climate (emissions)

But there is insufficient attention for the impact of the climate on shipping



Clearly changes in the water system affect (parts of) the waterborne supply chains

These impacts can cause cascading effects sometimes hundreds of kilometers away

In Delft we therefore focus our Ports and Waterways research on:

“the interaction between waterborne supply chains and the physical environment”

NB: Non-linear feedbacks and system-scale knock-on effects make it extremely risky to design interventions on intuition only

Digital Twin - waterways

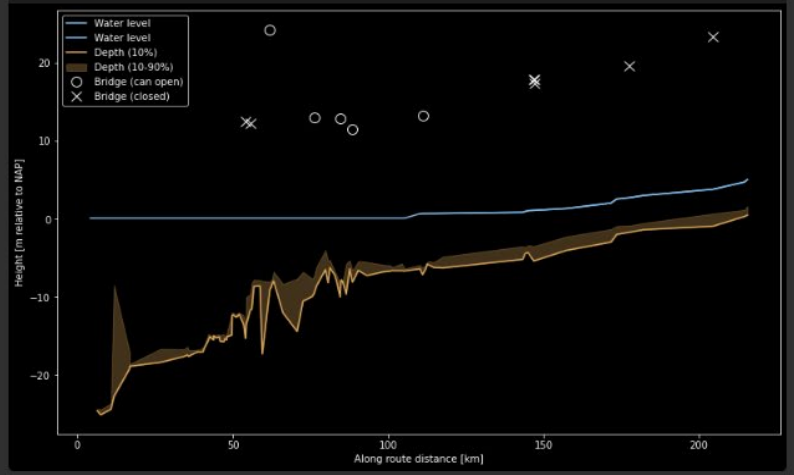
Sites — Fleet — Climate — 4 Load — 5 Animation

Set the underkeel clearance and vertical clearance safety margins.

Under keel clearance [cm]: 20

Vertical clearance [cm]: 20

Route profile



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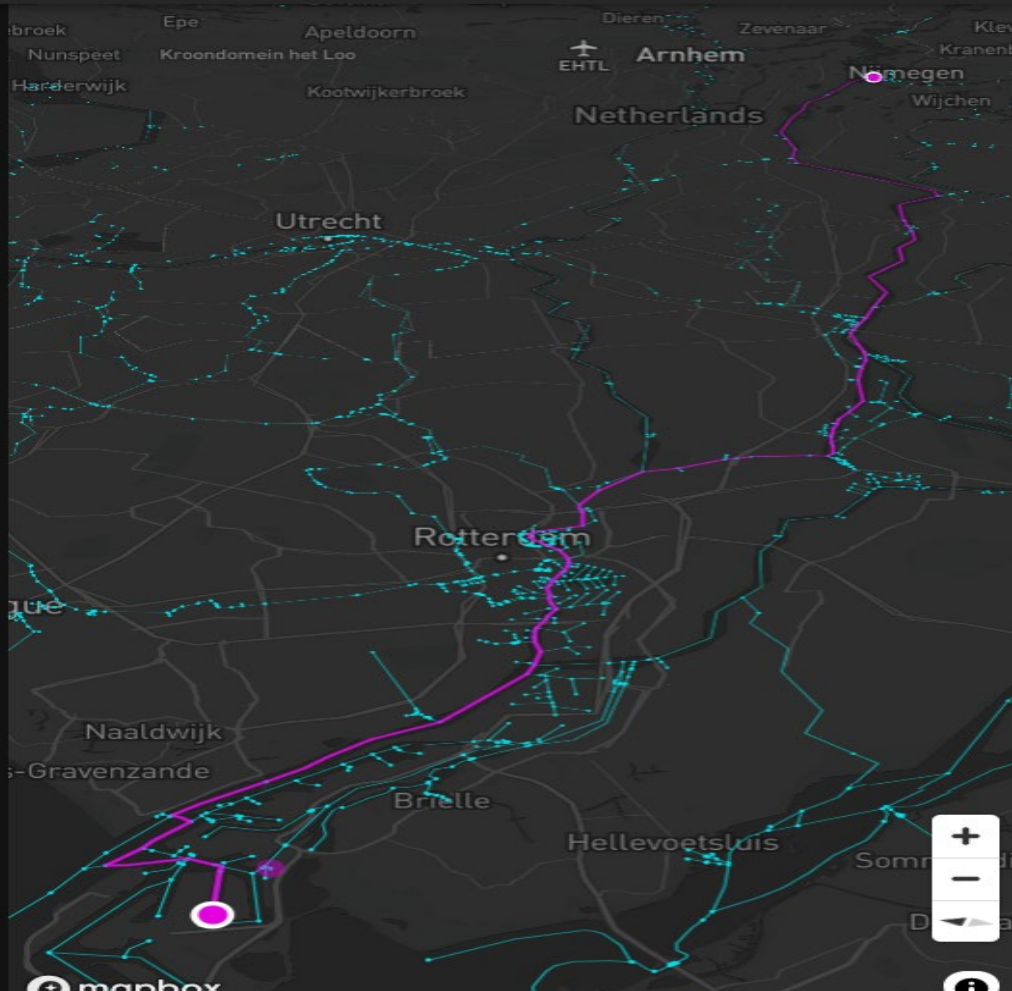
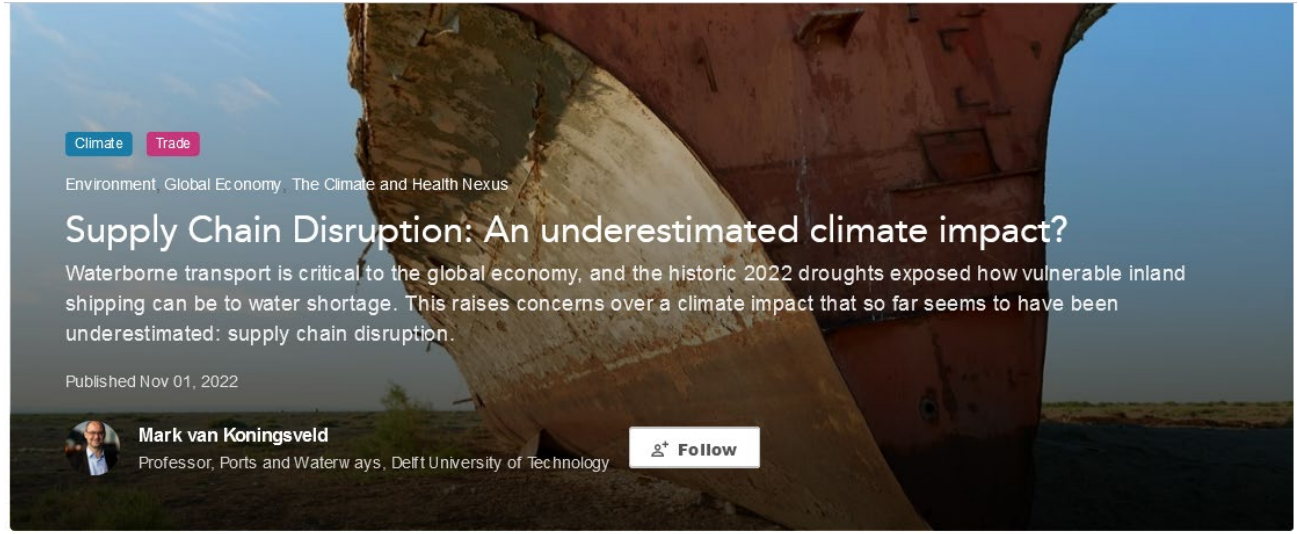


Key take aways!

- **Water transport and (global) economic development are closely related** (even though benefits may not be equally distributed)
- There is a lot of attention for the ***"impact of shipping on the climate"*** (emissions), but much less for the ***"impact of the climate on shipping"***
- The climate ***is*** changing, this change ***is*** going to impact water transport, and this impact ***is*** going to have economic consequences
- My plea is this:
  - Economies around the world need to analyze their vulnerability to this climate impact (stress tests using an integral approach)
  - Concrete interventions in the water system need to be considered and prepared (this requires the system thinking described, but also prepations in governance and funding)
  - Don't stop at the level of studies, but actively plan for implementation (large interventions take years to implement, there could be less time than we think)



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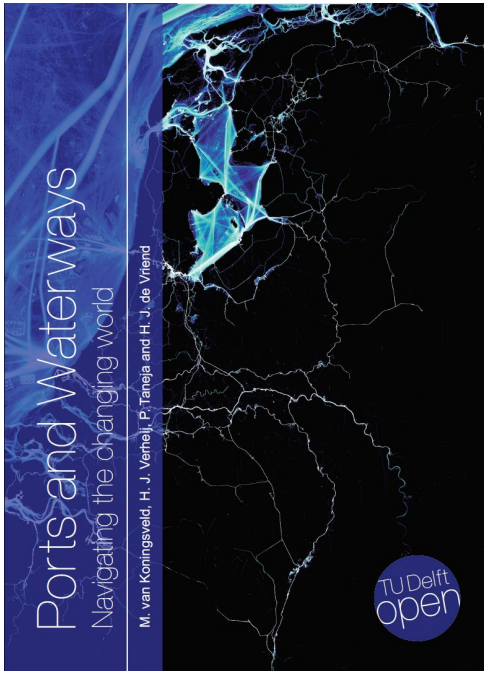

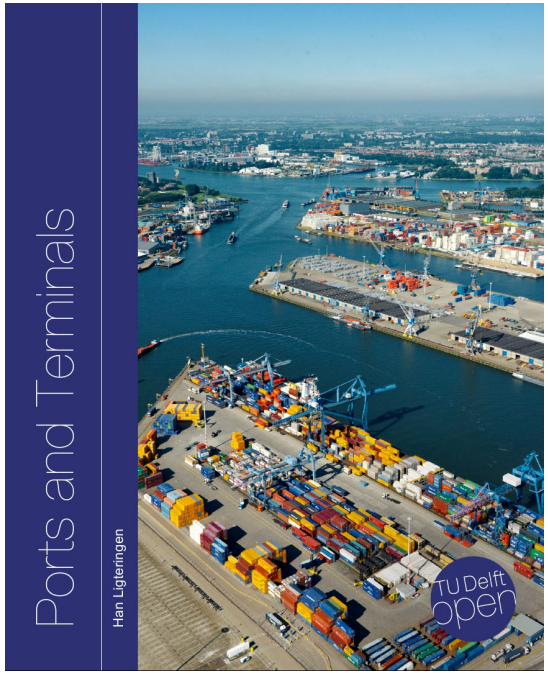

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