Turbulent times?

With the help of 100-year-old weather data, storm and climate researchers in Hamburg are trying to determine whether there are now more windstorms over Germany than in the past. Their findings contradict the commonly held perception: in fact, storms haven't become more frequent!

TEXT: KATJA TRIPPEL

The storm surge that hit Usedom on New Year's eve 1913 was devastating: in Zinnowitz, the waves tore away the landing bridges, and gale-force winds swept water from the Baltic as far inland as the castle courtyard in Wolgast. Nevertheless the diligent staff of the harbour signal station ventured outside several times a day to raise their flags, warning those out to sea of the storm hazard, and noted in their logs: blowing snow; wind force 12 Beaufort; water temperature three degrees.

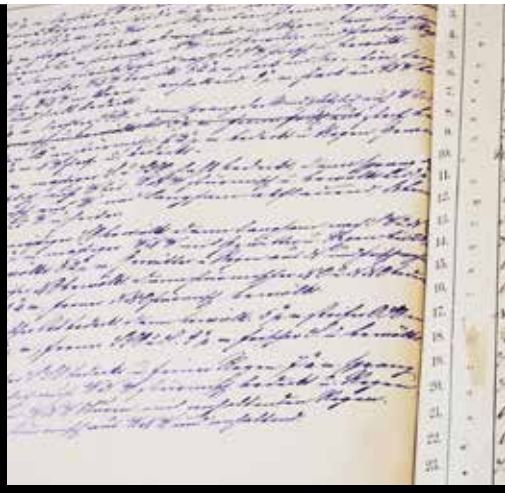
When the storm finally passed, the imperial postal service transported the weather records to the German Marine Observatory (Deutsche Seewarte) in Hamburg. Once there, they were archived, just like all other 'meteorological manifestations', which the 'storm signallers' (Sturmsignalisten), who manned 164 stations in the German Bight and along the southern Baltic coastline, began documenting by hand in 1877. The reason: ever since the mid 19th century, when the American naval officer Matthew Fontaine Maury had analysed historical ship's logs and discovered that there were regional and seasonal patterns for both storms and calm waters, the German Empire, too, had taken a new interest in the weather at sea. With its own meteorological research efforts, the German Marine Observatory hoped, in the service of the Kaiser, to help naval and merchant captains find safer routes. Accordingly, it required them, along with those working at Germany's North Sea and Baltic Sea ports, to record the temperature and atmospheric pressure and to take visual readings of the wind intensity at least three times a day, using the Beaufort scale: ranging from 0 (no wind), to 5 (fresh breeze, tree limbs waving, waves capped with foam), to 12 (hurricane, devastation, zero visibility).

Rediscovered in the basement

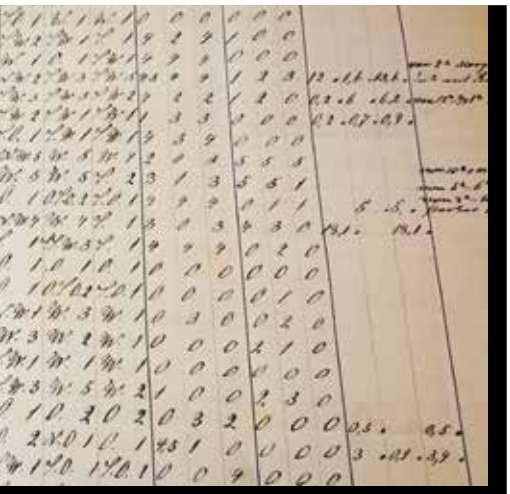
The storm signallers were still active until 1999, and their records wound up in the basement of the Sea Weather Office (Seewetteramt) in Hamburg's St Pauli quarter, the successor to the German Hydrographic Office. It was there that, the meteorologist

Whipped up by a winter storm, roaring waves crash into a seawall on the island Helgoland. The damage done by such storms is often massive. Broken power poles (right) are just one common example.

Two members of staff from a storm signal station roll a 'wind ball' to the signal post. If the ball were hung from the post, anyone who saw it would know it meant the wind was blowing at an intensity of 6 to 7 on the Beaufort scale.



In the basement of the Sea Weather Office in Hamburg, Birger Tinz from the German Meteorological Service (below) discovered the leather-bound ledgers of the 'storm signallers'. Their charts and reports represent a valuable source of data for modern storm research, and are currently being transferred into digital form.



Dr Birger Tinz from the German Meteorological Service (DWD) stumbled across the all-but-forgotten black leather books – and immediately had the feeling that he'd found a treasure trove for research purposes. "Historical time series like this are extremely valuable when it comes to researching storms on a regional scale," Tinz explains. "Moreover, good wind and atmospheric pressure data for the Baltic Sea region, which can be used to reconstruct past storm activity, is hard to come by. And this information isn't just of interest to those operating harbours or offshore wind parks, but everyone who has trees anywhere near their house."

Without a doubt, the damage that windstorms and other storms can do, even at our latitudes, is considerable. Probably everyone living in Germany and over the age of 35 still remembers the winter of 1990, when eight hurricanes in a row, including the infamous duo Vivian and Wiebke, destroyed countless buildings and forests, claiming 64 lives; or Lothar, the 'storm of the century', which struck on Boxing Day of 1999: its record-breaking 272 kilometre-per-hour winds produced fatal accidents throughout half of Europe, and the damage cost ten billion euros to clean up. In 2007 the storm Kyrill raged so wildly that, for the first time in history, Deutsche Bahn suspended all rail transport.

Media changes hazard perception

More recent storms like Xaver (2013), Ela (2014), Felix (2015) and Friederike (2018) weren't as extreme – yet images of houses with their roofs torn off and uprooted trees, which flitter about Facebook and YouTube, give many people the feeling that catastrophes are becoming more and more frequent. But is their gut feeling actually right?

At least for the citizens of Hamburg, who the Institute of Coastal Research at the Helmholtz Centre Geesthacht (HZG) has surveyed regarding their views on climate change and its impacts every year since 2008, the answer is clear: though in 2018 the majority of those surveyed (64 percent) once again cited flooding as the natural catastrophe with the worst potential consequences, more of them than ever before (19 percent) claimed that storms were the most serious threat; in 2008, it was only nine percent.

Scientists are of course more sceptical by nature, and prefer to put their faith in numbers, ideally reliable ones. And the more figures available, the better. Consequently, Birger Tinz is now working to preserve the storm signallers' historical records in a clearly legible, digital form – a herculean task. At the same time, in her doctoral thesis, his colleague Dr Dörte Wagner is analysing how valid the data is, or to put it another way: whether the signallers actually did a good job. To do so, she and colleagues from the HZG's Institute of Coastal Research are checking the extent to which the wind and atmospheric pressure data from selected signal stations match with data from regular weather stations and the weather maps produced by Germany's Imperial Navy. What they've found: only one of about 100 stations was consistently inaccurate in the New Year's eve storm 1913. As for the other storm signallers, Tinz has nothing but the greatest respect for their work: "They really knew their business; they were true sea dogs!"

In the meantime this digitalised data has also been provided to the climate researcher Dr Frauke Feser, who coordinates storm research at the Institute of Coastal Research. Together with her colleague Dr Oliver Krüger, she is performing statistical analyses on meteorological time series from a variety of sources – e.g. from the DWD's monitoring stations, which have been in operation since 1875; from weather stations in Iceland, Norway and Ireland; and from international databases on atmospheric pressure, like those provided by the WMO (World Meteorological Organization).

Air pressure most reliable measure

In this regard, data on wind strength and direction is much less important than atmospheric pressure data. "Wind measurements alone aren't generally considered to be a reliable parameter for describing storm activity over a longer timeframe," Feser explains, "because the results depend substantially

LOOKING AHEAD

I want to find out where these alternating strong and weak storm phases in the past came from. To do so, we're currently working to identify which mechanisms are responsible for the long-term development of the storm climate, both in our latitudes and around the globe.

FRAUKE FESER
Climate modeller, Helmholtz Centre for Materials and Coastal Research in Geesthacht (HZG)

on the local surroundings. For example, on a stormy day in Hamburg, you'll get very different readings at the airport than at the harbour." Further aspects for reliable time series: stations were often relocated in the past and external influences can skew long-term wind records: "For example, if over the course of time a small forest grows near a measuring station, or a new building is erected near it, it can have a significant impact on the readings," says Feser.

To determine how the intensity of storms over the North Sea and Baltic developed in the past, Feser's colleague Oliver Krüger works with historical atmospheric pressure data - from measuring stations that are located at least 500 but no more than 800 kilometres apart. He uses these sources to form triangles in which a parameter referred to as the geostrophic wind – an approximation of the atmospheric circulation that is suitable for the middle latitudes – can be calculated. According to Krüger, "The more of these triangles we calculate, the more precisely we can analyse the storm history of the North Atlantic, and that of the North and Baltic Seas."

Surprising result

His findings may come as a surprise: "There are neither more storms, nor have they grown more intense," the climate expert reports. That being said, the chronological development is somewhat more complex, as Frauke Feser explains. "If we look at the development over the past 50 years, starting in the mid 1960s the total number of major storms over Germany began rising. But if we look back another 100 years, and further forward into the early 2000s, there doesn't appear to be any long-term trend." Instead, there are alternating decades: some with an unusually high number of storms, and others that are fairly quiet. For example, since the mid 1990s the number of storms has - contrary to popular opinion – dropped back down to the long-term average.

"In other words, when it comes to wind there is no general increase like with atmospheric and ocean temperatures; it's more like waves, that are stronger or weaker for several years at a time," Feser emphasises. Why is it different with wind? "That's something we're investigating right now. And the data from the storm signallers will hopefully help us to do so."

For his part, Birger Tinz from the DWD is happy to see that the old weather records are being used to contribute what he calls 'part of the great storm puzzle'. In his work so far, he was especially surprised to discover that the Baltic is apparently just as stormy as the North Sea. "That's not only important for tourists, yachtsmen, but also for investors who are considering building an offshore wind park," says the meteorologist. "Knowing how powerfully the wind has blown, and where, over the past 150 years can be crucial in terms of deciding for or against a potential site for a new wind park."

However, he can't promise that these insights into the past will soon also provide clues to what the future holds; the climate researcher Feser is also reserved: "We still need a better understanding of where these decadal variations came from, and of how various effects of the climate system and climate change influence storm activity in our regions. We won't be able to gain insights for the future until we've grasped the nature of storm activity in the past."

IN BRIEF

- **Wind strength and direction usually don't offer suitable parameters for investigating long-term storm trends; atmospheric pressure data is more reliable.**
- **The winter of 1990 was one of the stormiest since the beginning of weather records: eight consecutive hurricanes swept over Germany.**
- **Neither the number nor frequency of storms over Germany is on the rise – instead, there are alternating periods of intense storm activity, like in the early 1990s, and those with fewer storms, like the period we're currently in.**

HZG climate modellers Frauke Feser and Oliver Krüger are using the storm signallers' historical atmospheric pressure data to reconstruct storm frequency in the past, and to determine why storms over northern Europe alternately increased and decreased. This is connected to a question that is also highly relevant for many industrial sectors: how will climate change affect the development of storm fronts? There are currently many indications that storms will become more intense in the future, and that their paths will shift further to the east.

THE TRAINS NEED TO KEEP ROLLING, STORMS OR NO STORMS

Since the summer of 2018, the certified forest manager Felix Gerhardt has led the 'Vegetation and Natural Hazard Management' team at DB Netz AG.

Mr Gerhardt, you work in natural hazard management – that has an exciting ring to it. What exactly does your work involve?

We're a four-member team, consisting of another forest manager, a water management engineer, a geoscientist, and myself. Our job is to plan efficient preventive and clean-up measures, so that rail transport can run more smoothly than in the past when it comes to extreme weather conditions like hurricanes or massive cold snaps.

And how do you do it?

First we analyse the damage done by past events like severe storms – and what we can expect to see in the future. In more practical terms, we focus on the vegetation near the rails. We ask ourselves: how can we avoid trees or limbs coming down on the tracks due to storms or heavy snowfall, causing delays?

Good question! How do you want to avoid this in the future?

For 2019 our goal is to check our core rail network – roughly 6000 kilometres! – for potentially problematic trees. In this regard, we're currently testing whether we can use drone imagery and special software to display and check certain wooded areas using tablets. Six metres to the right and left of the tracks, in what we call the trim zone, we'll completely cut down the vegetation. In the stabilisation zone 20 to 30 metres beyond the trim zone, we want to take a closer look at the composition of the woods, so as to make them more resistant to storms. In other words: trees that pose a risk will be trimmed or cut down, while sturdy ones will receive targeted support to preserve their health – needless to say, only outside of the nesting season. But in order for these efforts to bear fruit, we have to rely on the support of forest owners, government offices and associations.

Do you also work together with climate researchers?

We participate in a number of experts' networks, and we also organise events to promote a healthy exchange between the European rail networks, and with technical and research institutes. Climate change isn't a linear phenomenon, which is why we need to constantly reassess our concepts and be prepared to update them. ■