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Press Dossier

50th Anniversary of the North Sea Flood of Hamburg

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“I flew over the flooded area in a helicopter to gain a first-hand impression of the situation. Thousands had sought refuge on roofs and would have drowned or frozen to death if we had not acted immediately. About a fifth of the city was under water. We knew that nothing like this must ever happen again. And so Hamburg invested huge amounts in flood controls in the years that followed."
(Helmut Schmidt, former Federal Chancellor)

1.) The North Sea threat

Storm surges are unusually high water levels caused when high tide is accompanied by powerful storm winds. This happens when strong winds blow towards the coast over a period of many hours driving sea water landwards in addition to the astronomical tide. Which coastlines are affected depends on the path of the low pressure system causing the winds. The time required for an early warning prediction of the water levels of a coming storm surge is today usually 12 hours or more. The low pressure system responsible for the storm surge can already be predicted two to three days beforehand. The risk of storm surges is particularly high in the winter half-year, when Atlantic storm fronts approach from a west to north-westerly direction. Spring tides occur twice a month when the sun, moon and earth are lined up in a row behind each other. The resulting increased differences in gravitation lead to a higher tidal range.

Storm surges rarely last for more than a day, as the low pressure systems usually sweep over the area relatively quickly. The peak period normally only lasts for a few hours; due to the astronomic tide cycle (the intertidal period between low tide and high tide lasts for six hours), the water level falls again quickly once high tide has reached its zenith. The strengths of storm surges on the North Sea coast are defined according to an official scale:

		Hamburg
Storm surge	1.5 – 2.5 m above MHW	3.6 – 4.6 m above SL
Strong storm surge	2.5 – 3.5 m above MHW	4.6 – 5.6 m above SL
Very strong storm surge	> 3.5 m above MHW	> 5.6 m above SL

MHW = mean high water
SL = sea level

Along the shorelines of the North Sea, which with an average depth of 70 metres is a comparably shallow sea, the tidal range (mean difference between low tide and high tide) is approximately 0.5 m (Southern Norway) to 6.8 m (The Wash, England). Along the German North Sea Coast, the tidal range varies from two and four metres, in Hamburg it is 3.65 metres. The height of a storm surge is influenced significantly by geometrical factors such as the shape of the ocean bed and the coastline. Storm surges are particularly intense in funnel-shaped river estuaries such as on the Thames, Elbe and Weser, and in bays, whereas their strength is weakened by offshore islands.

2.) Historical storm surge events

In the past century, a series of catastrophic storm surges in the North Sea are well-known not only for having claimed an immense number of lives but also for having changed the shape of the coast, in some parts significantly.

26 Dec. 838		Large areas of NW Netherlands under water, 2,500 dead
28 Sept. 1014		Almost the entire coast of the Netherlands flooded, thousands of fatalities
17 Feb. 1164	Julian Flood	20,000 dead between the Rhine and Elbe estuaries; formation of the Jade Bight bay
16 Jan. 1219	1st Marcellus Flood	Reportedly 36,000 dead
1228		In the Netherlands: 100,000 dead

14 Dec. 1287	St. Lucia's Flood	50,000 dead; beginning formation of Dollart Bay
16 Jan. 1362	2nd Marcellus Flood "Grote Mandränke“	100,000 dead, large-scale loss of land
1375		Netherlands: formation of the Zuiderzee
19 Nov. 1404	1st St. Elizabeth's Flood	Large parts of Flanders, Zeeland, Holland flooded
19 Nov. 1421	2nd St. Elizabeth's Flood	Zeeland, Southern Holland flooded
5 Nov. 1530	St. Felix Flood	Zeeland
1 Nov. 1570	All Saint's Flood	Water levels higher than in 1953; Friesland, Zeeland and Antwerp extremely badly hit, over 20,000 dead, tens of thousands homeless
11 Oct. 1634	Burchardi Flood	At least 8,000 dead
12 Nov. 1686	St Martin's Flood	
24 Dec. 1717	Christmas Flood	Entire North Sea coastline of Northern Netherlands from Germany to Scandinavia; greatest till then known storm tide; 14,000 dead
1 Jan. 1721	New Year's Flood	Higher than Christmas Flood of 1717
3/4 Feb. 1825	February Flood	Netherlands: enormous proportions, 3770 sq km around the Zuiderzee flooded; 800 dead in East
Friesland		
1/2 January 1855	January Flood	Widespread destruction on the East Frisian Islands
1894		Netherlands: impact greater than in 1825
13 March 1906	March Flood	Highest flood ever along the East Frisian coastline (Emden): 5.18 m.
14 Jan. 1916	Zuiderland Flood	Following this flood, between 1927 and 1932, a 32 km long and 90 m wide tidal power dam was built which formed the Ijsselmeer from the Zuiderzee and shortened the coastline of the Netherlands by 300 km. The top of the dam is 6.8 to 7.5 m higher than the normal Amsterdam water level.
7 Jan. 1928	Thames Storm Surge	London and English East Coast, thousands homeless
1 Feb. 1953	North Sea Flood of Holland	2,167 dead, Force 9 winds and higher raged for 20
	hours;	
		Max. water level 4.55 m; dyke failures in 89 places; 200,000 farm animals killed; the Delta Works project in the Netherlands was initiated as a result of this storm surge.
16/17 Feb. 1962	Hamburg Storm Flood	61 dyke failures, 347 dead; 370 sq km flooded
1976	Hurricane Capella	Hundred-year storm surge, highest water levels ever measured in many places

24 Nov. 1981	November Flood	Highest water levels in North Friesland
26-28 Feb. 1990	Five storm surges	Greatest accumulation of storm surges.
28 Jan. 1994		Hamburg, Schleswig-Holstein
10 Jan. 1995		Hamburg
6 Feb. 1999		Entire North Sea coastline
3/4 Dec. 1999	Hurricane Anatol	Elbe, Hamburg, Schleswig-Holstein, Denmark
29/30 Jan. 2000		Schleswig-Holstein, Denmark, sand depletion on Sylt
1-2 Nov 2006	Hurricane Britta	Entire North Sea coastline
27 Feb 2010	Hurricane Xynthia	France, Bretagne, 47 dead

Over the past fifty years, coastal preservation in Europe has been brought up to a standard intended to contain damage caused even by heavy storm surges. However, in view of the enormous values and high population density along the North Sea coastline, an event with a statistic return period of 100 years and more still harbours an immense potential threat.

3.) Causes and events of the 1962 storm surge

The hurricane that triggered the storm surge along the entire German North Sea coast on the night of the 16-17 February 1962 marked the end of a stormy west-wind weather period that had lasted since the end of December 1961. The German North Sea Coast had been hit already by a storm surge on 12 February 1962 which, however, had only reached water levels that were approximately two metres higher than the mean high-tide water level. On the Thursday evening of 15 February, a Force 9 storm warning for the North Sea was first issued at 21 hrs. In the late hours of the evening, the wind along the entire German coast grew steadily stronger and turned from the south west to the west. On 16 February, the wind fields of the intense low pressure system reached the North Sea. Wind velocities in the northern areas of the North Sea and in Skagerak exceeded the measuring range of the instruments used at that time. As a result of the increasingly bad weather conditions, a gale warning was issued on the morning of 16 February noting the possibility of a dangerous and later of a very dangerous storm surge ahead.

In the midday hours, the storm veered off in north-westerly direction and continued to gain momentum, so that during the outgoing tide after the high tide at midday, the waters dropped only insignificantly. In Bremen and Hamburg, the low tide that began around 20 hrs was as high as the normal high-tide levels. During the evening hours, the weather conditions deteriorated dramatically. In the sea areas of the German Bight, average wind velocities of 9 to 10 on the Beaufort scale were measured, along with Force 12 squalls. At the same time there was an increased occurrence of thunder, hail and sleet showers. Due to the increasingly stronger winds, the water levels measured on 16 February at the gages along the entire North Sea coastline and rivers during high tide at midday were already significantly higher than the predicted high-tide levels by some two metres. This tide had already filled the summer polder protected only by the summer dykes. As the weather continued to worsen and the wind turned to the Northwest, the midday tide was prevented from receding, so that the tidal low water on the early evening of 16 February corresponded to the level of the normal high tide in many places. As the tide along the North Sea coast and rivers began to rise again, a rapid and very strong increase in the water levels was observed as the waters met with the already full summer polder and, consequently, advanced very quickly towards the main dykes. Shortly before 21 hrs, the ferry traffic on the lower reaches of the rivers came to a standstill. At this point in time, a very critical situation arose not only at the sea dykes but also on the East Frisian Islands.

In Hamburg, the first dykes in the area of the Süderelbe were already overtopped just after after midnight. Dykes were quickly breached due to massive construction deficiencies such as buildings and systems integrated into the dyke, non-flood-control use and the landward slopes having been built too steeply. Buildings located right next to the breaches were completely destroyed. Altogether, the dykes failed in more than 60 places. The Hamburg inner city district of Wilhelmsburg was particularly heavily hit. One factor that proved to be disastrous was the fact that the main Klütjenfelder dyke, which was very wide in this district, was being used as a garden allotment site inhabited permanently by people who had been bombed out of their homes during the Second World War. As the closed grass cover that is essential for the safety of the dyke was missing due to the gardening activities, holes formed very quickly and ultimately led to breaches in the dyke. All help came too late for the some 200 inhabitants of the temporary homes on the main dyke along the Berliner Ufer, as rescue work was only possible by boat following the rapid flooding of the Wilhelmsburg settlements that were no longer protected by the breached main dyke. In some cases, people taken unaware by the waters were washed into the basement of their houses by the inrushing water masses and drowned. A total of 222 people lost their lives in Wilhelmsburg. Also badly hit was the city district of Waltershof where 37 people died, and the city districts of Billbrook (13 dead), Neuenfelde (10 dead) and Moorburg (5 dead). Apart from the entire Port of Hamburg, parts of the inner city in the area of the Alster River and the Rödungsmarkt were also flooded. The extensive dyke breaches in the area of the Süderelbe also led to widespread flooding in the hinterland of Lower Saxony.

The immediate impact of the storm surge left 318 dead, tens of thousands of homeless and some 6,000 buildings destroyed. Almost one sixth of Hamburg's city territory (120 km²) was inundated, the transport infrastructure to the south and in the direction of the Alte Land region was disrupted, basic services were restricted. Total damage to property amounted to approximately three-quarters of a billion D-Mark. The city district of Waltersdorf was abandoned as a residential area following the flood. Apart from Hamburg itself, massive damage was also caused along the entire German North Sea coastline: in Bremen and Bremerhaven, in the lower Weser area of Lower Saxony, on the Weser Islands and the Frisian Islands. The sea dykes that had been reinforced shortly before the flood and had consequently not yet become fully consolidated, as well as other sections of dykes that had not been reinforced, were badly damaged in some areas. Of these, the dyke groups on the eastern side of the Jade Bight were particularly badly affected. In this case, the lack of an adequate dyke defence infrastructure proved to be a major problem.

The main burden in the area of dyke defence and rescue operations, that had begun in the evening already, was borne primarily by numerous voluntary fire brigades, the Technisches Hilfswerk (German Agency for Technical Relief), the police forces and German and US army units. In many places, the first emergency task forces convened already on the afternoon of 16 February 1962 in the offices of the local authorities. In Hamburg, the authorities did not adequately recognise how dangerous the situation was until well into

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the late hours of the evening. The population in the jeopardised areas were first warned when many of them had already gone to bed. And then, due to massive disruptions of the communication channels, it was not possible for a long time to obtain precise information on the extent of the catastrophe in order to coordinate rescue operations. Already as soon as the first dykes had been overtopped, the most severely affected disaster areas could already no longer directly be reached over land. Flooding of the cable ducts and power stations led within a short time to a total failure of the electricity supplies and telephone lines in the impacted areas. The telephone lines that were still working were constantly blocked by incoming emergency calls. Unclear decision-making hierarchies, competing responsibilities and the lack of practicable disaster management plans made the situation even more difficult; important senior officials stayed at home, even after a state of emergency had been imposed at 0:30 hrs in the city of Hamburg. Until Hamburg's Minister of the Interior, Helmut Schmidt, arrived on the morning of 17 February, there had been no central commander of operations in the Hamburg city district.

Those in charge first obtained an overview of the extent of the disaster in the hours before midday. According to the reports received by then, it was to be feared that the storm flood had claimed, or would claim, thousands of lives in Hamburg alone, if military aid was not availed of as quickly as possible. As Helmut Schmidt had previously been occupied with defence affairs in his capacity as a member of the Bundestag and knew most of the commanding officers of NATO personally, he was able on the morning of 17 February, although not authorised to do so by constitutional law, to request NATO Pioneer troops with storm boats and 100 helicopters from the German Army and the Royal Air Force to support the approximately 25,000 civilian helpers.

All in all, the storm flood in Hamburg claimed 318 lives and caused losses to the sum of DM 820m (€1.6bn according to today's values).

4.) Consequences drawn from the flood

Already in the aftermath of the North Sea Flood of Holland, the authorities responsible for coastal protection had come to the conclusion that the defence systems along the North Sea coast were in urgent need of upgrading and reinforcement. The coastal protection programme for Lower Saxony was consequently set up in 1955, defining as its most important measure the heightening and reinforcement of the dykes. One of the major lessons learned from the North Sea Flood of Holland was that the dykes had only begun to collapse when they had been overtopped by the flood waters. This was because the steeply inclined landward slopes common in those days had started to slide down due to erosion, so that the entire dyke was swept away as a result. In the ensuing time period, the sea and river dykes directly exposed to storm surges were not only heightened but their sides were also reconstructed with a significantly flatter gradient (slope inclination 1:3). Another important insight gained from the Holland flood was that buildings in and at a dyke and also the use of dykes for purposes other than flood control, even during a storm surge, pose an immense risk.

The funds that were then available allowed the elimination of the very worst danger spots in the coastal dykes and dykes along the Ems and Weser rivers before the February storm surge of 1962. However, when the storm flood hit in 1962, the programme had not yet been concluded. The flood of 1962 led to the fundamental restructuring of the coastal defence systems. The flood protection line was straightened in some parts and the dyke systems were completely reconstructed according to the principles of state-of-the-art engineering. In the Hamburg area, numerous dykes were reinforced and raised to a height of at least 8 m asl. some to a height of 9 m asl. The dykes are now dimensioned to withstand a hundred-year flood (plus a safety tolerance). The construction of the storm surge barriers on the tributaries of the Elbe and Weser and on the Eider also radically shortened the dyke line and reduced friction in the Unterelbe.

However, since 1962 the Elbe has been extensively developed for navigation purposes. The outcome of this channelisation was that storm surges in Hamburg now run up higher than they did prior to 1962, as the water can no longer flow off into the Elbe marshlands.

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Structural preventative measures in Hamburg:

- 78 kilometres of dykes
- 25 kilometres of flood defence walls
- Storm surge barriers
- Adapted construction along the Elbe
- Protection of individual houses
- Protection of private land
- Protection measures in the port
- Flood protection walls at the jetties

Protection of

- 270 km^2 city area
- 200,000 inhabitants
- 165,000 employees
- Commodities to the value of €11bn

Coastal protection along the North Sea and East Sea coastlines is today of a very high standard. The Lower-Saxony coast from Dollart to the Lüneburg Elbe Marshlands is protected by a 611 km long main dyke line. Thirteen storm surge barriers were built to protect the hinterland along the tributaries of the Elbe, Weser and Ems against severe storm surges. Floods caused by the failure of individual stretches of dykes cannot, however, be ruled out entirely. During the storm flood of 1976, the most severe of the past century, water did penetrate into some areas of the hinterland, but the coastal defence measures largely withstood the waters so that this extreme event did not develop into a disaster.

5.) Prevention pays off

- The North Sea Flood in 1962 caused losses in Hamburg to the order of €1.6 bn in Hamburg (city district without the port) according to the values of 2009.
- Since 1962, Hamburg has invested approximately €2.2bn in flood control measures (values of 2009).
- Since 1962, Hamburg has experienced four more storm surges with maximum water levels that were higher than 5.9 m above sea level – that means more than 20 cm higher than in 1962 (1976, 1994, 1995, 1999).
- No significant damage was caused in the city area during any of these four floods (although losses amounting to some €1bn were incurred in the port in 1976.)
- An exemplary scenario shows: given an annual value appreciation rate of €100m (in values for 2009), these four events since 1962 with more than 5.9 m above sea level would have caused losses of approximately €17.5bn if the flood control measures had been on the same level as immediately prior to the 1962 flood and if the same areas had been affected.
- Following deduction of the €2.2bn invested in the construction measures, the protective effect of the prevention measures for the city of Hamburg since 1962 comes to approximately €15.3bn.

Highest storm floods in Hamburg	**Water level**
3/4 February 1825	asl + 5.24
1/2 January 1855	asl + 5.11
16/17 February 1962	asl + 5.70
7 December 1973	asl + 5.33
3 January 1976	asl + 6.45
24 November 1981	asl + 5.81
28 February 1990	asl + 5.75
23 January 1993	asl + 5.76
28 January 1994	asl + 6.02
10 January 1995	asl + 6.02
5 February 1999	asl + 5.74
3 December 1999	asl + 5.95

30 January 2000	asl + 5.16
29 January 2002	asl + 5.26
9 November 2007	asl + 5.40

- 1976: to date the highest storm flood in Hamburg (asl+6.45m); losses in the port to the order of DM 2.0bn
- 1995 fastest increase in water levels (6 m in 6 hours)
- Six storm floods from 1900 to 2000 with more than 5.7 m asl

6.) Storm floods and insurance

The prevalence of insurance against storm floods varies from country to country. Whereas a practically comprehensive insurance coverage for storm floods is customary in Great Britain, and enormous insured losses in the event of a catastrophic storm flood are consequently to be expected in this country, storm flood losses in other countries (including Germany) are only covered in the property insurance segments of Industry, Engineering Insurance, Transport, Marine and Comprehensive. In the Netherlands, probably practically nothing is insured in the private and commercial sector. Storm floods are often included in international industrial programmes only. The greatest value density lies most likely in the port of Rotterdam. To estimate storm flood losses, the following insurance segments, which have very different levels of penetration, must be taken into consideration.

- Private buildings, household effects (usually not included)
- Commercial buildings, inventory, CBI
- Industrial buildings, inventory, CBI
- Infrastructure
- Transport/Marine (almost 100% coverage for freight transport insurance)
- Comprehensive car insurance (market value)
- Engineering insurances
- Life and health
- Employee accident

- Other insurances such as event cancellation

Flood losses always are accompanied by wind losses so that the separation of the (insured) storm losses from the (usually uninsured) water losses can prove difficult.

Why is there no coverage within the framework of elementary loss insurance?

In Germany, over 70% of all households are not properly insured against the financial repercussions of elementary risks. To protect themselves against the financial consequences of such extreme weather events as torrential rains and floods or other natural disasters such as earthquakes, house owners and tenants require so-called elementary loss insurance. However, on national average, only just under 30% of households have taken out elementary loss insurance for their homes. And only 15% insure their personal household belongings against natural hazards. Without the inclusion of "further elementary hazards", residential building and household effects insurance only covers damage caused by tap water, storm, hail and fire. Elementary loss insurance provides protection against the financial consequences of such natural events as floods, torrential rains, backwater, earthquakes, land subsidence, snow pressure, avalanches and volcano eruptions. It can be taken out as a supplementary component of the household effects and residential building policy.

However, the risks of groundwater and storm floods cannot be insured within the framework of "further elementary hazards" coverage. Precisely the risk of storm floods in Germany is not representable in actuarial terms due to the high-level accumulation risk, the possibility of adverse selection and the lack of losses data required for calculation of the premiums. The most recent GDV conditions also specify these exclusions for retail business. At present, there no activities within the association or market trends advocating the inclusion of these risks.

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Strategic Topics

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