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Chapter 10:

The Baltic Storm Surge in November 1872: Urban Processes, Gendered Vulnerability and Scientific Transformations[1]

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The first weeks of November 1872 had been unusually cold with strong winds hitting the countries surrounding the Baltic Sea from the West. And then, suddenly, everything seemed to calm down. ‘On Sunday 10 November, nature was marked by a deathlike silence indicating a drowsiness among humans as well as animals,’ an eyewitness on the southern Danish island of Falster later wrote.[2] But the water was coming. Early on Wednesday 13 November the sea rose so high above the normal level that the low dikes were overtopped, effectively ‘transforming the greater part of Southern Lolland into a sea inhabited with a few islands’.[3] Panic broke out: ‘In many places inhabitants fled to attics and roofs, as rescue personnel and lifeboats were not available in all places. No one had expected a natural disaster necessitating long escapes over fields and meadows and between houses and farms.’[4]

During the weeks leading up to the storm surge, a meteorological low pressure with strong westerly and north-westerly winds had gradually pressed water from the North Sea into the Baltic Sea through the narrow Danish straits (Figure 1) and created an gradient in the water level between the eastern and western part of the Baltic Sea with a difference of more than five meters. These enormous water masses were just waiting to swing back like a pendulum and wreak havoc in the western Baltic. On the November 11 and 12, a low pressure passing through northern Germany and Poland changed the direction of the prevailing wind to an easterly/south-easterly direction, intensifying it at the same time. This sudden change in the wind caused the water masses that had built up in the eastern part of the Baltic Sea to move westwards. The water masses reached the bottleneck comprised of the Danish straits during Tuesday, November 12 and started overflowing the surrounding low lying and largely unprotected land areas in Southern Denmark and Northern Germany.

At noon on Wednesday, November 13, the storm finally lost its breath, but the floods did not crown until well into the afternoon when the level had risen to an astonishing three meters above the normal – in some areas in Southern Jutland and Schleswig even reaching more than three and a half meters. By evening 52 people had died on Falster and 28 on Lolland in one of the worst disasters caused by natural hazards in Danish and German history. 32 people lost their lives in Mecklenburg-Vorpommern alone. All around the Baltic the November storm of 1872 is believed to have killed more than 250 people destroyed almost 3000 houses and made 15000 people homeless.

(INSERT FIGURE 1 HERE)

Figure 1. Map showing the region around the Baltic Sea affected by the storm surge in 1872.[5]

Flooding was not totally unknown to people living around the Baltic Sea. The first reported flooding is known to have happened in 1304, and since then the region experienced frequent flooding as a result of storm surges. Sources identify 1625, 1684, 1836 and 1864 as storm surges above two meters, and there were other severe storms and floods in 1760, 1825 and as late as 1868. Many of these storm surges are only known from eyewitness accounts or can only be identified by landmarks. The storm surge in February 1625 might have been as severe as 1872, but very few people lived in the coastal areas of Lolland and Falster at that time, minimising the risk of human casualties.

The destructive power of the encroaching water in November 1872 was incredible. In the western part of Lolland, another large island just to the west of Falster, the water entered at Lineslyst, while at the same time a dike was breached near Nakskov town, creating two simultaneous inland waves that converged at Humminge and resulted in great devastation. At Saxfjed, a small farm belonging to Denmark's first sugar factory, 13 people fled to the roof of a garage when the water came. They were washed away when the roof suddenly turned into a raft. The north coast of Germany was hit just as hard. The memorial in Flensburg marking the highest point of the flood in

1835 stood a full foot under water, and in the old trade town of Lübeck as many as 150 inhabitants lost everything.[6]

In addition to the devastation on land, almost 300 ships were lost in Danish waters during the November 1872 Baltic storm, many of them underway with timber from Swedish ports up along the Danish coast towards Copenhagen. More than 60 ships went down in the waters around the south-eastern island Møn alone, with the loss of 33 sailors, and according to estimates from Bureau Veritas as many as 450 ships in total may have been lost in the Baltic during the storm. Many tragedies played out during those days in November. One ship, the inappropriately named British barque *Hope*, was lost with all 18 hands close to Nyord on Møn. At least 56 sailors died in the disaster, but many more could have lost their lives had it not been for the relatively soft beaches along the Danish coasts. Only on the ships that stranded on the bedrock-island of Bornholm, to the East of Falster, were all hands usually lost. 133 ships went down or were damaged along the German coast, not nearly as many ships as in Denmark, but Schleswig-Holstein was by far the region in Germany suffering the most shipwrecks with 65 vessels either totally lost or wrecked.[7]

As the water receded during the night and in the morning of Thursday 14 November the disastrous effects on the affected areas became apparent. Farmland had been flooded; villages washed away; towns badly damaged. But not all the consequences of the catastrophe were readily visible. Some were subtle such as the scientific and legislative development that followed, not to mention the characteristics of some traits of modernity that the floods brought to the surface: urbanization, industrialization and the role of women in relief efforts. These were larger societal transformations taking place in this particular historical period revealed and fuelled by one of the deadlier disasters to strike part of Northern Europe – a region otherwise not considered significantly exposed to natural hazards.

Understanding vulnerability

In this chapter, we analyse the impact of the 1872 November storm on the Danish and German societies through a vulnerability approach. We aim at understanding the affected societies by investigating the ‘cracks in the past’ created by the flood, providing us with access to otherwise hidden structures and patterns of the past. From a historical point of view, disasters are productive events in that they act as lenses through which we become more knowledgeable about the development of societies.[8]

We focus on three themes: 1) processes of urbanisation, 2) gendered vulnerability, and 3) scientific transformations in the fields of meteorology and flood protection. Other analytical framings could have been singled out, such as cultural impacts or impacts on economic development in the wake of the catastrophe. However, we argue that these three cases are exemplary in the case of the 1872 storm. We focus on both Danish and German towns because there are important comparative perspectives, differences as well as similarities, between these that provide a more nuanced picture of why villages, towns and cities in the region were vulnerable to an event like the storm surge in November 1872.

In seeking to understand why the Baltic Storm of November 1872 resulted in disaster, one has to understand why the Danish and German societies along the coasts of the region were vulnerable. Without vulnerability, natural events such as storms will not turn into disasters. Being at risk from disasters implies that certain social, political, economic and ideological conditions have produced patterns of vulnerability over time that are revealed once a hazard (e.g. a storm or an earthquake) impacts a society.[9] In an attempt to analyse these conditions in a comprehensible way, Wisner et al. developed the widely adopted Disaster Pressure and Release Model (PAR), also known as ‘The Crunch Model’.[10]

The PAR model depicts the progression of vulnerability, which the authors divide into three phases: root causes, e.g. power distributions and ideologies; dynamic pressures, e.g. lack of resources, economic/ecological changes; and unsafe conditions, e.g. dangerous surroundings, poor house construction. A disaster is a result of root causes producing dynamic pressures that create unsafe conditions, which in turn interact with an external hazard, such as a storm. As depicted in figure 2, we apply the model in order to analyse the three themes we have chosen to focus on: 1) urban concentration and infrastructural development, 2) perceptions of gender and the organization of women, and finally, 3) the birth of modern meteorological science and implementation of engineered coastal protection measures.

(INSERT FIGURE 2 HERE)

Figure 2. The Disaster Pressure and Release Model, adapted from Wisner et al. 2004 and populated with factors that contributed to the November 1872 disaster in the Baltic.

The PAR model is meant as a heuristic tool that enables us to understand the forces that produced the event in November 1872. Throughout this chapter, we will draw on the framework that the model provides, in trying to understand how certain aspects of Danish and German societies at this particular time in history created patterns of vulnerability that enabled the disaster to unfold as it did. Moreover, the model gives us a comprehensible tool for linking social transformations in Denmark and Germany in the late nineteenth century with events that occurred during the storm, whereby the aforementioned cracks in the past are revealed. Understanding the link between larger social transformations at the time and the patterns of vulnerability also gives us an idea of how the affected societies were able to respond, recover and rebuild after the event, a process that Wisner et al. call the 'progression of safety'.[11]

As stated above, the three particular themes that we have selected are all tied to the period of modernization at the end of the nineteenth century in Northern Europe. These themes will form the three main sections of the chapter that follow this introduction. We will link the historical empirical material to the PAR model throughout. In the first section, we look at processes of urbanization and infrastructural development. During the second half of the nineteenth century, the industrial revolution was at its height in Europe, and with it came the extension of infrastructures linking cities, towns and villages through rail, roads, power lines and telegraphs, fuelling urbanization processes. Urban developments and demographic changes meant that more people than ever before to live in zones of risk. In the second part, we look at gendered vulnerability. Social constructions of gender roles and the status of women at the time created the conditions for a gendered form of vulnerability. Although the historical sources indicate that women were more vulnerable, men were also at risk, for instance when conducting rescue missions or going out to sea. Women were also not merely passive bystanders but often acted quickly on their own, or through the many women's organizations and networks that were on the rise in Europe at the time. The third section looks at the scientific and engineering aspects of the case. Out-dated and insufficient coastal protection measures had instilled a false sense of protection for people living along the coast. The vulnerability of the built environment produced risks that were only made visible after the storm surge had damaged the affected areas. This subsequently fuelled a need for new forms of engineering knowledge to keep the coastal areas of Northern Europe safe. Also, while there was not an organized field of meteorology at the time, the event was a catalyser for establishing meteorology in Denmark and Germany, as the benefits of such knowledge became evident for governments and civil society alike.

After having analysed in detail these three themes, we conclude the chapter with a discussion of how the integration of the themes in the PAR model can open up various perspectives for understanding Northern European coastal societies at the time. Here we also touch upon the changes that the affected towns and communities witnessed in the following years and decades.

Urbanization, Concentration and Infrastructure

Sociologist Charles Perrow noted in *The Next Catastrophe* that modern disasters are the product of concentration along three axes: people, power and energy. Urbanization is exactly that. With higher population density came more knowledge sharing, higher production efficiency, easier access to centrally distributed power etc. – but urbanization also created novel vulnerabilities. When a small fishing village, like those mentioned below, aptly located close to the sea, grew into a town of considerable size during the eighteenth and nineteenth centuries, what once was a traditional foundation of livelihoods (the sea) became a modern source of risk requiring assessment and mitigation.

The settlements around the Baltic expanded rapidly during the 1800s. The population of Greifswald, an old Hanseatic city with a popular university, grew from 5740 in 1800 to more than 23000 a century later, while the medieval town of Faaborg on the south coast of Funen also quadrupled its population in the same period, reaching 4218 in 1901.[12] With urbanization came industrialization and new socio-economic patterns. As railways were spreading across Europe in the middle of the nineteenth century, coastal towns evolved into regional hubs linking land and sea trade systems that enabled fast and efficient movement of goods but at the same time created new societal dependencies on these infrastructures. Near the town of Greifswald, the vital railway tracks linking much of the region were flooded. A most dramatic event occurred when a bridge on the outskirts of Greifswald going over a river could not withstand the pressure from the storm and flood. Its foundation gave in just as a train was passing over it. A few freight train cars plunged into the river below the bridge, but luckily, the locomotive and the postal car had made it to the other side. Most fortunately, the passenger car had been decoupled from the rest of the cars before the train reached the bridge. Striking examples of how Danish infrastructure was severely affected by the storm and flood are also available. A stranded barque blocked the railway between Køge and Copenhagen until it was cut in pieces and removed, local fisherman Andreas Christensen remembered 75 years later.[13]

The production and distribution of energy was another trait of modernity that rapidly gained momentum in the second half of the nineteenth century. Since the 1850s, gas plants had provided energy to factories and households in towns and cities only to be largely replaced by electricity around the turn of the century. The first Danish gas plant opened in Odense on Funen in 1853 as a clear manifestation of industrialization and modern urbanization. One gas plant could deliver fuel for stoves and a source of lighting for many households, mills and factories in a village or town whereas before every home and business had to produce its own energy. But this concentration of energy production not only increased efficiency – it also created new vulnerabilities. In Faaborg on the south coast of Funen the gas plant was flooded with the rest of the town with great consequences: ‘The gas plant is totally surrounded by water, and the encroaching water has apparently extinguished the fire under the retorts‘, reported the local newspaper *Faaborg Avis* on the day of the storm surge.[14]

In November 1872, all the new industrial and urban centres around the Baltic were exposed to the rising water level following the storm. One author quotes an unidentified source for stating that the town of Gråsten in German South Jutland was stricken by ‘unrivalled horror and fear’ during the floods as the inhabitants had to be rescued through windows and roof hatches to boats. In nearby Haderslev the old people at Hertug Hans’ Hospital also had to escape through the windows, while Aabenraa, a large town in the same area, was hit so hard by the water that many houses in the southern part collapsed, leaving only floating debris and ruins: ‘Many people who were inside the damaged buildings were clearly in danger, and they were just barely saved by rescuers in passing boats.’[15]

As was the case in southern Denmark, the northern part of Germany was also hit hard. All across the German Baltic Sea coast, from larger towns to the smallest settlements and villages, people were overwhelmed by the storm surge and feared for their lives. In many towns, people mistakenly thought they would be most safe in their own homes. Those living in low-lying areas of towns, near a harbour or along the coast had to be rescued by boat or improvised rafts. People would gather in houses and buildings that were not threatened by collapse from the winds or the encroaching water masses. None-the-less, the storm claimed many lives, wrecked ships, and made families homeless.[16]

The storm surge hit the small fishing village Niendorf particularly hard. Due to a unique geographical placement right at the sea, and with a large lake behind the settled areas, the village was already in a precarious position. Forty people were forced to flee to the roofs of their houses. Four persons drowned while twelve houses were destroyed and fourteen heavily damaged. Thirty-eight families were made homeless overnight. In the fishing town of Stralsund, the storm turned the entire harbour area into a giant pool of water and the rail bridge was destroyed. In the midst of this spectacular and theatrical scene, a fire broke out in a chemical chalk factory in the middle of the flooded harbour area, causing severe anxiety among people. This was but one example of new vulnerabilities produced by concentration of people and energy: Root causes such as industrialization and capitalism created pressures in the shape of economic reconfigurations of societies, which resulted in novel unsafe conditions, e.g. exposed infrastructure or choke points in energy production.

Industrialization processes had thus increased the vulnerability of the entire region and especially in urban areas where new industries were damaged and never fully recovered. Early capitalism itself was also vulnerable. An example of this was the entrepreneurial brothers Johan and Erhard Frederiksen, who earlier in 1872 had founded Denmark's first sugar factory on Lolland. Their buildings, which had been undergoing repairs in the weeks leading up to the storm, were destroyed, and after the catastrophe, the brothers donated many of their still unused bricks to other people in the area who needed material to rebuild their houses. The sugar factory finally closed down in 1877, never having recovered from the catastrophe.[17]

The storm surge severely affected most of the villages and towns along the coasts of Schleswig-Holstein, Mecklenburg and Prussia. Larger German towns and cities such as Lübeck, Kiel and Flensburg in Schleswig-Holstein were also hit by the storm, but the destructions here were, for the most part, less severe than in the smaller settlements along the Baltic coasts. Nowhere, however, did the storm cause as much damage as in the town of Eckernförde.[18]

Located in a small bay that opens out to Baltic to the northeast, the German town of Eckernförde (pop. 5000) was severely vulnerable to storm surges, but the perception of risk was apparently not strong in the local community. On the evening of 12 November, several streets were already completely flooded, yet people were not startled or worried. The next morning, teachers and pupils even reported for school, although they had to take detours. The waves beat against the seawalls on Jugenfernstieg, one of the central streets in Eckernförde facing the seaside. 'It was a magnificent spectacle', locals reported, as the waves clashed against the seawalls and houses, only to retract and repeat all over again. Although the town had installed dike systems and walls along the coastline, they were unable to withstand the storm. All of them were either breached or swept away entirely by the floodwaters.[19]

The water in Eckernförde reached a height of 3.76 meters above the normal level. Almost all the streets were inundated, and people used whatever boats and rafts they could find to flee the low-lying parts of the town and head for higher grounds. The water rose faster than expected, and soon the water level in the centre of the old town had reached the same level as at the harbour. Attempts to stop the water at the house doors with sandbags and rocks were futile, and many inhabitants had to flee the ground floor of their houses to the roof. People tried to save their belongings, but many houses were threatened by collapse and had to be abandoned. As in most disasters, the elderly and sick were especially vulnerable, and a considerable amount of effort was put into getting these out of harms way. The now homeless people were sheltered in the few remaining houses that were located on higher grounds of the town. Those who could not find room in these shelters were placed in the local military barracks. Many believed that they could return to their homes next day. The following morning on November 14, however, they were able to get an overview of the damage the storm had caused, and the situation was bad.[20]

Eighty-seven houses in Eckernförde were destroyed and another 138 critically damaged. In the following days, more houses gave in to the damages they had suffered. 112 families lost their homes, and more than 400 people had to be supported and supplied with clean drinking water and food by the town authorities.[21] Sand, mud and seaweed filled the streets along with timber from destroyed houses and ships. A Herr Schmidt, who lived in a nearby town, described his first impression as he arrived in the town the day after the storm:

> The next morning I was in Eckernförde, and there was an indescribable sight. The streets were completely impassable. Even large boats you see lie capsized in the streets. By Jungfernstieg 30 houses had completely collapsed, 200 were severely damaged and almost all houses in the city were marked. Even the church was badly damaged and could not be used as a shelter.[22]

All roads and railways connecting Eckernförde with the surrounding area were damaged, which made it difficult for people to move in and out of the town. Roads to and from the much larger town of Kiel were disrupted, and traffic had to be redirected. Yet help soon started to pour in from all over Germany, even from German immigrants in far-away America.[23] Humanitarian recovery and relief efforts in Eckernförde were efficient and swift, as they were in many other damaged parts of Germany's Baltic Sea coast. Relief came through a combination of various local government initiatives, the central administration in Berlin, and local committees tasked with surveying the damages. But help also came from different private organizations and initiatives that rushed to organise aid to the coastal towns. Part of this relief was organised through women's organizations that played a significant part in distributing goods after the disaster – an example of how the slowly changing gender roles and gender perceptions towards the end of the nineteenth century became relevant in the context of the 1872 storm.

Gendered Vulnerability and the Organization of Women

It is widely recognized that disasters affect men and women differently across societies and cultures. In the recently adopted Sendai Framework for Disaster Risk Reduction 2015-2030, the United Nations has once again called for increased gender-sensitive national disaster management plans and policies.[24] In many societies, women are today more at risk from dangerous events such as floods, earthquakes and storms because they are marginalized socially, culturally, economically, politically and legally.[25] In a gender-specific version of the PAR model developed by Oxfam, it is argued that lack of access to education, basic skills training, and legal rights are some of the main root causes and dynamic pressures that result in unsafe conditions for women during disasters today.[26] One historical statistical study has argued that this discrepancy is visible in how disasters affect the life age expectancy of women to a much larger degree than men. More precisely, when calculating the average life expectancy between men and women and correlating with direct or indirect deaths from natural disasters, men generally live longer than women do.[27]

Coming back to the 1872 storm, reports of women in danger and in need of rescue are found throughout the historical material we have drawn upon in this chapter. It can be argued that the gender roles of 19th century Northern Europe predisposed women to be more vulnerable, as their social roles and identities were constructed as passive caretakers and homemakers. In the logic of the PAR model, we categorize such social constructions of gender as root causes that ultimately lead to women finding themselves in more unsafe conditions than men. As an example, more men than women could not swim, and that made them vulnerable in urgent situations of evacuation and flight. The lack of swimming skills is still observed to be a crucial factor explaining the difference in deaths among men and women, especially in the developing world.[28] However, there are also several examples from the historical accounts of men being vulnerable, as well as women exhibiting forms of agency in the emergency, as we will highlight below.

While we argue that gender was an important factor of vulnerability during the 1872 storm flood, it is, however, difficult to draw precise and general conclusions from the eyewitness accounts and historical sources. No records or studies have examined the effects of gendered vulnerability on mortality, or of long-term psychological, economic and social impacts. What is striking from the eyewitness accounts is rather how women and men are portrayed differently as certain types of responders to the catastrophe.

Several eyewitness accounts from both Denmark and Germany portray heroic acts of men while women, for the most part, remain confined to the backstage as bystanders and passive victims to the flood. In Denmark, adult men would typically leave their homes early in the morning to report for work at the farms and manor houses on Lolland and Falster, leaving the women and their offspring alone in small, fragile houses. Women were thus generally more vulnerable than men in an event such as the 1872 storm, mainly as a result of their roles as housewives. Moreover, some accounts also portray women as more prone to panic in the hectic hours when the water rose in the coastal towns. Two accounts from Denmark provide examples:

Just north of Gedesby on Falster was a cluster of four cottages belonging to Bøtøgaard, a large farm close to the drained Bøtø Nor. Eight families, 33 individuals in all, lived here. The wife of Jens Jensen, a workman at Bøtø, witnessed the neighbouring houses being washed away in the maelstrom and 'became almost mad with horror and despair.' She tried to take her own life by jumping into the water, but another woman held her back. They were later rescued by boat – after more than 30 hours in the heavily damaged cottage.[29] In another case from Bøjden on Funen, a wife lost her life with two children only four and seven years old when she panicked while the other inhabitants in her house fled to the roof: ‘She refused to leave the bed she lay in, but when the water kept rising, the strong waves caused the ceiling to collapse, and the firewood stored in the attic crushed her and the children so they all drowned.’[30]

However, to portray women only as passive victims and men only as active agents would be too crude, simplistic and indeed wrong. Here, it is important to note an often overlooked aspect of gendered vulnerability to disaster: that of men. Men were expected to respond quickly in such emergencies in order to take care of not just their own families, but their local communities as well. As a result, men were put at risk because of socially constructed gender roles, albeit in a different manner than women. This is visible in the many eyewitness accounts of brave men that put their own lives at risk to save children, women and the elderly from the storm. On the German island of Fehmarn, for instance, local sailors and fishermen went out on several suicidal rescue missions, to save people who were trapped in their houses by the floodwaters.[31]

While the role of men also put them in positions of danger, the roles of women were not always that of victims. Several accounts of self-sacrificing and heroic acts of women can be found. In a low house, a little south of Gedesby on Falster lived Jens Rasmussen Mejer with his many children and his old mother. While rescuing his offspring the house collapsed over Jens and his mother, and they both became entrapped in the ruins. Jens managed to dig himself out, but his mother commanded him to leave her behind, crying: ‘Take care of the children and don’t worry about me.’[32]

In other cases, the work by individual women for the relief and recovery of their local communities were just as, if not more, important than that of men, as the following case exemplifies. The catastrophic events of November 13 severely impacted the local schoolteacher and cantor in Gedesby on Falster, Svend Petersen, and his wife. The flooding had rendered all fireplaces in the homes in the area useless, and Svend Petersen’s wife had to open the school building and host both their homeless parishioners and many of the relief workers arriving in the affected areas from elsewhere in Denmark, while the cantor himself was busy doing damage assessments as head of the local disaster committee. The flood caused the couple ‘so much trouble and distress that our health suffered considerably because of it', Petersen later wrote. The aftermath of the flooding especially took a great toll on Christine Petersen according to her husband:

> My wife, who was healthy and strong and effective as few, was required to attend on her own to this magnificent feast: prepare the meals from the arriving food and then serve them to the crowd in the schoolroom. Under the unhealthy conditions present, she had to work day and night. Even with good health, there is a limit to what any human can endure, and even if she didn't admit it, it was obvious that she was exhausted, and that her health suffered badly as a result.[33]

In some cases, the worst part of the response and relief efforts of the catastrophe fell to women. On Falster, women from the poorhouse were requested to put the bodies of the victims into coffins. They carried out their grim work in the church and had to leave the door open all through the night to rid the porch of some of the stench from the decaying bodies.[34]

In another regard, women were also active in the management of the emergency. Civil relief and recovery committees played crucial roles in providing aid and funds for the reconstruction efforts in the days, weeks and months after the storm. Some of these committees and organizations already existed as networks or institutions, while others emerged in the wake of the disaster – and some of them were women's organizations.

In Germany, women's organizations (*Frauenvereine*) were very important actors in collecting and allocating goods and resources to women and the poor in the immediate aftermath of the floods. Women's organizations had begun to take form in Germany at around the time of the Napoleonic wars in the early nineteenth century, with inspiration from similar initiatives in France. Also sometimes referred to as women's relief organizations (*Frauen Hilfe Vereine*), they played a vital role during the wars that various German states had fought throughout the nineteenth century, leading to the unification of Germany after the defeat of France in 1871. The organization of women for war relief was part of the growing humanitarian movement in Europe, exemplified by the emergence of the Red Cross in Switzerland. But these women organizations were also politically active, forming the alliances from which the fight for increased legal, political and economic equality for women was carried out. One organization named "The Women's Organization of the Fatherland for the Care of the Injured and Sick Soldiers" had been established in 1870 and operated in many cities and towns across Germany from their headquarters in Berlin, coming to the aid of the victims of the flood in 1872. These organizations took a decisive priority in making sure that women's needs after the storm were met, and that most of the relief funds were allocated for rebuilding households, sewing equipment, and so forth. [35]

In general, women were more likely to find themselves in unsafe and vulnerable conditions during the 1872 Baltic Storm Surge. Yet, the story is more nuanced than that. Men were also vulnerable to the storm, as they would put themselves at risk in rescue situations. Moreover, women would in many cases, and to the same degree as men, take charge in the relief work that followed the fatal day in November 1872. And as highlighted, the organization of women in times of war could also result in highly effective management in times of disaster. This indicates that although the social constructions of gender in Nineteenth century Northern Europe predisposed women to be more vulnerable as indicated in the PAR model, the event also revealed signs of social and cultural transformations that were slowly taking hold at the time, namely the increased organization and political awareness of women. In the beginning of the following section, we explore another kind of awareness: the awareness of disaster risks.

(INSERT FIGURE 3 HERE)

Figure 3. A scene from Southern Falster during the storm. Reproduced from the Danish magazine *Illustreret Tidende*, 1872.

Modern Measures of Prevention and Prediction

After the storm had disappeared and the floodwaters had receded, people sought explanations for the catastrophe and quickly turned to both myth and science to find answers. One family on Lolland in Denmark discussed that it might be a "deluge like in Noah's days".[36] Even an earthquake on the Baltic island of Bornholm was suggested as a possible cause of the floods; people in Nakskov on Lolland asked themselves if there hadn't been a strange thundering sound rolling through the heavy November snow.[37] Despite such speculations, the explanation for the catastrophe was to be found elsewhere.

As disaster sociologist Kathleen Tierney has convincingly argued, disaster risks are socially produced. This means that societies are vulnerable due to the way society has arranged itself, which includes the awareness of risks. Prior to the catastrophe in 1872, German and Danish society lacked knowledge of flood risk management and awareness that could have prepared civil society for this event and mitigated the damages. This is evident not only from the limited knowledge of dike construction that existed at the time but also because the dikes that were constructed were built not primarily to prevent flooding.

Many of the dikes constructed on Lolland and Falster since the early 1600s had been built to gain access to new land for economic purposes, not only for protection against the sea. In the middle of the Nineteenth century, these activities had evolved into a "dike-building frenzy".[38] Rising land prices in the middle of the 1800s following the enclosure encouraged many to experiment with drainage, and even commons and meadows that previously had produced nothing but grass were transformed into agricultural land. But protective sea walls were not perceived as important as earlier floods had only affected areas that at that time were of limited economic value.[39]

In Germany, managing natural hazards through the building of dikes and coastal protection had been a central part of the self-government of the northern German coastal communities for centuries, and according to one analysis, this shaped the political culture of the region significantly.[40] After the union of the northern regions of Germany with Prussia in 1866, many citizens demanded that the government in Berlin should do more to secure the northern shores of the empire. In some places, the storm surge in 1872 made people aware that local dike systems and private initiatives would not be enough should a new event of a similar magnitude and force occur.

In Denmark, a capacity increase through structural mitigation measures was needed in order to lower the risk for urban areas. This meant building coastal protection in the form of dikes and implementing non-structural measures by increasing preparedness, early warning systems and passing legislative actions. The increased risk awareness among decision makers and civil society following the 1872 storm surge did improve the construction of dikes, technologies for damming up land, the implementation of early warning measures as well as the passing new legal acts.

Both the overflow and breaching of dikes caused the destructive flood pathway in November 1872. An army engineer described in detail how the Danish dikes had been constructed with a too steep inclination, and at the same time lacked covering vegetation, that – had it been in place – would have stabilized the sea walls. Instead, it resulted in slope failure and erosion and, eventually, dike breaching.[41] In addition to these design weaknesses, many of the dikes had a height of only one and a half to two meters. Because the water level during the storm surge at many places exceeded two and a half meters, overtopping occurred. With sea walls of this height, the area was extremely vulnerable to severe flooding. Such unsafe conditions were produced by the damming up of land, more intensive land use, increasing local political ownership and the rise of a more entrepreneurial economy – factors we term dynamic pressures in the logic of the PAR model These pressures, in turn, were the result of deep-lying root causes like structural changes in the economic order following Danish reforms around 1800 etc., early capitalism and democratization processes.

In several cases, landowners had constructed minor dikes without realizing the potential for the water to flow through the surrounding areas, making the dikes obsolete. The technical knowledge of how to construct and maintain dikes properly was available before the 1872 flood, but it is was not existing among local landowners when the dikes were constructed between 1820 and 1840.

As mentioned several times, lack of awareness and blind faith in existing structural measures to mitigate the impact of storm surges contributed significantly to the disaster in November 1872. The event subsequently had a major impact on the building of dikes and coastal protection in all the impacted regions of Denmark and northern Germany. In Schleswig-Holstein, the first dike had been built in 1581, and in the coming centuries, more dikes were constructed. Yet these were, just like in Denmark, not adequately designed to withstand major storm events. It would take the destructions of the storm in 1872 and subsequent extreme weather events to initiate the systematic planning and building of coastal protection installments.[42]

The immediate and temporary repairs to the low Danish dikes were to a large degree carried out by the Danish Army's Corps of Engineers. In the aftermath of November 1872, however, both public and private initiatives were mobilized to mitigate future repetition of the disaster. On May 23, 1873 – after just two weeks of political discussion in the two chambers - the Danish parliament passed legislation authorizing the government to require two new dikes be built on Lolland and Falster with support from the Danish state. A 17-kilometer dike was completed on Falster in 1875 while a 63-kilomter dike protecting the southern coast of Lolland against new floods was completed three years later.[43]

The construction of the dikes was made an urgent political priority as two new storm surges in the area in 1873 and early in 1874 had revealed the need for structural protection even further. The latter storm surge did not cause fatalities, but flooded fields actually resulted in more economic damage to agriculture than the 1872 flood. While dike building prior to the storm surge was insufficient, the construction of new coastal protection in Denmark after 1872 was done in accordance with modern engineering knowledge. Building material and dimensions resemble methods that are used today including the inclination and width of dikes as well as the layering of different soils and covering vegetation.

Dikes would have been less important to save lives if early warning measures had been in place. The opening of the Danish Meteorological institute (DMI) in April 1872 marked a wish to increase preparedness towards storm surges by disseminating early warnings to the public. The aim was to replicate the advanced meteorological institutes in France and England.[44] From the beginning the DMI published daily weather updates, but the background knowledge and scientific understanding of the weather phenomena in and around the Baltic Sea proved insufficient to precisely predict and warn the public of the storm surge in November 1872.

After the catastrophe, however, and the ability to scientifically analyse the meteorological conditions causing the storm surge became a priority. Several scientists described the conditions leading to the storm surge and how the water in the Baltic Sea had flooded the western areas surrounding the sea.[45] The understanding of these weather phenomena empowered the DMI to issue forecasts on a more regular basis from the late 1870s and onwards, and as such the catastrophe in November 1872 can be said to have driven the scientific approach to weather forecasting in Denmark forward. Technological developments in the field of meteorology at large contributed to the transformation of forecasting that enhanced the capacity for storm and flood warnings. This laid the grounds for mitigating the lack of risk awareness that had been a part of the dynamic pressures leading to the disaster in November 1872.

The improved knowledge of the meteorological conditions together with the implementation of structural mitigation measures contributed to an overall decrease of vulnerability and risk to the societies and industries surrounding the Baltic Sea that distinguish the 1872 storm from previous events. The southern Baltic Sea had experienced a number of storm surges in historic time, although none had reached the same extreme level as in November 1872. These reoccurring events did, however, not lead to an implementation of coordinated structural and non-structural mitigation measures. Nor did they increase awareness prior to the 1872 event. Today, the 1872 storm surge is used by the Danish government administration to define baseline levels for hazards, vulnerability and risk of flooding in Denmark and was as such used in the screening and implementation of the 2007 European Floods directive in 2012/2013.[46] Interestingly, this case story shows how attempts at mitigating risks may have counterproductive outcomes if not based on sound political, economic and scientific considerations. An important difference between earlier floods and the disastrous one in 1872 was exactly the presence of low sea walls along the Danish coasts. Whereas the water in 1825 and again in 1858 had risen gradually, giving the affected populations enough warning to flee their homes, the dikes now meant that a massive basin would build up against the dikes before the protective structures finally gave way, unleashing a giant wave of sudden destruction that in a very short time would sweep over a large area.[47]

Conclusion

In this chapter, we have sought to analyse how the 1872 Baltic Storm Surge impacted cities, towns and settlements in Denmark and Germany through a vulnerability approach. We have drawn upon the Disaster Pressure and Release Model to argue that the conditions that produced the catastrophe are to be found in society itself. Moreover, we have consistently highlighted how such extreme events reveal particular cracks in the past: that by looking at a disaster event, we come to know more about society. The breakdown of critical infrastructure and the dangers that damaged factories and power plants posed, revealed how the societies of nineteenth century Northern Europe were going through a remarkable process of industrialization and urbanization. The differences in gendered disaster vulnerability and the relief efforts organized by women's organizations remind us that Denmark and Germany were on the verge of a social revolution towards greater gender equality. And finally, the rebuilding and upgrading of dikes, as well as the establishment of new weather forecasting techniques and knowledge regimes, reveals how meteorological science was about to become a vital component of how modern human societies prepare and act in relation to nature's uncertainty.

Broadly speaking, the objective of disaster response and recovery plans is to promote a return to normality as fast as possible after a disaster, as a minimum by restoring the situation for the impacted population as it was prior to the event. In addition, relief aid and recovery should ideally aim at reducing future risks to disaster by mitigating and alleviating conditions of vulnerability. In this process, the fact that vulnerabilities interlink mainly as a consequence of insufficient knowledge of the social and economic structures of society is easily forgotten. In the case of 1872, entrepreneurs had constructed low sea walls to dam up land for early industrial use, thus creating a demand for labour in previously uninhabited areas, which attracted male workers and their families who settled in unsafe areas. Since disasters are social phenomena, one has to look for the causes for a disaster in society itself, not only in the forces of nature.

The vulnerable conditions leading to disasters will often be difficult to modify since they are the results of long-term transformations at the cultural, social, economic, political and technological levels. This is especially the case for root causes, as the term is used in the PAR model. For example, one of the original contributors to the model, Ian Davis, has shown that one root cause for the destruction of the Fukushima Nuclear Power Plant following the tsunami in Japan in 2011 was a deep political desire to improve industrialization and economic activity by introducing and promoting nuclear energy after the country's defeat in the Second World War.[48] In other words, pinpointing exactly which factors contributed to the production of a disaster is a complex exercise. In this chapter, we have identified that among the root causes of the catastrophe of 1872 in the Baltic sea were the political and economic transformations of nineteenth century Europe, such as the rise of capitalist market-based liberalism following the dismantling of absolutist rule, which encouraged entrepreneurialism and decentralized growth. This development simultaneously allowed natural hazards to evolve into unchecked urban risks.

Parallel to this, nineteenth century Europe was characterized by a cultural system based on patriarchal social values that structured gender roles in ways that rendered women and men at risk from natural hazards, albeit in very different ways. As stated earlier, it is difficult to pinpoint whether the 1872 event had a direct impact on gender roles in Danish and German societies – other than exhibiting these roles for the later interpreter. However, the point here is not to discuss whether this is the case or not, but rather to highlight that eyewitness accounts of the disaster reveal a discrepancy in gendered vulnerability. Moreover, the event also made visible the changing role and agency of women through organizations. The 1872 storm thus provided a glimpse of a tendency that was brewing at the time, and which would gain momentum in the decades to come: the move towards greater political and legal equality between the genders.

When looking at dynamic pressures and unsafe conditions, changes in the affected societies after the catastrophe in 1872 were mostly top-down such as the initiative by the Danish government to quickly pass a legislative act on coastal protection and allocating additional funding to the construction of new coastal protections. The increased social awareness of storm and flood risks did lead to a new understanding of the need to use science for forecasting and warning. This is reflected in the increased coordination where information on how to improve construction on coastal protection was distributed to stakeholders. In addition, scientists analysed the meteorological conditions leading to the disaster, thus potentially improving future early warning in the region.

The trends in urbanization and demography did not change as a consequence of the storm surge since the population continued to migrate towards urban areas along the coast, but the risk of flooding in urban areas decreased considerably because of the construction of safety measures. Building new large dikes on Lolland and Falster was also seen as a way to change the economic system identified as a dynamic pressure in the PAR model. To dam up land and thus increase agricultural areas in Denmark was also a need created by of the loss of Schleswig, Holstein, and Lauenburg to Prussia in the 1864 war, representing the loss of one-third of the country's area. The dam up of land, however, was not a success on Lolland and Falster. Areas that were anticipated to create economic profits from agriculture did not bring new economic adventures.

The catastrophe in 1872 brought about change – but not necessarily for the better or for the worse. Modern dikes were built, allowing, even more, people to settle in the low areas behind the artificial protective measures. And women united in organizations that preceded much stronger gender movements of the decades that followed. Most of all, the storm surge exposed structures and processes already in place and underway by sweeping away all the daily business of politics, traditions, work and family. When the floodwaters finally receded they revealed a landscape now belonging more to the beginning of modernity than the end of the previous era.

Notes

1. All quotes from Danish and German sources have been translated by the authors. The authors wish to thank Christina Holst Johansen for assisting with locating historical sources and professor Guðný Björk Eydal, University of Iceland, for useful comments to a draft of the text.

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