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Baltic Sea open waters extreme events of last 30 years caused by climate-weather hazards

Keywords

Baltic Sea open waters, sea accident, climate-weather states, extreme weather hazard states

Abstract

The paper deals with the sea accidents that have occurred at the Baltic Sea open waters for last three decades. For each accident, the climate-weather change process state is fixed to examine the weather hazard influence on this accident. Moreover, the Baltic Sea open waters accidents caused by the extreme weather hazard states are described.

1. Introduction

Despite the lack of exhausting, detailed and completed documents on ship accidents at the Baltic Sea for last three decades, we collected more than 100 sea accidents that have happened at the Baltic Sea area for last three decades [Bogalecka et al., 2017a].

A lot of them (81%) occurred at the Baltic Sea open waters (*Figure 1*). The remaining accidents (19%) happened at the Baltic Sea port waters [Bogalecka et al., 2017b].

2. Weather condition during ship accidents at the Baltic Sea open waters

To examine the influence of weather condition on the sea accidents, we established the kind of state of the climate-weather change process at the Baltic Sea open waters [EU-CIRCLE Report D6.4, 2018a] during particular sea accidents.

2.1. States of climate-weather change process for ship operating at the Baltic Sea open waters

To define the climate-weather states at the Baltic Sea open waters, there are distinguished $a = 2$ parameters that mainly describe the climate-weather states in this area: w_1 – the wave height measured in meters and w_2 – the wind speed measured in meters per second.

Next, taking into account expert opinions on the climate-weather change process for the ship operating area at the Baltic Sea open waters, $w = 6$ climate-weather states are distinguish in [EU-CIRCLE Report D6.4, 2018a]:

- the climate-weather state c_1 – the wave height belongs to the interval $\langle 0, 2 \rangle$ m and the wind speed belongs to the interval $\langle 0, 17 \rangle$ m/s;
- the climate-weather state c_2 – the wave height belongs to the interval $\langle 2, 5 \rangle$ m and the wind speed belongs to the interval $\langle 0, 17 \rangle$ m/s;
- the climate-weather state c_3 – the wave height belongs to the interval $\langle 5, 14 \rangle$ m and the wind speed belongs to the interval $\langle 0, 17 \rangle$ m/s;

- the climate-weather state c_4 – the wave height belongs to the interval $<0, 2)$ m and the wind speed belongs to the interval $<17, 33)$ m/s;
- the climate-weather state c_5 – the wave height belongs to the interval $<2, 5)$ m and the wind speed belongs to the interval $<17, 33)$ m/s;
- the climate-weather state c_6 – the wave height belongs to the interval $<5, 14)$ m and the wind speed belongs to the interval $<17, 33)$ m/s.

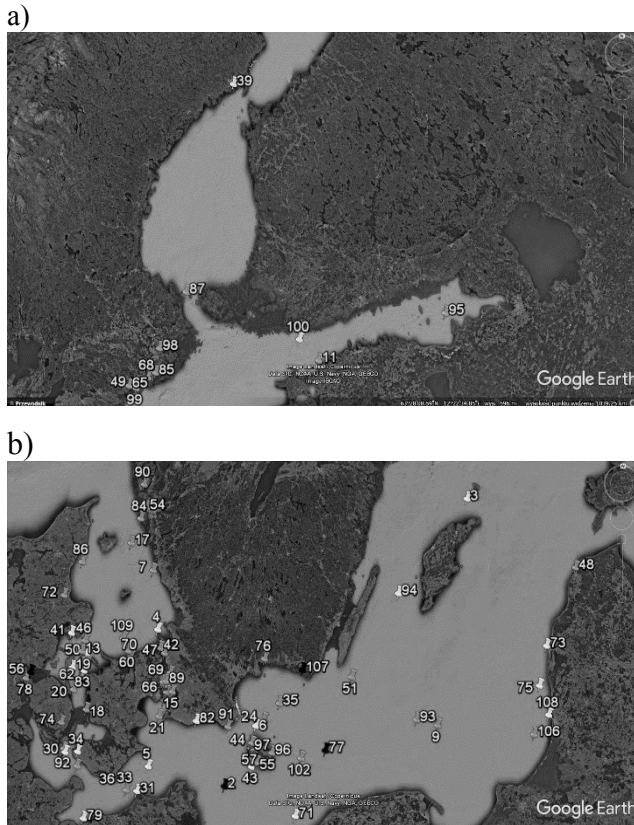


Figure 1. Ship accidents at open waters of a) the North Baltic Sea, b) the South Baltic Sea (the number on the map is corresponding to the accident number in Table 1 in [Bogalecka et al., 2017a]).

2.2. States of climate-weather change process during accidents at the Baltic Sea open waters

In the compilation of the Baltic Sea open waters accidents there are 76 ones that happened when the climate-weather change process was at the state c_1 . In opposite, there are 5 accidents that happened when the climate-weather change process was at the state c_6 , means the extremely bad weather condition (Figure 2). Moreover there are 5 accidents occurred in the ice condition.

3. Description of the Baltic Sea open waters accidents of the extreme weather hazard state

The accidents that happened when the climate-weather change process was at the state c_6 are

marked with black pin on the map in Figure 1. We described these accidents in detail below.

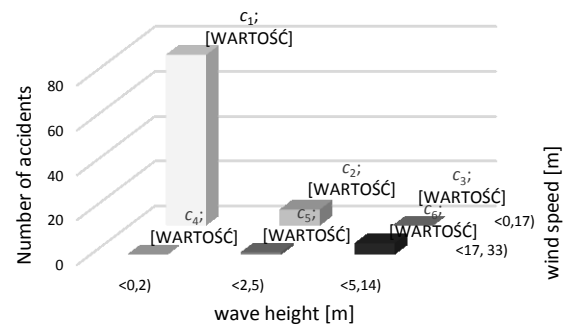


Figure 2. Number of the Baltic Sea open waters accidents according to the states of the climate-weather change process.

3.1. Jan Heweliusz accident

Polish ferry *Jan Heweliusz* (Figure 1, #2 on the map) capsized in a fierce storm off the north German coast in the early hours of the morning. At 4:10 am on 14th January 1993, the ship started listing in hurricane-force winds, estimated at 180 km/h. The waves were up to 6 metres high. It capsized at 5:12 am [Institute of Meteorology and Water Management, 1993].

The *Jan Heweliusz* accident was classified as a very serious casualty according to the Circular MSC-MEPC.3/Circ.3 of the IMO Maritime Safety Committee and Marine Environment protection Committee [IMO, 2008].

Heavy storm with hurricane-force gusts occurred over the Baltic Sea at the second half of the night on 13/14 January 1993, due to an area of low pressure and weather fronts which were moving ESE over the North and the Baltic Sea.

Surface low with pressure with a central pressure value of 1002 hPa was lightly marked in weather charts at 00 UTC on January 13th, over 1300 km from Great Britain. The depression with a tendency to develop was moving rapidly northeast. In the afternoon the cyclone reached southern part of the island. Its intensity of deepening decreased to near zero, gaining the central surface pressure of 986 hPa. In the evening and at night, while moving towards ENE over the North Sea, Denmark and southern Sweden, it reactivated. At 03 UTC on January 14th low reached 972 hPa in center, which was located over Scania. Before the *Jan Heweliusz* disaster, the low center moved more than 2300 km in 24 hours. The form of the low pressure center as it moves over the Baltic Sea is illustrated with a weather chart and a weather fronts map in Figure 3.

South and south-west wind veered west, reached speed 30-32 m/s with gusts of 44 m/s at the deepest stadium of the low pressure center over the Baltic

Sea, at 03 UTC in Hammerodde at Bornholm and in Arkona at Rugen Island.

3.2. *Trans Frej* accident

The *Trans Frej* (Figure 1, #49 on the map) on 14th January 2007 left Järnverkskajen (Ironworks Quay), Oxelösund, without a pilot. The ship was loaded mainly with steel, wood and containers in the cargo holds and containers on deck.

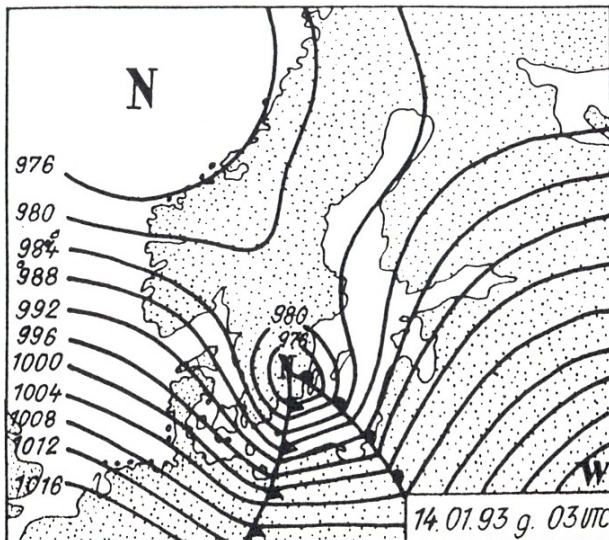


Figure 3. Synoptic situation on the Baltic Sea on January 14, 1993 [Institute of Meteorology and Water Management, 1993].

At departure the weather was bad, strong wind with showers of snow and rain. The master took the ship from berth out through the archipelago. About 10 minutes after departure also the third officer came to the bridge but did not take part in the navigation of the ship. At one waypoint the *Trans Frej* took the wrong course and got her first touch to the bottom at the Stora Rönnskär ground and grounded on Runnskärgrund. The ship rested on the ground from approximately frame 35 to frame 85. The sea level was 70 cm above the normal [GISIS, 2017].

The *Trans Frej* accident was classified as a less serious casualty according to the Circular MSC-MEPC.3/Circ.3 of the IMO Maritime Safety Committee and Marine Environment protection Committee [IMO, 2008].

On January 14th 2007 a ridge of high pressure originated over eastern Europe and the Baltic Sea was dissipating and moving west. An active low was approaching from the west. It had formed 24 hours before over the southern Atlantic and shortly before the midnight 13/14th it reached Great Britain coast.

At 00 UTC the low pressure center of 965 hPa was located over the south Norwegian shore. Next it was moving east. From early hours of the 14th the whole

Baltic Sea was already influenced by the low. At 12 UTC the center of 974 hPa was located over the Gulf of Bothnia.

A gradually occluding frontal system was associated with the low pressure center. Around midnight the Baltic Sea was influenced by a warm arctic maritime air mass (a warm part of an area of low pressure). Nevertheless, from early morning, in conjunction with advancing cold front, the unsteady-balance-flow of a arctic maritime air mass began to advance from the west (Figure 4).

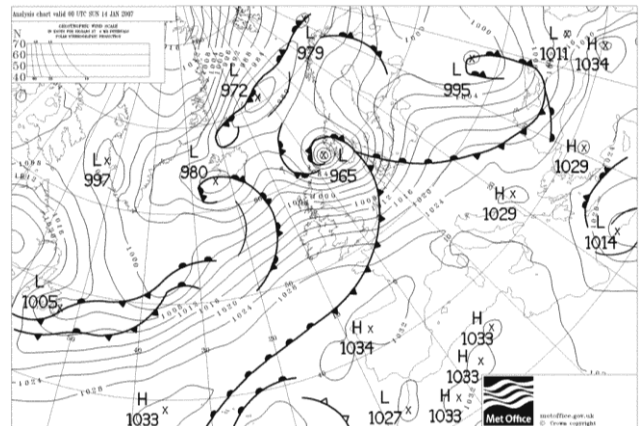


Figure 4. Synoptic map for Europe on January 14, 2007.

3.3. *Schleswig-Holstein* accident

The *Schleswig-Holstein* (Figure 1, #56 on the map) departed Fredericia Harbour. At approximately 16.45 hours LT, on 31st January 2008, the ship collided with Skanseodde Lighthouse 0.7 nm east of the harbour. The weather was bad. The wind came from south-west with a speed of 22 m/s, and the current was to the north-east speed 3 knots. Due to narrow waters and a considerable drift, it was difficult to manoeuvre the ship, and it collided with the lighthouse [GISIS, 2017].

The *Schleswig-Holstein* accident was classified as a serious casualty according to the Circular MSC-MEPC.3/Circ.3 of the IMO Maritime Safety Committee and Marine Environment protection Committee [IMO, 2008].

On January 31st 2008 a weak ridge of high pressure was drifting east from southern Sweden and Denmark (Figure 5).

From the late morning, an extended and active depression was expanding over the Baltic Sea from the west. At 12 UTC its center of 954 hPa was located over the Faroe Islands. Despite moving very slowly, the low pressure center influenced the whole Baltic Sea. Not until the evening on the 2nd of January the area of low pressure moved over eastern Europe and its center over Finland.

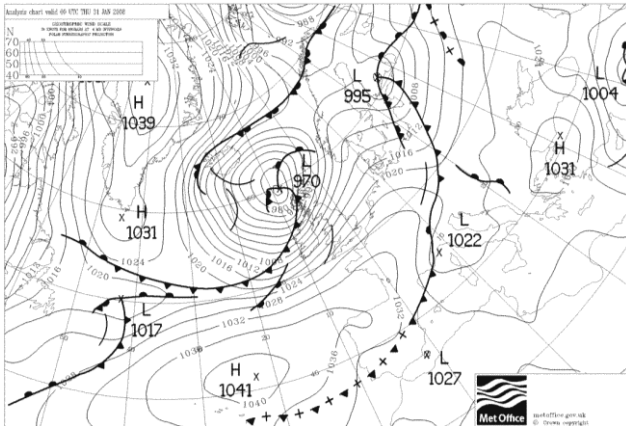


Figure 5. Synoptic map for Europe on January 31, 2008.

3.4. Unora accident

The fishing vessel *Unora* (Figure 1, #77 on the map) on 17th February 2009 was employed in the South Baltic sea in fish trawling, when suddenly the vessel listed to starboard, capsized and sank very quickly. 4 crew members were rescued by SAR helicopter and 2 crew members were missing [GISIS, 2017]. Loss of *Unora* was caused by offence of ship's Stability Information in connection with the exceeded weight of the cargo of fish in the vessel's hold and on deck, and possible shift of fish cargo in cargo hold after a vessel's list to starboard. During investigation it was established that overweight of cargo in fishing vessels is a common offence. Sometimes the weight of cargo of fish in a fishing vessels 3 times exceeds the allowed weight which is noted in a ship's stability criteria [DIMA of MAL, 2009].

The *Unora* accident was classified as a very serious casualty according to the Circular MSC-MEPC.3/Circ.3 of the IMO Maritime Safety Committee and Marine Environment protection Committee [IMO, 2008].

On February 17th 2009 the Baltic Sea was influenced by a periphery of a strengthening anticyclone centred over northern Scandinavia, and a depression centred over eastern Russia. The arctic air mass advanced from the north over the Baltic Sea (Figure 6).

3.5. Stena Alegra accident

The RoPax ferry *Stena Alegra* (Figure 1, #107 on the map) on 28th October 2013 grounded after dragging its anchor in Knot winds off Karlskrona, Sweden. The ship's bottom plating and frames were damaged, and one ballast tank and one void space were flooded. Two tugs towed the ship off the rocks after the weather had moderated the next day. Following an underwater inspection the ship proceeded to Gdynia, Poland, for repair [GISIS, 2017].

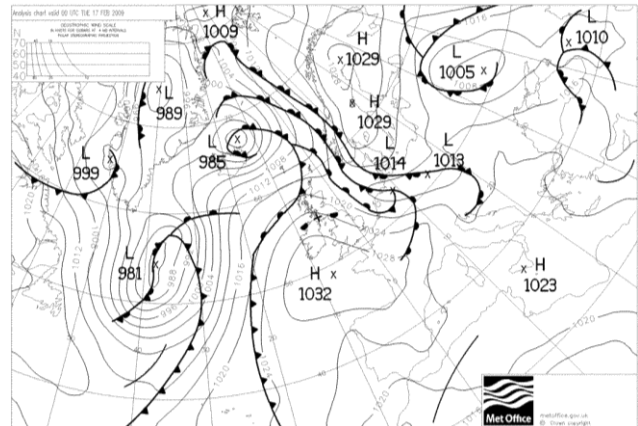


Figure 6. Synoptic map for Europe on February 17, 2009.

The *Stena Alegra* accident was classified as a serious casualty according to the Circular MSC-MEPC.3/Circ.3 of the IMO Maritime Safety Committee and Marine Environment protection Committee [IMO, 2008].

On October 28th 2013, the Baltic Sea was influenced by an extended area of low pressure with its centers over the Faroe Islands and Norway. At 00 UTC a small area of low pressure with a central pressure value of 981 hPa, originated over the Atlantic approached to the western Great Britain coast. The low was deepening fast and moving northeast. The center deepest value was reached at 12 UTC while approaching to Denmark coast. A slowly occluding weather fronts system was moving along with the low center. During a day the Baltic Sea was temporary influenced by a warm arctic maritime air mass. After a midday the Baltic Sea was influenced by cold arctic maritime air mass from the east (Figure 7).

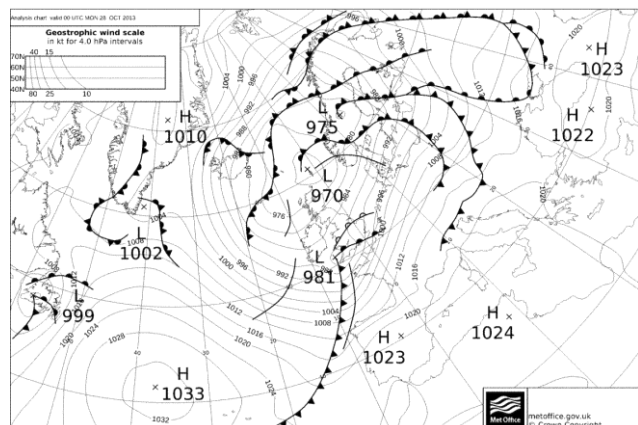


Figure 7. Synoptic map for Europe on October 28, 2013.

4. Conclusion

The description of ship accidents of the extreme

weather hazard state occurred at the Baltic Sea open waters was done in this paper. The data are the part of the set of sea accidents at the world sea waters and will be used to the risk analysis of chemical spill at sea. Its practical applications will be performed in [EU-CIRCLE Report D3.3-GMU24, 2017] to the chemical spill consequences generated by the accident of one of the ships of the shipping critical infrastructure network operating at the Baltic Sea waters as the preparatory approach to the Case Study 2, Sea Surge and Extreme Winds at the Baltic Sea Area, Scenario 2: Chemical Spill Due to Extreme Sea Surges [EU-CIRCLE Report D6.4, 2018b].

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