

Sedimentary archives of storminess and storm induced coastal flooding – do they tell the same story?

Karolina Leszczyńska

Department of Geomorphology, Faculty of Geographical and Geological Sciences, Adam Mickiewicz University, Poland, karles3@amu.edu.pl

The Baltic Sea basin is located between the North Atlantic water masses and Eurasian land masses, in the transitional zone between oceanic and continental air masses. This area is highly sensitive to changing climatic conditions, in particular, to the position and strength of the North Atlantic Oscillation (NAO) and the westerly storm tracks (Rutgersson et al. 2021). The storminess, defined as frequency and intensity of storms within the Baltics Sea is intrinsically related to position of westerly storm tracks.

It is not fully understood, what is the influence of enhanced storminess periods on frequency and intensity of storm induced coastal flooding. The aim of this review is to compare the sedimentary archives of storminess and storm induced coastal flooding. The state of the art of the knowledge on storminess intensity fluctuations as well as the frequency and intensity of storm induced coastal flooding, is presented.

The sedimentary archives of storminess, coming from inland peatlands, span continuous periods of few thousand years and indicate processes operating on extra regional scale. Majority of the published record comes from south-eastern, southern and south-western part of the Baltic Sea basin, ie. Estonia, Denmark, Sweden. The preservation potential of sedimentary archives of storm induced coastal flooding is less well understood, with extensive research spanning only the southern and south-western coast of the Baltic Sea basin. Sedimentary archives of storm induced coastal flooding represent local record of only extreme events of marine inundations.

Due to fragmentary character of depositional evidence for storminess and coastal flooding caused by storms it is important to base the inference on past patterns of these weather phenomena on combined evidence from various settings. The periods of enhanced storminess within the Baltic Sea deciphered from the sedimentary archives span periods between 9700-9100, 8800-8600, 8300-7100, 6900-6700, 6400-5500, 5100-4700, 4400-3800, 3300-2800 B.P. (Goslin et al. 2018).

The analysis of sedimentary archives of extreme sea levels and storm induced coastal flooding shows geographical variability of susceptibility to marine inundations. Along the Swedish coasts of the Baltic Proper and Gulf of Bothnia, exposed to the east, the threat of storm induced coastal flooding is the lowest within the Baltic sea basin. This is associated with the exposure of these coasts to the lee side in relation to westerly winds as well as pressure centers and air masses travelling within the region from the west to the east. The southern part of the Bothnia Bay, central part of Baltic, i.e. Baltic Proper and the Danish Straits are areas of medium threat of coastal flooding associated with storms due to strong deviations of the weather and hydrological conditions at the “ends” of elongated Baltic Sea basin (Wolski & Wiśniewski 2020). The most extreme storm induced coastal flooding events with highest frequency took place along the eastern and north-eastern coast within the Gulf of Riga, Gulf of Finland and Bothnia Bay due to exposure of these shorelines to westerly wind. The Mecklenburg Bay and Kiel Bay represent a special case being particularly sensitive to subtle changes of the sea level due to seiche effect and following from that storm induced coastal flooding due to shallow depth and exposure to the east.

The comparison of geological evidence for both, storminess as well as storm induce coastal flooding shows that these two types of evidence tell complementary stories. The sedimentary archives of marine inundations give an insight into local consequences of extreme events, while the depositional signature of storminess draws a context for these events.

References

- Rutgersson, A., Kjellström, E., Haapala, J., Stendel, M., Danilovich, I., Drews, M., Jylhä, K., Kujala, P., Larsén, X. G., Halsnæs, K., Lehtonen, I., Luomaranta, A., Nilsson, E., Olsson, T., Särkkä, J., Tuomi, L. & Vasmund, N., 2021: Natural hazards and extreme events in the Baltics Sea region. *Earth System Dynamics* 13, 251-301.
- Wolski, T. & Wiśniewski, B, 2020: Geographical diversity in the occurrence of extreme sea levels on the coasts of the Baltic Sea. *Journal of Sea Research* 159, 1385-1101.
- Gosli, J., Fruergaard, M., Sander, L., Galka, M., Menviel, L., Monkenbusch, J., Thibault, N. & Clemmensen, L. B., 2018: Holocene centennial to millennial shifts in North-Atlantic storminess and ocean dynamics. *Scientific Reports* 8:12778.