

Resilience of coastal lakes to extreme marine inundations: a paleoecological assessment from the Burin Peninsula (Newfoundland, Canada)

Tsunamis and storm surge, collectively referred to as extreme marine inundations, belong to the most disastrous natural processes. They can cause the death of hundreds of thousands of people and multibillion economic loss. Although usually examined from the human perspective, their impact is not restricted to people. Extreme marine inundations drive also catastrophic environmental changes. The perturbation of some of the ecosystems is clearly visible, e.g. trees knockdown in the coastal forests or erosion and covering of coastal marshes with sand. Other changes caused by the events are not so obvious. For instance, lakes which are the focal theme of this project, before and after the extreme marine inundations are not visibly altered. Is that mean that lakes are unconcerned by the events?

The majority of coastal lakes are freshwater and brackish. The sharp salinity increase due to the extreme marine inundations combined with the pulse supply of a large amount of various organic and inorganic compounds cause drastic changes to lakes conditions that can exert catastrophic impact on lakes biota. However, knowledge of what happens to lakes in detail, e.g. What are the mortality rates? How long-lasting is the recovery process? Is the recovery always complete? remains very limited. It is also hard to say if there are any particular attributes influencing lakes resilience. The projected marked increased in coastal flooding frequency caused by storm surges, which is related to the global sea-level rise, is going to make lakes perturbations by extreme marine inundation much more common in the future. Thus, better assessment of lakes resilience to the events is becoming increasingly important.

Opportunity to push our understanding of the impact of EMIs on ecosystems based on state observations before and after the events is very limited as both tsunamis and storm surges are generally unpredictable phenomena. Therefore, alternative approaches should be adopted to address the problem. A very promising approach is an application of paleoecological techniques that allow environmental reconstructions to be drawn from geological archives. Lakes continually record what happens to them in their sediments. Collection of these sediments and their detailed analysis can enable reconstruction of lakes responses to extreme marine inundations. Such an approach provide also an opportunity to look to the distant past, and thus potentially to reconstruct system reaction to many events. Comparing the results of the analysis of sediment cores collected from several lakes enables evaluation of the range of lakes vulnerability to the events and potentially also to point to the attributes driving differences in lakes responses to extreme marine inundations.

The above strategy provides a basis for this project that aims at the assessment of the resilience of the coastal lakes of Burin Peninsula (Newfoundland, Canada) to extreme marine inundations. The study area has been flooded frequently by the storm surges, has been struck by at least one tsunami, and contains numerous coastal lakes of various characteristics. Moreover, in contrast to many other coastal areas, the region is under the low anthropogenic impact. Thus, long-term lake ecosystem changes to be reconstructed using paleoecological techniques are likely to be driven mainly by natural processes. We expect the planned reconstruction of long-term effects of multiple extreme marine inundations to multiple sites of different characteristics will enable the development of a universal model that can provide a basis for assessment of lakes resilience to tsunamis and storm surges. Consequently, this project will provide a valuable contribution to the field of disturbance ecology.