Subaerial beach volume change and sea level rise on decadal time scale in the Lithuanian coasts of the Baltic Sea

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Background of research

Long term changes of coastline dynamics

Sea level changes, sand availability (Carter et al., 1987; Healy, 1996; Selivanov, 1996; Storms et al., 2002; Thom, 1984), wave climate (Guillén et al., 1999; Cooper and Navas, 2004)

Storminess (de Ruig and Louisse, 1991; Corbella and Sttretch, 2012)

Coastal morphology (Roy et al., 1994; Cowell et al., 2003; Aagaard and Sørensen, 2012)

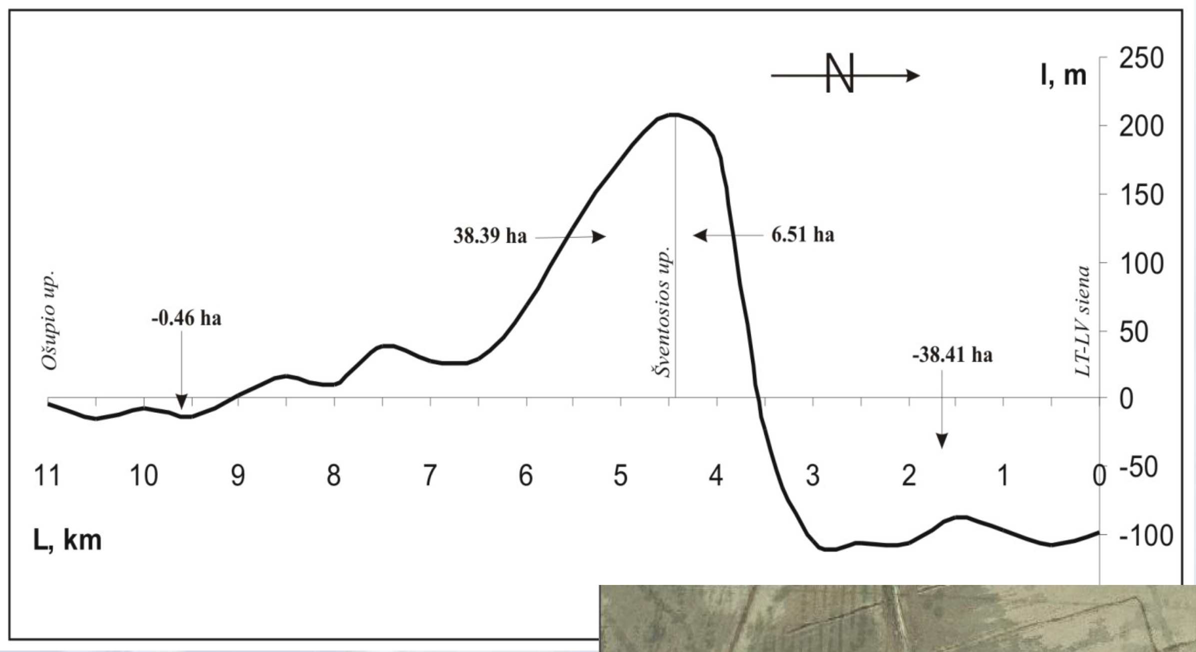
Geologic framework (Riggs et al. 1995; Honeycutt et al., 2003)

Human impact (Žilinskas et al., 2010; Jarmalavičius et al., 2012; Pupienis et al., 2013; Kriaučiūnienė et al, 2013).

Background of research

Long term changes of coastline dynamics

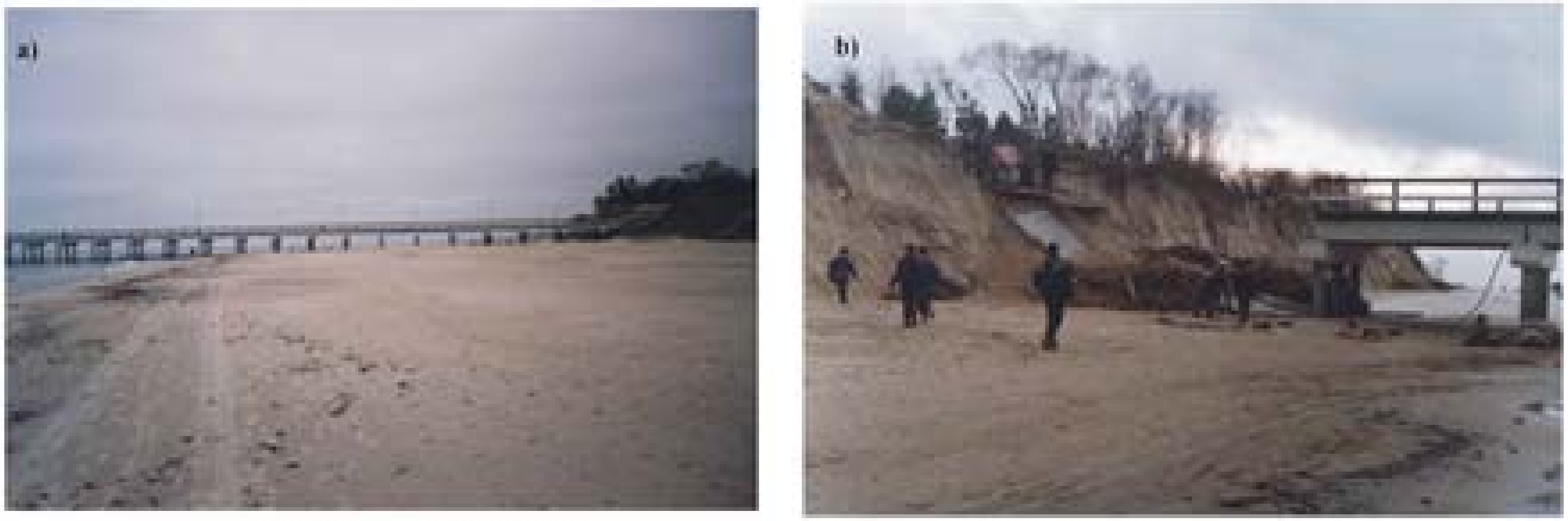
Changes of coastline in 1910-2010 (Šventoji port region). „0“ of X coordinate – state in 1910



Background of research

Short term changes of coastline dynamics

Wind and wave regime, sea level changes

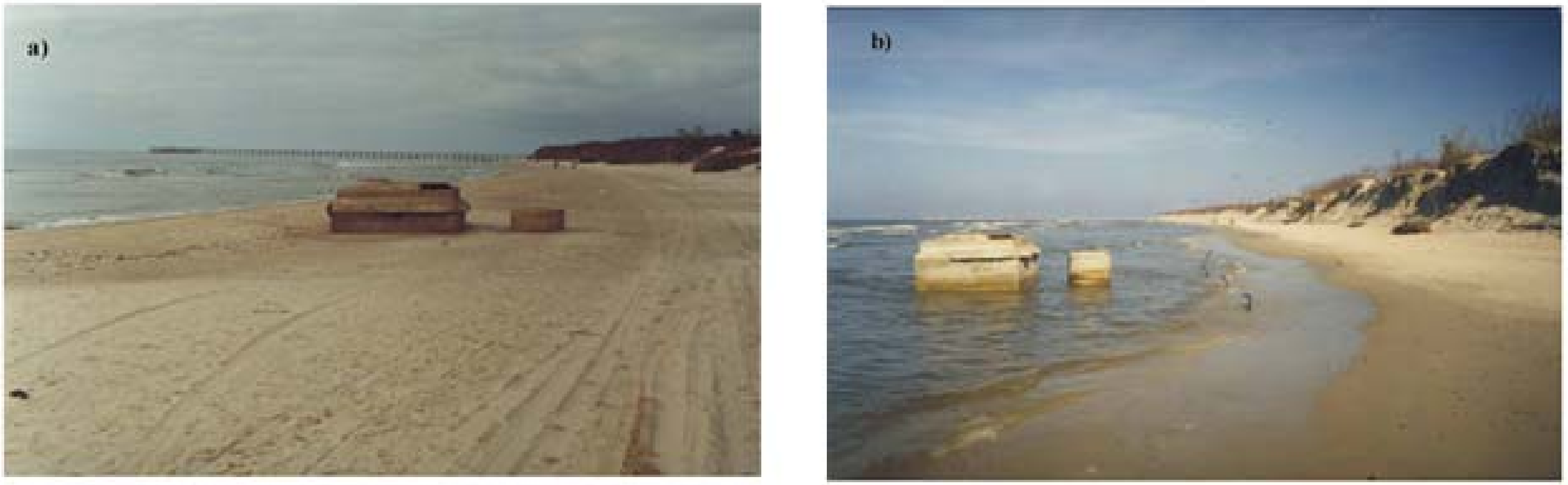


Impact of hurricane „Anatolijus“ (04-05 12 1999) on coastline (Palanga): a)1998 09 02, b) 1999 12 06

Background of research

Short term changes of coastline dynamics

Wind and wave regime, sea level changes



Changes of coastline by 45 – 60 m from 01 10 1998 to 29 03 2002 in Palanga

Research task

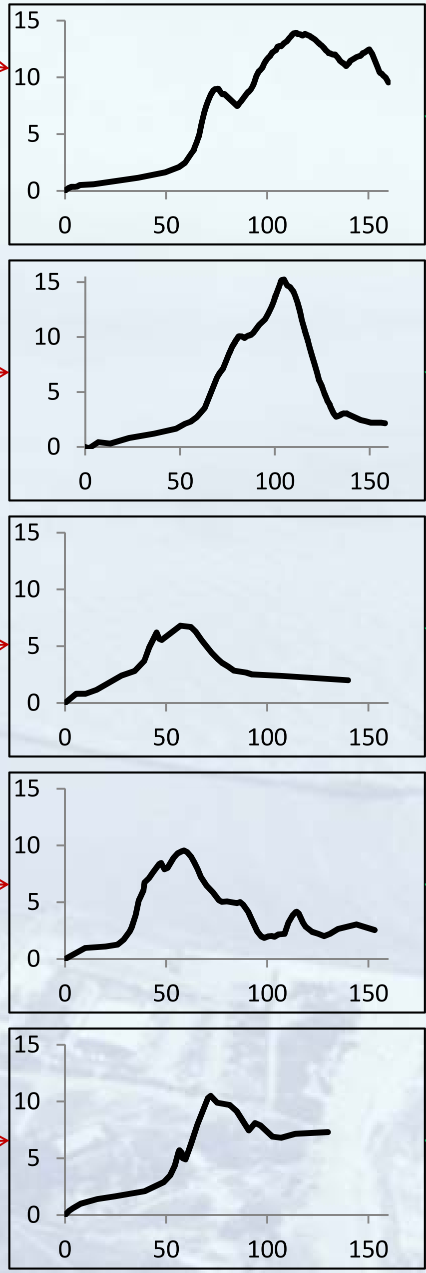
The aim of this presentation is to evaluate the impact of sea level fluctuation and wind energy on the coastal systems with different geomorphology dynamics on decadal time scale.

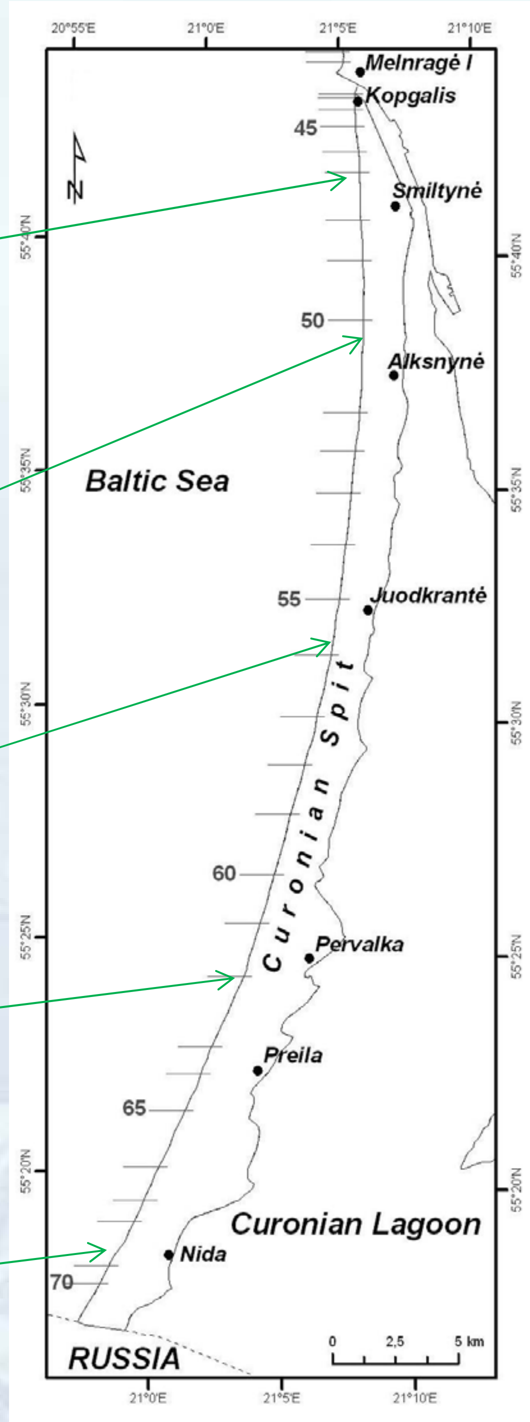
Wind - wave regime changes and water level changes in the Baltic Sea nearshore (Lithuania)

Coastal changes in decadal time scale and their relations with wind energy and sea levels

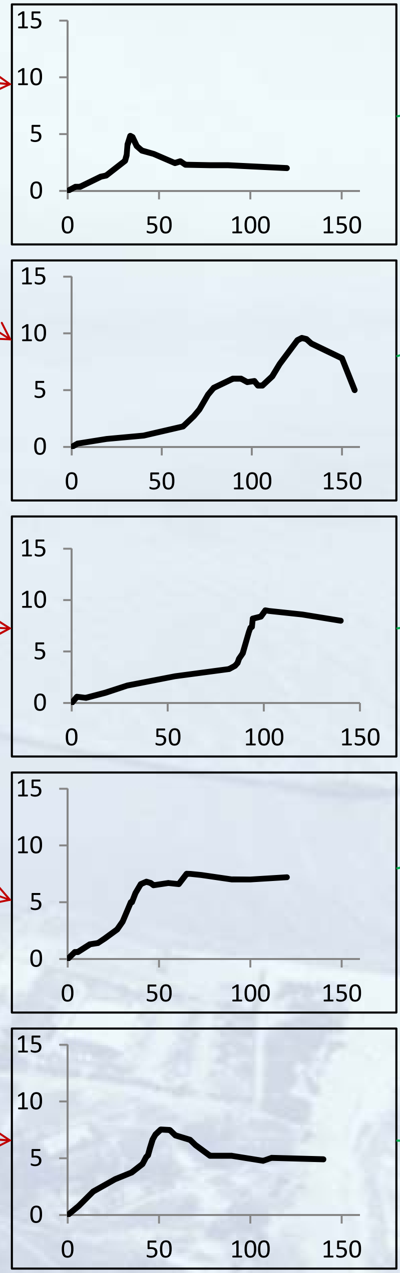
Yearly variability in the subaerial beach volume, wind energy and sea levels

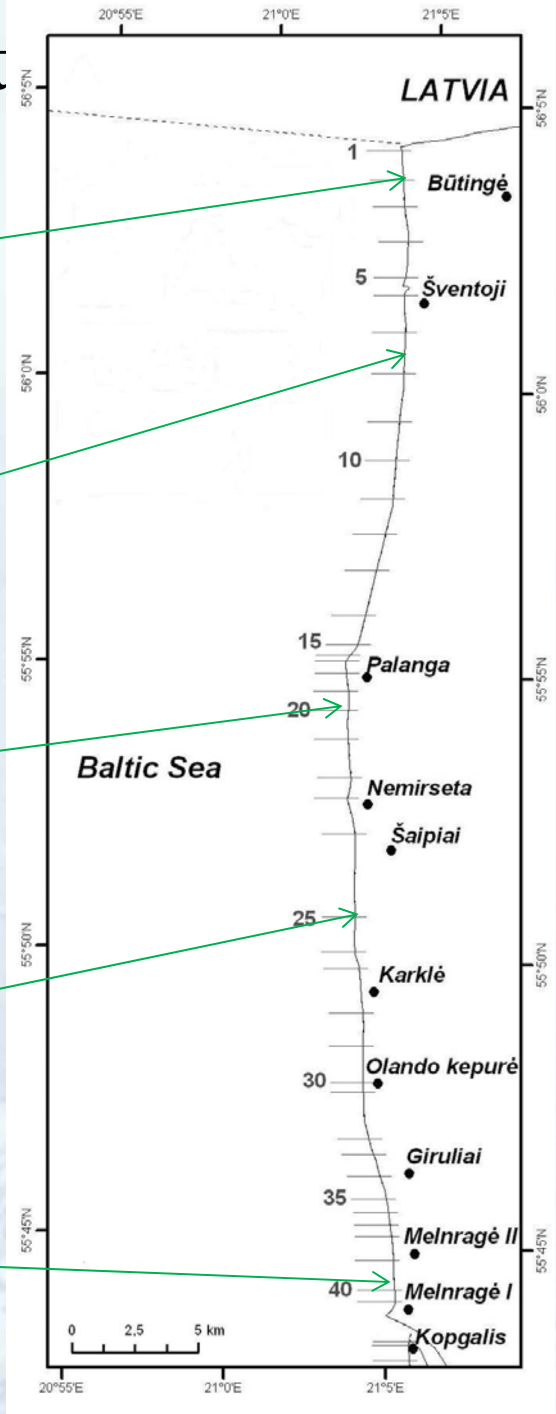
Object - Curonian spit coast





Object - Mainland coast





Methodology

Subaerial beach sand volume was established as the main indicator of coastal dynamics, reflecting both accretion/erosion of coastal system and sand budget. Its volume change comprises of coastal profile volume change from foredune crest to intersection of mean sea level.

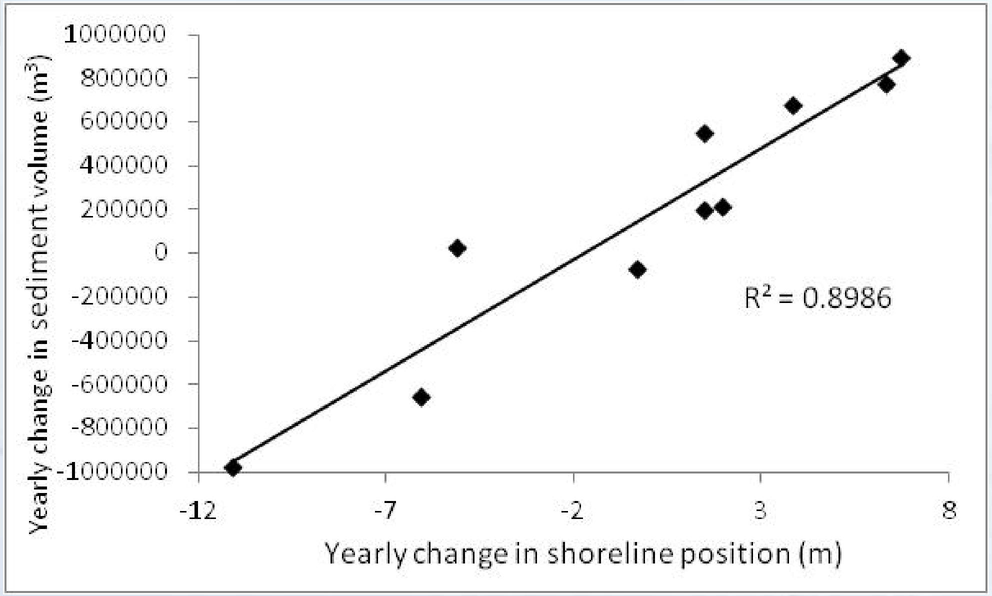
Monitoring of coastal dynamics (levelling in 70 cross-sections) in May (2002 – 2013). Evaluation of coastline changes and calculation of changes of subaerial beach sand volume in every year.

Methodology

To evaluate beach sand volume in different time scale, there were calculated both decadal change and year-to-year variability.

In the first case the changes of subaerial beach sand volume were calculated over time from the first observation in 2002.

Yearly variations of volume in 2003 – 2013 were calculated as the differences between two consecutive years.



Relation between yearly change of subaerial beach sediment volume and yearly change of shoreline position

Methodology

Beach sand volume data were averaged separately for the mainland coast and the Curonian Spit coast.

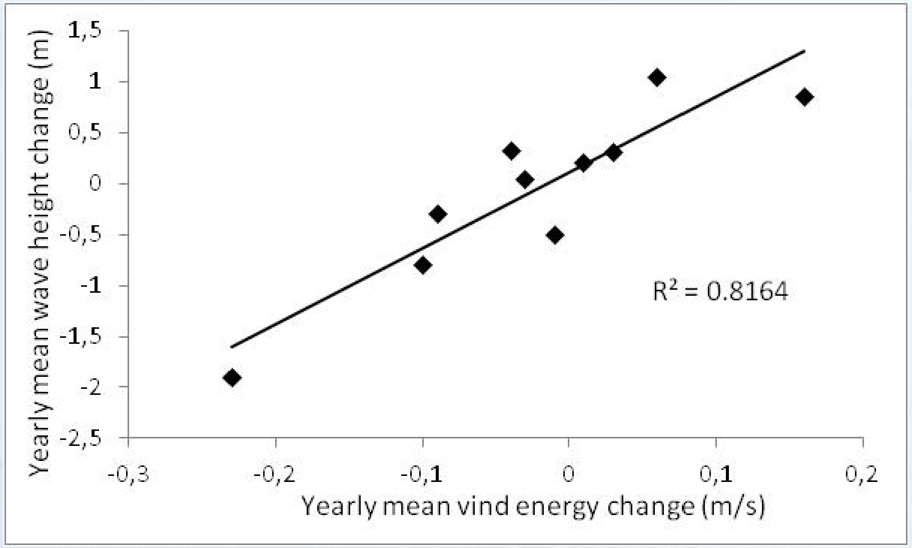
Because the lengths of distinguished coastal sectors were different (the mainland coast is 38 km, while the Curonian Spit coast is 51 km), the amount of sediment was calculated in cubic meters per meter length of shoreline (m^3/m).

Methodology

A wind energy indicator which competently reflects both wave regime and general storminess was used in the research. It was calculated according to the formula:

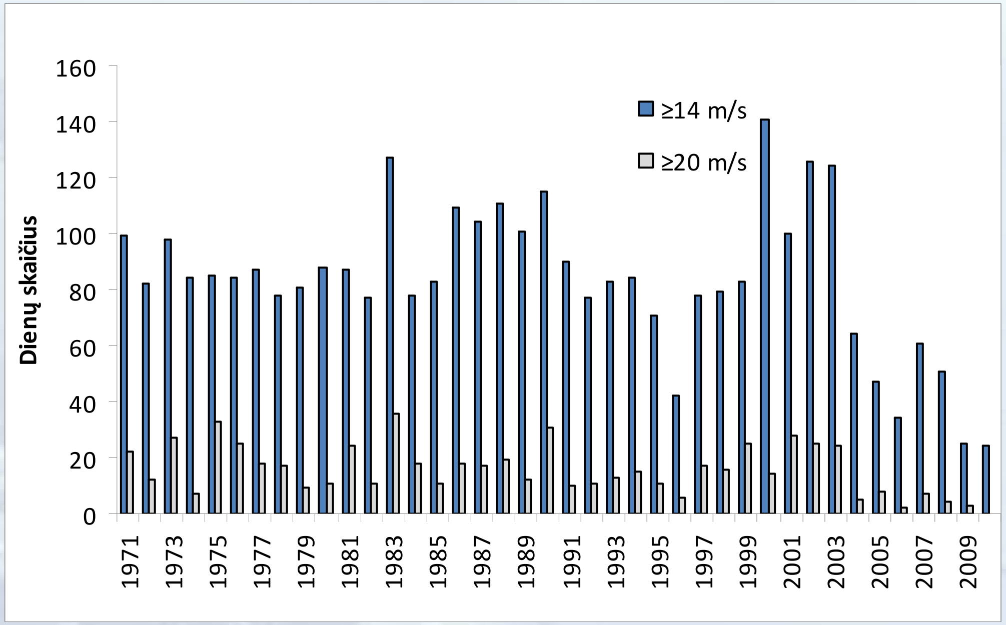
$$Ve = \Sigma(-\sin\alpha * V)/n,$$

where Ve – wind energy; V – wind speed; -sinα – sinus of wind direction; n – case's number.

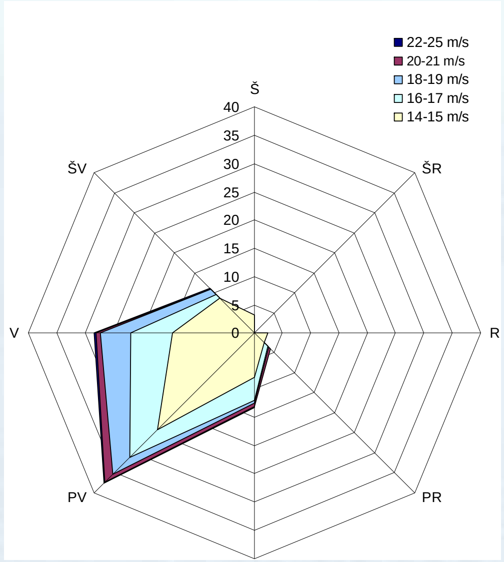


Relation between yearly change of mean significant wave height and yearly change of mean wind energy

Wind - wave regime and water level changes in the Baltic Sea nearshore (Lithuania)

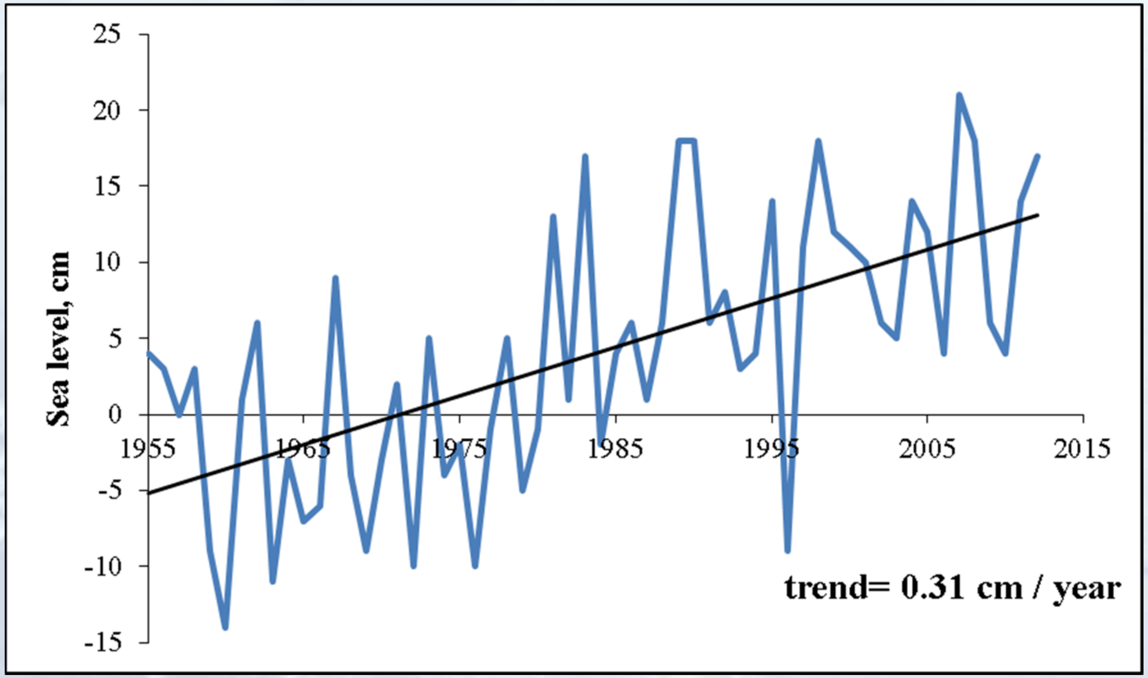


Number of days with strong winds in 1971-2010

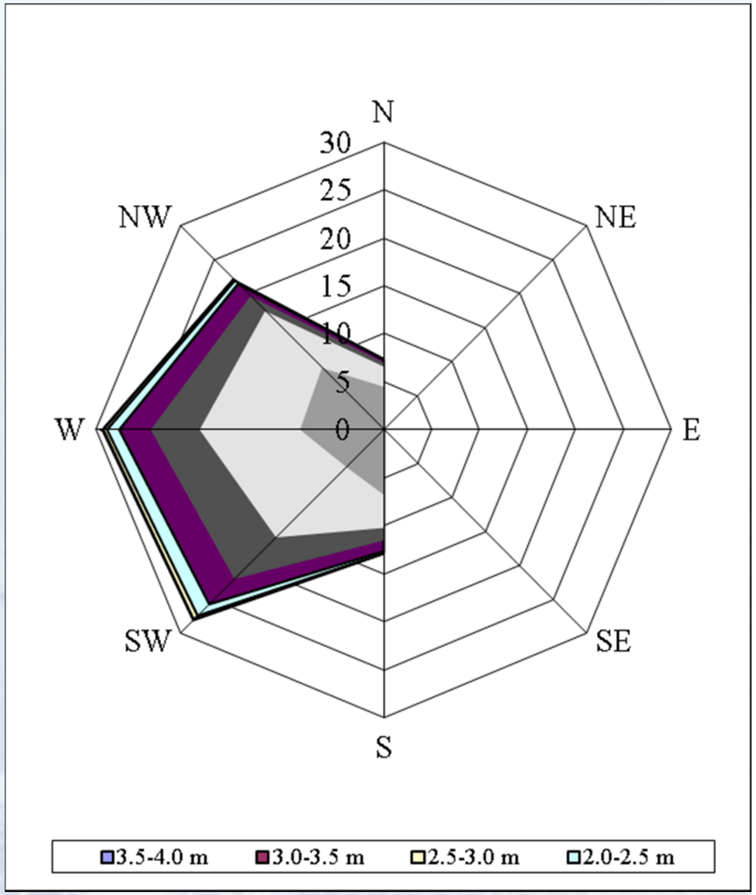


Distribution of strong winds in 1999-2010

Wind - wave climate and water level changes in the Baltic Sea nearshore (Lithuania)

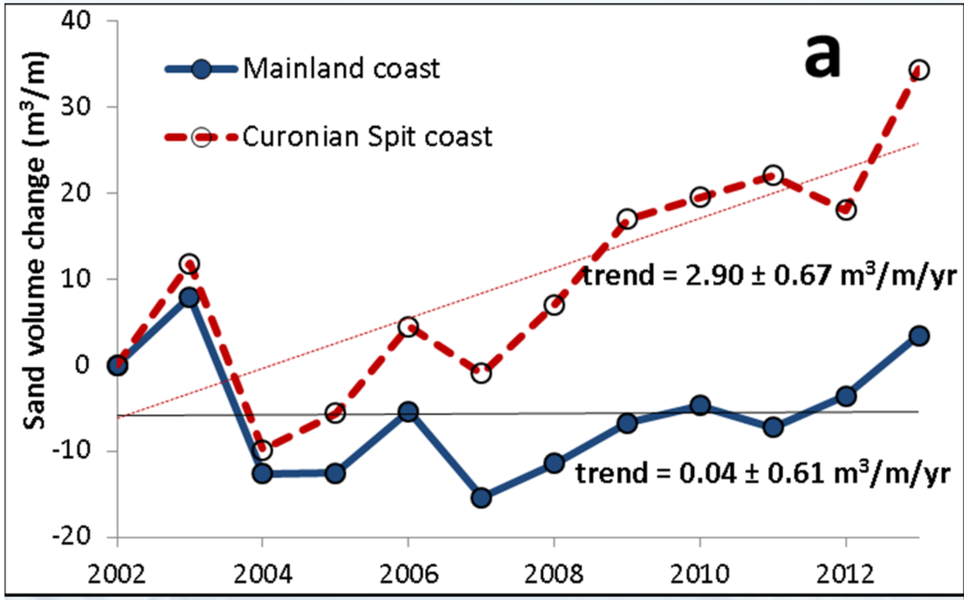


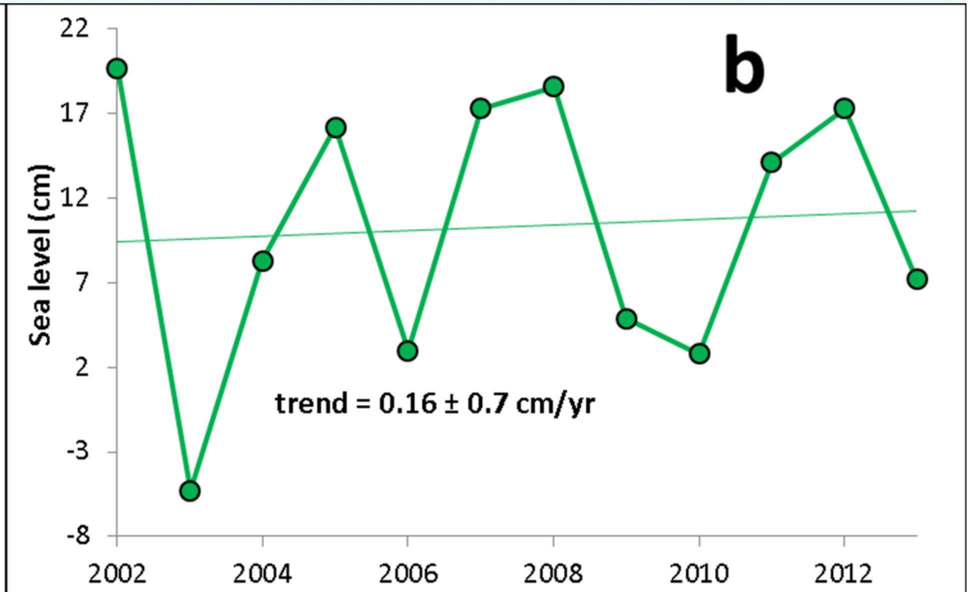
Water level variation (Klaipeda station) in 1955 – 2012 (Data of Hydrometeorological Service)



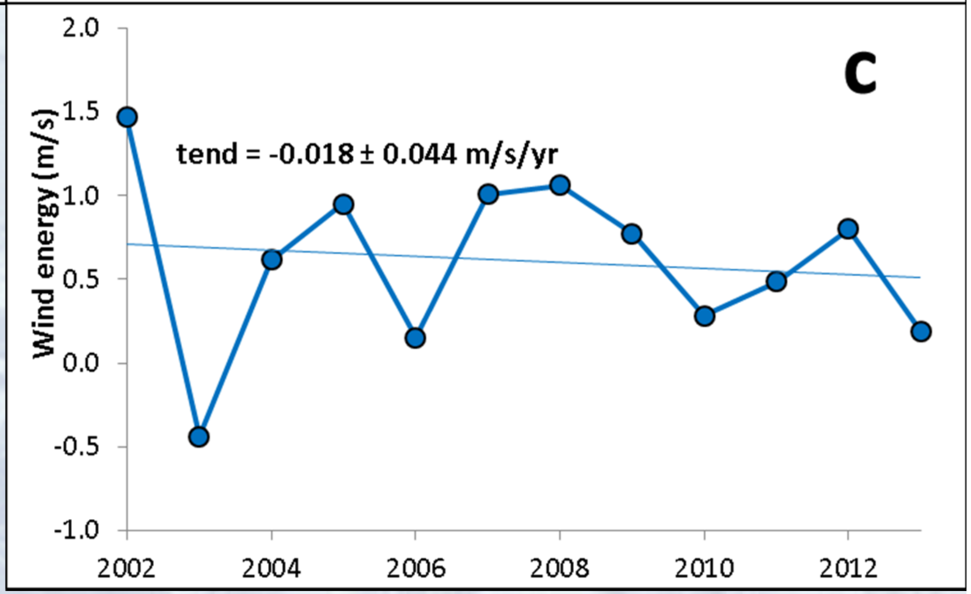
Wave distribution accorging to data of Klaipeda station in 2002 – 2012

Coastal changes in decadal time scale and their relations with wind energy and sea levels

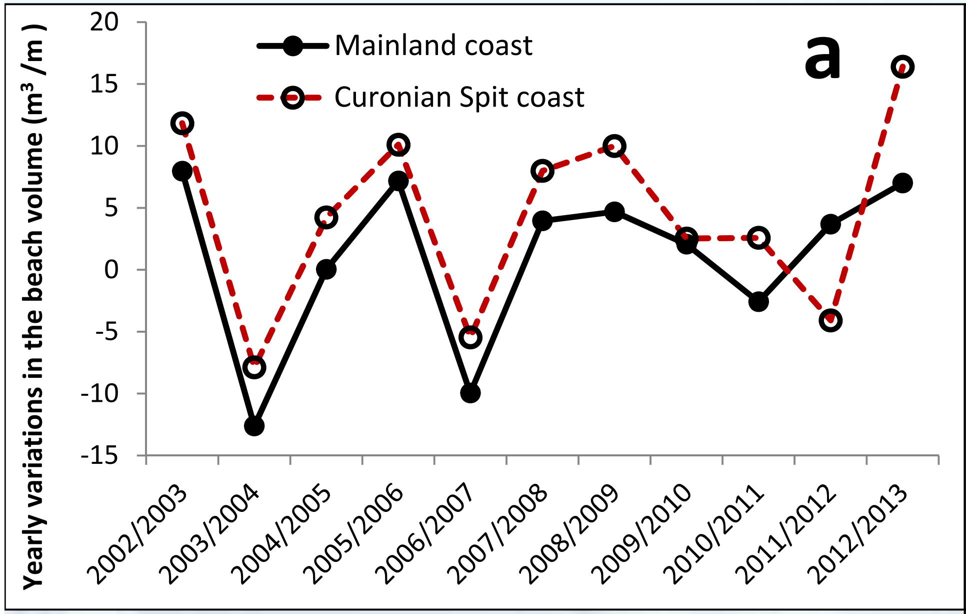


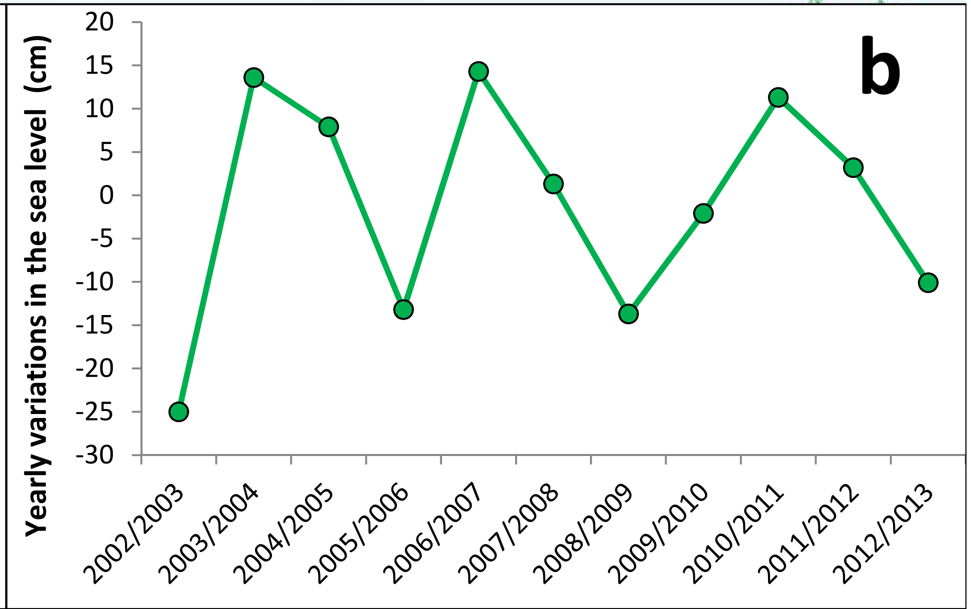


Subaerial beach volume change in mainland coast and in Curonian Spit coast (a), sea level changes (b) and wind energy changes (c) in 2002 - 2013 and their linear trends

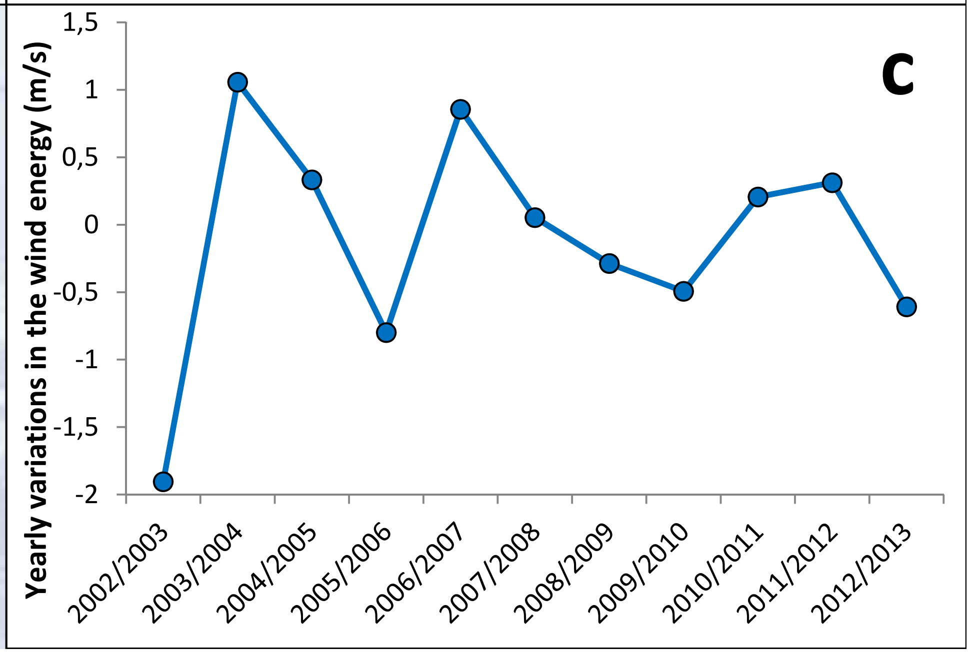


Yearly variability in the subaerial beach volume, wind energy and sea levels

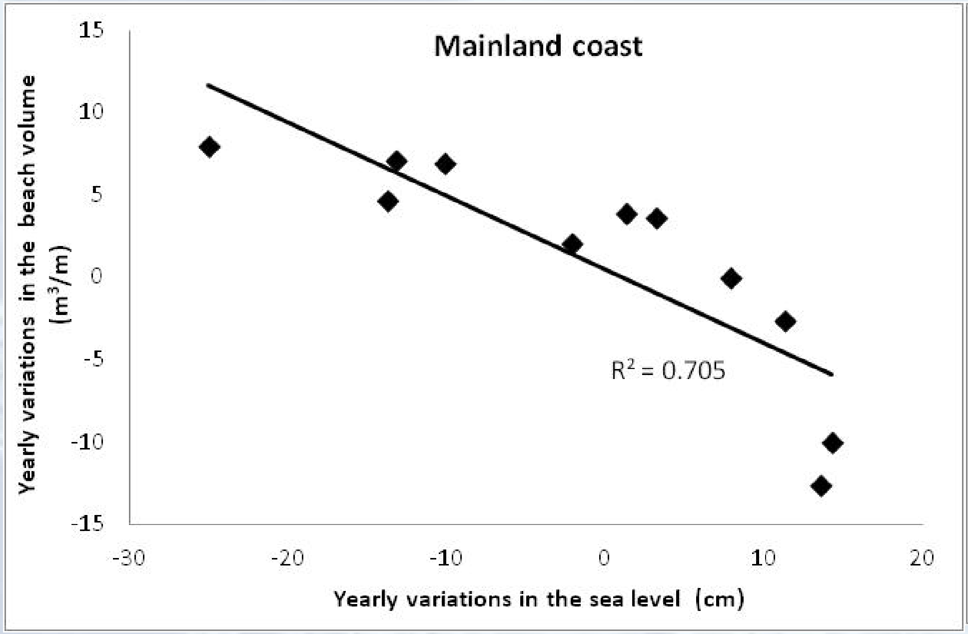


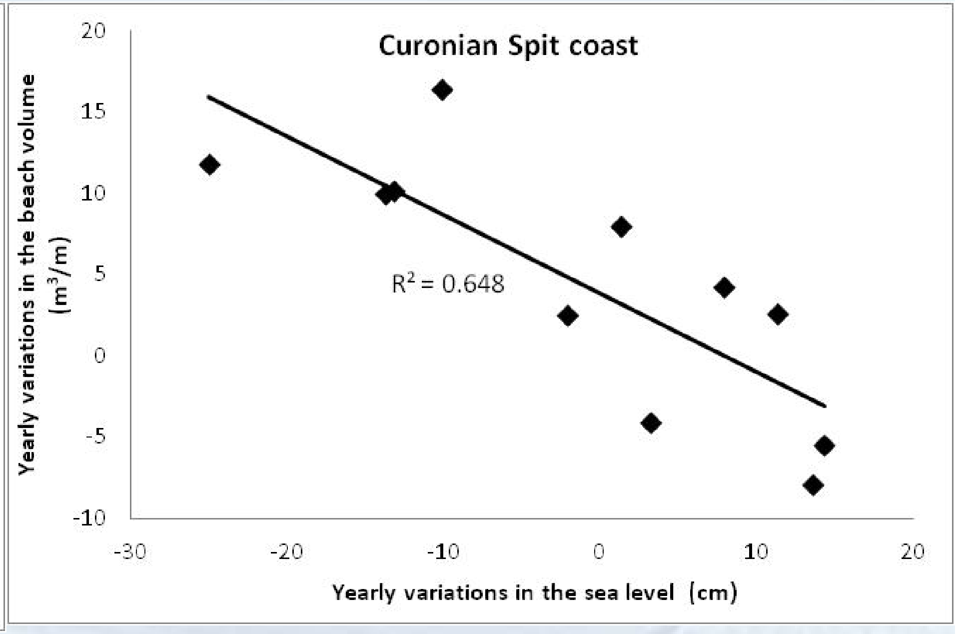


Yearly variability in the subaerial beach volume (a), in sea level (b) and in wind energy (c) in 2002 - 2013

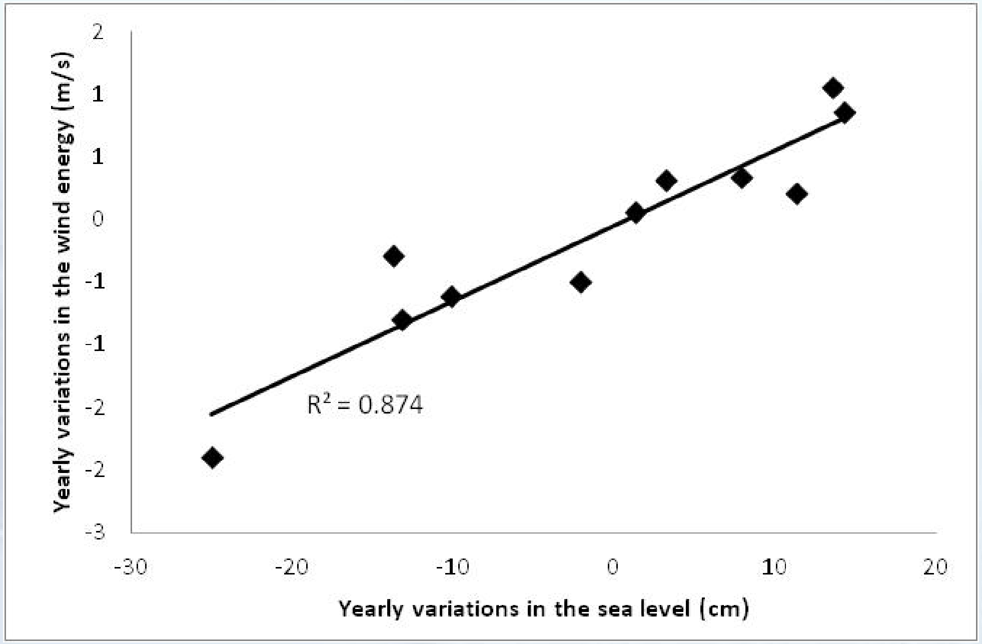


Yearly variability in the subaerial beach volume, wind energy and sea levels





Correlation between year-to-year variations in the sea level and in the suaerial beach volume in mainland coast (a) and Curonian Spit coast (b).



Correlation between yearly variations in the sea level and in the wind energy

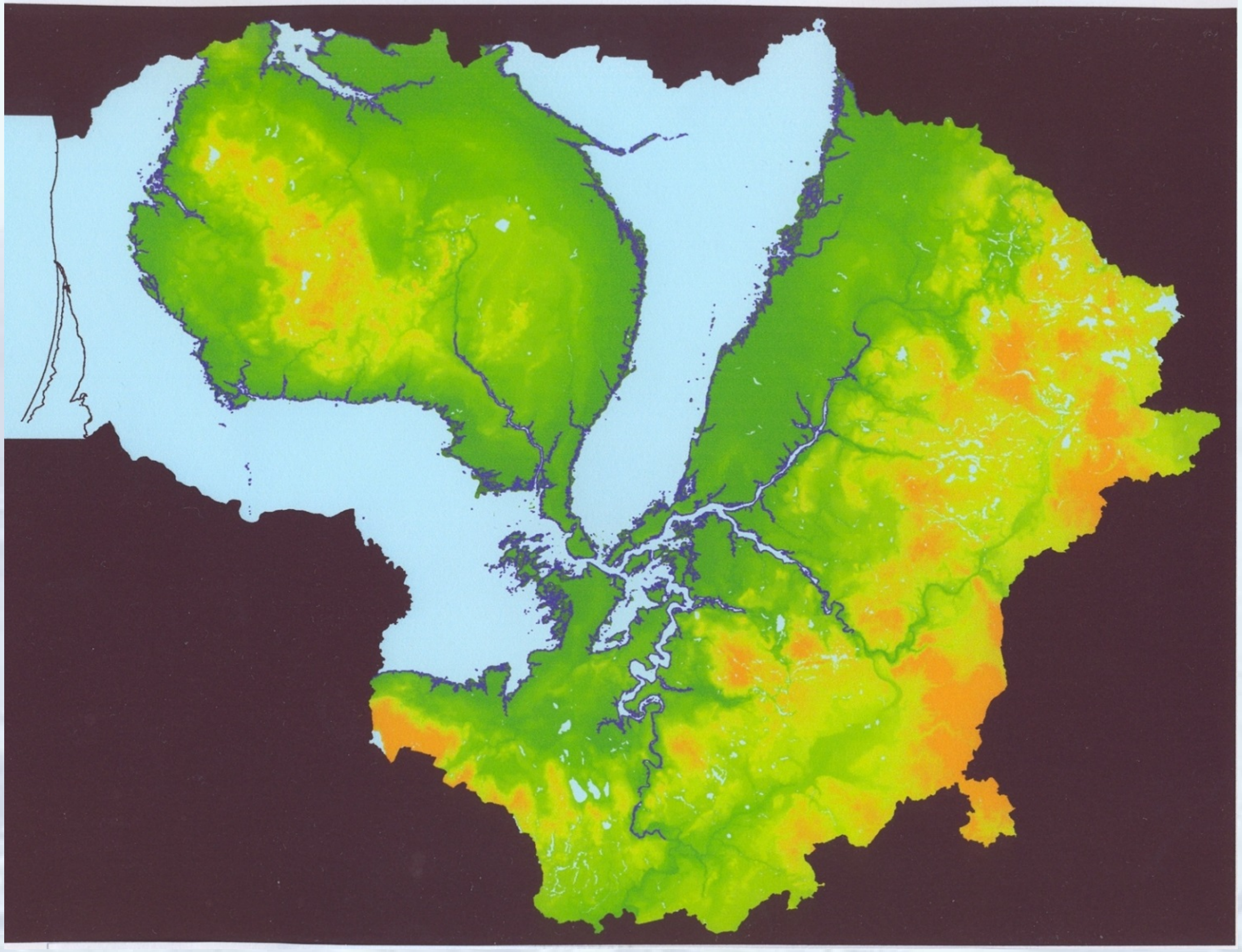
CONCLUSIONS

- After the analysis of sediment amount dynamics for the 2002-2013 period, no significant correlation between subaerial beach volume change and relative sea level rise on decadal time scale was identified.

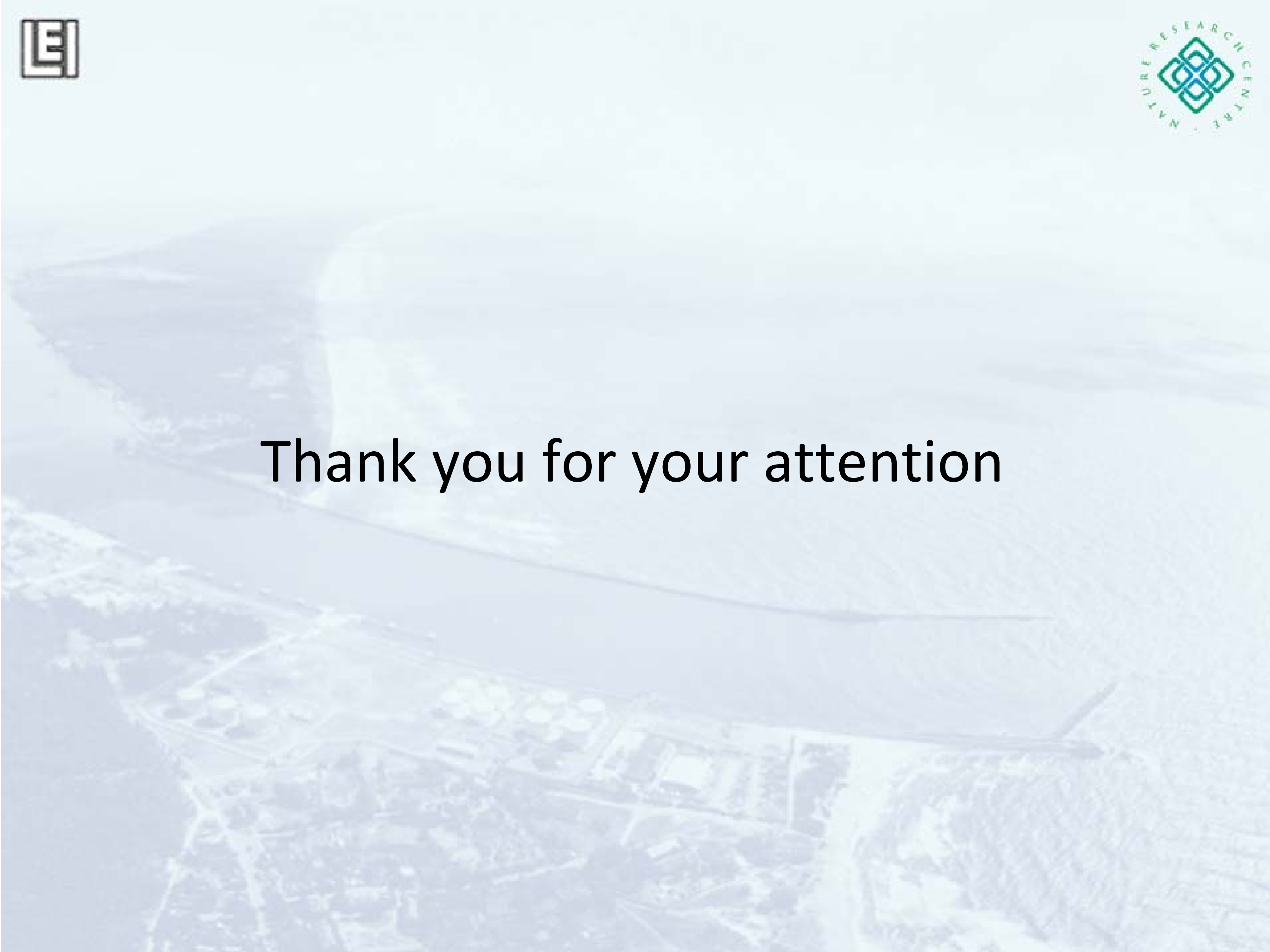
- The magnitude of beach volume change is controlled by the sediment supply, storm activity, wave climate, and coastal geomorphology. In addition to that, because sea level, wave height, and magnitude of wind energy are all closely connected in a short time scale, it is difficult to identify the influence of solely the rise of sea level separated from other factors.

CONCLUSIONS

- In a decade time scale, the extent of coast erosion depends more on the frequency and intensity of storms than on the slow rise of sea level. On the other hand, when there are enough sand reserves in the nearshore, a small increase in sea level can stimulate accumulation processes on the coast.
- A small, up to 0.2 cm/yr rise (period 2002 – 2013) in sea level does not have any significant influence on the coastal recession.
- Only long time monitoring data analysis could give more clear explanations.



The Lithuanian territory would decrease if the sea level increases by 60 m (all glaciers would melt) ???


Thank you for your attention