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West Estonian coast – climate change adaptation measures for low lying coastlines

Valter Petersell, Mikhail Shtokalenko, Sten Suuroja, Mark Karimov, Jaan Kivisilla

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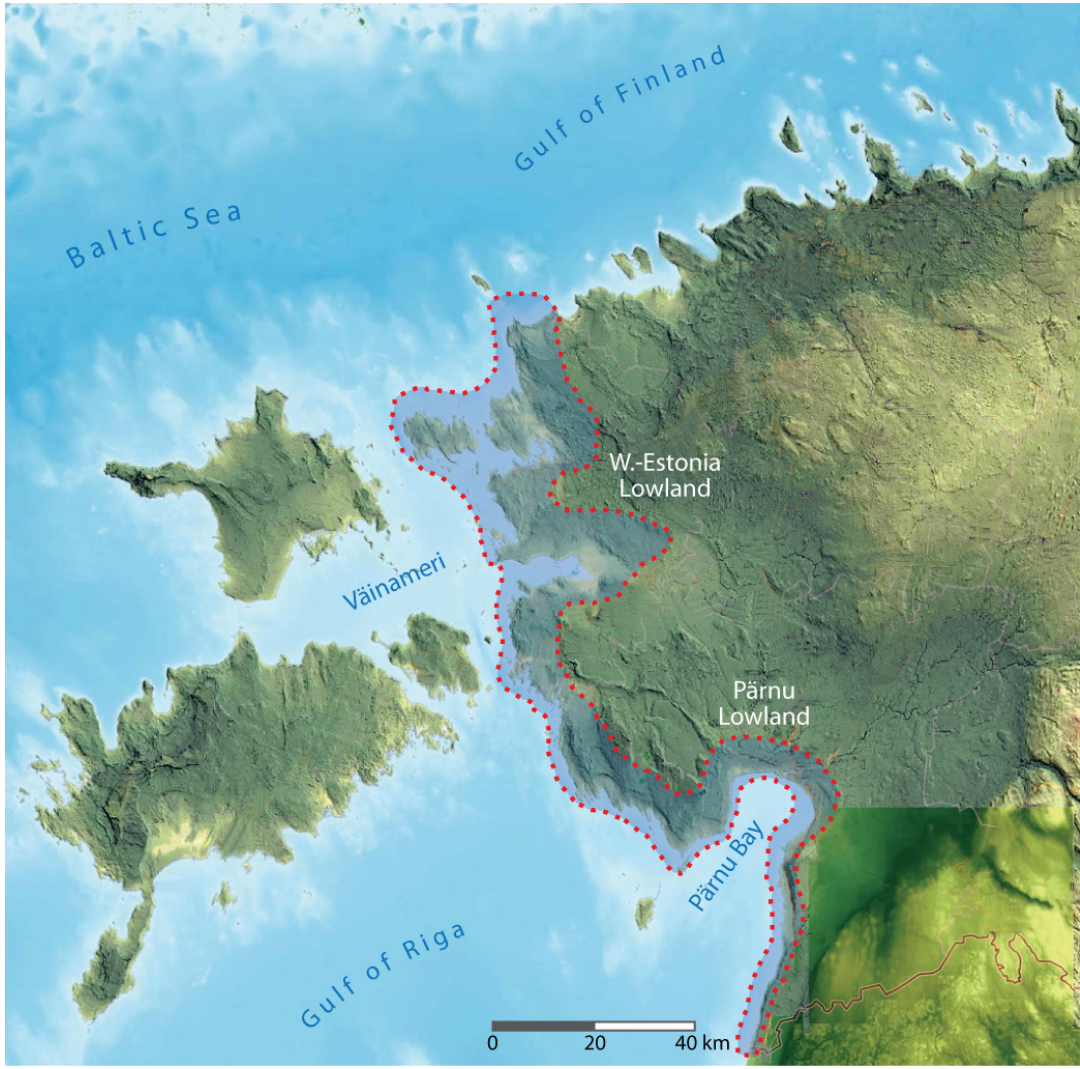
West Estonian coast Case study area:

The case study area comprises principally two lowlands – West-Estonian and Lowland Pärnu Lowland.



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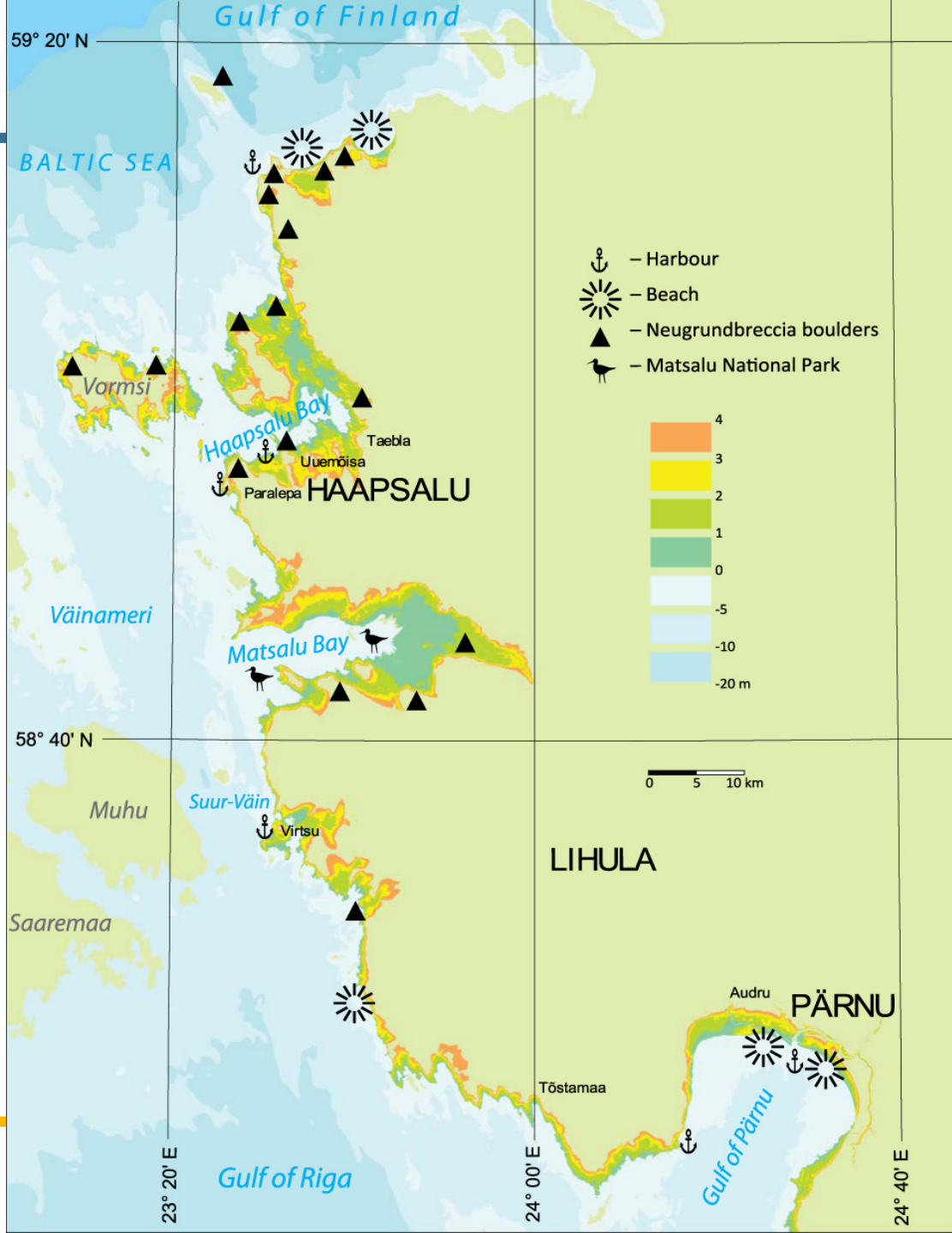
Case study area:

The coastline is cut by bottleneck shape bays: Pärnu, Matsalu Haapsalu.

The nature in the case study area is diverse and there are several objects worth visiting. In addition to typical coastal recreational areas with sandy beaches.



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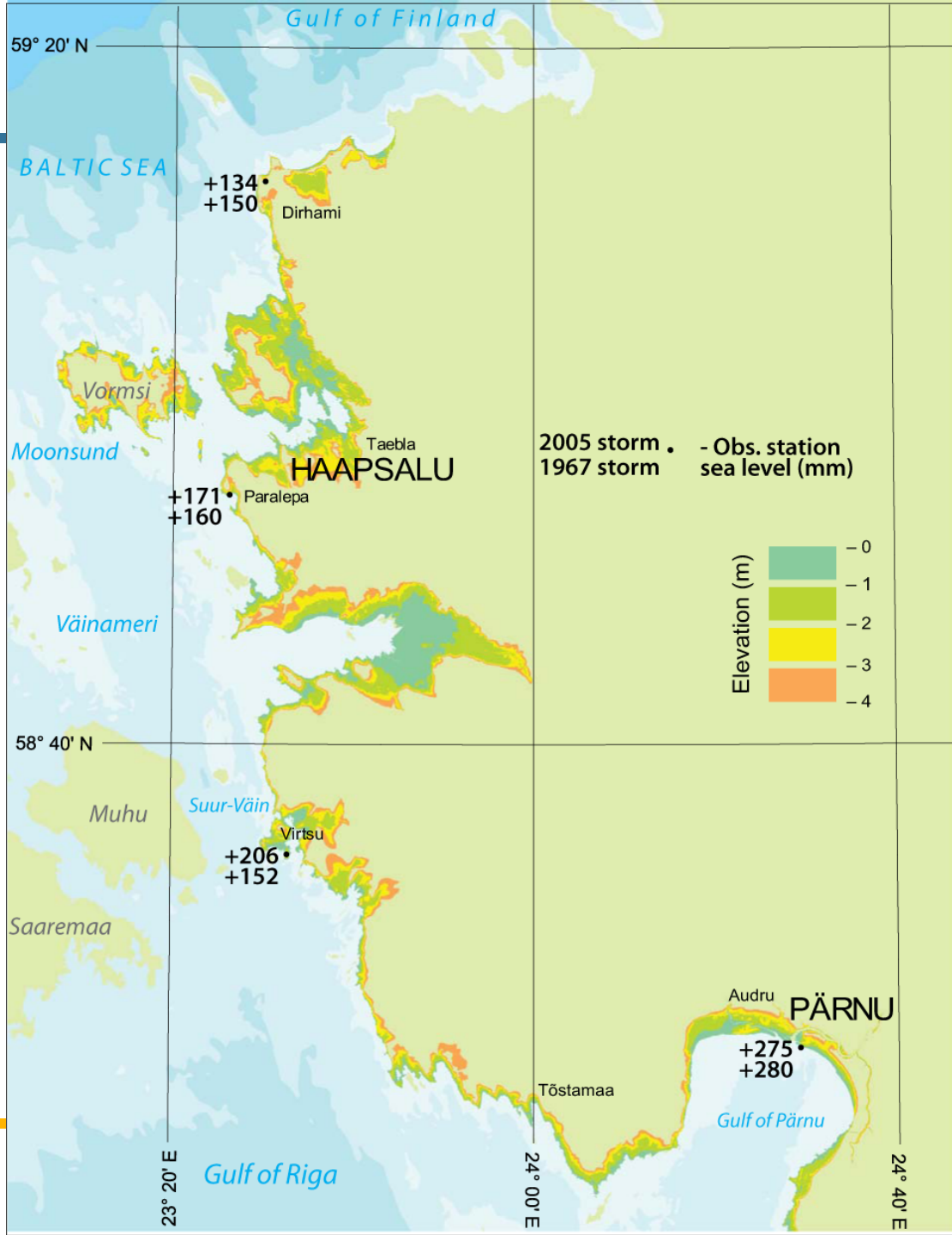
Case study area:

Elevation a.s.l	Area
<1 m	150 km²
<2 m	250 km²
<3 m	450 km²
<5 m	760 km²



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Neugrundbreccia erratic boulders

Among the erratic blocks there are numerous of unique impact breccia blocks that originate from the ring wall of the Neugrund meteorite crater.

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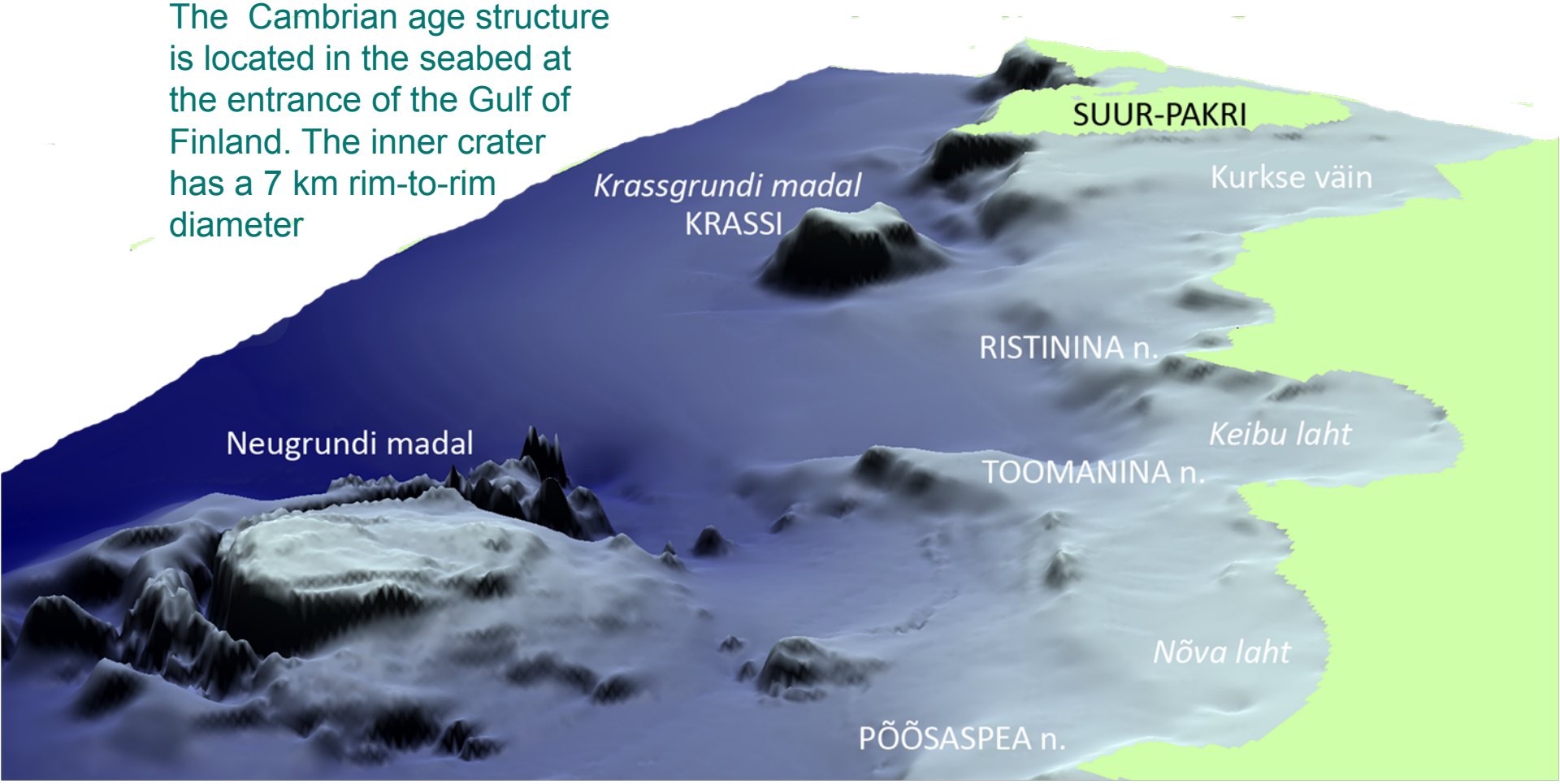
Neugrund meteorite crater

The Cambrian age structure is located in the seabed at the entrance of the Gulf of Finland. The inner crater has a 7 km rim-to-rim diameter



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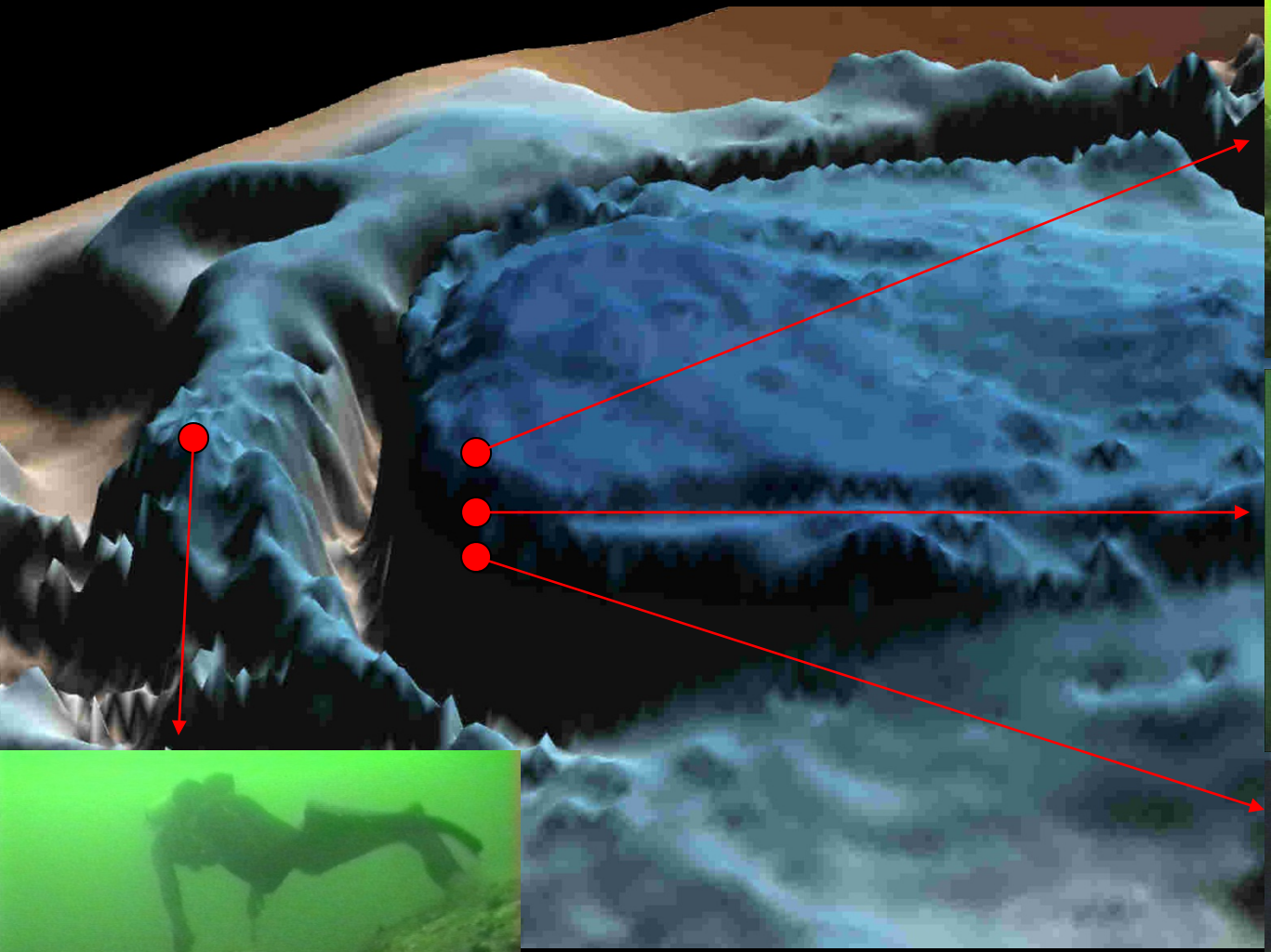

Scuba Divings

Sandy beaches:

The INDEPENDENT

European Beaches – TOP 10 (2011):
No. 9th is Pärnu with Valgrerand.

Over 10 000 people per day visit these beaches during the summer holiday season. Mostly the beaches are bordered by a terrace formed in the dune sand.

Also nice and popular beaches are in North and West part of the area (Keibu, Nõva, Dirhami, Matsi)

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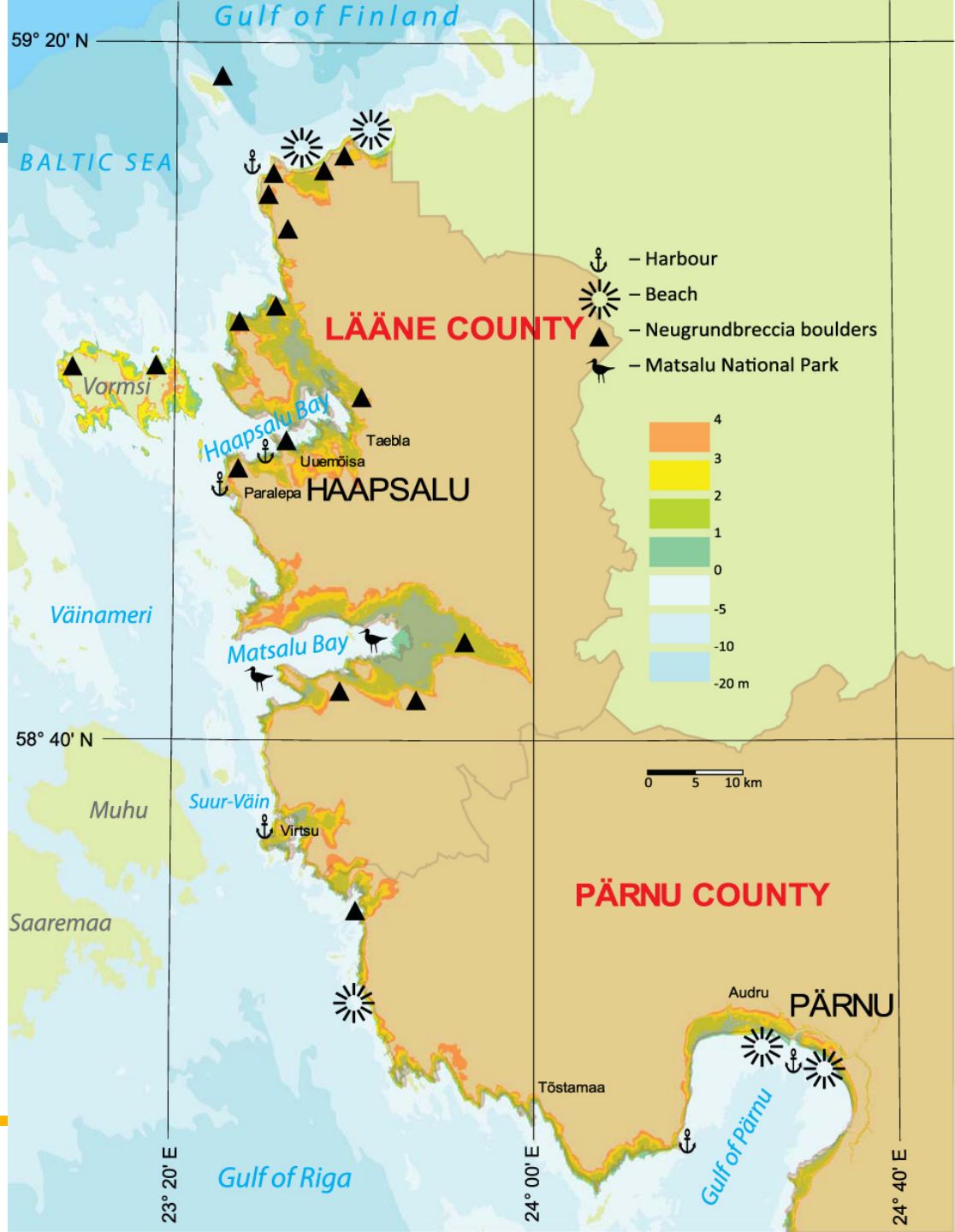
Case study area:

The administration divisions

Pärnu county (4 coastal communes incl. city of Pärnu)
Lääne county (7 coastal communes incl. city of Haapsalu and Vormsi Island.



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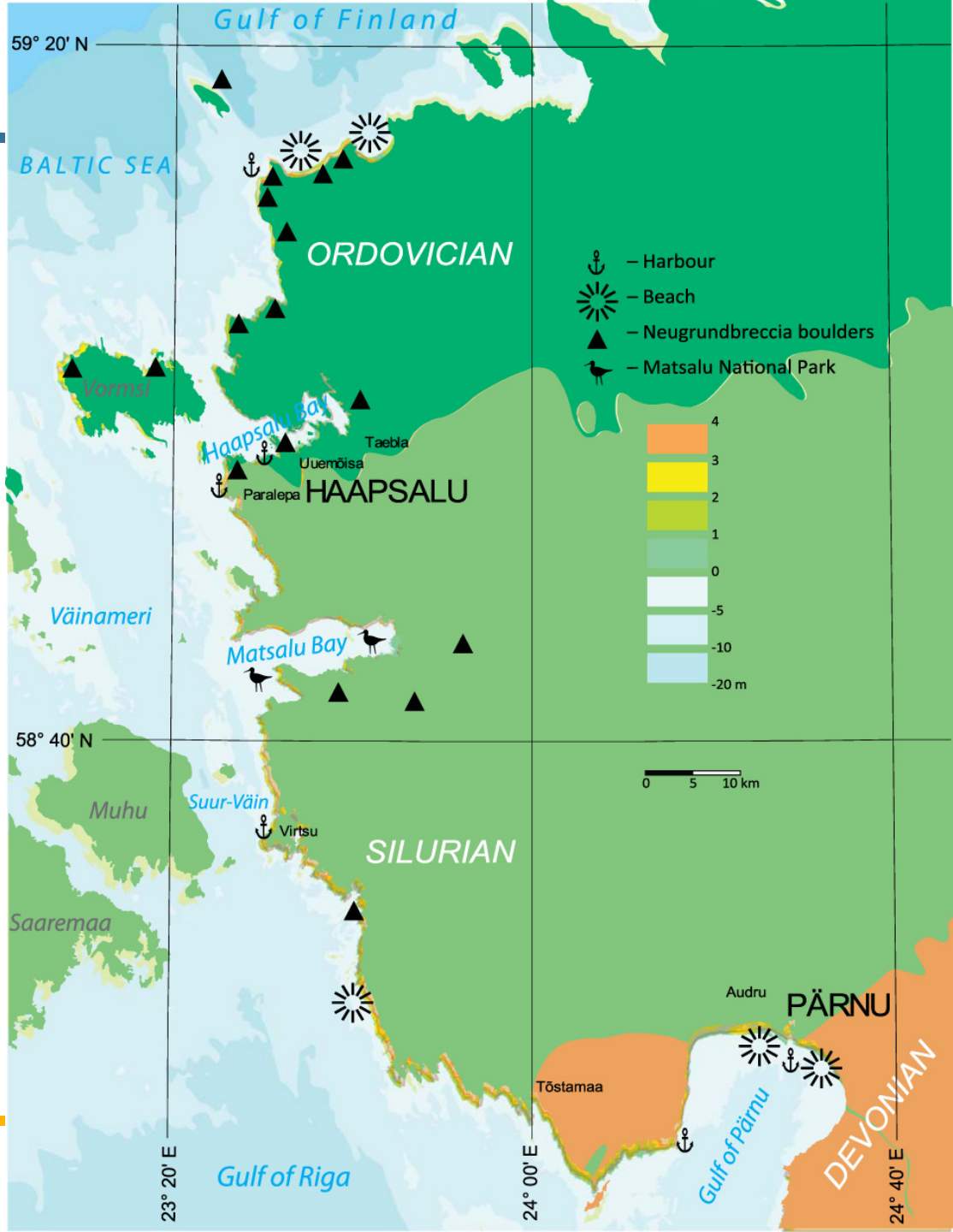
Geology

The west Estonian coastline morphology is controlled by the bedrock geology. In the south, the sea is in contact with the **Devonian** weakly-cemented **terrigenous sedimentary rocks**. Thus the coastline is formed by relatively straight stretches and beaches are sandy. In the north, the sea is in contact **with Silurian and Ordovician carbonate rocks**, which produces sinuate coastline, fewer beaches, and sand is accompanied by carbonate pebbles.



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Geology

Limestone outcrop on Vormi Island

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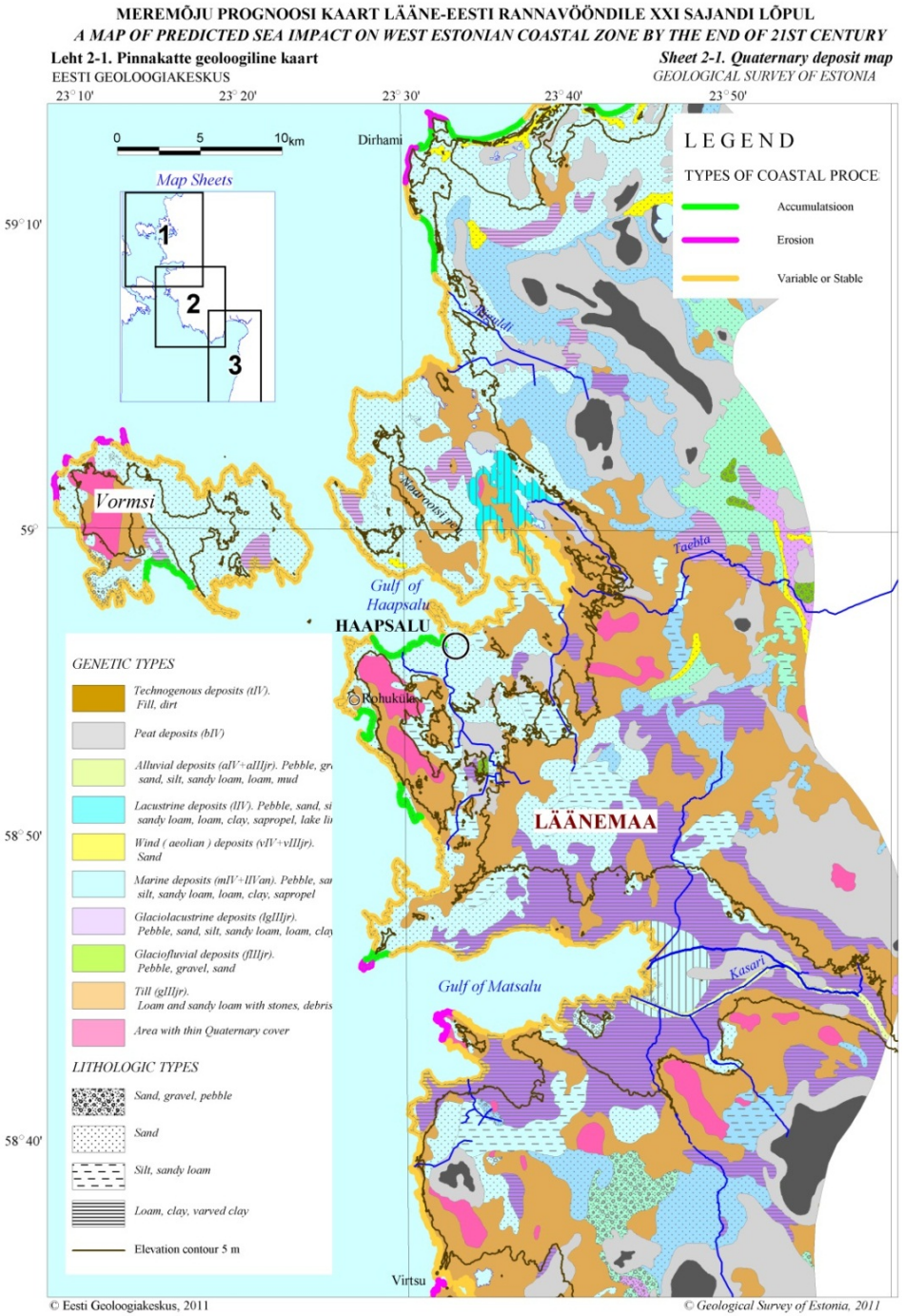
Quaternary

The thickness of the Quaternary cover is 1 to 5 m, also ALVARS and bedrock outcrops are common to the area. More than 25 m thickness are in locations where ANCIENT VALLEYS enter the sea (Haapsalu, Tõstamaa and Liu regions). Large areas are covered by tills and the marine sedimets which forms beach barriers and dunes. Low beach barriers are characteristic to the Pärnu bay and Kabli shore to the south, as well as in NW Estonian shoreline.



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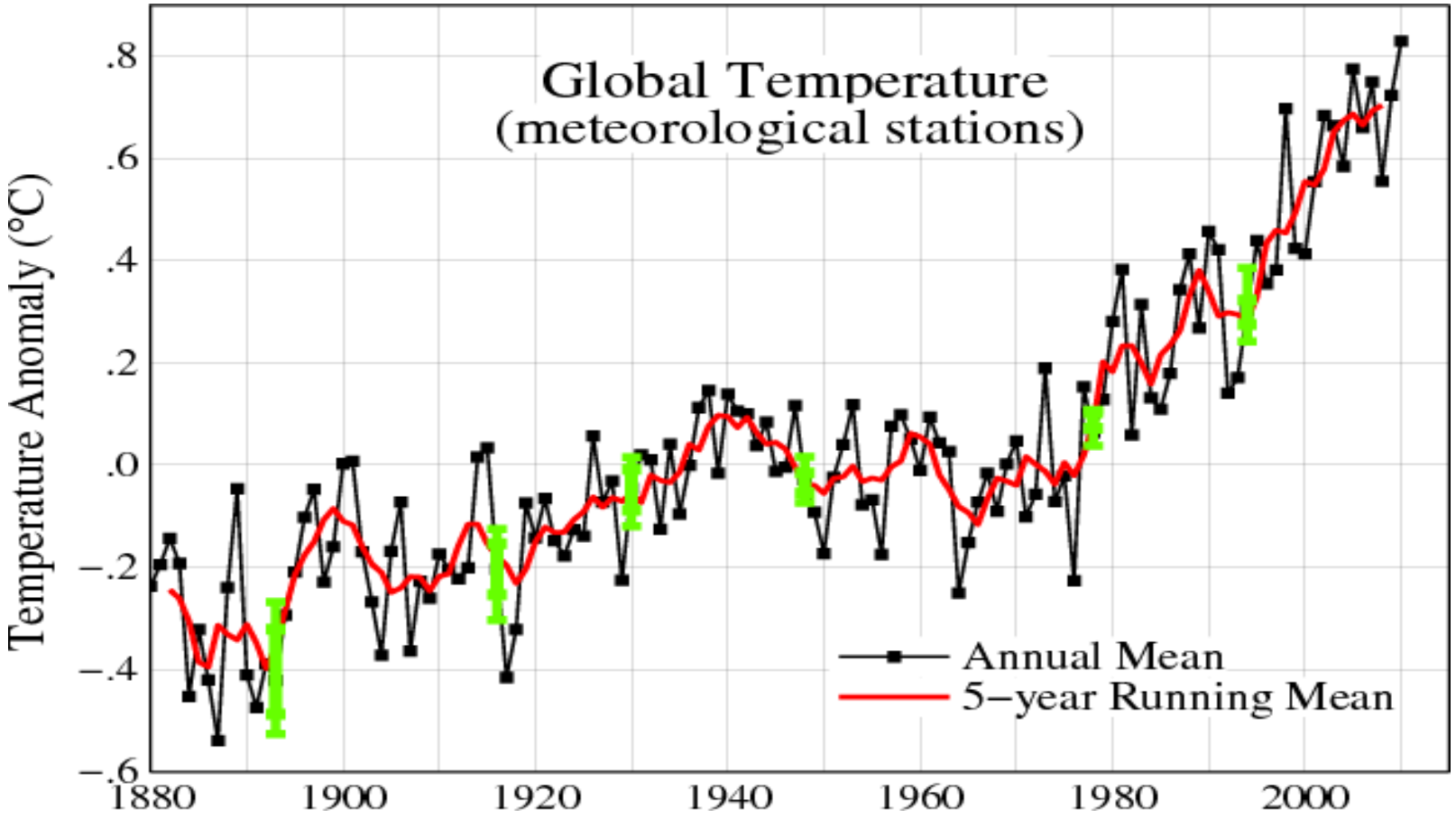

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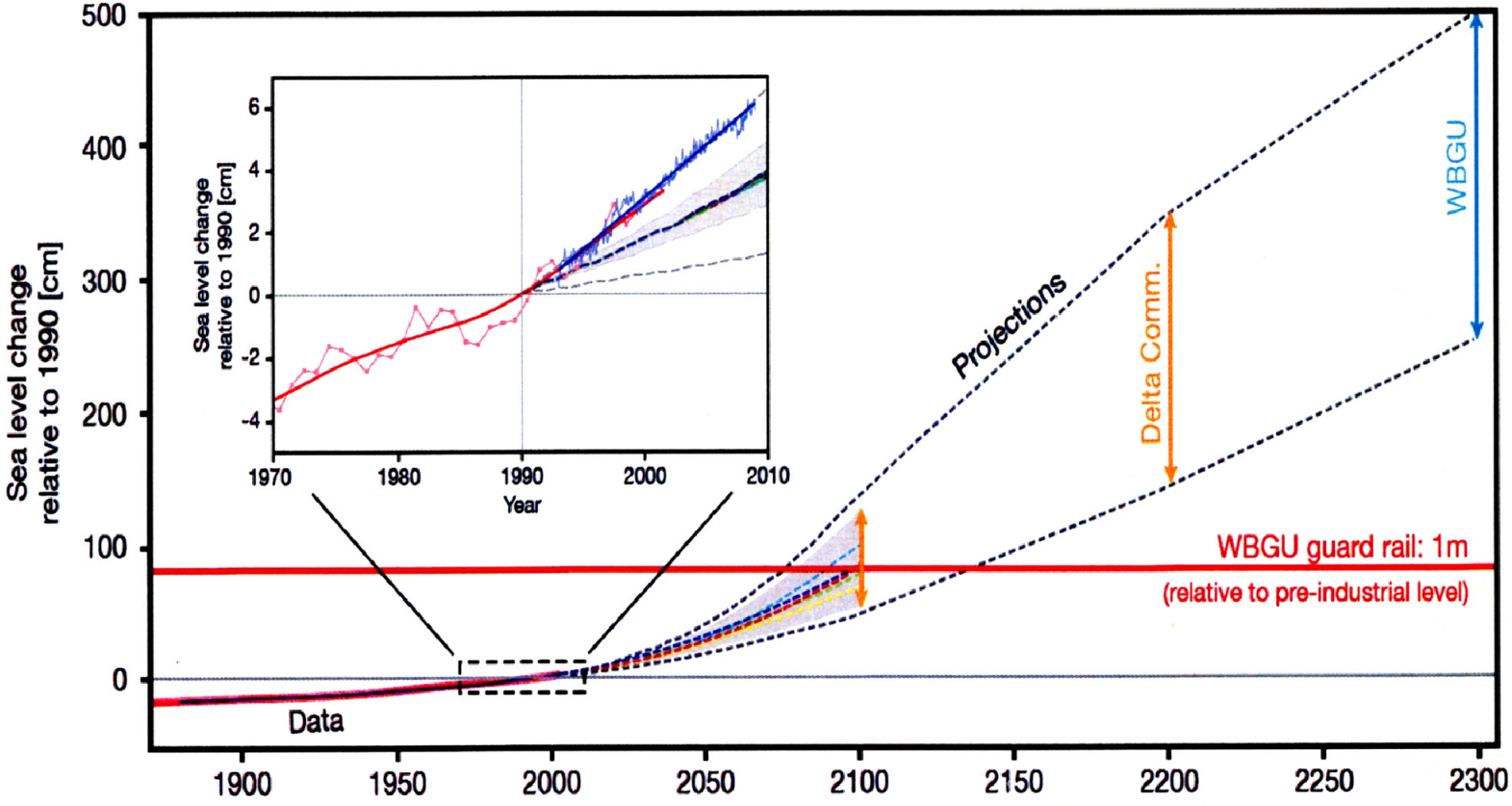
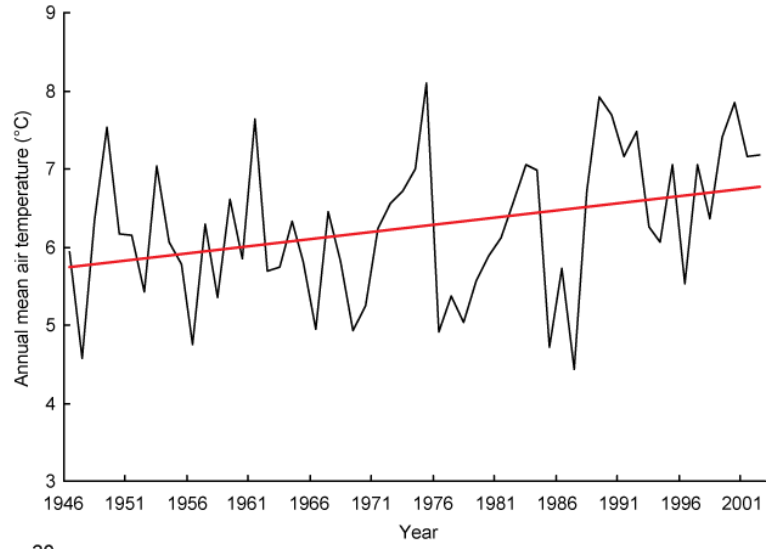
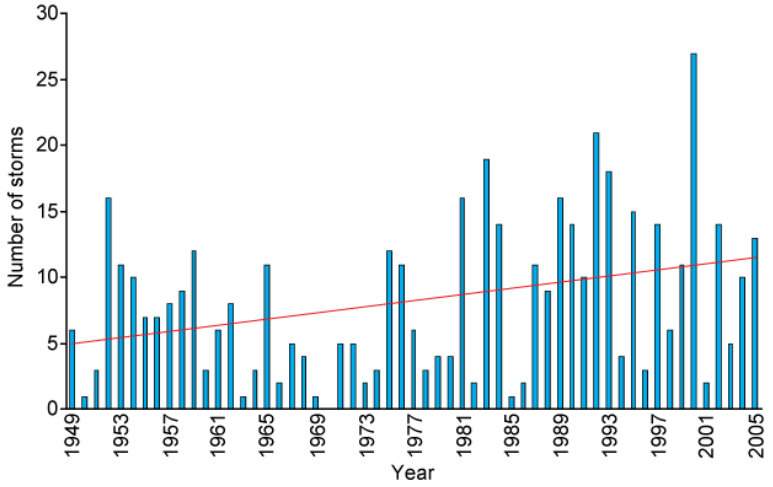
Prognosis for the sea level rise (WPGU; IPCC)





Increase of temperature

Time series of annual mean air temperature in Ristna, from year 1946.



Increase of storm days

Time series of number of storm days in winter (DJF) at Vilsandi during from year 1949.

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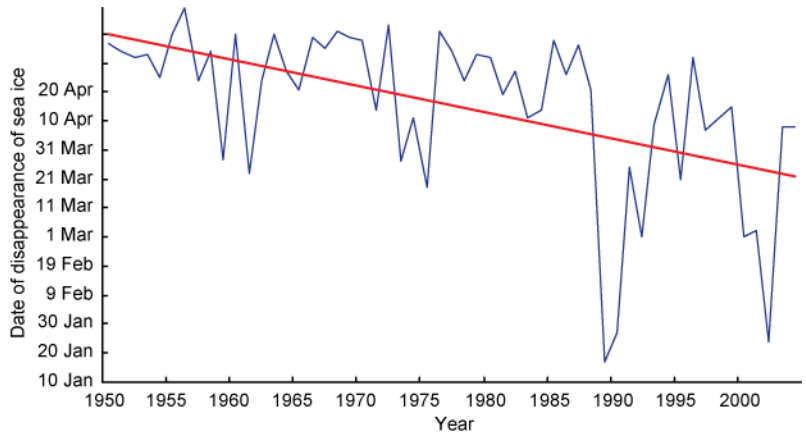
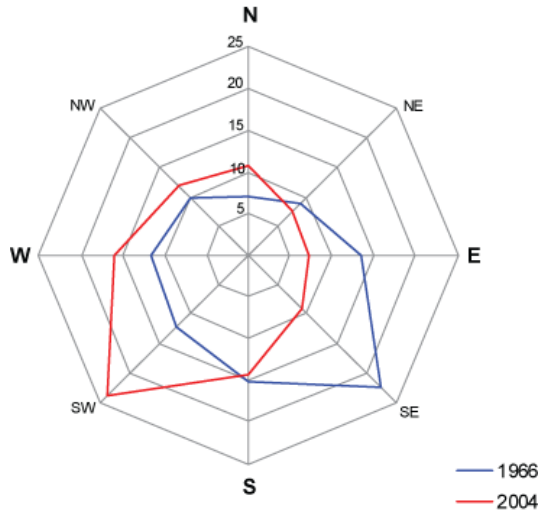


Final disappearance of sea ice

Time series of the date of the final disappearance of sea ice in Kihnu and it's linear trends during from year 1949.



Changes in frequencies of wind directions

Wind-roses in winter are changed dramatically, turning mostly from SE and E to SW and W (data from Vilsandi obs.stat).

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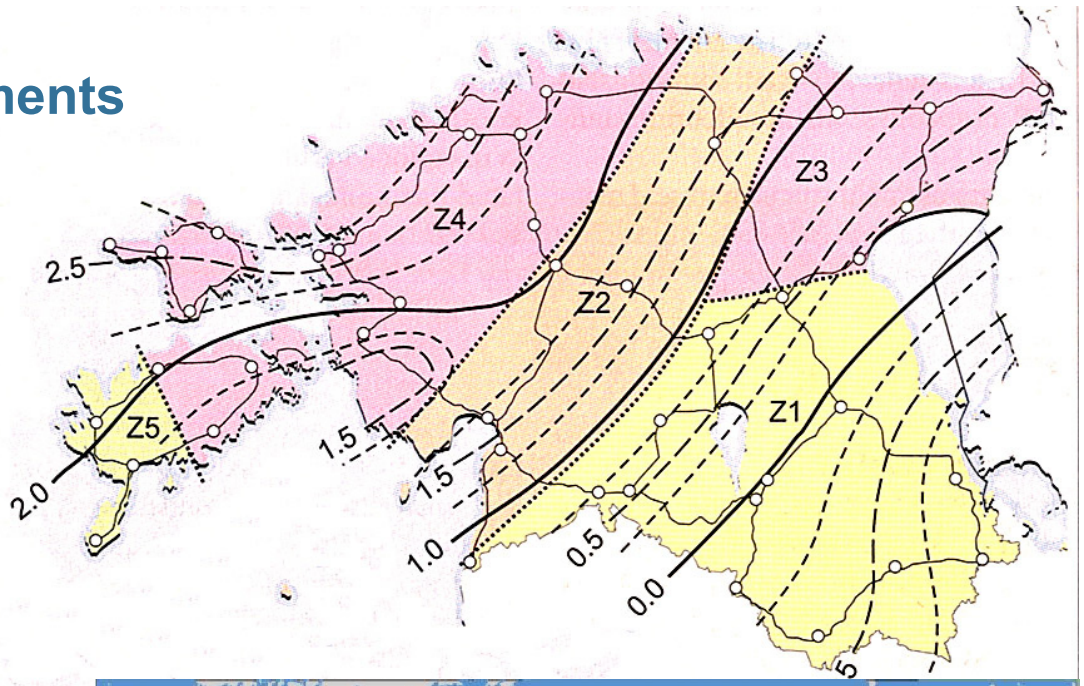
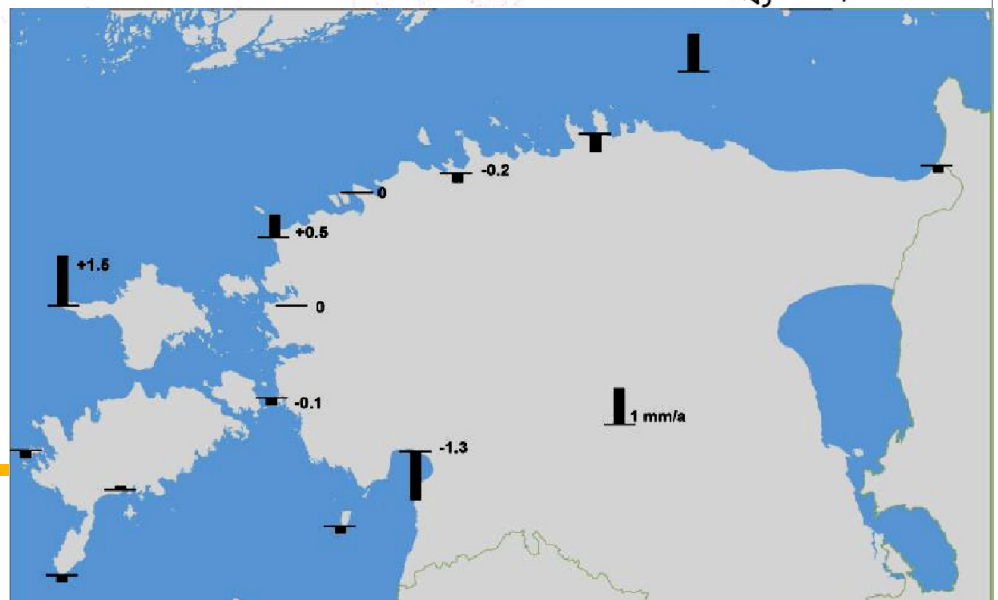
Neotectonic movements

Vallner et al., 1988; affermed by Nordic Geodetic Committee.



Observations by Estonian marine stations.



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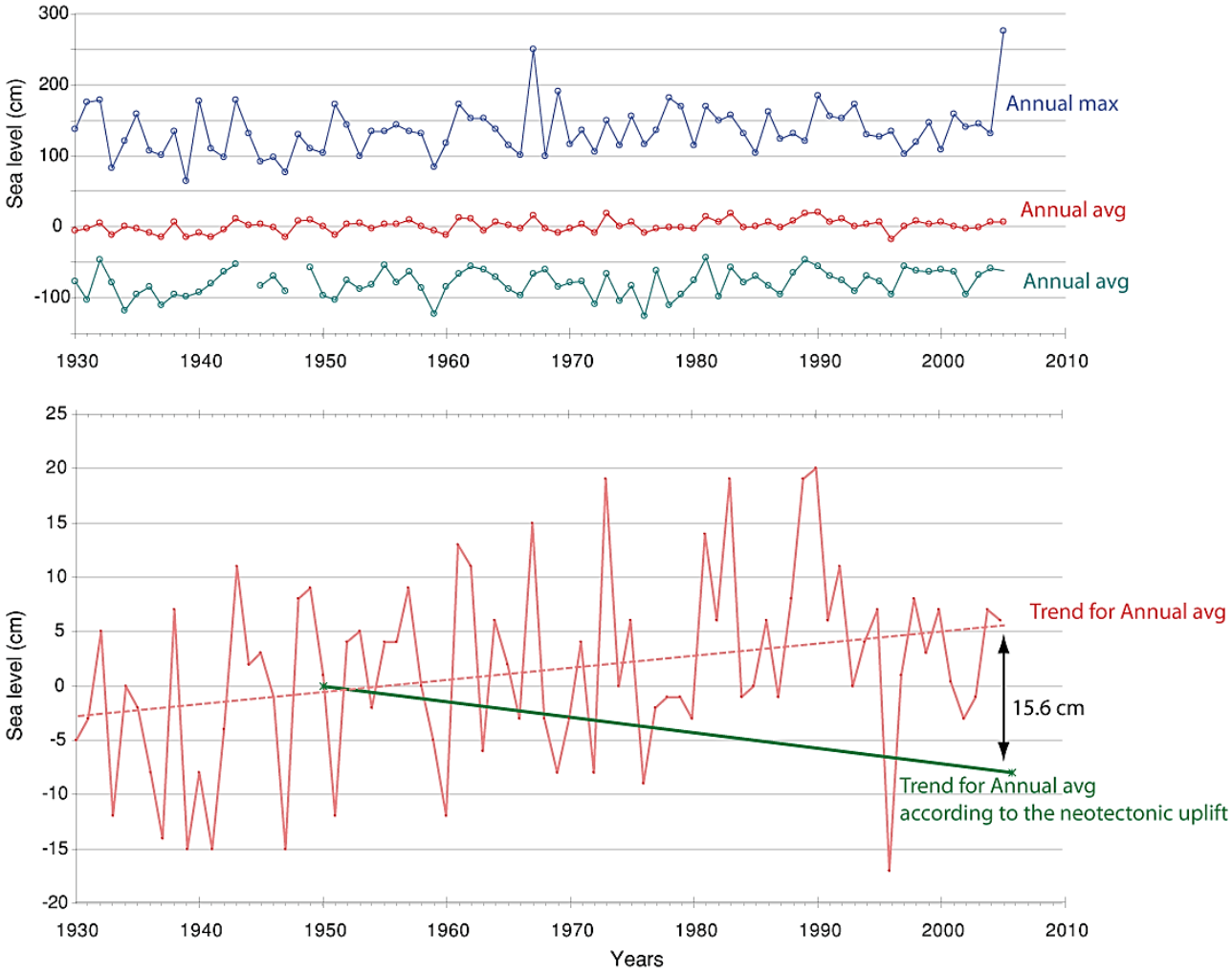
Sea level (Pärnu)



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Impact of the sea to the coast

As a consequence of one single storm only, the beach can move meters towards the continent, e.g. in Valgeranna up to 25 m.

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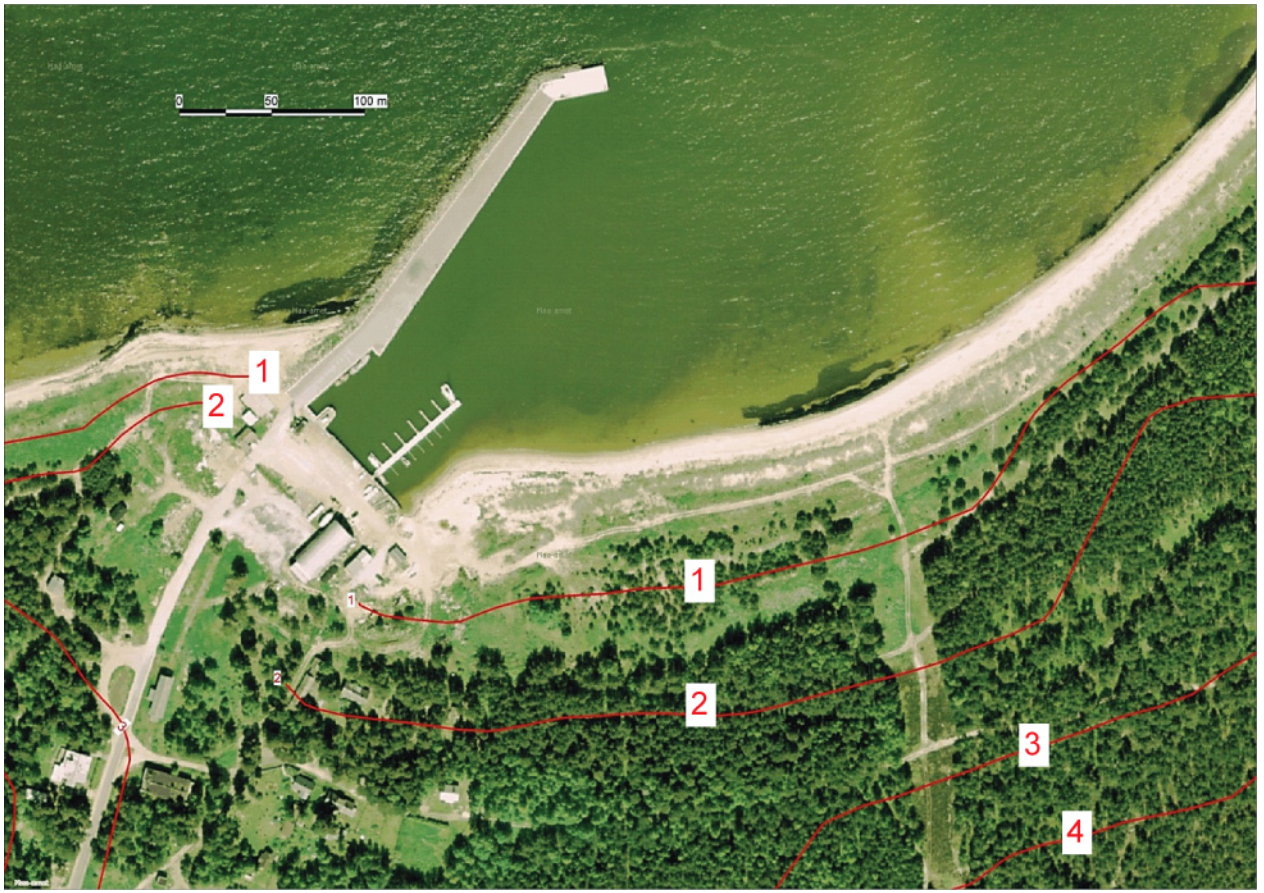
Dirhami harbour



Absolute elevation of the quaies is 2.0–2.3 m a.s.l

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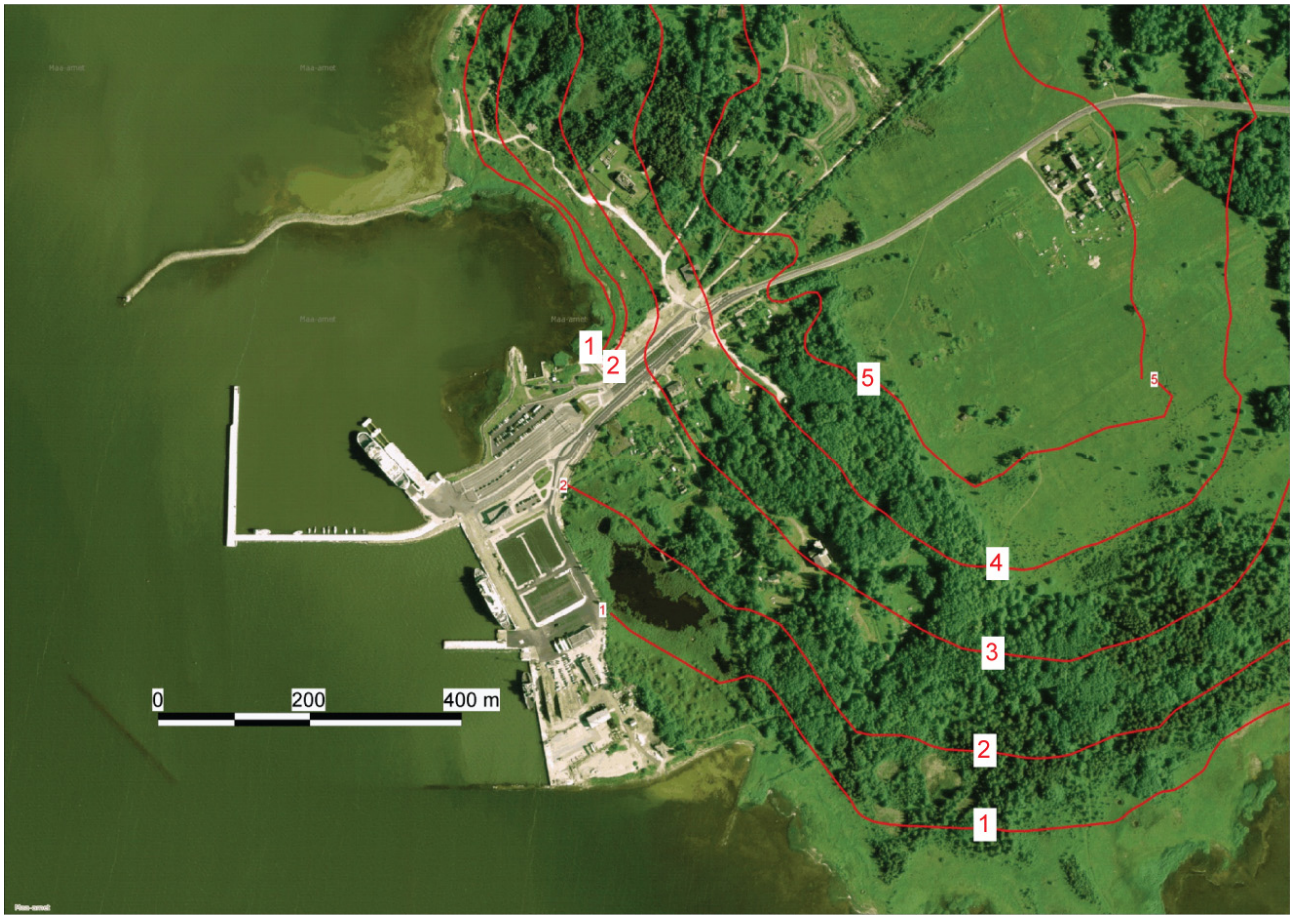
Rohuküla harbour



Absolute elevation of the quaies is 1.7–2.3 m

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Virtsu harbour

The absolute elevation of the quaies is 1.8–2.3 m.

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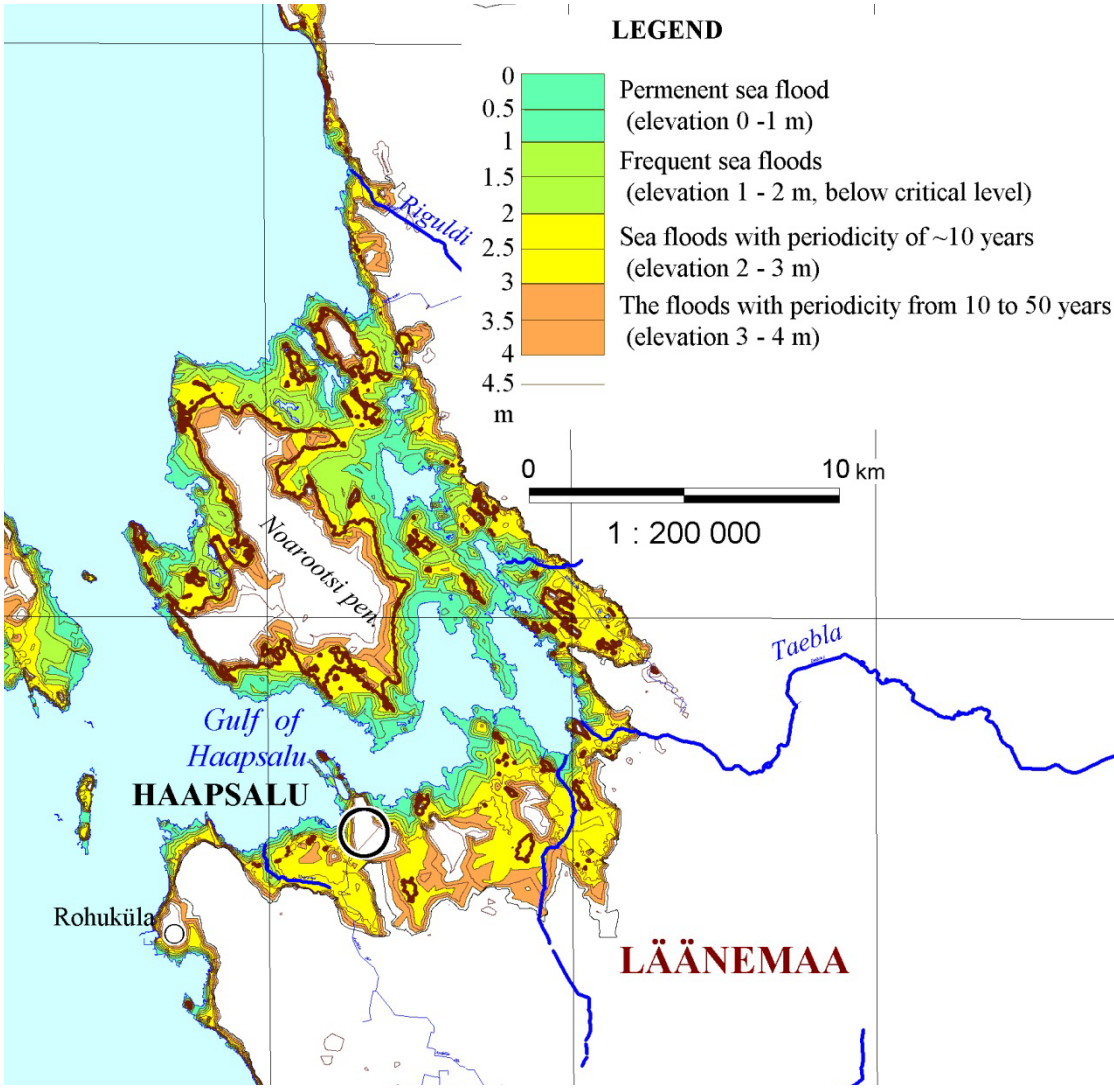
Gulf of Haapsalu



Haapsalu city

...is located at the south coast of Haapsalu bay.

The town started to form around a bishop's fort, founded in 1260 AD. Its ruins are one of the important historical relicts of Estonia.

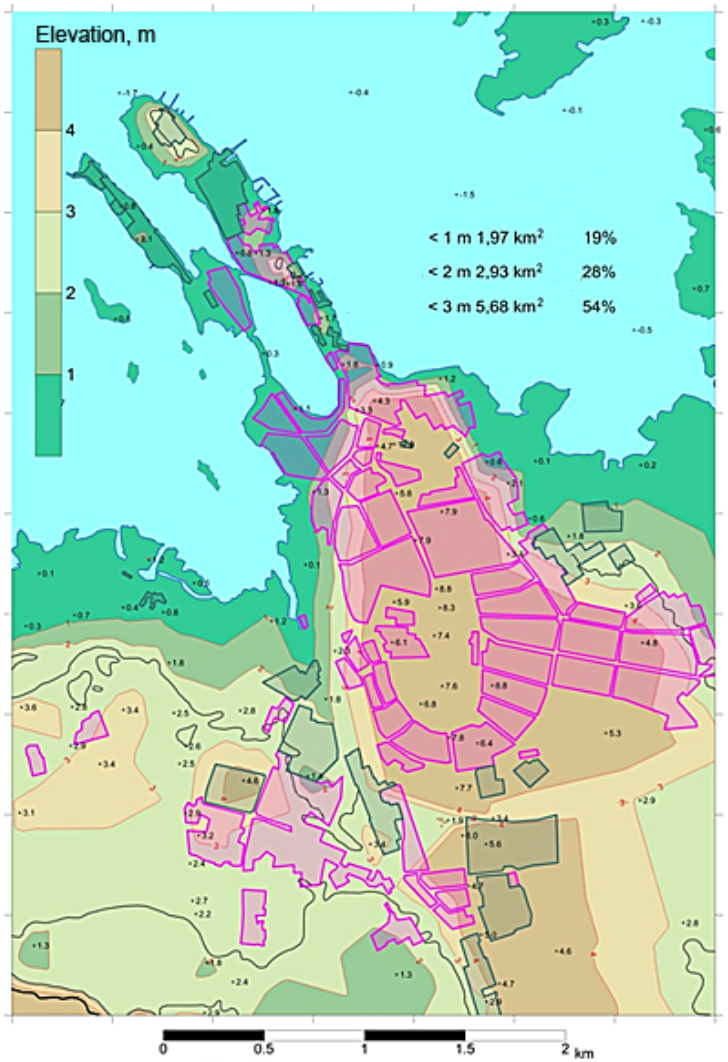
The oldest part of the town is located on a peninsula that is formed of two eskers in the NW direction.

The town area is 10.6 km^2

13 000 inhabitants.

Almost 1/3 of the area is only up to 3 m a.s.l

Current critical sea level is 100 cm a.s.l.



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Haapsalu city

Recent day

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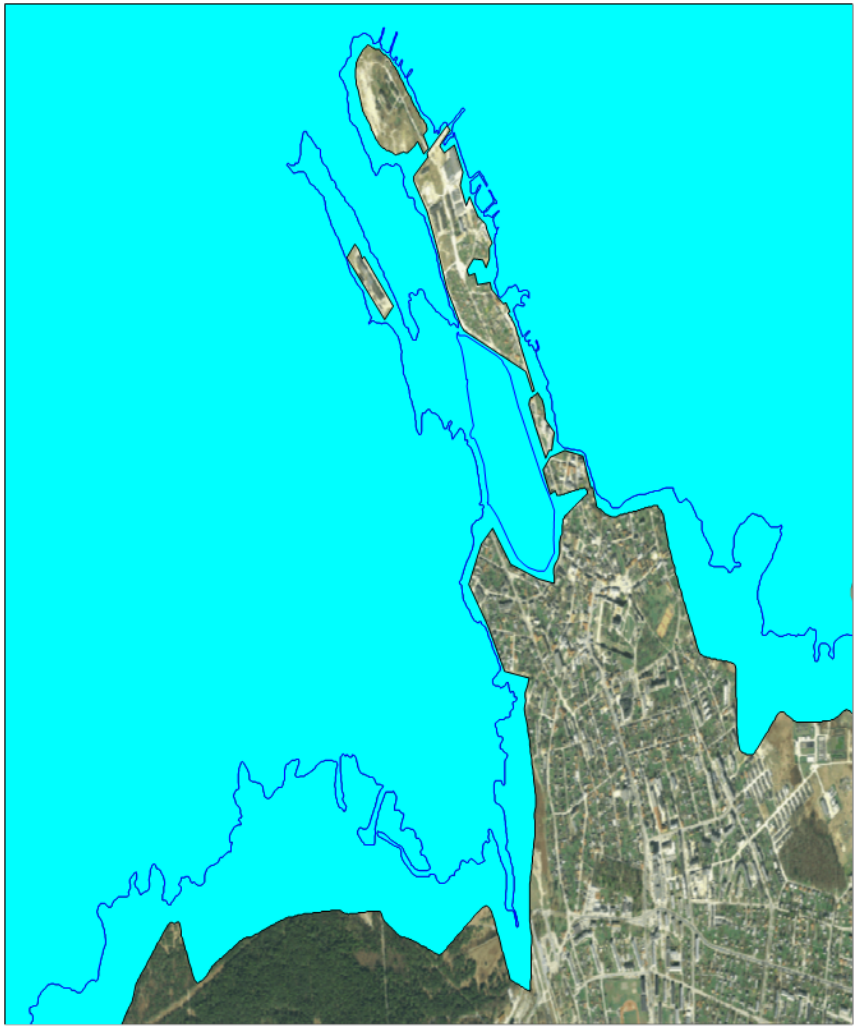
Haapsalu city

+1 m (end of century)



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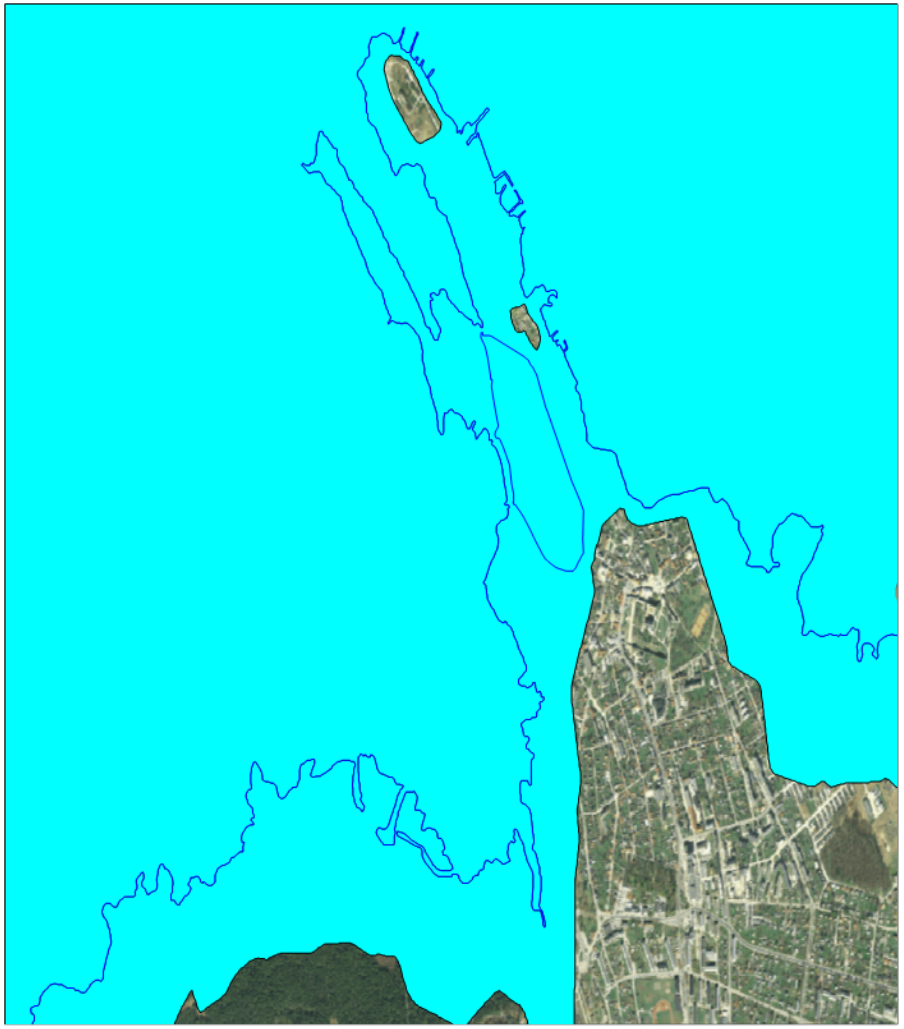
Haapsalu city

+ 2m (year 2200)



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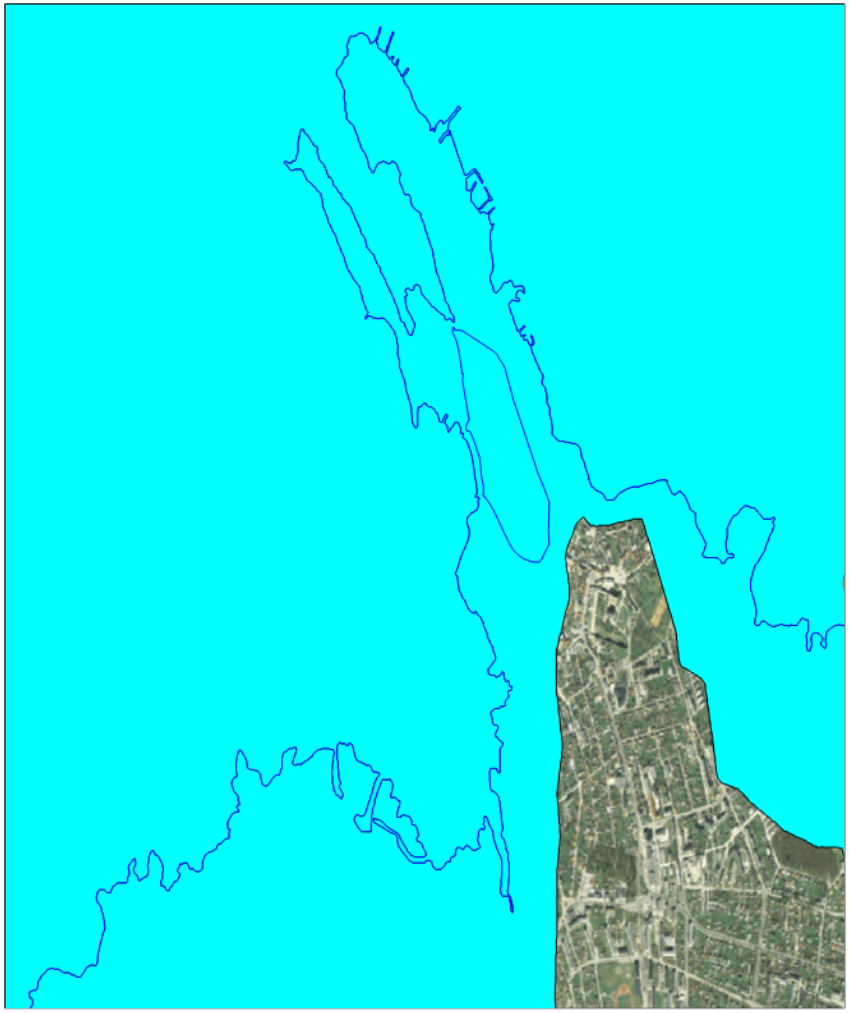
Haapsalu city

+3m (2300)



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Gulf of Matsalu

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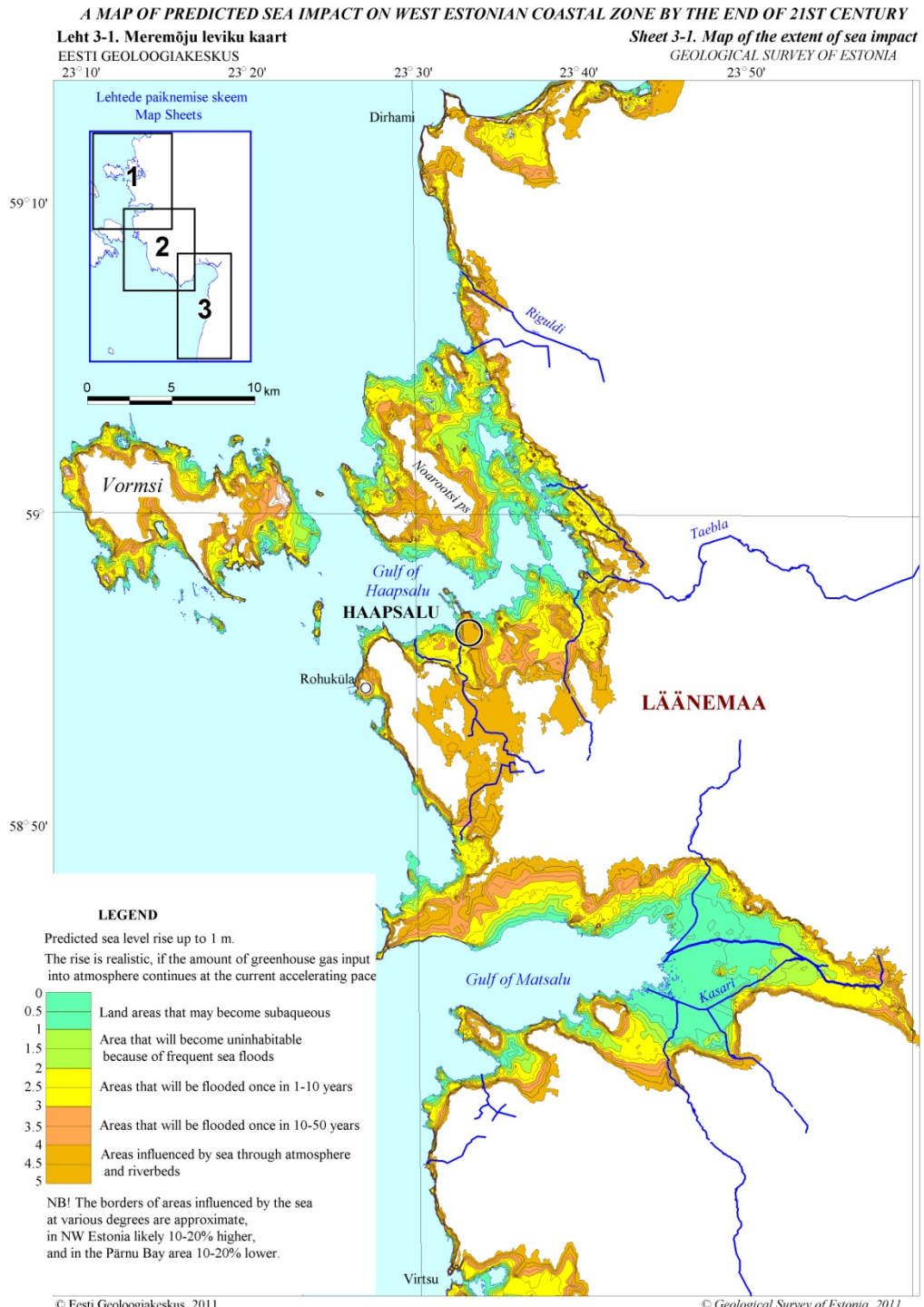

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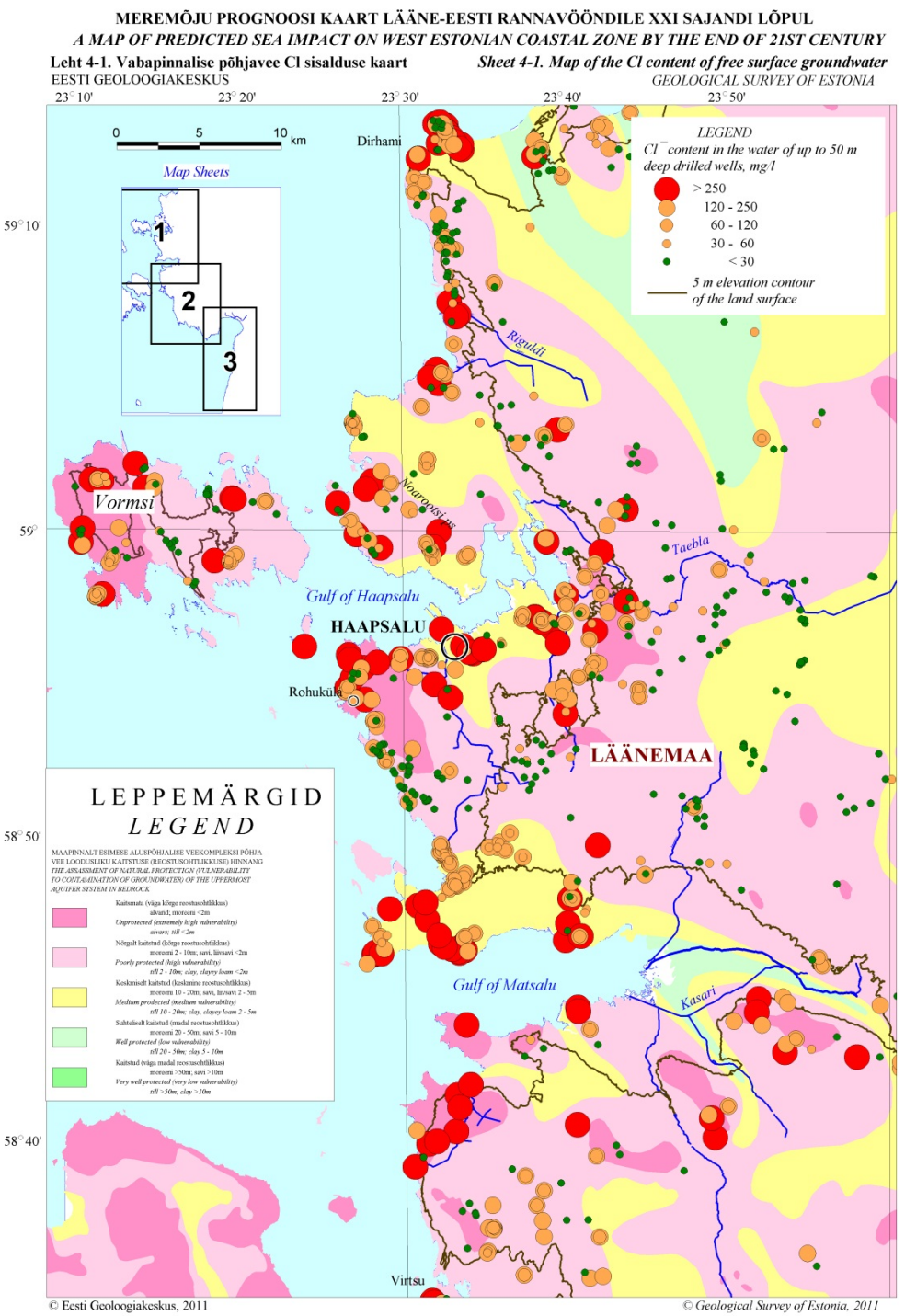
Hydrogeological and hydrological conditions of the coastal zone.

Chlorine (Cl) content:

Red dots = Cl >250 mg/l (above the reccomended EU Directive 1998/83/EC for the drinking water)



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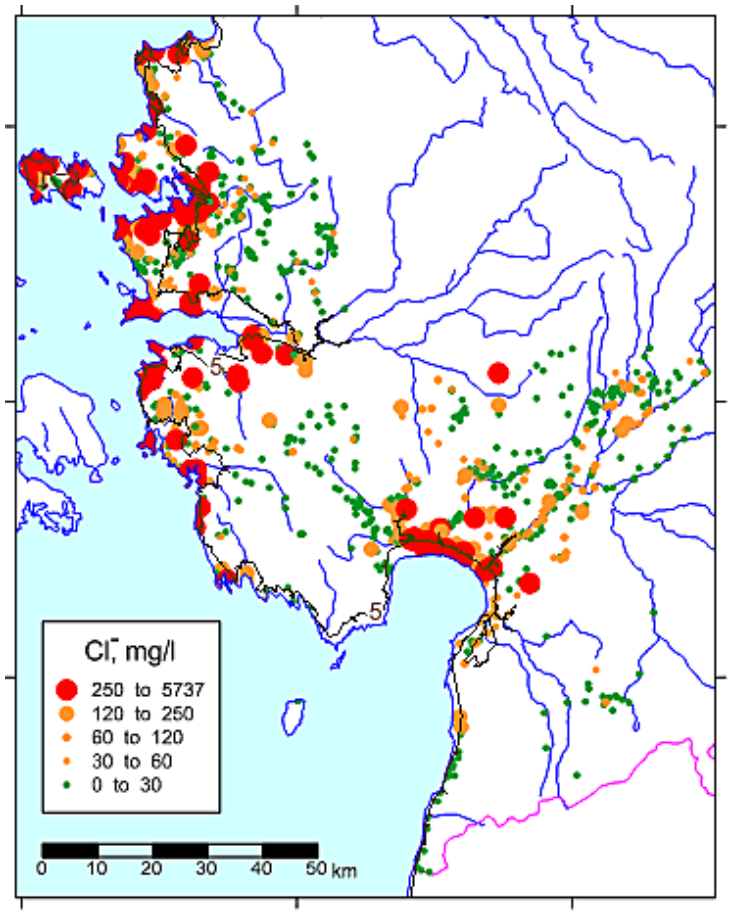
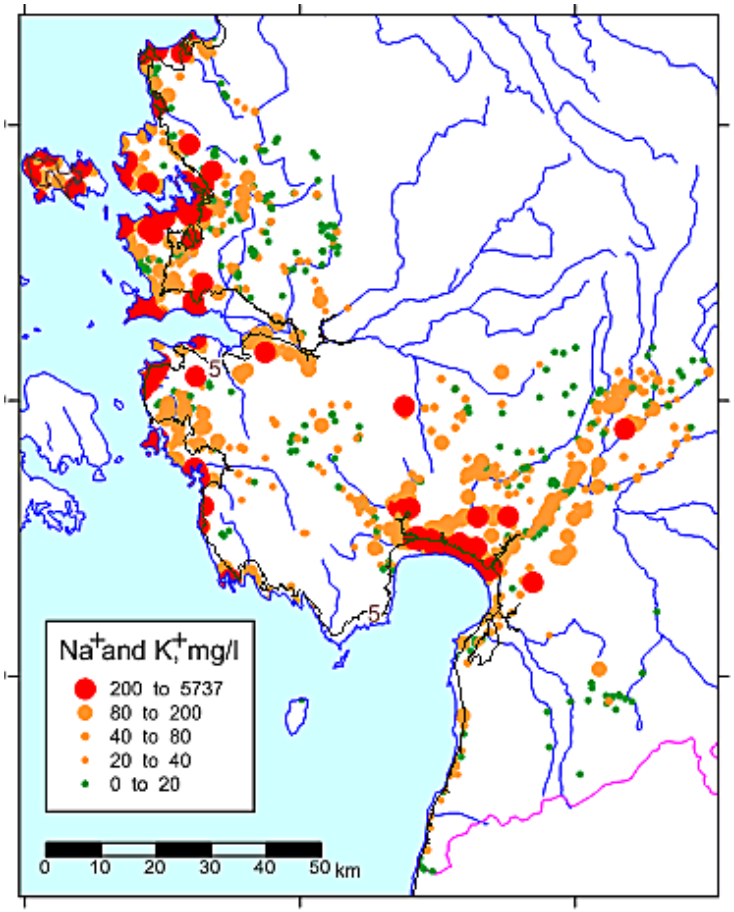
The high Cl content varies mainly between 220 and 500 mg/l and in some cases is up to 2000 mg/l. High contents of Na+K are typically at same levels and correlate very well with the Cl content. The mineralization of the free-surface groundwater layer decreases with the distance from the sea.





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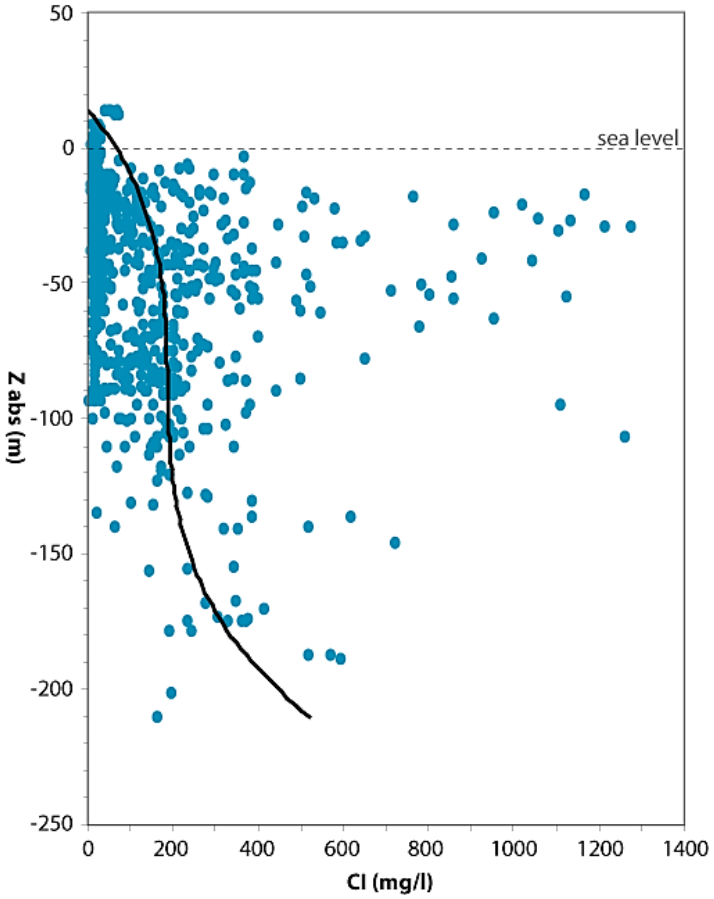
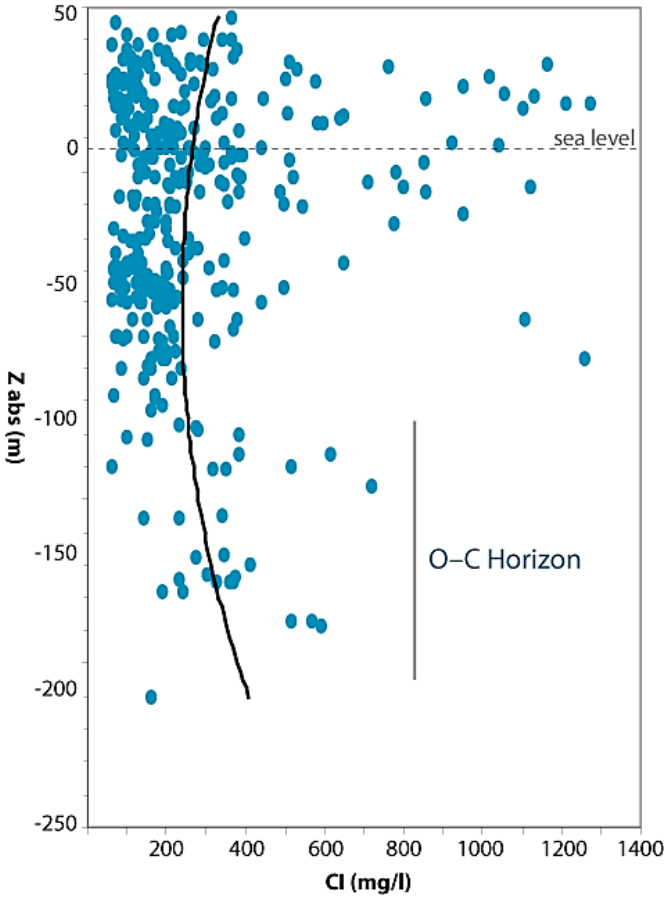
Cl content:

All drill-holes



Drill-holes, where Cl >60 mg/l (above background)



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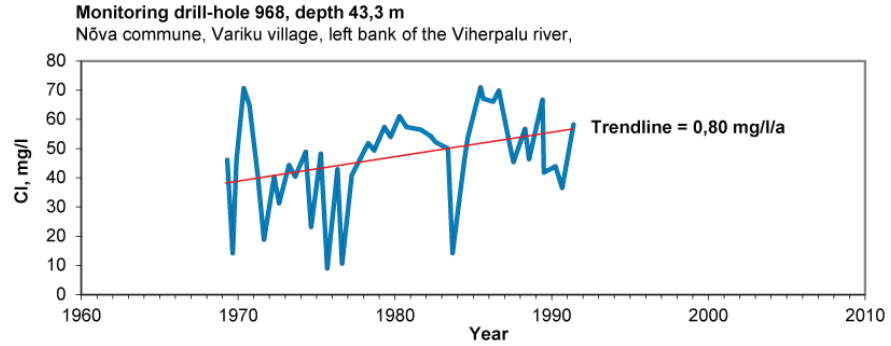
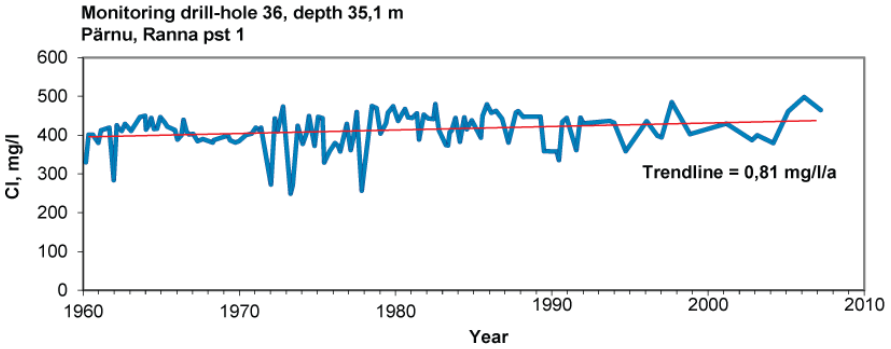
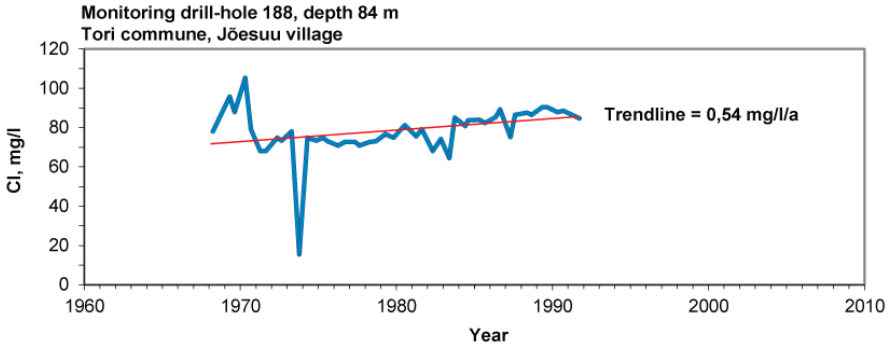
Encrease of the Cl content:







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Interactions (Workshops)

- In the initial phase, specialists of the Ministry of the Environment and the Estonian Ministry of the Interior were informed of the goals of the project, participating states, planned methodology and expected results.
- The scenario workshop in **Läänemaa coverment** and **Haapsalu municipality**
- The scenario workshop in **Vormsi** (island) **commune administration** and workshop with **Environmental Ministry administration**
- The scenario workshop in **Audru commune** administration with county administration

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Interactions (in media)

In newspapers

EestiPäevaleht	V. Petersell - Storms and climate changes
EestiPäevaleht	Estonian coastal areas is in the risk

Paper in journals

Keskonnatehnika	Estonian coastal areas is in the risk

In radio

V. Petersell – About climate change
S. Suuroja – About costal changes

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Outputs

- Haapsalu municipality and Audru and Vormsi commune administration refer to the their council to enforce the official min. elevation limit for main buildings.
- The prescription **is already implemented in Audru** commune.

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Possibilities for mitigation

Estonians cannot prevent the sea level rise along the west coast, but means for minimising the effect can be applied. Based on large extent and long duration of the predicted losses, it is recommended that during the next 20 years:

- until the prediction of sea level rise is elaborated, construction of buildings that are expensive or meant to be in long term use should be halted that are in areas that are less than 3 m a.s.l. in the Pärnu region, and less than 2.5 m in the Haapsalu region, respectively;
- resume monitoring of salt content in the free-surface groundwater in the coastal zone;
- conduct geological and hydrogeological mapping in the scale 1:50 000 in the coastal zone;
- explain to Haapsalu and Pärnu cities of the possibility of minimising the impact of sea level rise by constructing protective dams.
- study the possibility of rising quaies in harbours and take action in it.
- In case of progressing sea level rise, the collected information makes it possible to plan and either conduct or discard means in order to minimise the effect.

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2003 2005 2007



Thank you!

v.petersell@egk.ee

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