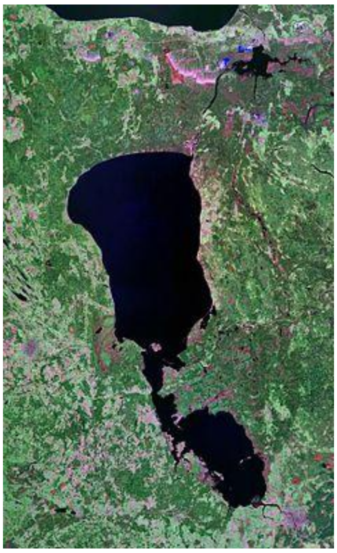
Daily report 10.9.2013 Erasmus IP „Soil & Water“, Estonia

Martina Balzarova – University of South Bohemia, photo: Martina Balzarova (www.balzarova.cz)

Yvonne Mayer – Ulm University

We were leaving the grounds of Tartu University early in the morning.

Our first stop was at **lake Peipsi** in town Mustvee (population around 1,610) in Jogevamaa county. And actually it is one of three parts of Lake Peipus – north L. Peipsi, south L. Pihkva and Lake Lämmijärv is connecting these two previous parts. The total area of the Lake Peipus is 3555 km^2. Mean depth of the lake is 8.3 m. Around 30 rivers and streams are entering the lake, the biggest are Emajõgi and the Velikaya River, the water from the lake is being taken out by River Narva. The lake is located on the border between Estonia and Russia which goes almost in the middle of the lake. According to scientific classification the lake is unstratified eutrophic lake with mesotrophic features. The total annual nutrient load is 15.57 tons N/km^2, 327 kg P/km^2 with more than 70% of N and around 40% of P originating from agriculture. Average pH is 8.14. Because of the shallow depth of the lake it warms up and cools quickly, average temperature in summer is around 25-26°C and the lake is frozen during winter months.



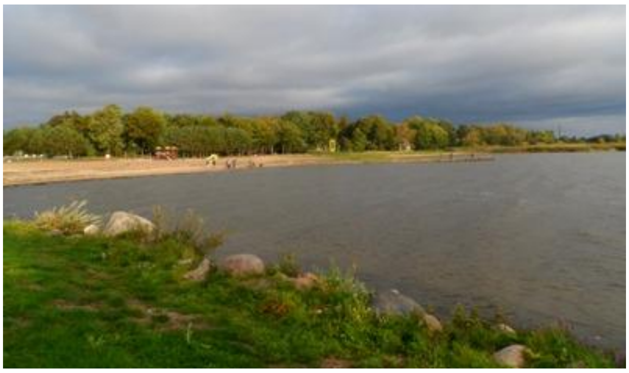
Water balance of Lake Peipus:

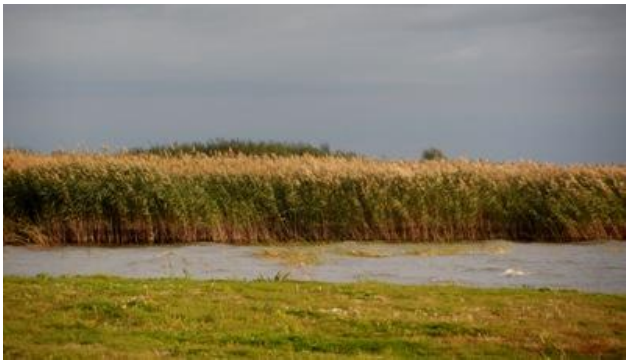
	Water balance	Volume
Inflow	Precipitation	560 mm (1.9 km^3)
	Surface and groundwater	3150 mm (11.2 km^3)
Outflow	Streamflow	3390 mm (12 km^3)
	Evaporation	320 mm (1.1 km^3)

← Satelite image of the lake from Google map

The main use of the lake is industrial and recreational fishing, even in winter time and of course tourism and sport activities. There are 36 species of fish recorded. Most common fish species are berch (*Perca fluviatilis*), bream (*Abramis brama*), pike-perch (genus *Sander*), roach (genus *Rutilus*), European smelt (*Osmerus eperlanus*).

One of the biggest problems of the lake is high rate of pollution that came from Russian site of the lake to the Estonian shoreline. In same seasons there is a problem of high fish mortality due to the pollution and high algae cover (lack of oxygen).





We observed several organisms out of 115 species of vascular plants being recorded in the Lake Peipsi. From plants we were able to see different species of Potamogeon, from family Potamogetonaceae. These freshwater plants can vary in size. Sometimes they are annual but often perennial. They can produce rhizomes which are the common over-wintering form. Some species can produce other specialised overwintering buds, these are called turions which may be borne on the rhizome, on the stem or on stolons from the rhizome. The leaves of this genus are alternate, which is in contrast to closely related genuses and therefore a good identification characteristic. We have seen these species in particular: *P. perfoliatus, P. cristatus, P. natans, P. trichoides, P. pussilus*

Other interesting plants that can be seen here: Ribbon-leaved water-plantain (*Alisma gramineum*), creeping spearwort (*Ranunculus reptans*), needle spikerush (*Eleocharis acicularis*) and common spike-rush (*E. palustris*), waterawlwort (*Subularia aquatica*), eight-stemmed waterwort (*Elatine hydripiper*), spring quillwort (*Isoetes echinospora*), *Sparganium gramineum,* arrowhead (*Sagittaria sagittifolia*), *Cladophora* spp.

Rumex maritimus is annual wetland plant species, 10-70 cm height. Family Polygonacea. →

Invasive plant Canadian Waterweed (*Elodea canadensis*, Kanada vesikatk in Estonian language) was also found on the site. This species is highly invasive thorough Europe. The origin of this water plant is from North America as the name suggest. It came to Europe via Ireland, firstly reported in 1836. After five years it was already found on island of Great Britain. In Estonia the first record of this species are from 1905 and nowadays it is very common. The plant is commonly used as aquarium species. It belongs to family Hydrocharitaceae. It is dioecious, with male and female flowers on different plants. The Canadian waterweed is very fast growing species and can easily overgrow native water plants. It also can cause a problem for water traffic since it can block water canals, slow moving rivers and ponds.

On shoreline we have seen many shells of Zebra mussel (*Dreissena polymorpha*). Zebra mussel is relatively small with maximum size of 3-5 cm. The shell is triangular in shape and is striped (dark and light pattering). But its population can expand really quickly and cause again many problems in boat traffic (for example they can grow on buoys and their weight just pulls the buoy down, or overgrow walls of the canals). It is native to Aral, Black and Caspian sea. In Estonia as in many other European countries it is an invasive species.

Also widely distributed were shells of Lister´s river snail (). There are many *Viviparus* species but only *V. contectus* acute mud snail lives on the bottom of large lakes. Mud snails are herbivores; they eat plants from the lake's floor. This species of snail is moderately pollution sensitive. Although it is widespread local populations can be threatened by extinction due to destruction of habitat (mostly by pollution). It is native to Estonia and can live up to 13 years.

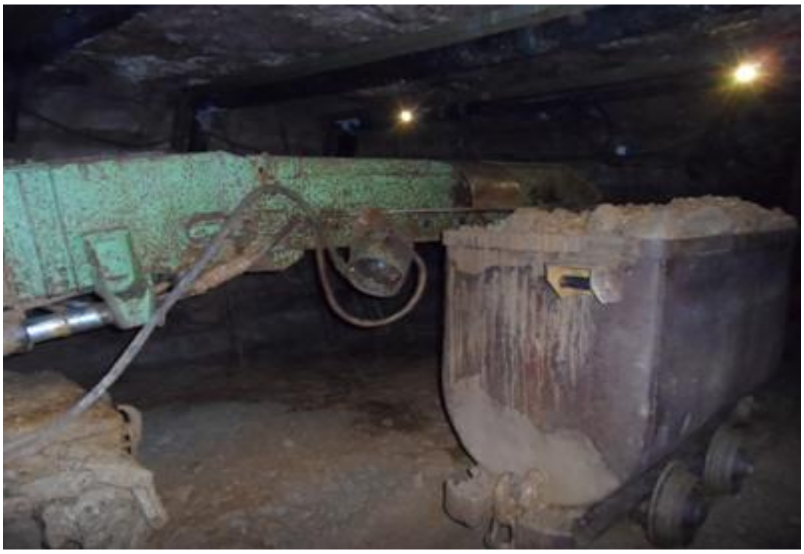
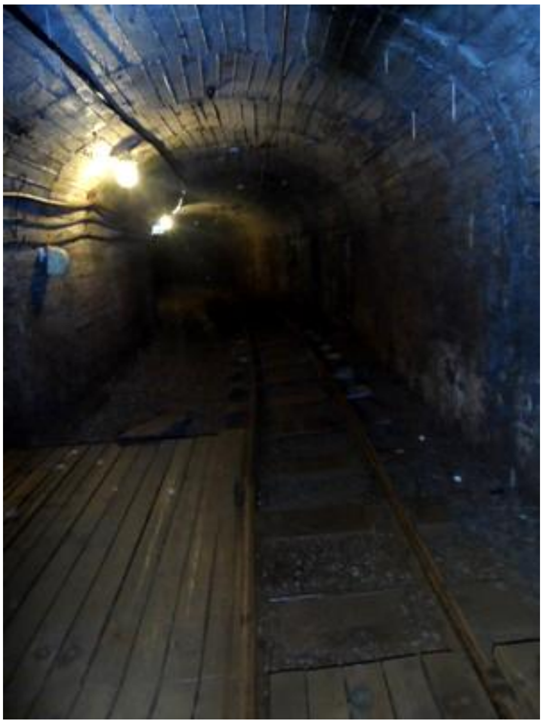
Our second stop was **Kohtla-Nõmme oil shale underground mining museum**

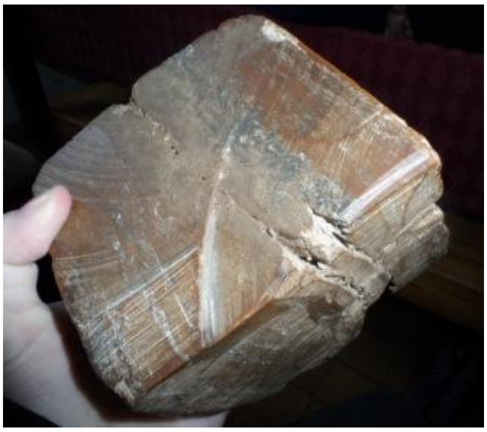
Oil shale is the most important natural resource in Estonia and geologically related to Middle Ordovician. It is used around the globe, for example in USA, Australia and Russia, but it is not as valuable as mineral oil or coal. It can be used to gain electricity and – after several cleaning processes – to produce mineral oil.

The Kohtla-Nõmme oil shale underground mining museum gave us an impression of the miner's daily underground life. The mine is located in north-east Estonia and was opened in 1937 by Englishmen. It was running till 2001, when it was closed mainly due to decreased productivity and less consumption of oil shale. The released oil shale was used to produce electricity. Altogether the mine produced more than 48 million tons of oil shale when it was shut down.

Generally the miners worked until an age of around 40 or 50 and were supposed to have an honorable job, as it was a difficult and dangerous work. However they suffered from several health problems caused by the working conditions in the mine – the heavy machines and the use of explosives to develop new tunnels were connected to huge noise and dust.

When we actually got underground we got a detailed impression of the working conditions in the mine and how they changed with the industrialization. By the time the miners still worked with men-powered drillers. This number increased after the industrialization heavily due to a machine called "mining combine", which made it possible to gain about 300 tons of oil shale per shift. With that numbers in mind it was quite easy to imagine how fast the exploitation of nature in this area took place and what huge impact must have been left.



Aidu oil shale mining area (open land)

Even before our arrival at the underground museum we could spot from the bus the huge changes to the environment due to the mining activity in this area. As some of the chambers collapsed during time, the water level changed which brought serious problems for agriculture. Another eye-catching aspect was the huge men-made hills due to Estonia normally being rather flat. These hills were not being recultivated and reforestated, but as there is still oil shale and limestone left in it, the hills are "burning from the inside" which also causes problems for the environment as the oxygen enters the deposites.

As an example of the mining area and revitalization of these hills, we visited the Aidu oil shale mining area right next to the underground museum. The mining activity caused a problem in terms of disposing the non-usable materials that were dug out of the earth - this is how the he calcareous hills developed in this area. Generally there are some serious problems for plants cultivated the area such as:

- There is no humus layer so there is no nitrogen
- The water intention is very low
- As for the exposition there is very much sunlight (extreme condition)

- There are adverse chemical conditions
- The pH is very low and may even be down to 1

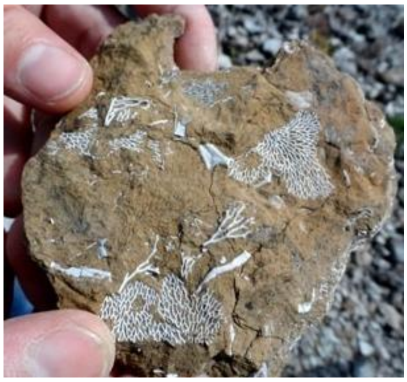
As for the hill we visited, it was easy to spot the process of primary succession and an increase of biodiversity which was due to the limestone contained in the soil. As limestone is the biggest store of organic carbon found in nature.

We discovered next that Cambium fossils can be found all over this artificial hills. In Cambium about 550 Mio. years ago a huge explosion of biodiversity took place in shallow waters, which is the explanation why you can find marine life in several layers of the soil. The fossils are generally formed by calcite minerals which enrich in buried organisms and slowly fill them with calcium carbonate. As for other properties of this soil, we found sediments of a more brownish colour that indicate clay sediments within the calcareous material. There are also different soil building processes which favour the vegetation growth, too. And as the fossilized organisms were rich in nutrients and then turned into stone without oxygen there is a high biological productivity in the soil.

After a short inventory of the fossilized organisms' variety we discovered that oldest ones we found were corals (*Cnidarians*) of two different types: *Hexacoralia* which are the main reef builders and *Octacoralia*. They were followed in evolution by *Polychaetes* and Sponges, of which we also found lots of fossilized individuals, especially Silica Sponges. We also got hold of lots of shells, barnacles and sea urchins and members of Scaphopoda class (*Dentalium vulgare*, Elefantenzahn in german) which represent the highest evolved organisms we found on this calcareous hill. As typical representatives of the cambium age, we found also lots of fossilized trilobites.

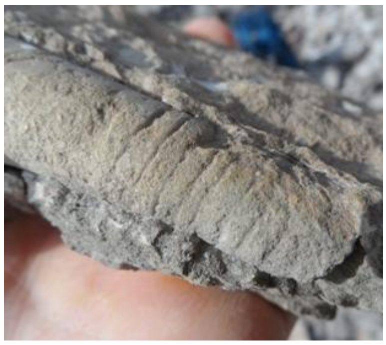
Scaphopoda ←

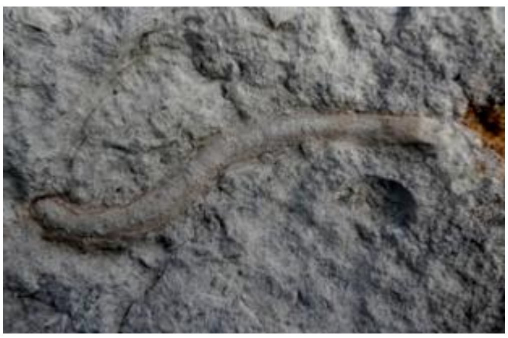
Bryozoa →



Trilobite ←

Part of belemnite →



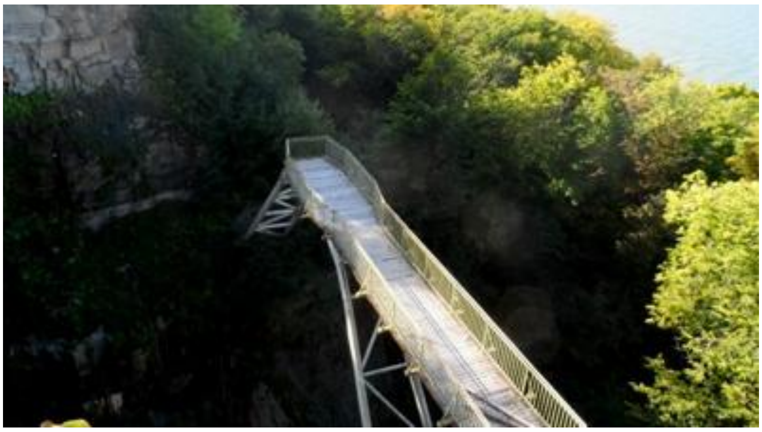


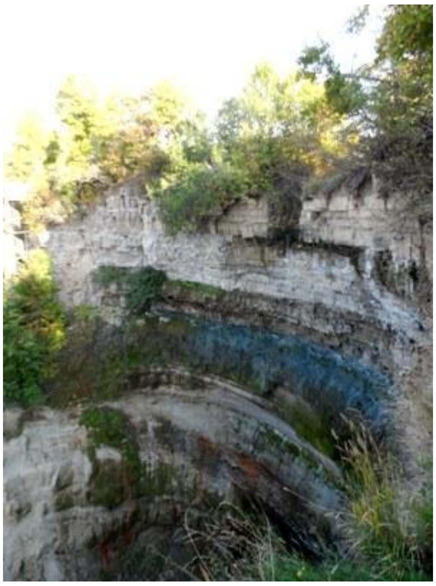
Polychaete worm ←

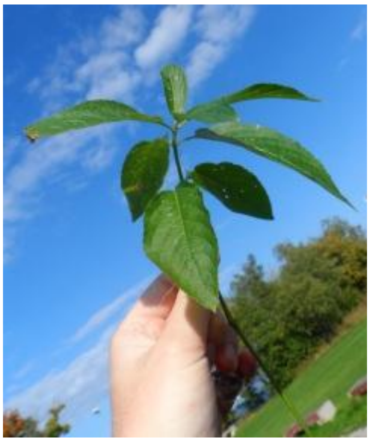
fossil sponge →

Waterfall Valaste in Ontika landscape reserve. The Watarefall is not natural it is manmade drainage. The recorded height of the artificial waterfall is 30 m. You can clearly see that it is artificial because the corridor by which the water come has sharp edges and the limestone is not smoothed by water erosion. Here we could see closed pathway with bridge build in front of the waterfall. This structure was build illegally and was closed because of this issue. The structure is also not very nice and destroys the otherwise beautiful scenic view. In future there is a possibility that it will be demolished. On the cliff we can easily see cross section of different layers: 1) Limestone (white), 2) Glaukonit (blue-green colour), 3) Argilit (dark colour), 4) Obulus sandstone layer which is rich in phosphorus and also contain shells, 5) sandstone, 6) Siltstone and 7) Clay.

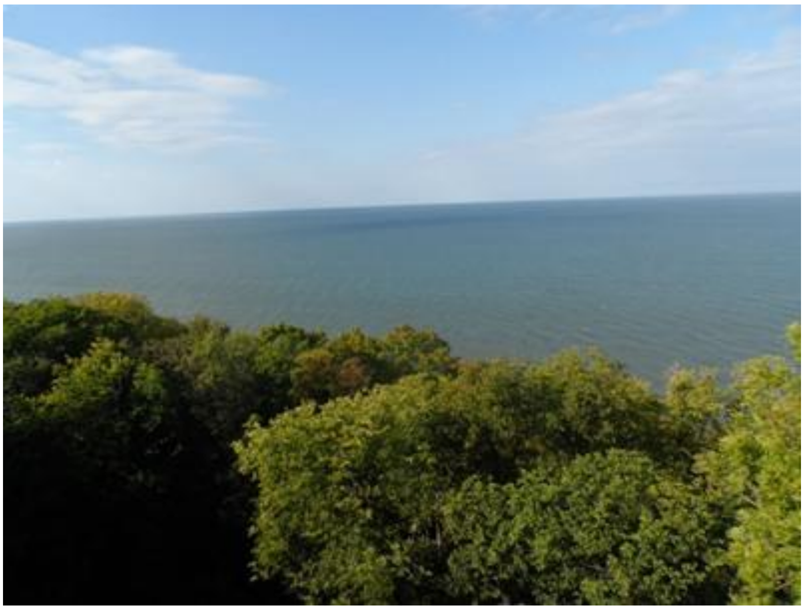
The clay was blue in colour and it is the finest clay in Estonia.





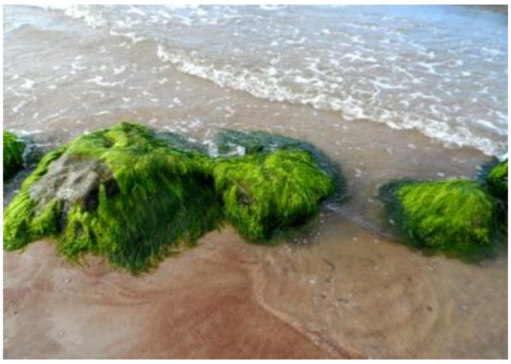


The plant cover was very dense, with high trees suggesting presence of rich soil. In upper layer there is leptosols and in deeper layers regosols. Also there is warm area – protection of strong inland winds and warm coming from nearby sea. And plant was especially pointed out - dog's mercury (*Mercurialis perennis*). It is member of family Euphorbiaceae, herbaceous plants often poisonous. Dog's mercury favours alkaline (basic) soils and can be found in abundance in suitable habitats especially in limestone regions.



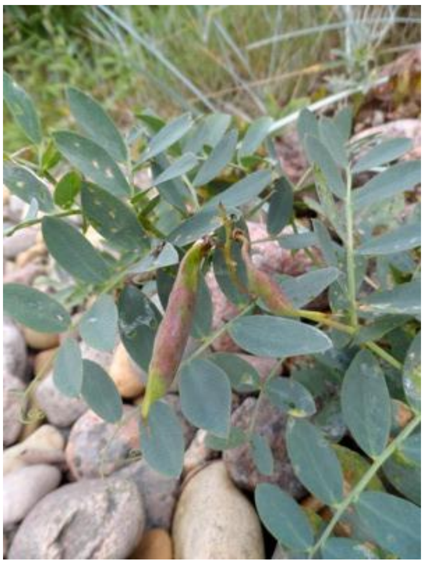
We than continued our trip to nearby **sea side area** to closely observe this ecosystem. On the sandy coastline there were many big stones that were brought here by glaciers. These stones are called erratic boulders.

In sea we could observe different algae – *Dictyota dichotoma*, members of rhodophyta group, green algae *Enteromorpha* (nutrient indicator algae) that was covering stones.



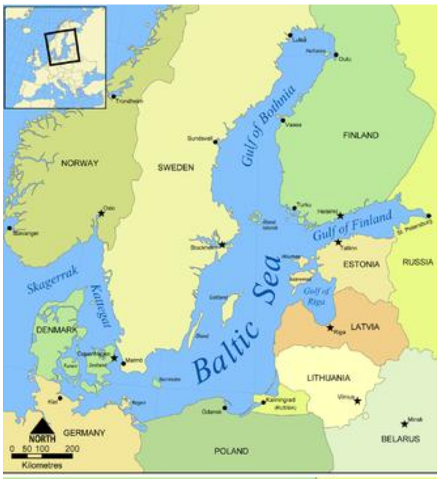
From animals we have seen different remains of mollusca and crustacea group, mostly their shells but also several living crabs running on the sand. Some barnacles were attached to stones in the sea. We also observed few sea birds especially sea gulls.

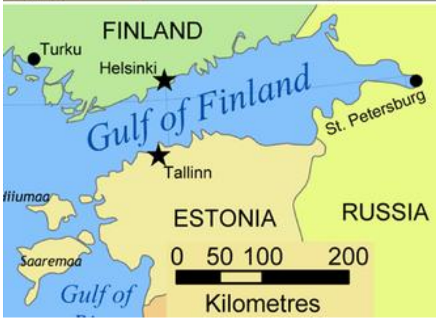
Plant covers near the sea consisted of plants able to tolerate high salinity and also are able to attach to sandy soil. Further from the beach where there is more soil the composition of plant cover changed and there was mostly *Phragmites australis*. We also have seen *Calammophila baltica* which is a hybrid between *Ammophila arenaria* and *Calamagrostis epigejos* that both have been also present on the site.



Lathyrus maritimus or in English called Beach Pea is a circumboreal species and can be found along the Pacific coast of North America and throughout parts of Asia and Europe. Fruit is a smooth flat pod.

Sea sandwort (Honckenya peploides) is the only species in the genus Honckenya of the flowering plant family Caryophyllaceae It can be also spelled *Honkenya.* The plant is a succulent perennial growing at the edge of the sea.





The Baltic sea is highly eutrophicated due to pollution. We were in a north- east part of Estonia on the coast of Gulf of Finland which is 400 km long and the maximum width is 130 km. The average depth is around 40 m and the max. depth recorded 115 m. There is large influx of freshwater from several rivers and therefore the salinity is low - between 0.2 and 5.8 ‰ at the surface and 0.3–8.5 ‰ near the bottom. The Neva River (from East) brings 2/3 of all freshwater. The average water temperature is close to 0 °C in winter; during summer it is around 15–17 °C at the surface and 2–3 °C at the bottom of the sea. The gulf is usually frozen from late November to late April.

← Map of Baltic Sea and Gulf of Finland from Wikipedia

In the Gulf of Findland there is significant contamination by ions of mercury and copper, organochlorine pesticides, phenols, petroleum products and polycyclic aromatic hydrocarbons.

Kiviõli ash hill

The Kiviõli ash hill is another example of the large footprint the mining activity in Estonia leaves to nature. The ash hill consist of dark material - the origin of which is burned oil shale and containing limestone – and a bit sandy matter on it. This ash is taken from a nearby powerplant that can be seen from the top of the ash hill. A recent experiment of Tartu University showed that the ash after some years bears no danger to the environment any more due to decomposition. The ash hill is today used for extreme sport and a lookout, as you can see far distances due to the ash hill being very high and Estonia's landscape rather flat. We also noticed some windmills producing energy nearby, but were explained that there aren't many of them in Estonia because their energy is not very lucrative compared to mineral fuels. As for the plants on the ash hill, the area was rather meager, but we did find sea buckthorn (*Hippophae rhamnoides*) and *Sylago*.

Our last stop was in **Moedaku** sport center where we had dinner and spend our night. In the evening we played Disco-Golf on local field, relaxed, talked and later we had a sauna and some singing as well.