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Du glint baltique au lac Peïpous

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Briefly about Estonia

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Abstract

In the paper basic information (location and topography, geology, mineral and biological resources, soil cover, nature protection) about Estonia is presented. Most information is based on the material of textbooks, newest information is added from Information materials of the Ministry of Environment and internet.

Key words

Estonia, Baltic Sea, mineral resources, kukersite oil shale.

Night landscape of Kuresoo Bog in Soomaa National Park(cliché : Martin Koitmäe, 2009, wikimedia commons, CC BY-SA 4.0).

Location and topography

The Republic of Estonia, the northernmost of the three Baltic States, is located in the North-East of Europe, on the coast of the Baltic Sea (figure 1). The name Estonia is probably derived from *Aists*, the name the ancient Germans used to denote the Baltic tribes, living to the northeast of the Vistula River. The territory of Estonia in nowadays boundaries extends from 57°30'34" to 59°49'12"N and from 21°45'49" to 28°12'44"E. The extreme length of the Estonian territory is 350 km from west to east, and 240 km from north to south. The length of Estonian coastline is 3780 km, of

this 1242 km are on the mainland and 2540 km are divided among the islands

Figure 1. Location of Estonia. Map compiled by M. Vainu (p. 36).

Estonia on the base of newest measurements has an area of 45 339 sq km of which 9.2% is taken up by islands and 4.6% is under inland bodies of water. Estonia has 2222 sea islands and together with inland water bodies 2355 islands. The biggest ones are Saaremaa (2673 sq. km) and Hiiumaa (989 sq. km). Climatically Estonia belongs to the mixed-forest subregion of the Atlantic continental region of the

temperate zone, which is characterized by warm summers and moderately mild winters. Mean annual temperature is 4.7°C; in February -6.6°C, in July +16.3°C, mean annual precipitation is 500 to 700 mm.

As part of the vast East-European Plain, Estonia is a generally flat country, where uplands and plateau-like areas alternate with lowlands, depressions and large valley-like forms. The average height above sea level is approximately 50 m, relative heights of landforms do not as a rule exceed 20 m, being only seldom over 50 meters (Figure 2). About 40% of Estonia's territory is at an absolute height of 50 to 100 m, and only one tenth has an elevation over 100 m above the sea level. The highest point in Estonia and in the Baltic States, the Suur Munamägi Hill (nearly 318 m), is located in the Haanja Heights in SE Estonia (figure 2).

Figure 2. Topography of Estonia. Map compiled by M. Vainu (p. 37).

The Geology

Geologically Estonia is located in the northwestern part of the East-European Platform. Structurally, it lies for the most part within the boundaries of the southern slope of the Fennoscandian Shield. The geological sequence is rather simple (Raukas, Teedumäe, eds., 1997). The lowest part is formed by crystalline basement rocks which do not crop out anywhere in Estonia. In northernmost part of the country the crystalline basement lies at the depth of some 60-70 m below ground surface but on Ruhnu Island in the Gulf of Riga at 784,1 m. In average the surface of the basement is inclined southwards 2-4 m/km. Estonian basement rocks (mainly amphibolites, gneisses, migmatites, quartzites) are formed ca 1.8-1.6 billion years ago

The igneous and metamorphic rocks of the crystalline basement are covered by Ediacaran (Vendian) sandstones and clays and Palaeozoic (Cambrian, Ordovician,

Silurian and Devonian) rocks 200-780 m in thickness. Cambrian rocks in North Estonia are represented by sand-, silt- and claystones, Ordovician and Silurian rocks in Northern and Central Estonia are carbonate rocks (limestones, dolostones, domerites and marls) and Devonian rocks in South Estonia mainly sand- and siltstones.

The Quaternary deposits are of uneven distribution. In North Estonia, on the Ordovician and Silurian carbonate rocks the thickness of the Quaternary cover is usually less than 5 meters. Occasionally, on alvars, it is virtually absent. The Quaternary cover is at thickest in the Haanja and Otepää heights (often more than 100 m) and in the South-Estonian buried valleys (up to 207 m).

About 95 per cent of the Pleistocene cover is formed of glacial and aquaglacal deposits. Glacial sediments, 70 per cent by volume and 47.7 per cent by surface area, dominate (Raukas, 1978). Five till beds, often of great thickness, are to be noticed more or less distinctly. Only in a few cases they are separated from one another by deposits containing spores and pollen of interglacial or interstadial origin which considerably aggravates the correlation and dating of the glacial strata.

Mineral resources

Estonia is rather rich in mineral resources (Raukas, Teedumäe, eds., 1997) Here are located the largest phosphorite deposits in Europe, all together about 11,8 billion tons. Estonian phosphorites, the so called Obolus phosphorites, are the near-shore accumulations of shells and detritus of lingulate brachiopods (10-90%, average 35%) in quartzitic sandstone. They are easy to concentrate by floating. The biggest Rakvere deposit (on 14 048,6 ha) can cover ca 1-2% of the total P2O5 supply in the world.

The kukersite oil shale is at present the most important mineral resource in Estonia (figure 3). Of the total mining volume up

to 20 million tons per year some 80% is used in electric power plants and 20% in chemical industry for the producing shale oil. The volume of commercial quality kukersite reserves, currently excavated from the Estonian deposit, are estimated at 4.7 billion tons. Superficially investigated Tapa deposit account for additional 2.6 billion tons. At the present rate of output and relevant losses, kukersite reserves are likely to be exhausted in the next hundred years.

Figure 3. Oil shale mining. Photo A. Raukas (p. 38).

Graptolite argillite is an alum shale, dark brown to brownish black color, low in calorific value (6.1-6,7 MJ/kg) and organic matter (up to 18%) The reserves of argillite are some 67 billion tons. The rock contains about 20 valuable elements: U (up to 850 g/t), V (up to 1050 g/t), Mo (up to 450 g/t), Ni (up to 260 g/t), Th, Pb, Zn, Cu, Cr, Co, Y, Cd, Sr a.o. The argillite in Soviet time has been used for producing of uranium near Sillamäe Town..

Estonia has big peat resources. Peatlands occupy 10 091 sq. km or 22.3% of the territory of Estonia. The area of commercially important deposits is 539 000 ha with peat resources of 2.37 Gt (Orru, 1992). The maximum thickness of peat layer measured in Estonia is 16.7 m. Peat is produced as sod and block milled peat and as briquettes. Peat is used mainly for energy generation and horticulture, the allowed peat production is 2850 thousand tons per year. A big part of production goes to export.

In Estonia there are more than 900 gravel and sand deposits. Clays occurring in Cambrian, Devonian and Quaternary deposits are mostly easily fusible, and their resources are practically unlimited. They are used mainly as a raw material for ceramics industry and for producing cement. .

Limestone is used as a raw material in producing lime, cement and building stone and glass; it has applications also in chemical,

pulp and paper industries. Dolomite is used for glass and facing stones. Approved reserves are big.

Curative mud has been used in health resorts since the beginning of the XIXth century. Known are sea (Haapsalu, Käina) and lake muds. The resources are big (Ramst, 1992). The largest deposits of curative lake mud are situated in Peipsi lake at Värskä (45 million tons, annual output 600-800 cubic meters). Lake mud can be used not only for medical purposes, but also as fertilizer, fodder for livestock, fuel etc.

Another mineral resources of local importance are as follows: lake chalk (utilized as an additive to concentrated fodder, as a neutralizing agent of increased acidity in silage and crayon), pyrite, ochre, glauconite and diatomite. Near Jõhvi in basement is known rather big iron ore deposit (about billion tons), but its perspectives, as well as polymetals (Pb, Zn) in basement and bedrock are not clear yet.

Soil cover

In Estonia are identified 13 soil taxa. Automorphic soils (Leptosols, Cambisols, Luvisols, Planosols, Podzoluvisols, Podzols, Arenosols) with their gleyic subtypes and eroded kinds occupy 42.0%, different Gleysols make up 32,5%, and Histosols (mires and bogs) comprise 23.2% of the Republic's territory. Fluvisols (alluvial and saline littoral soils) form 2.1% and Technogenic formations on reclaimed land constitute 0.2%. Sandy soils make up 26.7%, peaty ones – 23.2%, whereas loamy sands, loams and clays occupy 17.0, 27.8 and 4.8%, respectively (Reintam, 1996). Pandivere Upland has 60% of Estonia's best soils – Cambisols and Luvisols (Arold, 2005).

Biological Resources

Forests

Estonia belongs to the temperate hardwood coniferous forest zone. There are ten main forest types which are categorized by E. Lõhmus. The most important types include

dry pine forests on sandy soils, temperate spruce forests, hardwood-spruce mixed forests, transitional swampy forests, dry heath pine forests, bog pine forests, fen birch forests, swampy black alder forests, river bank forests and alvar forests. 87 native and more than 500 introduced tree and bush species are recorded in the dendroflora of Estonia. The main tree species in forests are: pine (41%), birch (28%), spruce (23%), speckled alder (4%), aspen (2%), black alder (1%) and broad-leaved trees, including oak, ash, linden and elm (1%). In Estonia the woodlands cover 2,3 mill. ha, which is roughly half (51,4 % in 2018) of the total land area. The average age of stands is a bit more than 50 years. Until 1995, the majority of forests belonged to the state. After the current land reform, 40-50% of forests are in private ownership. The area of woodland has constantly increased and it is considered sufficient from the aspect of both environmental protection and timber production. In respect of woodland area and the reserve of standing forests per capita, Estonia ranks fourth and third in Europe, respectively. The annual growth in 2017 was 16.1 and cut about 11 mill. cubic meters and most experts agree that it is possible to increase the volume of felling significantly without causing any damage to the forest resource. Estonian forests are important in hunting, recreation and using different byproducts (berries and mushrooms). The export of wood, paper and paper products forms 18% of Estonia's total export and 29% of energy produced in Estonia comes from wood (Reinberg, 2018).

Game animals

There are 18 species of game animals in Estonia: the moose, the wild boar and the roe deer being of the highest commercial interest (Ratas, Raukas, 1997). As a result of reasonable hunting policy and moderate forest management, Estonia has rich population of animals, strictly protected elsewhere in Europe. These species, like the wolf, the lynx and the brown bear have been included in the list of game animals. Hunting, including international hunting, is significant economic sector in Estonia.

Flora and Fauna

Estonia is traversed by an important European biogeographical borderline. Of the 251 species of higher plants having the habitat boundary within Estonia, 71 species have reached the northern, 50 species the eastern, 32 species the southeastern, 9 species the southern, 14 species the southwestern, 16 species the western, and 59 species the northwestern distribution limit (Ratas, Raukas, 1997). Zoogeographically, Estonia is a transitional region between the western and eastern Palaearctic zones, with a small majority of western Palaearctic species (Kull, 1999). Results of botanical and zoological research have demonstrated a very rich composition of a number of floristic and faunistic groups in Estonia but the probable number of species is much higher. Thus, in the composition of Estonian flora, the approximate number of fungi is 6000 (identified 3461) algae and cyanobacteria 3000 (2500), lichens 850 (786), bryophytes 600 /507). Among the macrogroups of animals in the fauna of Estonia, the approximate number of invertebrates is 270 000 and the number of identified species only 11 597.

There are 64 species of mammals, 11 species of amphibians and 5 species of reptiles recorded in Estonia. On the 332 bird species 222 are breeding in Estonia (206 regularly). In addition to those, dozens of species have been recorded as passage migrants and/or winter visitors. 5 species of mammals have been introduced: the raccoon dog, the American mink, the muskrat, the red deer, the sikka deer. Some years ago appeared jackal. 29 species of mammals are protected. The rarest and most endangered of them are the European mink, the flying squirrel and the gleridans.

Fish stock

For centuries, coastal and inland fishery has been one of the most important branches of economy in Estonia. Today, the total catch in Estonia is approximately 45 000- 50 000 tons. Fish resources in the coastal and inland

waters are sufficient for the local market and export and are regulated at the international level since signing the Convention of Living Resources in the Baltic Sea and Belts in 1973. The main commercial fish species in the sea include Baltic herring, Baltic sprat, Baltic cod and Baltic salmon, the total stock of which in waters under Estonian jurisdiction is estimated at about half of million tons. The inland water bodies supplied less than 5% of the total fish catch. The biggest share gives Lake Peipsi. The spawning grounds of salmon have preserved only in some rivers. Estonia is participating also in open sea (Atlantic) catch.

Water resources

Owing to abundant precipitation – 500–700 mm per year, and slight run-off, Estonia is rich in lakes and wetlands. There are some 16 500 mires larger than one hectare in area, of which 132 are larger than 1000 ha. The largest mires are Puhatu (468 sq km), Lihula-Lavassare (383 sq km) and Sangla 8342 sq km).

There are over 7000 rivers, brooks and canals in Estonia. 90 per cent of the rivers are short, up to 10 km and only 15 over 50 km in length. The longest are Võhandu (166 km) and Pärnu (144 km). Only three rivers have an average runoff exceeding 50 m³/s at the river mouth: Narva (connecting Lake Peipsi and the Gulf of Finland) – 399 m³/s, Emajõgi (connecting Lake Võrtsjärv and Lake Peipsi) – 72 m³/s, and Pärnu – 64 m³/s. Construction of dams at rivers dates back to the XIIIth century. However, larger-scale river reclamation activities have only been carried out since the XIXth century in order to improve water regime in agricultural areas. As a result of intensive reclamation in post-war years the natural regime of rivers has been thoroughly changed in places. For example, the estimated length of artificial canals and dredged parts of rivers and streams account for 77% of the total length of the flowing water-bodies within the catchment area of the Kasari River.

In Estonia are thousands lakes, the largest Lake Peipsi (3555 sq km) is shared with Russia

and Lake Võrtsjärv (270 sq km) is in central Estonia. The deepest is Rõuge Suurjärv (38 m). The lakes vary to a high extent, having a rich fauna and flora which contain a number of rare species normally typical to arcto-alpine, atlantic and other regions. Large-scale drainage performed in recent decades, have brought about considerable lowering of the water level in several lakes, for example in Kurtina area. In Estonia are over 1560 natural lakes and a lot of water reservoirs, being constructed for regulating water flow. According to results of the typological analysis, most of the natural lakes are dyseutrophic (36.6%) or eutrophic (36.4%). The former type represents the final stage of lake development in our climate zone, while the latter together with alkalitrophic and dystrophic lakes represents the intermediate stage. A number of lakes are damaged via eutrophication processes.

Groundwater

Groundwater suitable for drinking is one of the most important natural resource of Estonia. In rural settlements and most of the towns groundwater is the main source of water supply. Only in Tallinn and Narva treated surface water gives a considerable share of consumption. Estonian water resources cover all needs of people and industry. In northern Estonia the groundwater has remarkable radioactivity, in oil shale basin is detected with phenols and other hazardous compounds. In several places is mentioned nitrate pollution of the upper groundwater layers caused by agricultural runoff of fertilizers and carelessness at management of stores.

Mineral waters were discovered in Estonia comparatively recently. The first finds date from 1958 when water with a high level of mineralization (21.7 g/l) was found in rocks of crystalline basement at Pärnu. Soon another 5 deposits (Kärdla, Kuressaare, Häädemeeste, Ikla, Värska) were discovered with total reserves 4700 m³ per day. Estonian mineral waters are chloric calcic-sodium or sulphatic-sodium, the mineralization and balneological properties differ. The most

highly appreciated mineral waters are Värskä, where four different water complexes have been developed. Mineral water has been produced in Estonia since 1968. In addition to the above-mentioned mineral water deposits several others have been discovered and they should offer opportunities for great choice of use as table water, therapeutic drinking water to cure various internal diseases, as well as for curative bath.

Landscapes

North-Estonia consists of an extensive limestone plateau, the northern edge of which forms a steep escarpment, known as the North-Estonian Klint (relative height up to 56 m). The narrow Fore-Klint Coastal Plain is situated in front of the klint. The highest areas in the northern part of Estonia are the Pandivere (166 m a.s.l.) and Jõhvi (81 m a.s.l.) uplands. To the south of the Pandivere Upland lies the gently sloping Vooremaa watershed (the Saadjärv Drumlin Field, with the elevations up to 144 m a.s.l.).

In western Estonia the absolute height seldom exceeds 20 m and large areas are entirely flat. This is the region of the lowlands of West Estonia and Moonsund Archipelago (figure 2). Some small elevations are Kõpu (63 m a.s.l.), Middle-Saaremaa (54 m), Sõrve (36,6 m) and Tõstamaa-Varbla (44 m); the scarps of the islands Saaremaa and Muhu (200 sq. km) and those in the western part of the mainland form the West-Estonian Klint (up to 21 m a.s.l.).

In South Estonia the topography is more varied and differences in the altitude are greater than elsewhere in Estonia. The area has four topographic highs: Sakala (up to 146 m a.s.l.), Otepää (217 m), Karula 137 m) and Haanja (318 m) (figure 4). They are separated from one another by the Valga and Hargla depressions and Võru Valley. The South-Estonian medium-height terrain (Ugandi Plateau, 40-100 m a.s.l.) is occupied by the South-West Estonian Plain.

Figure 4. View to the Haanja Heights from the tower Munamäe. Photo M. Vainu (p. 43).

Main features of the Estonian landscape were formed in Pre-Quaternary time as a result of the long-term continental erosion. Later on the biggest importance had glacial processes. The development of modern landscapes began after the retreat of continental ice sheet, glacial meltwaters and the sea, that once covered nearly 2/3 of the territory. The Earth's crust that was released from the weight of the ice cover, started to rise, especially rapidly in North-West Estonia. As time went by, the initial fast land uplift (more than 10 mm/y) slowed down, currently being near Tallinn about 2 mm/y. There are many islands and peninsulas that have emerged and are emerging from the sea.

Arold (2005) distinguished in Estonia 25 landscape regions with different size and structure (figure 2): Haanja Height (816 km²), Otepää Height (1247 km²) (figure 5), Karula Height (275 km²), Vooremaa (977 km²), Pandivere Upland (2415 km²), Sakala Upland (2792 km²), Valga Depression (760 km²), Võru-Hargla Depression (985 km²), Harju Plateau (3948 km²), Viru Plateau (1727 km²), Middle Estonian Plateau (1488 km²), Ugandi Plateau (3124 km²), Palumaa Plateau (827 km²), Irboska Plateau (73 km²), The Gulf of Finland Coastal Lowland (1003 km²), West-Estonian Lowland (6035 km²), The Gulf of Livonia Coastal Lowland (872 km²), Saaremaa (2914 km²), Hiiumaa (1122 km²), Alutaguse Lowland (3345 km²), Peipsi Lowland (807 km²), Võrtsjärve Lowland (147 km²), Kõrvemaa (3130 km²), Soomaa (1545 km²) and Metsapole Lowland (258 km²).

Figure 5. View to the Otepää Heights from the tower Harimäe. Photo M. Vainu (p. 44).

Nature protection activities

Estonian environment is unique in several aspects. Within Estonia proceed the areal

boundaries of several plant (figure 6) and animal species. The islets of the West-Estonian archipelago furnish a wonderful natural laboratory for studying the formation of recent soils and appearance of pioneer plants. Ancient coastal formations of the Baltic Sea and relief forms left behind by the last glaciation are represented here more completely than in neighbouring countries. Unique are the meteorite craters and Palaeozoic sections.

Figure 6. *Cypripedium calceolus*. Photo M. Vainu (p. 44).

Environmental and nature protection have long traditions in Estonia. In 1910 a bird sanctuary was established on the Vaika islets in the West-Estonian Archipelago. The Nature Investigation Society has already been active since 1853. The first nature conservation law was adopted in 1935. In 1971 the first in former Soviet Union National Park (Lahemaa National Park) was established. The Act on

Sustainable Development was adopted in 1995. In the same year the Parliament approved also the Act of the Protection of Marine and Freshwater Coasts, Shores and Banks. Estonia has joined to many international and bilateral agreements.

In Estonia there are 3864 protected areas and objects (landscape elements, primeval trees and big boulders), which cover 18,7% of total land area of the country and 31.1% of aquatory. Under State protection are 5 National Parks, 158 Nature Reserves and 152 Landscape Reserves (figure 7). A lot of different objects are under the protection of local communities.

Figure 7. Land cover and protected areas in Estonia. Map compiled by M. Vainu (p.45).

References (p. 46)