2. Natural resources

Economic growth and well-being depend on the existence of resources. With the world population growing, the sustainable use of natural resources to meet the consumption needs of people is becoming an increasingly topical subject. There is a significant shift in attitudes from (over)consumption and production to a more mindful use of resources so that future generations can also enjoy a high quality of life.

Ecological footprint is one way of quantifying the environmental impact of human activities. If all people on the planet consumed the same resources that the lifestyle of the average person in Europe demands, it would require two earths to support humanity (the relevant indicator for the whole world is 1.5). Our consumption habits extend the boundaries of Europe because Europe depends on imported resources from a wide range of countries around the world. Estonia has a relatively high level of energy independence thanks to the use of oil shale. However, oil shale mining has an adverse effect on the whole ecosystem – it affects the quality of air and water and modifies the land cover. Therefore, our ecological footprint is one of the biggest both in Europe and the world.

Natural resources are the basis of human activity. On the one hand, we use natural resources as a resource; on the other hand, they provide various services to the environment – a forest acts as a habitat and a carbon sink; water is used for consumption and acts as a habitat for water ecosystems, while soil is where nutrients are preserved and through which pollutants are filtered. What is most important today is mindful use of the existing resources without compromising the environment.

2.1 Forestry

The diversity, extent and importance of the values offered by forests to humanity have been acknowledged in a number of international forums. The principles set forth in the Statement of Principles of Forests declaration of the UN Conference on the Environment and Development (UNCED) held in Rio de Janeiro in 1992 can be considered the first principles of sustainable management and conservation of forests that are recognised worldwide.

The Ministerial Conference on the Protection of Forests in Europe (MCPFE, also referred to as Forest Europe) is the most important of the regional efforts that continued where the Rio conference left off. At MCPFE, the principles for the sustainable management of forests, along with the implementing measures, were agreed upon at the level of ministers responsible for forestry. The Estonian forestry policy, which was approved by the Government of the Republic and the Riigikogu (1997), reflects Estonia's commitment to international obligations.

The forest policy stresses the great natural and ecological value of Estonian forests as well as the potential of the forestry sector for generating material and social benefits. Forests are one of the most important natural resources in Estonia — they cover about one-half of the country's territory. Diverse forest communities provide habitats for numerous species of animals and plants. Wood is used as a raw material in the building and industrial sectors and in the manufacturing of consumer goods; it is also an increasingly important source of renewable energy. Forests also have an indispensable role in the carbon cycle, acting as a carbon sink by capturing carbon from the atmosphere and absorbing it in woody biomass and forest soil. The use of wooden products increases the period of carbon assimilation; using wood as fuel decreases the demand for fossil fuels. Forest management should take into account the need to protect soil, water and the atmosphere. More than 35,000 jobs in the forestry sector and numerous jobs in the tourism, sports, transport and hunting sectors are related to forests. The biggest challenge in the forestry sector is to achieve a balance between various forest-related interests.

The framework guidance document on the development of forestry "The Estonian Forestry Development Plan until 2020" was approved by the Riigikogu on 15 February 2011. The main objective of the development plan is to ensure the productivity and viability as well as diverse and efficient use of forests. For this purpose, the long-term objectives are: to use wood within the margins of the increment, increase reforestation and take at least 10% of the surface area of forest land under protection as well as to improve the representativeness of protected forests.

2.1.1 Forest area and growing stocks

The total forested area and reserves have increased significantly in the last half-century (figure 2.1). Forests cover about one-half of Estonia's territory (2.2 million hectares). Forests constitute about 48.9% of the total area of Estonia; if the area of Lake Peipsi is excluded, forests account for 50.6%. The main reasons for the increase in the forest land and growing stock are the afforestation of the land that has fallen out of agricultural use and the draining of wetlands (1960–1980). Despite the rapid afforestation of the land that had fallen out of agricultural use in the 1990s, the total forest area has remained around 2.2 million hectares. In the last decade, the forest area has decreased due to infrastructure development and re-use of the afforested land for agriculture. The growing stock has been around 450 million m³ in recent years, while the average volume per hectare of stands has increased significantly (219 m³/ha in 2010). Moreover, the forest area and growing stock indicators have increased due to changes in the methods used to make an inventory of forests. Aggregated data on forest resources have been published since 1999 on the basis of the Statistical Forest Inventory Data. The data on earlier years are those of

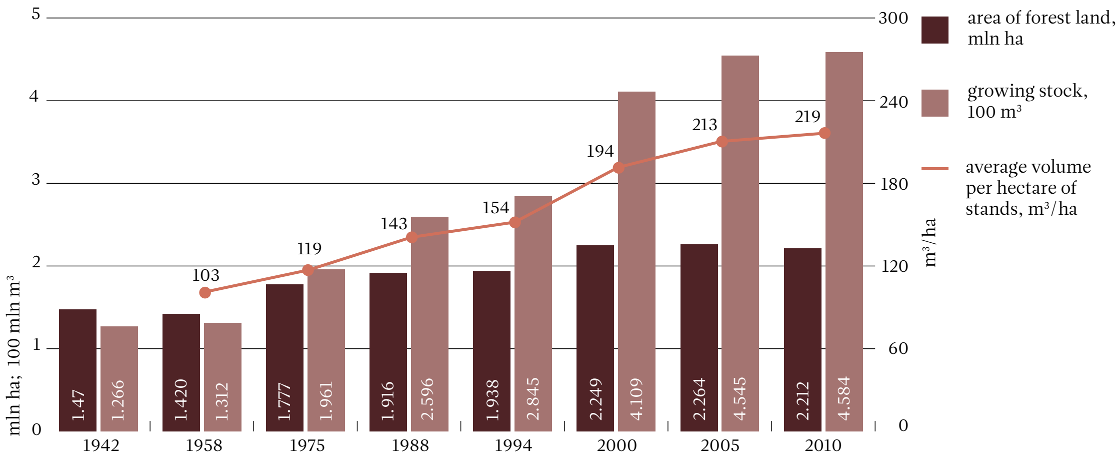


Figure 2.1. Forest area, growing stock volume and change in the volume per hectares of stands. Data: 1942 – Akadeemilise metsaseltsi toimetised V (publications of the Academic Forest Society); forest inventories of 1958–1994; Statistical Forest Inventories of 2000–2010 (SMI) ESTEA (the Estonian Environmental Agency).

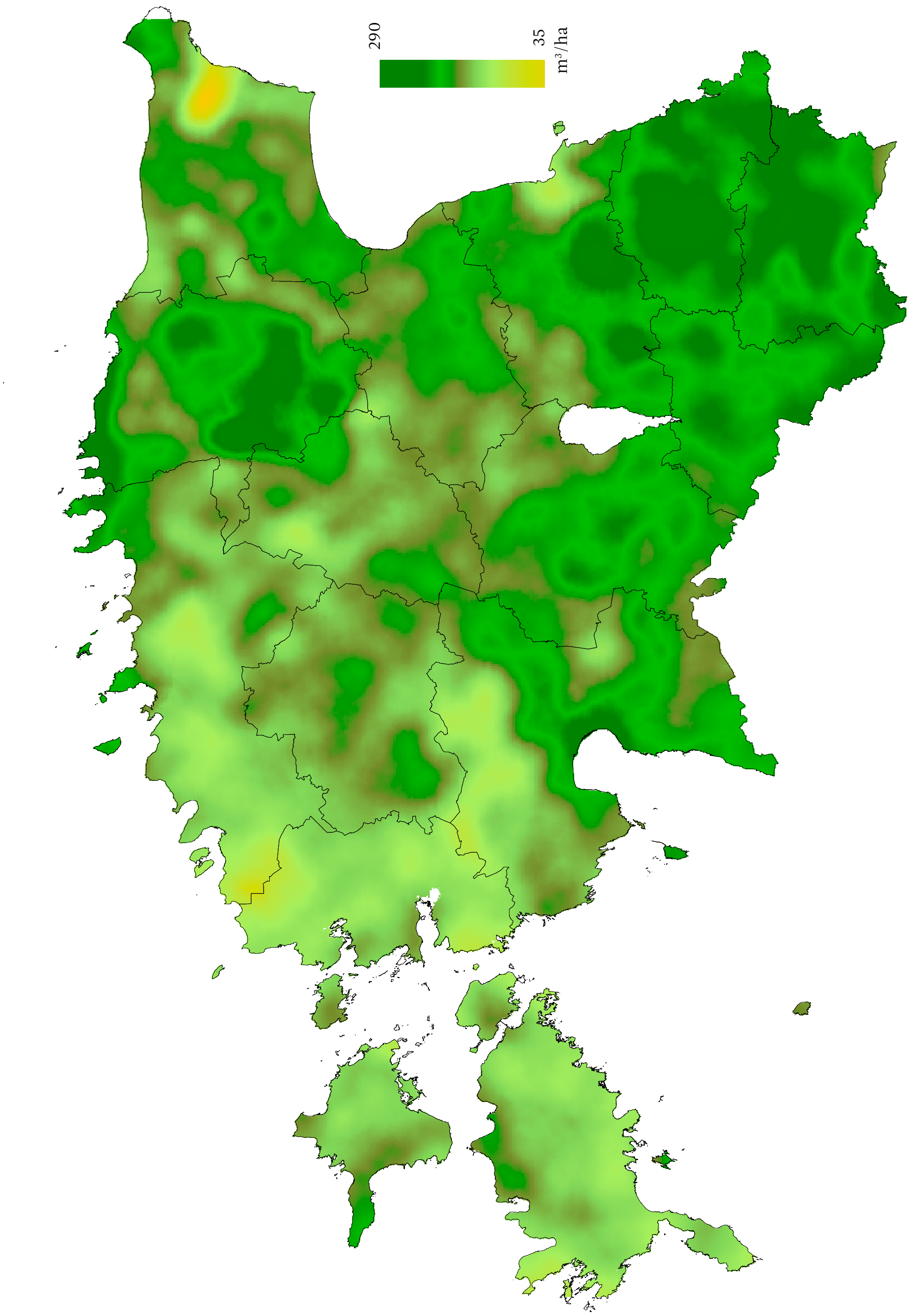


Figure 2.2. Average volume per hectare of stands[1] in 2012, in m³/ha. Data: Forest Register.

1 Average volume per hectare of stands (m³/ha) – volume of growing forest per hectare. Determined on the basis of the sum of per-hectare stock of all stand elements. The per-hectare stock of a stand element is calculated on the basis of the stand's height, basal area and stocking density or number of trees.

the forest management planning (planning inventory of stands).

2.1.2 Share of tree species

Major changes have taken place in the structure of tree species. The shares of the stands of broad-leaved trees and mixed stands with a broad-leaved majority have increased (Figure 2.3). The main reasons for this are the changes in the forest inventorying methods and the afforestation of land no longer used for agriculture. The low volumes of reforestation works in private forests have also played a role together with the fact that the areas of natural forest regeneration are mainly forested by broad-leaved trees (Figure 2.4). The most common species of trees in Estonia are pine, birch and spruce.

The relative shares of tree species is affected by the use of forest stocks. In the last decade, spruce and pine stands have been most intensively exploited. Aspen and grey alder have been logged less; therefore, their share is increasing compared with pine and spruce in older stands. According to the data of the Statistical Forest Inventory, mature aspen stands account for 62% of the total area of aspen forests, while mature grey alder grows account for 58% of the total area of alder forests.

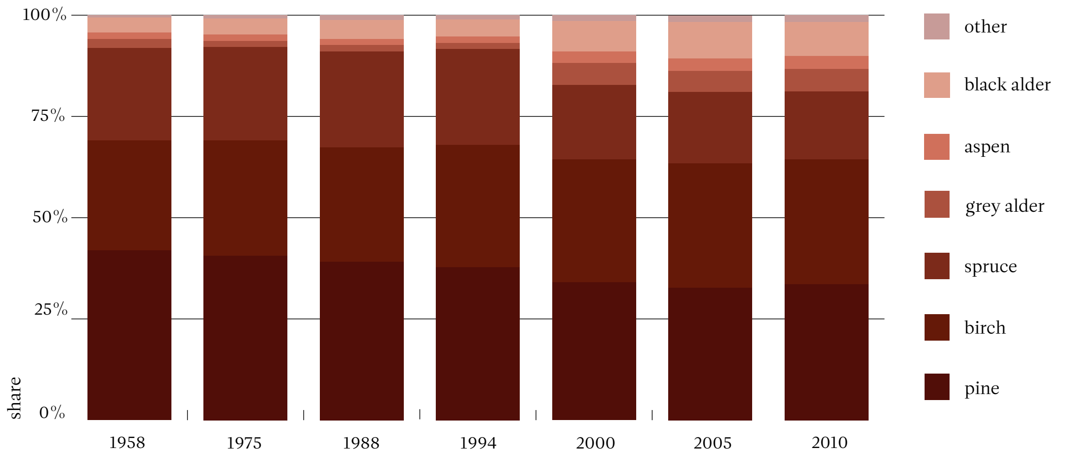


Figure 2.3. Change in the share of tree species by the forest land area of the dominant species. Data: Forest inventories of 1958–1994; Statistical Forest Inventories of 2000–2010 (SMI) ESTEA.

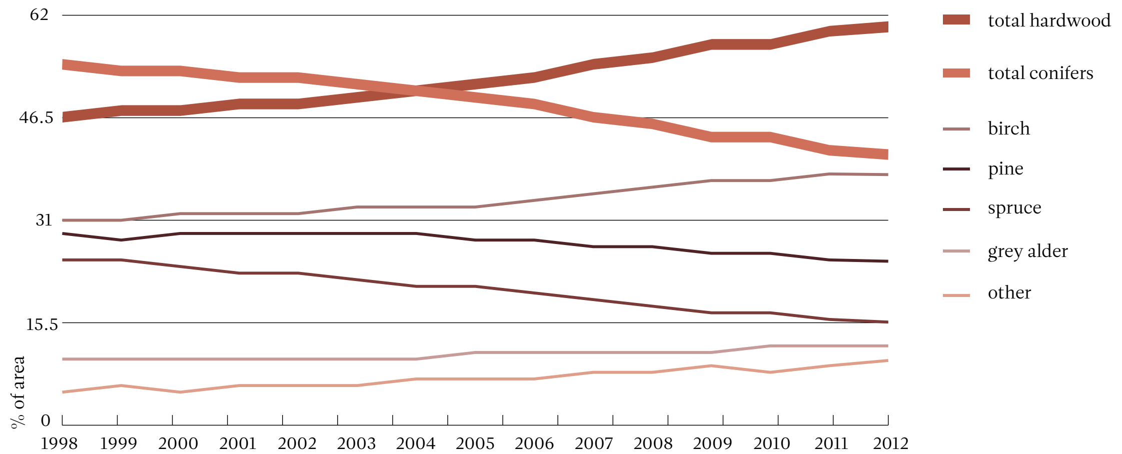


Figure 2.4. Division of the area of registered private forest stands by dominant species in 1998–2012. Source: Statistical Forest Inventory — National forest resource register, ESTEA.

2.1.3 Prescribed cut and increment

The nature and structure of forests is largely determined by human activity. The activities that have the greatest impact on forests are various uses of forests (gathering of forest goods, recreational activities, protection of soil and water, national defence, etc.) and forest management activities (logging, reforestation and maintenance, including road construction and forest drainage).

The optimal prescribed cuts set forth in the Estonian Forestry Development Plans until 2010 and the Estonian Forestry Development Plan until 2020 are 12.6 million m^3 and 12–15 million m^3 per year, respectively. The volumes of felling have changed significantly over the last decade:

In the early 2000s, the annual felling volumes increased to record levels, being of the same order of magnitude as the increment in stands, i.e. around 12 million m^3 (Figure 2.5). The reasons for such an increase were primarily the high percentage of mature stands that had not been actively managed in the previous decade, the active management of lands that had been transferred into private ownership as a result of the land reform, the rapid development of mechanical wood processing and high demand for wood products, especially in the real estate and construction sectors.

The annual felling volumes plummeted from 2003. In order to meet the need for raw material, the imports of timber logs increased. This situation was brought about by the tax system that put private forest owners at a disadvantage, decreasing the uptake of unused forest land and increasing the cost of forest harvesting. Forest harvesting was also affected by mild and short winters because an unfrozen and soft surface makes the felling and transport of wood difficult.

The timber market of the Baltic Sea region was also thrown into disarray by the "January storm" of 2005 — the market became saturated with cheap wind-damaged timber. All efforts were concentrated on eliminating the damage caused by the storm. The consequences of the storm were still affecting the market in 2006 and the prices of wood only recovered in 2007. In the context of decreased felling volumes, a sudden increase in the import of timber logs from Russia helped to alleviate the industry's demand for raw material. In June 2007, the Russian Federation established higher export tariffs on timber logs; this was followed by a so-called railway embargo in the wake of the April 2007 civil unrest, which in effect closed the primary transport route for timber logs. Only 5.3 million m^3 of forest was felled in 2007.

In 2008, felling volumes started to increase. According to the Statistical Forest Inventory, 5.9 million solid cubic metres of forest were felled in 2008, 6.6 million m^3 in 2009 and 8.5 million m^3 in 2010. According to the expert opinion of the Environment Agency, the volumes of felled forest reached 9.1 and 9.4 million m^3 in 2011 and 2012, respectively.

An important indicator in the assessment of the sustainability of forest management is the ratio of forest annual fellings of wood over net annual increment. If more forest is felled over a long period than can be grown in the same time, it will endanger the biodiversity of forests and the sustainability of the supply of raw material wood. Low rates of use indicate that the accumulated wood resources are used inefficiently. It should be remembered that the volumes of felling are affected by the structure of forest stands (the nature of mature stands), accessibility (weather, infrastructure, legal status of forest land, share of forests with limitation on use) as well as by external factors, such as the general demand for wood and the demand for specific types of wood, wood prices, the availability of the necessary harvesting and processing technology. While the ratio of felling to increment was 44% in 2007, it had increased to 75% by 2012. A relatively big share of mature stands means that more forest could have been felled.

The share of broad-leaved trees in the total volume of felled forest has increased in recent years. While softwood (pine and spruce) accounted for about 60% of the total cut in 2006, its share fell to 52% by 2009. However, aspen and alder are used relatively little (the shares of mature stands of the total forest area where the dominating species are aspen or alder are 62% and 58% respectively). Of deciduous species, birch was logged the most (Figure 2.6).

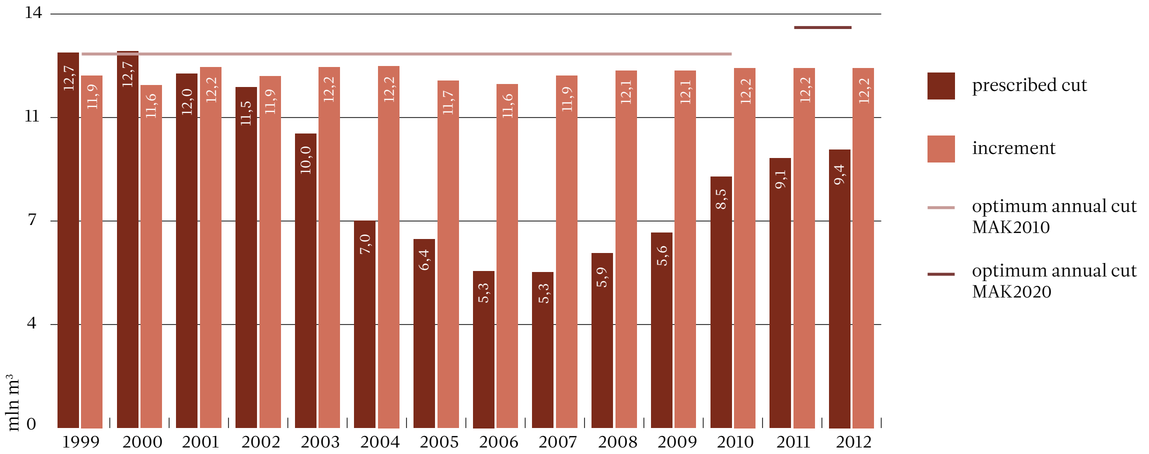


Figure 2.5. Prescribed cut and increment in 1999–2008. Data: ESTEA (Estonian Environmental Agency). Source for cut data: Prescribed cut in 1999–2010 (Statistical Forest Inventory), 2011–2012 expert opinion (actual cut in state forest and share of other owners based on and analysis of orthophotos (data from calibrated forest notifications)

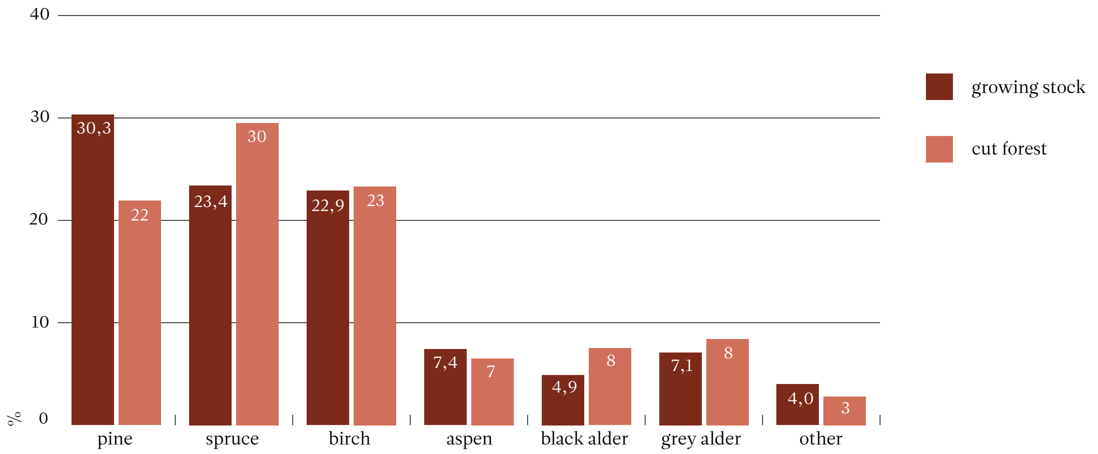


Figure 2.6. Growing stock and cut forest by species of tree (based on the estimated cut of 2009).
Data: Statistical Forest Inventories (SMI) ESTEA.

2.1.4 Reforestation

In the last decade, the volume of reforestation has grown slightly (Figure 2.7). The support granted for reforestation plays a role in this development. Forest planting accounted for the majority of the work. In 2000–2009, an average of 5,900 hectares of forest were planted in a year: The volumes of reforestation works have increased rapidly in the past three years. In 2010–2012, an average of 7,500 hectares of forest were planted in a year. Of all saplings planted, 67% were spruce, 25% pine and 7% birch saplings. The annual average area of forest sowing was 1,200 hectares. Actual volumes of work in state forest and in the forests of other owners – planned activities according to forest notifications.

Besides reforestation, natural forest regeneration was facilitated (including by sowing seeds, planting saplings and restricting the growth of competing vegetation) on around 1,000 hectares per year. The volume of activities aimed at creating forest plantations and preparing soil for natural forest regeneration (mineralisation) has also grown (from 5,600 ha in 2005 to 8,600 ha in 2012). The remaining clear-cut areas or areas where the forest had died were left to be regenerated naturally. The regeneration of clear-cut areas with wooded plants is progressing well. A problem is the big share of broad-leaved trees — there are too many trees and shrubs that, from a human perspective, have little economic value.

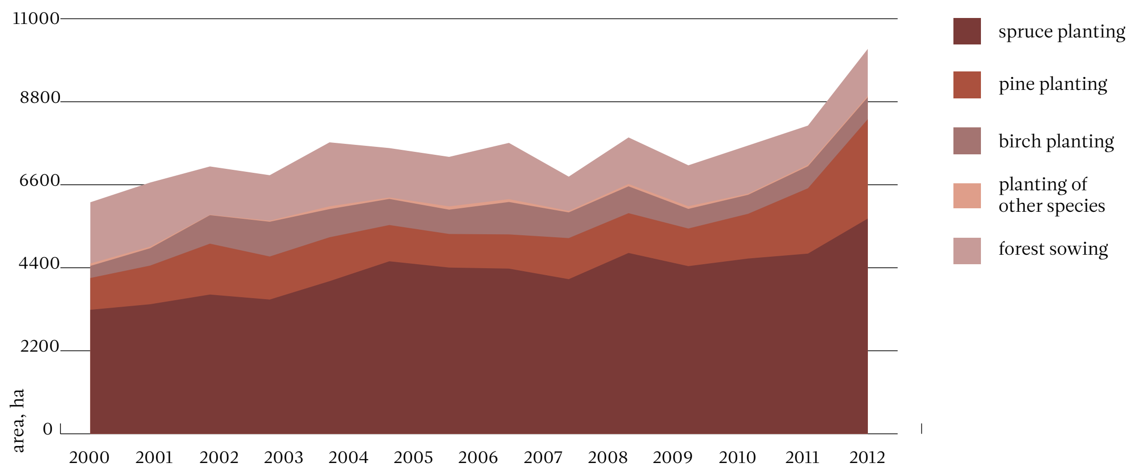


Figure 2.7. Forest planting and sowing in 2000–2012. Data: State forest – actual volumes; other owners – planned activities according to forest notifications, ESTEA.

2.1.5 Forest fires

One of the biggest human-induced risks to forests is wildfire. The number and area of wildfires depends on the weather conditions in dry seasons. Most wildfires are attributed to human sources. The greatest number of forest fires occur in forests that are situated close to larger cities and towns in Harju and Ida-Viru counties. Natural factors, such as lightning, only cause wildfires in isolated cases. Most forest fires are caused by careless visitors (holiday-makers, berry-pickers, children, etc.). Other causes include arson and negligent forestry works, etc.

Weather patterns can also increase the risk of wildfires. The risk of wildfire is very high during prolonged dry spells. During the very dry summer of 2006, an average of more than 12 hectares of forest was destroyed by each wildfire. In 2008, the area of forest destroyed per wildfire was 18 hectares — more than in any year in the previous 16-year period (Figure 2.8).

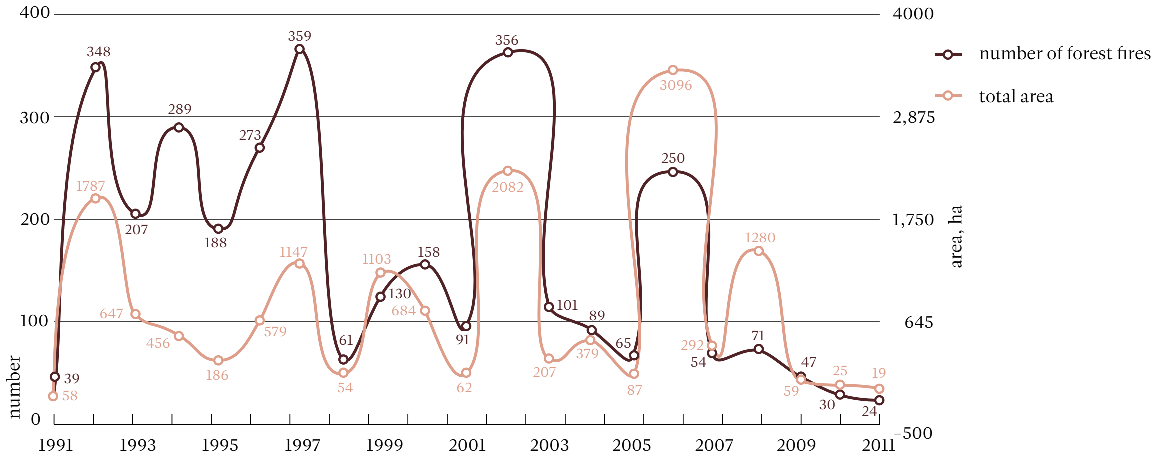


Figure 2.8. Number of forest fires and area, 1991–2011. Data: Rescue Board; Ministry of the Environment.

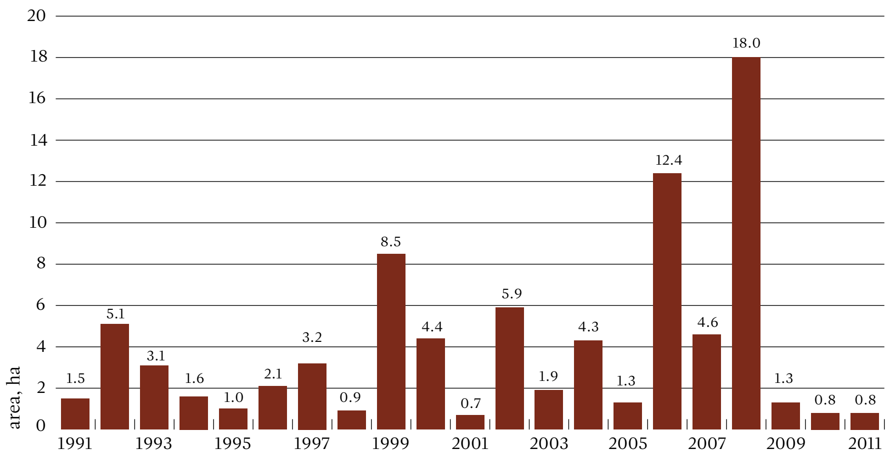


Figure 2.9. Average area of forest destroyed per fire, 1991–2011. Data: Rescue Board; Ministry of the Environment.

2.1.6 Distribution of forest land by the reason for protection

The Estonian Forestry Development Plan until 2010 had an ambitious objective – to increase the area of forests under strict protection to 10% of the total area of forests. The Estonian Forestry Development Plan until 2020 specifies the previous target: to put under protection at least 10% of the total forest land and to improve the representativeness of protected forests.

The share of protected forests in total forest land has increased considerably over the years. According to the Statistical Forest Inventory 2010, the area of protected forests is 690,000 hectares, which accounts for 25.4% of the total forest land. Protected forests make up about 35.7% of the forests managed by the State Forest Management Centre, and about 19.6% of other forests.

According to the Statistical Forest Inventory, the share of strictly protected forests or the forests in the former protected forests category was 9.8% (216,300 ha) in 2010 (Figure 2.10). Strictly protected forests include reserves of protected areas and special management zones, the special management zones of species protection sites, habitats of Category 1 protected species, key biotopes in the forests managed by the State Forest Management Centre as well as sites located on private land and protected under contracts and the proposed protection sites under the planned protection regime. The share of all strictly protected forests in the total forest area was 10.1% in 2010. The difference between the two indicators can be explained by the fact that some forest areas that are under strict protection are included in the category of key biota, rather than in the category of protected forests. Similarly, a forest can be classified as protection forest (e.g. in the limited management zone) and at the same time put under strict protection as a key biota.

According to the Statistical Forest Inventory 2010, the area of protection forests was 339,660 ha or 15.4% of the total forest land. Protection forests include limited management zones of protected areas, special conservation areas, water protection zone forests, forests in infiltration areas, forests designated for the protection of the environmental status, proposed protection sites under the planned protection regime and protected areas for which the protection rules have not been updated.

Key habitats, i.e. areas of up to seven hectares, which need protection outside a protected natural object due to the high probability of the occurrence of narrowly adapted, endangered, vulnerable or rare species. According to the Statistical Forest Inventory 2010, the area of such forests was 6,400 ha (0.3% of the total forest land).

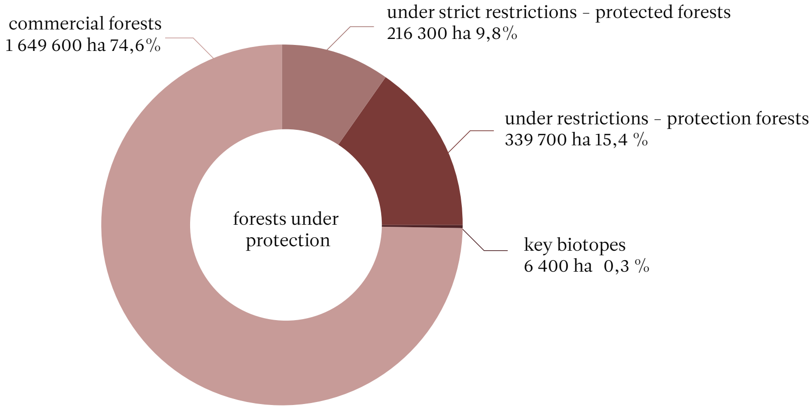


Figure 2.10. Distribution of forest land based on the reason for protection in 2010. Data: Statistical Forest Inventories (SMI) ESTEA.

Further reading:

- Website of the Estonian Institute for Meteorology and Hydrology. Fire hazard map. *[www] http://www.emhi.ee/index.php?ide=19,270*
- Website of the Estonian Environment Agency. *[www] http://www.keskkonnainfo.ee/main/index.php*
- Forest registry. *[www] http://register.metsad.ee/avalik/*
- State Forest Management Centre website. *[www] http://www.rmk.ee*
- Protection of valuable forest habitats in Natura 2000 areas. Riigikontrolli aruanne Riigikogule (Report of the State Audit Office to the Riigikogu). *[www] http://www.riigikontroll.ee/audit.php?audit=67750*

2.2 Hunting

Hunting is closely related to rural economy and nature conservation. Game animals constitute an important natural resource that must be used sustainably. The new Hunting Act was adopted in the spring of 2013. The preparation of the legislation started back in 2009. The new Hunting Act gives land owners more say in the organisation of hunting activities and an opportunity to receive compensation for damage caused by wild animals. The basis for wild animal control was also changed – the earlier habitat quality assessment was replaced by the monitoring of the condition of wild game populations. In 2012, the Minister for the Environment approved a new Development Plan for the Protection and Control of Large Carnivores for 2012–2021. The development plan sets forth the recommended sizes of large carnivore populations – the number of wolves should be between 15 and 25 litters in a year; the number of lynxes is between 100 and 130 individuals and the number of bears is at least 60 individuals. Currently, the main focus of hunting lies on bi-ungulates (cloven hoofed mammals), which are hunted both for meat and for sport. Hunting small predators (raccoon dog, fox, pine marten, mink) has become more of a conservation activity, owing to the very disturbed state of the fur market; the abundance of these species is regulated in connection with their possible negative impact on other species. Beavers are hunted in order to reduce the damage caused by the animal, in particular in drained forest lands. Large carnivores (wolf, bear, lynx) are hunted mainly for sport; there are also efforts to regulate their populations because they feed on bi-ungulates, which are the main focus of hunting. Moreover, wolves can cause significant losses to sheep farmers, and bears pose a risk to apiculture.

2.2.1 The status bi-ungulate populations

The status of the population of **moose** in Estonia is good. According to the estimation of hunters, there were 11,000 moose in Estonia in 2009 and their number increased rapidly in the following three years, reaching 12,740 individuals in 2012. The results of quadrate sampling conducted in four consecutive years confirm such a trend (Figure 2.11).

The structure of hunting in 2009 in some mainland counties indicated that hunting was weighed heavily towards bulls. Saaremaa, on the other hand, stood out by the fact that more cows were hunted than bulls. In 2009, such a trend was also observed in other counties of the western Estonia and the islands. In 2011, the actual and recommended hunting trends were more in line with each other as compared to previous years and no county stood out among the rest by significant deviation.

As the number of moose increased, so did the extent of damage caused by moose to forests, in particular to young stands of pine. The extent of damage varies from region to region and from year to year. Maintaining a moderate moose population concentration and willow stands will have an important role in preventing damage in the future.

The population of **wild boar** has increased significantly in Estonia over recent years. This trend is similar to other European countries. The rapid increase has been facilitated by very intensive supplementary feeding and low levels of hunting of breeding sows, because hunters are interested in maintaining the number of wild boar.

Since 2008, the hunting of wild boar has increased in line with the increase in the number of animals. In the last four years, there were about 20,000 individual animals in Estonia (Figure 2.12).

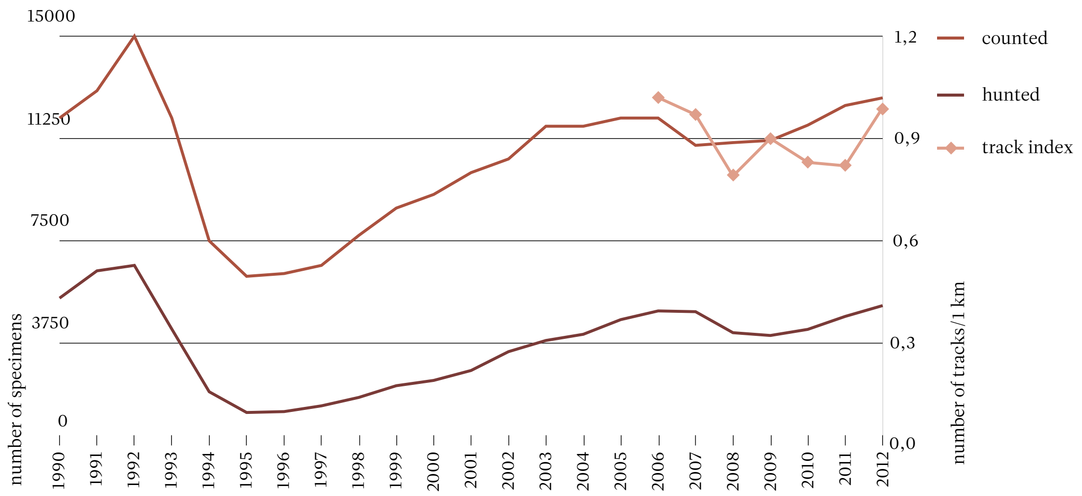


Figure 2.11. Hunters' estimation of the number of moose, hunting bag in 1990–2012 and changes in the quadrat sampling track index in 2006–2012. Data: ESTEA (Estonian Environmental Agency).

Although the results of quadrate sampling indicate the opposite, we should bear in mind that the low track indices of the quadrate sampling conducted in 2010 and 2011 were largely caused by difficult weather conditions (deep snow), which limited the movement of wild boars (Figure 2.12). The last winter (2012) was an average one and there were no obstacles to the movement of wild boar.

In many regions, the share of male wild boars in the population has decreased because the pressure of hunting on male boars, young boars and adult boars has been greater than the pressure on sows. Unfortunately, hunting sows or even young sows is still strongly disapproved in some hunting regions.

The data on the fertility of wild sows hunted in the winter of 2009/2010 indicate that sows achieve sexual maturity early and the share of fertile sows in the wild boar population is quite significant. As regards fertility, Estonian wild boars are more similar to their conspecific in Central and South Europe than to those in neighbouring regions with similar climatic conditions. It is very likely that the fertility indicators have escalated largely due to supplementary feeding. However, there are no clear statistically reliable links between the fertility of wild boar and supplementary feeding because there are no data on the intensity and frequency of the latter.

The number of **roe deer** has decreased slowly but steadily since 2007. The reasons may be several and varied but the two main and most clear of them are an increase in the number of lynx and consequently in pressure from carnivores, and more intensive hunting. The snowy winters of 2010 and 2011 added an important mortality factor – a significantly bigger number of roe deer died in the second half of winter than in previous years. The unusually deep layer of snow restricted access to food, while the increased need for energy weakened the organism and made the animals more susceptible to diseases. The congregation of roe deer to feeding places facilitated the spread of infectious diseases and made the deer an easy target for carnivores. According to hunters who had significantly reduced hunting since 2010 (Figure 2.12), the number of roe deer continued to decrease until the spring of 2012. The winter track index of roe deer also decreased significantly and the occurrence of tracks diminished (Figure 2.12). The number of animals continued to drop in the aftermath of the tough winters of previous years. The effect was passed on to the age and gender structure of the population in 2012. Besides the harsh winters of previous years, a significant pressure was put on the population of roe deer in 2011 by the high populations of lynx and wolf.

The population of **red deer**, the majority of which is living on the islands of Saaremaa and Hiiumaa, has steadily increased over the last decade. The population on the mainland is uneven – characteristic of the edges of a habitat – and consists mainly of bulls. The hunting of red deer is increasing in line with the increasing population. While 403 red deer were hunted in 2009, the number almost doubled by 2012 (829 individuals). According to the quadrate sampling of 2012, the concentration of the deer population is increasing and their habitat is extending in mainland Estonia. When managing the population of red deer, it should be taken into account that in bigger concentrations and in the conditions of sparse undergrowth, red deer may start to compete for food and habitat with the largest game animal of mainland Estonia (elk). Significant concentrations of red deer on the mainland would result in greater damage to agricultural land and forests, which inevitably would force us to reduce the number of elk in the hunting regions where red deer is abundant.

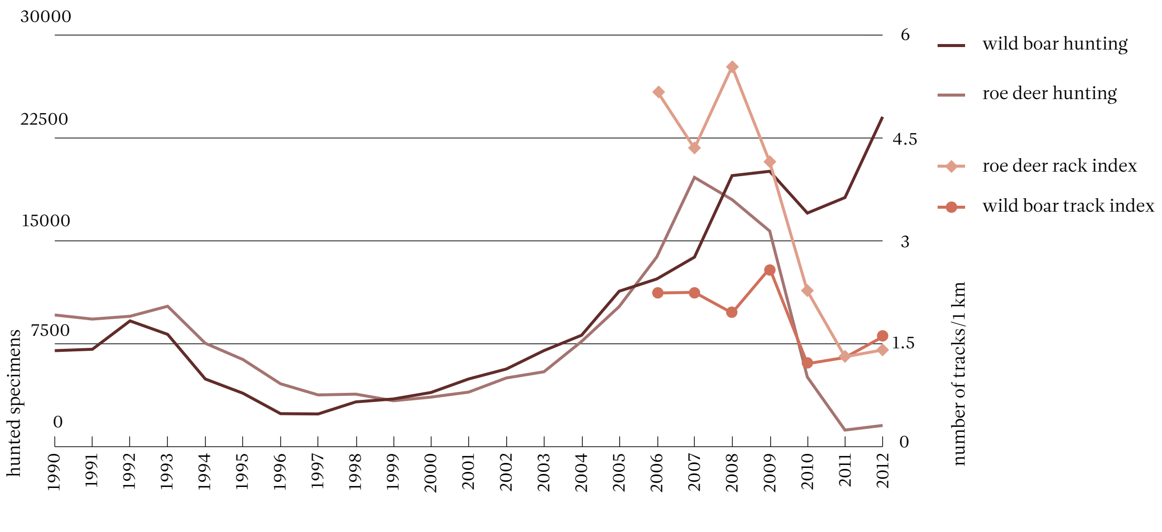


Figure 2.12. Hunting of large carnivorous animals in 1990–2012, number of litters in 2005–2011 and changes in the quadrat sampling track index in 2006–2012. Data: ESTEA.

2.2.2 Populations of large carnivores

The monitoring of large carnivores is focused on mapping litters because groups are more easily distinguished from each other and move in a smaller area than individual animals. They also provide an overview of the reproduction of species, their actual spread and the vitality of their populations. The number of litters is used to calculate the targets for reducing the number of carnivores. The general number of animals in autumn is also derived from the number of litters.

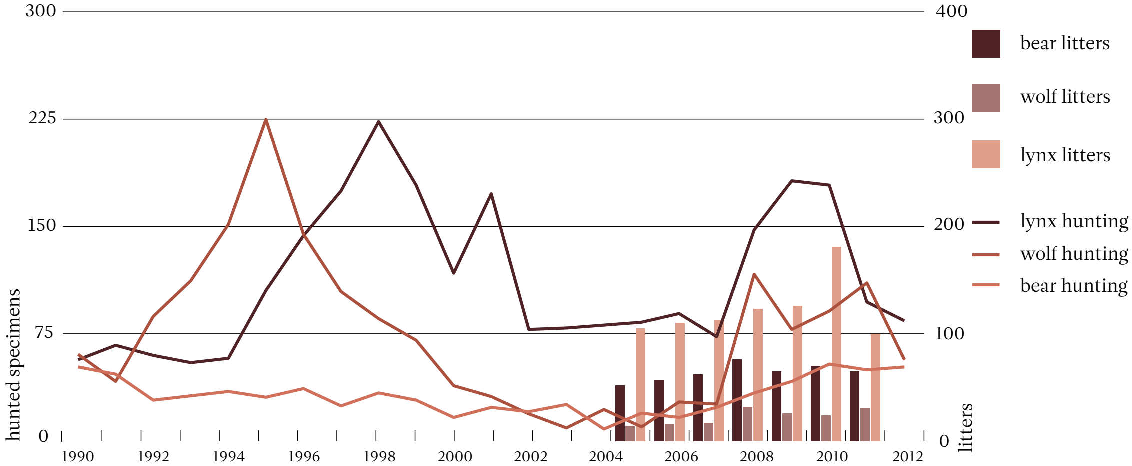
The number of **brown bear** has been on the increase for a long period of time and seems to have stabilised throughout Estonia. It has even decreased slightly in recent years (see Figure 2.13). The range of brown bear continues to expand, as does its concentration on the edge of the range in the southern and western parts of Estonia. The estimated number of brown bears is between 650 and 700 individuals. The Development Plan for the Protection and Control of Large Carnivores sets forth an objective to maintain at least 60 litters of cubs of the same year each year (the total size of the population is approximately 600 individual animals). Hunting is primarily continued in order to keep the species afraid of people and to reduce the damage caused by bears, while expanding their habitat southward. The habitat of brown bear has not expanded southward in the last ten years (as opposed to the westward expansion). The main reason is the disproportionate hunting of mother bears / the killing of bears in self-defence, which restricts or even stops the expansion of the habitat. The expansion of the range is very important for the protection of the population.

The level of damage caused by bears to apiaries has remained stable – between 70 and 100 cases. These damages are usually local in nature, which indicates that apiaries are raided by single bears that have become "specialised" on them.

Wolves are common throughout mainland Estonia, except for the areas where wolves are only a migratory species. By 2008, the concentration of wolves reached the level at which the species expanded to areas with a bigger share of cultivated land where sheep farming is more widespread than in wilder areas. The year was extremely favourable for wolves and the number of litters increased to 32 (Figure 2.13). The number of litters dropped to 26 in 2009 and 24 in 2010 due to extensive hunting undertaken in order to curb the number of wolves. In 2011, the number of litters increased to 31; some litters were also discovered on the islands of Saaremaa and Hiiumaa. While Saaremaa probably had the last litter of wolves in 1995, there are no earlier reports on discovered litters from Hiiumaa. According to the current Development Plan for the Protection and Control of Large Carnivores, it is recommended to preserve between 15 and 25 packs of wolves with cubs each year (the recommended total size of the wolf population is between 150 and 250 animals).

The damage caused by wolves to animal husbandry has steadily increased since 2007. In 2011, wolves killed over 1,000 farm animals, mostly sheep. On the one hand, this is undoubtedly caused by the fact that the number of wolf litters has increased and wolves are moving to new habitats where the share of cultivated land is bigger. On the other hand, it may also be related to the decreased number of deer and expanding sheep farming.

Lynx are spread evenly across mainland Estonia. The number of lynx increased steadily in 2003–2008 but the number of litters started to fall in 2009, dropping to 103 in 2011. The decline was also seen in the total number of individuals in the population, both according to the quadrate sampling and the estimations provided by hunters (Figure 2.13). A decrease in the total size of the population is usually observed with a slight delay – more adult fertile animals are hunted, while the cohorts that reach maturity are too weak to fill out the gap and regenerate the population. The objective of the Development Plan for the Protection and Control of Large Carnivores for 2012–2021 is to maintain the number of lynx litters at the level of 100–130 (total size of the population: 600–780 animals).



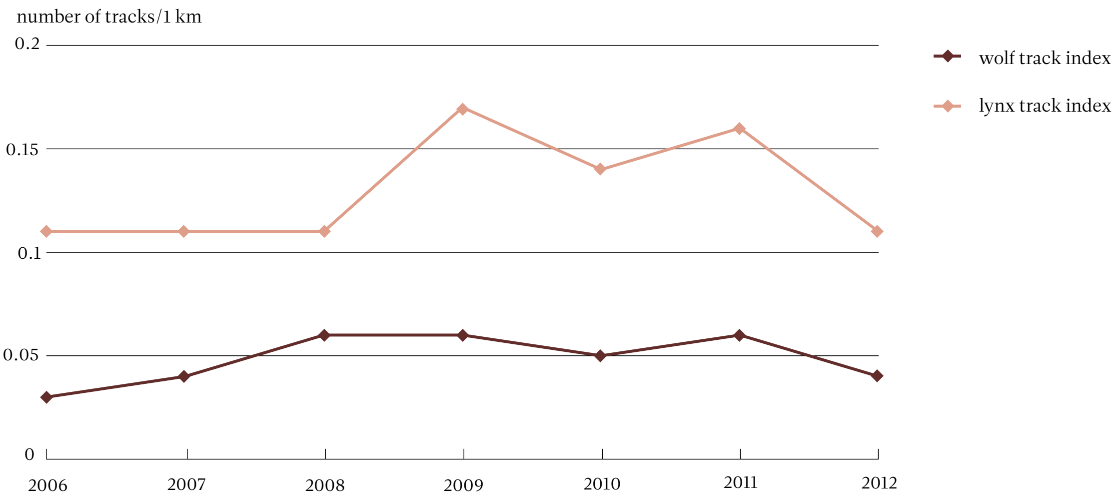


Figure 2.13. Hunting of large carnivorous animals in 1990–2012, number of litters in 2005–2011 and changes in the quadrate sampling track index in 2006–2012. Data: ESTEA (Estonian Environmental Agency).

Further reading:

- Estonian Environment Agency (2012). Ulukiasurkondade seisund ja küttimissoovitus (Status of carnivore populations and hunting recommendations). *http://www.keskkonnainfo.ee/failid/ULUKISEIREARUANNE_2012.pdf*
- Estonian Environment Agency (2011). Ulukiasurkondade seisund ja küttimissoovitus (Status of carnivore populations and hunting recommendations). *http://www.keskkonnainfo.ee/failid/ULUKITE_SEIREARUANNE_2011.pdf*
- Estonian Environment Agency (2010). Ulukiasurkondade seisund ja küttimissoovitus (Status of carnivore populations and hunting recommendations). *http://www.keskkonnainfo.ee/failid/ULUKITE_SEIREARUANNE_2010.pdf*
- Estonian Environment Agency (2009). Ulukiasurkondade seisund ja küttimissoovitus (Status of carnivore populations and hunting recommendations). *http://www.keskkonnainfo.ee/failid/200909_seirearuanne.pdf*

2.3 Water

The existence of clean fresh water is essential for life. Due to climate and small population, Estonia's fresh water resources are sufficient – fresh water is found in aquifers and surface water bodies. Nevertheless, there are problems with surface and groundwater quality in some areas, especially in industrial areas and intensive agricultural areas, where pollution load is high. Consideration of all components has created good preconditions for achieving a good ecological status of water bodies. The status of a water body is affected by the pollution load from the catchment area as well as by the general level of eutrophication, eg in coastal waters of the Baltic Sea.

2.3.1 Legal background

The management and protection of water bodies is based on a number of legal acts and regulations.

One of the objectives of the Estonian Environmental Strategy 2030 is to improve the status of surface water (including coastal waters) and groundwater (to achieve the "good" status) and to maintain the status of water bodies that already have "good" or "high" status. The evaluation of the status of groundwater is based on the concentrations of nitrates, pesticides and other hazardous substances. The general status of surface water bodies is assessed based on the ecological status of these water bodies and chemical indicators; the assessment includes the monitoring of the biota and the quality of surface water.

These objectives stem from directives of the European Parliament and the Council and are aimed at maintaining the aquatic environment natural or semi-natural conditions. These objectives provide guidance on how to prevent deterioration of water bodies status and to avoid pollution from densely populated areas and agricultural lands (nitrates). Main directives regulating water issues:Water Framework Directive (2000/60/EC);Marine Strategy Framework Directive (2008/56/EC);Urban Waste Water Treatment Directive (91/271/EEC);Nitrates Directive (91/676/EEC) as well as certain international conventions, such as the Convention on the Protection of the Marine Environment of the Baltic Sea Area (the governing body of the convention is called HELCOM) and the Baltic Sea Action Plan. Estonia has transposed the requirements of the water directives with the Water Act and other legal acts adopted under the Act (eg Regulation No 99 of 11 November 2012 of the Government of the Republic "Requirements for waste water treatment and discharge of effluent and rainwater into recipients, rainwater pollution limits and compliance monitoring measures" etc).

The Public Water Supply and Sewerage Act, regulating the organisation of the public water supply and collection and treatment of waste water, rain water, drainage water and other soil and surface water through the public water supply and sewerage system, provides the rights and obligations of the state, local governments, water companies and clients.

2.3.2 Water resource and use of water

Water resource is the total amount of water in seas, surface water bodies and groundwater aquifers. Water resource in a narrower meaning is the total quantity of water available for human consumption and for other uses. Although according to M. Lvovich[1] the total volume of the Earth's hydrosphere is about 1,455*106 km^3; most of it is unsuitable for use (93.9% is saline sea water and 4.1% is frozen – locked in snow, ice and permafrost). Only 2 percent of the Earth's total water resources are available for use and it is unevenly distributed throughout the regions of the globe.

From a global perspective, Estonia is very well supplied with water – we have an abundance of rivers, lakes, springs and mires. However, there are also areas where water is scarce in Estonia. In order to assess the amount of water available for industry, agriculture and human consumption, we have to apply the new definition of water resources. This means that we have to take into account that water is in constant circulation in the hydrosphere and only part of it is available for use. The average annual precipitation in Estonia is between 550 and 800 mm, exceeding total evaporation by nearly twofold. The renewable surface water resource (runoff of rivers) depends on the amount of precipitation and varies by the years; the average annual amount is about 12 km^3. Groundwater constitutes the second part of the renewable water resource. The confirmed groundwater resource is about 0.18 km^3 per year (about 500,000 m^3 per day). The majority of Estonian urban communities and undertakings use groundwater. Surface water is used for water supply in Tallinn, Narva and by some larger industrial companies (in Sillamäe, Kohtla-Järve and Kunda). In order to see how sustainably the water resources are used, the amount of water abstracted from water bodies is compared to the long-term annual average runoff, i.e. the water use index is calculated (%). Water consumption by the population and industry is calculated, along with the amount of water pumped out of mines and quarries; however, cooling water for Narva power plants is omitted from the calculation, as it is drawn from the Narva River and returned to the same river after use. The water use index for Estonia is low - some few percent. This means that the actual use of water is way under the critical water resources use limit, which is 20% of the total amount of renewable water resource. However, even here it may happen that in some regions the annual consumption of water may exceed the actual volumes available.

1 M. I. Lvovich. GeoJournal, 1979, Volume 3, Issue 5, pp. 423-433

2.3.3 Water abstraction and water use

Water abstraction steadily decreased in Estonia in the 1990s from 450 million m³ to below 100 million m³ per year (look water abstraction and use in the Estonian Environmental Review 2009). Such changes were caused by the restructuring of the economy and a shift towards the more sustainable use of water; the price of water has also had its effect on water consumption. Water abstraction figures have been rather stable over the last decade. The amount of groundwater abstracted during the decade is between 45 and 50 million m³ per year and the amount of surface water is between 50 and 57 million m³ per year (Figure 2.14).

The largest towns that use surface water are Tallinn and Narva. When the price of water started to rise in the 1990s, forcing consumers to adopt a more sustainable approach to the use of water, the amounts of surface water abstracted in Tallinn and Narva fell by more than five times (Figure 2.14). Although there have not been significant changes in the amounts of abstracted water, the downward trend continues in Tallinn and Narva. Tallinn as one of the largest user of water abstracted nearly 21.5 million m³ of surface water from Lake Ülemiste in 2011; the amount of groundwater abstracted in Tallinn remained below 2.5 million m³. This indicates that the abstraction of groundwater has decreased by nearly a half during last four years, while the consumption of surface water has remained at the same level. Narva used 6.46 million m³ of surface water and 6.5 million m³ of groundwater in 2011 (Figure 2.15). Elsewhere in Estonia, groundwater is mainly used. Groundwater is mainly abstracted from the Silurian-Ordovician and Cambrian-Vendian aquifers (Figure 2.16).

The consumption of water for industrial purposes has decreased by five times compared with the early 1990s due to the implementation of new, sustainable technologies and the reuse of water. The consumption of water by agriculture has decreased by 7.5 times, mainly due to the decrease of agricultural production. The consumption of water by households has decreased least – during last ten years the amount of water used for human consumption has remained at the level of 50 million m³ per year (Figure 2.17). The use of water per capita was 69 m³ in 1992, 33 m³ in 2007 and 26 m³ in 2011. In 1992, an average of 188 litres of water per person a day was used for human consumption, while the respective figure was 83 litres in 2007 and 70 litres in 2011 (Figure 2.18).

Figure 2.19 illustrates the distribution of water consumption in 2011. Almost 95% of Estonian water use forms cooling water, mainly used by Balti Elektrijaam and Eesti Elektrijaam power plants. The remaining 5% is water used for human consumption and by the industrial, energy and agricultural sectors as well as for irrigation. Half of this volume is used for human consumption. Figure 2.20 illustrates the use of water by type and purpose. Surface water is mainly used in almost every sector, except for agriculture and human consumption, which mainly use groundwater from bored wells.

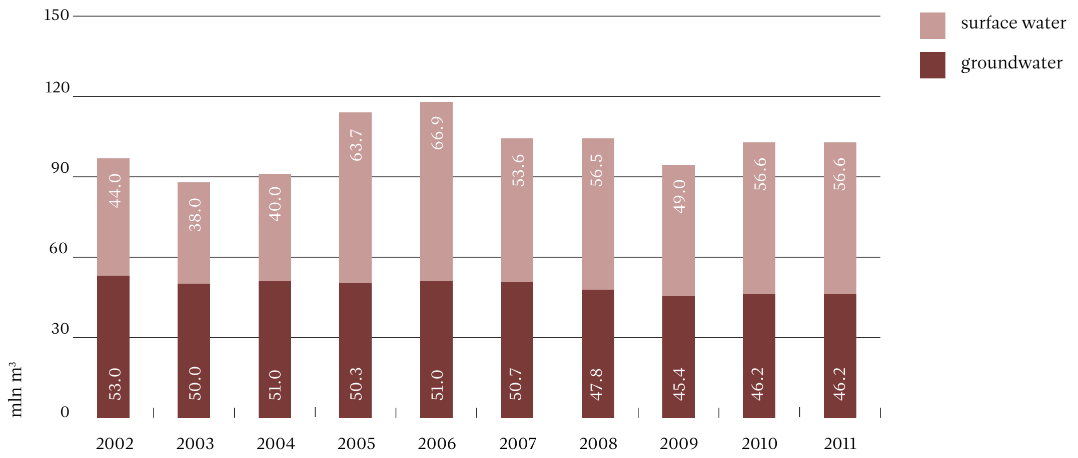


Figure 2.14. Water abstraction (excluding mining and cooling water), 2002–2011. Data: ESTEA (Estonian Environmental Agency).

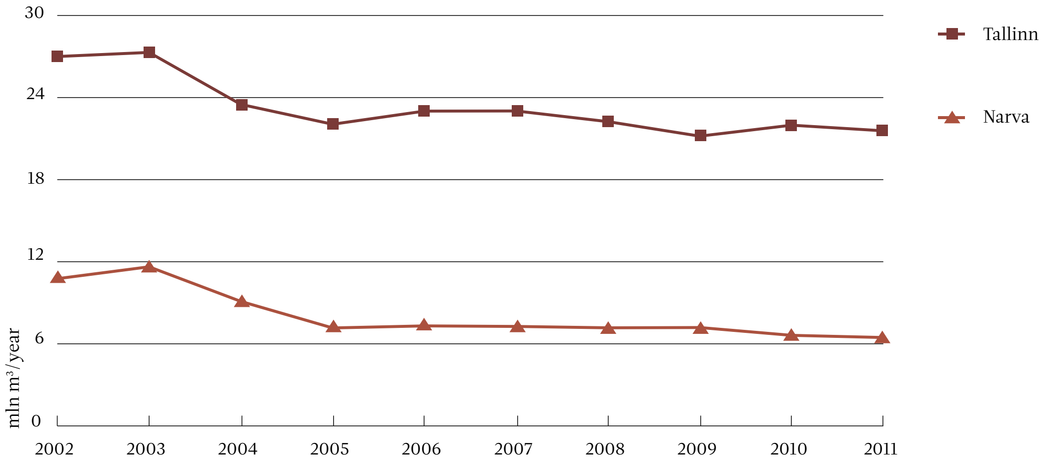


Figure 2.15. Surface water abstraction for Tallinn and Narva in 2002–2011. Data: ESTEA.

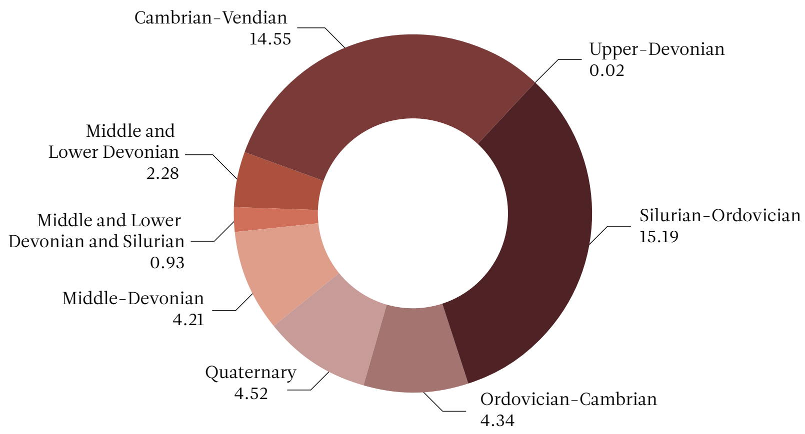


Figure 2.16. Groundwater abstraction from aquifers throughout Estonia in 2011 (excl. mining water). mln m³. Data: ESTEA.

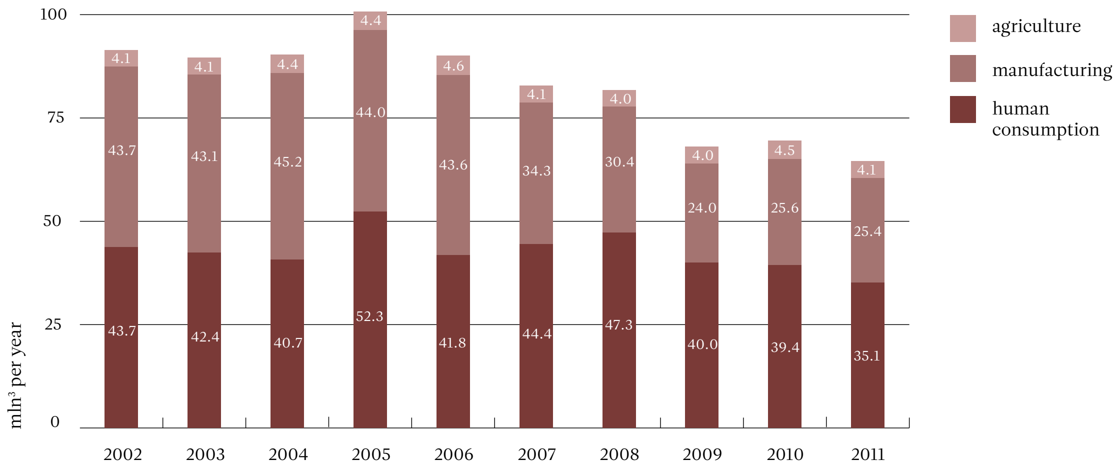


Figure 2.17. Use of water in agriculture, manufacturing and for human consumption in 2002–2011. Data: ESTEA.

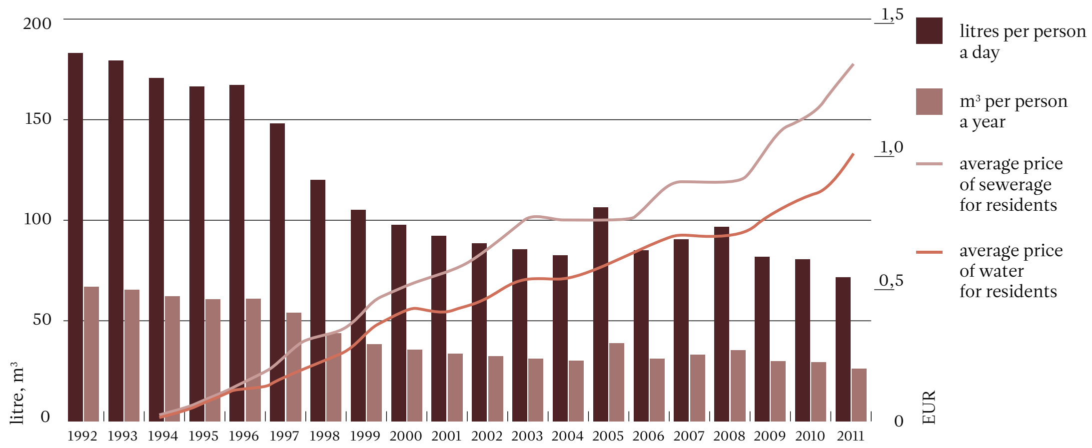


Figure 2.18. Water use for human consumption and the price of water, 1992–2011. Data: ESTEA.

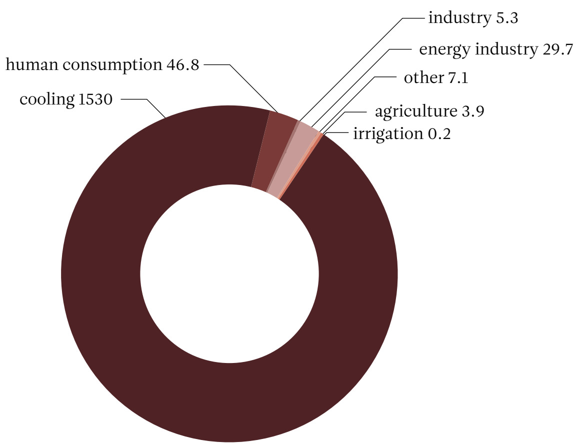


Figure 2.19. Water use in 2011, mln m³. Data: ESTEA.

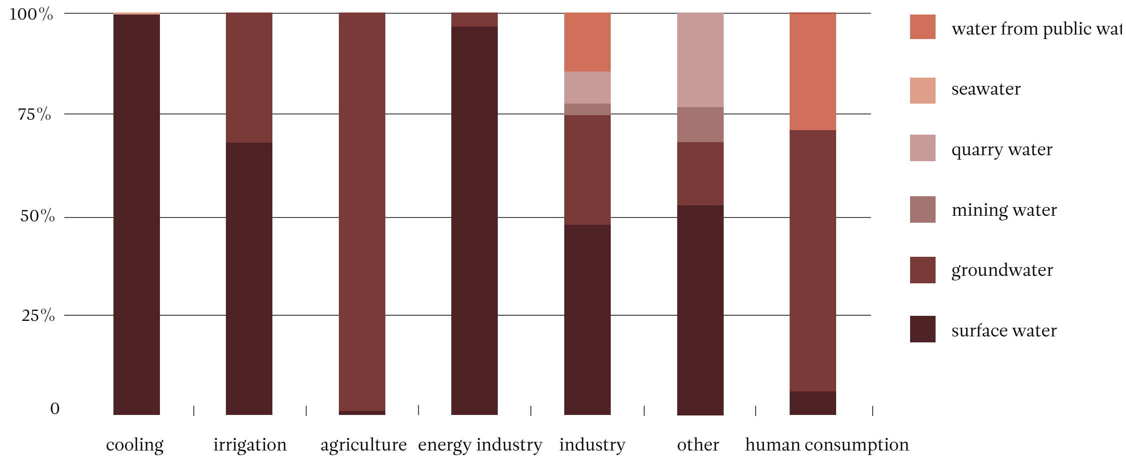


Figure 2.20. Water use in 2011 by type of water. Data: ESTEA.

2.3.4 Mining and cooling water

During 2002–2011 the amount of mining water varied widely – between 160 and 300 million m³ (Figure 2.21). In 2011, more than 250 million m³ of water was pumped out of mines. Over 90% of mining water is pumped out of the Ordovician aquifer in North-Eastern Estonia.

The volume of water pumped out from mines and quarries is directly linked to the amount of precipitation in the region (Figure 2.22).

The biggest users of cooling water are the large power plants in Ida-Viru County — Eesti Elektrijaam and Balti Elektrijaam. According to their environmental permits, the power stations in Narva may use water from the Narva River for cooling operations. Power station Eesti Elektrijaam is supplied with water by a system that uses the river bed of Mustajõgi. Additional water is directed into the system from the Narva River. Cooling water is taken from and returned to the Mustajõgi River. Power station Balti Elektrijaam takes its cooling water from the Narva Reservoir. Nearly all cooling water is returned to the water body it was taken from.

The largest volumes of cooling water were used in 2007 and 2011 — about 1,526 million m³ a year. Power plants Eesti Elektrijaam and Balti Elektrijaam used 940 million m³ and 583 million m³, respectively, of cooling water (Figure 2.23).

Cooling water accounted for an average of 13% of the annual runoff from the Narva River in 1990–2011. The cooling water used by Balti Elektrijaam and Eesti Elektrijaam in 2011 accounted for an average of 4.75% and 7.6%, respectively, of the annual runoff.

Figure 2.21. Groundwater abstraction, including mining water and consumption reserve in 2002–2011. Data: ESTEA.

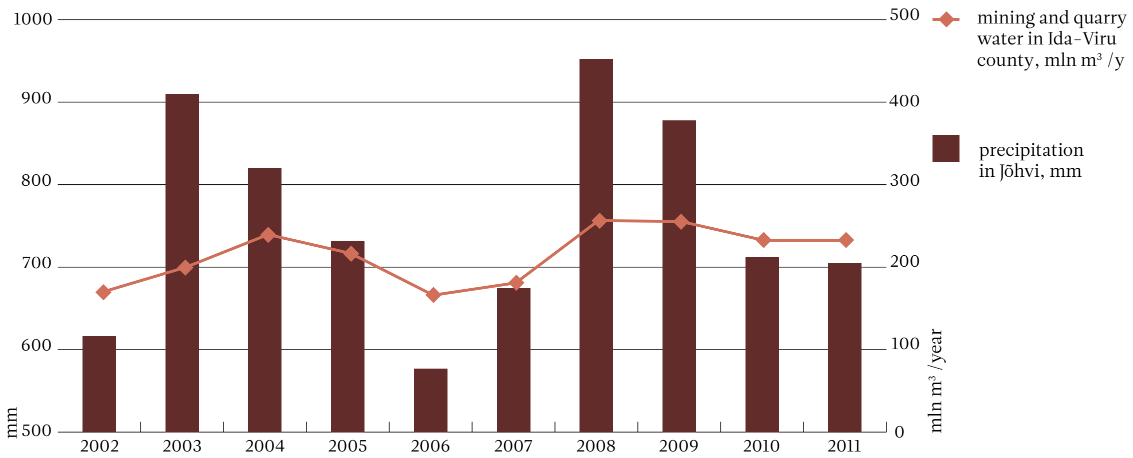


Figure 2.22. Precipitation in Jõhvi meteorological station compared to mining and quarry water discharged in Ida-Viru county. Data: ESTEA

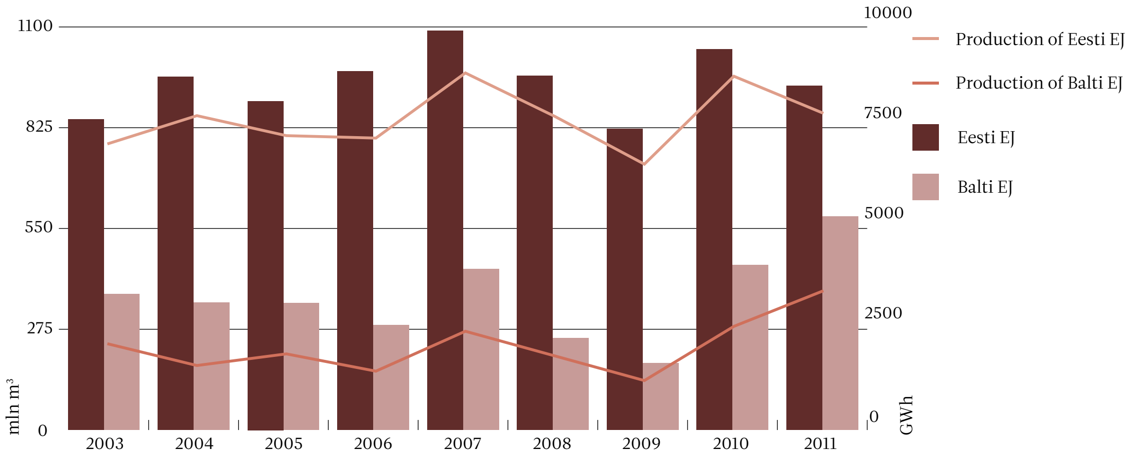


Figure 2.23. Consumption of cooling water and productivity by thermal power stations Balti EJ and Eesti EJ. Data: ESTEA.

2.3.5 Pollution load

Water pollution is a major environmental concern that has serious consequences. It may have a harmful effect on nature and human health. The condition of water bodies and recipients or the composition and volume of effluent discharged into recipients is monitored to determine the pollution load. Pollution charges are calculated based on the pollution load from the effluent discharged into the environment. Pollution taxes motivate companies to reduce pollution by implementing efficient measures, such as investing in environmentally friendly technology. Pollution load is determined based on the volume of effluent, concentration of pollutants and flow rate. For this purpose, water samples are taken.

Pollutants are discharged into aquatic environment from point sources, such as industrial facilities, waste water treatment plants and landfills, and from diffuse pollution sources, such as pesticides and fertilisers used in agriculture and domestic waste water. Pollution loads the mass or weight of pollutant transported in a specified unit of time from pollutant sources to a waterbody expressed as substance concentration multiplied with discharge. The organic pollution load can be expressed in terms of population equivalent (PE) – the pollution load produced in 24 hours by one person, whereas 1 PE = 60 g BOD_7 per day.

According to permits for the special use of water, the concentrations of the following substances in domestic water are monitored: BOD[2], suspended solids, total phosphorus, total nitrogen and COD[3] (normally determined in industrial waste water). 547.1 tonnes of organic substances (according to BOD_7), 1,121.8 tonnes of nitrogen and 99.7 tonnes of phosphorus were discharged to water bodies in 2011 (Figure 2.24). All agglomerations over 2,000 PE are important pollution sources. In 2011, the pollution load from such sources accounted for 74% of BOD_7, 84% of the total nitrogen and 75% of the total phosphorus load.

The threat of pollution has been reduced by the reconstruction of sewerage and waste water treatment plants as well as by high pollution taxes. After 2008, the pollution load mainly decreased due to reconstruction of Kohtla-Järve waste water treatment plant in 2009. The reconstructed plant in Kohtla-Järve also has the function of nitrogen removal. The efficiency of nitrogen removal is directly related to the temperature of the waste water that is being treated (the temperature is significantly lower in winter than in other seasons. If the temperature of waste water is below 12 °C the efficiency of treatment decreases.

117.0 million m³ of waste water was generated in Estonia in 2011. 81% or 95.1 million m³ of this amount came from agglomerations over 2,000 PE. 43% of waste water originated from Tallinn, 7% from Tartu and 6% from Kohtla-Järve. The amount of waste water has been stable in recent years (fluctuating no more than 0.3%). The minimum waste water amount in 2006 was caused by an exceptionally long dry period. In 2008, the amount of waste water was bigger because of a very rainy autumn and new sewerages connected to the main network in Tallinn. The amount of waste water has decreased after 2008 by 3%, mainly due to the economic depression and smaller amount of precipitation.

Waste water is treated at the location where it is generated. Domestic and industrial waste waters mainly undergo biological or biochemical treatment with the removal of phosphorus and/or nitrogen (Figure 2.25). Currently, nearly 84% of domestic and industrial waste water undergoes tertiary treatment (Figure 2.26). About 2% of waste water was treated mechanically in 2011.

Water discharge and pollution load figures do not include cooling water, which does not need to be treated, and water used by fish farms that is considered as unpolluted. The figures also do not include storm water discharges. A small part of mining water also does not need treatment. While the amounts of mining water are huge, they contain relatively little pollutants (BOD, total phosphorus and total nitrogen) and their concentrations are close to that of river water. Mining water contains big amounts of sulphates, chlorides and suspended matter. The concentration of sulphate in mining water can reach up to 500 mg/l (natural concentration *ca* 20 mg/l). Sulphates are not directly harmful to the water environment; besides, there is no available sulphate removal technology that could be used in quarries and mines. After sedimentation, mining waters are discharged into natural water bodies. In 2011, about 0.1% of water that needed treatment was discharged into water bodies untreated.

In 2008, new agglomerations were designated in Estonia. There are 59 agglomerations over 2,000 PE, including 37 agglomerations with a population between 2,000 and 10,000 PE and 22 agglomerations with a population over 10,000 PE: Tallinn, Kohtla-Järve, Tartu, Pärnu, Narva, Rakvere, Kehra, Põlva, Kuressaare, Viljandi, Ahtme, Valga, Sillamäe, Võru, Põltsamaa, Haapsalu, Paide, Rapla, Haljala, Jõhvi, Järva-Jaani and Keila (Figure 2.29). As of today, the deadlines for the implementation of the Urban Waste Water Treatment Directive – 31 December 2009 for agglomerations over 10,000 PE and 31 December 2010 for those between 2,000 and 10,000 PE – have expired. It is acknowledged that the requirements of the EU Urban Waste Water Treatment Directive are very stringent. Therefore, sewerage and waste water treatment facilities have been built and reconstructed intensively over the last decade. Recently, new sewerage facilities were built or the existing ones reconstructed in Pärnu, Keila, Narva, Otepää, Paide and Põltsamaa as well as in some other towns. In addition, a number of new waste water treatment facilities have been built and the existing ones have been renovated. Räpina, Kehra, Järva-Jaani, Kose, Türi and Võru have new WWTPs. In Haljala and Tõrva, the construction of WWTPs has not been completed yet.

2 BOD7, or biochemical oxygen demand, is the amount of oxygen (expressed in milligrams) needed by microbes to break down organic material present in one litre of water over seven days
3 COD, or chemical oxygen demand, is the amount of oxygen corresponding to the amount of an oxidant ($K_2Cr_2O_7$, $KMnO_4$, $K_2S_2O_8$ etc.) consumed by dissolved and suspended organic matter present in a sample under certain predetermined conditions.

Waste water treatment facilities have been renovated in Kohtla-Järve, Kuressaare, Vändra, Elva, Otepää, Kadrina, Tamsalu, Põlva and Aruküla; those in Tapa and Rakvere are under development. After the completion of the project, i.e. by the end of 2013, households in all larger settlements should have an opportunity to connect to a modern sewerage system in order to have their waste water treated as required. This should ensure the proper treatment of waste water for decades, because systems and treatment facilities are designed to be operational for at least 30 years. This is the biggest investment in the development of the water infrastructure in Estonia.

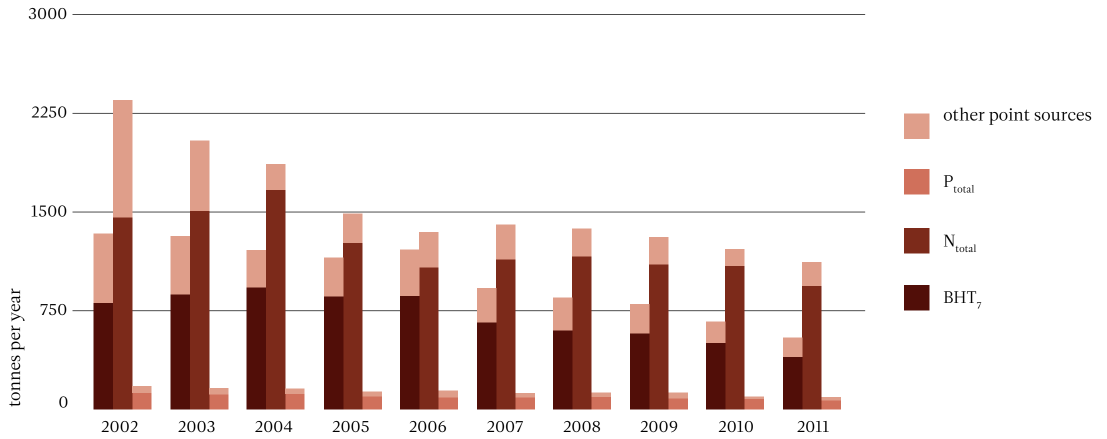


Figure 2.24 . Pollution loads from agglomerations over 2,000 PE and other point sources in 2002–2011.

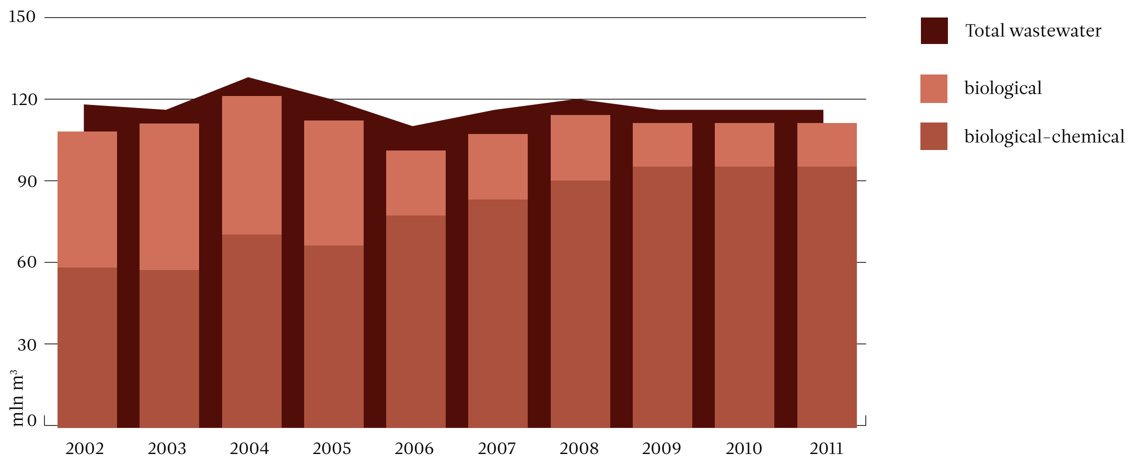


Figure 2.25. Treatment of wastewater in 2002–2011.

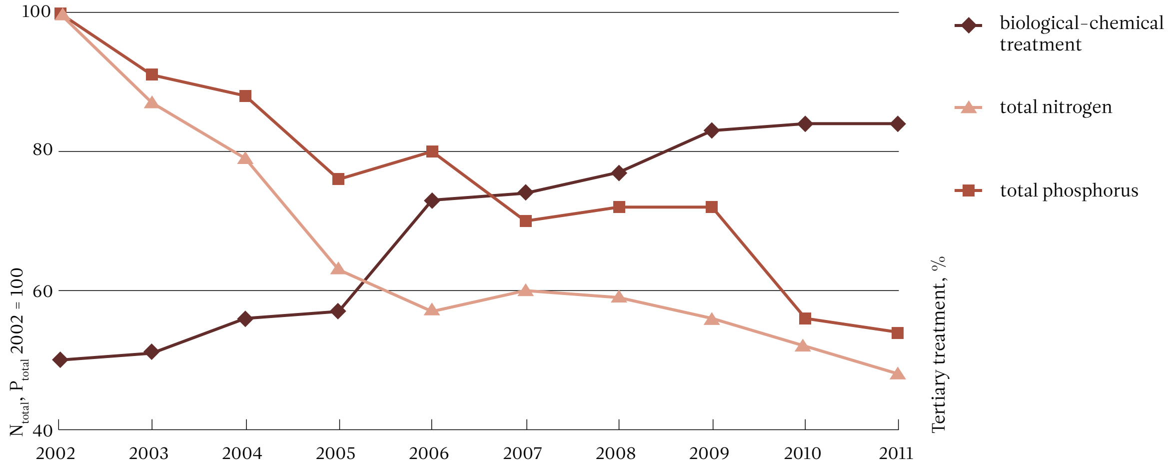


Figure 2.26. Decrease in pollution loads due to the use of higher level treatment in 2002–2011.

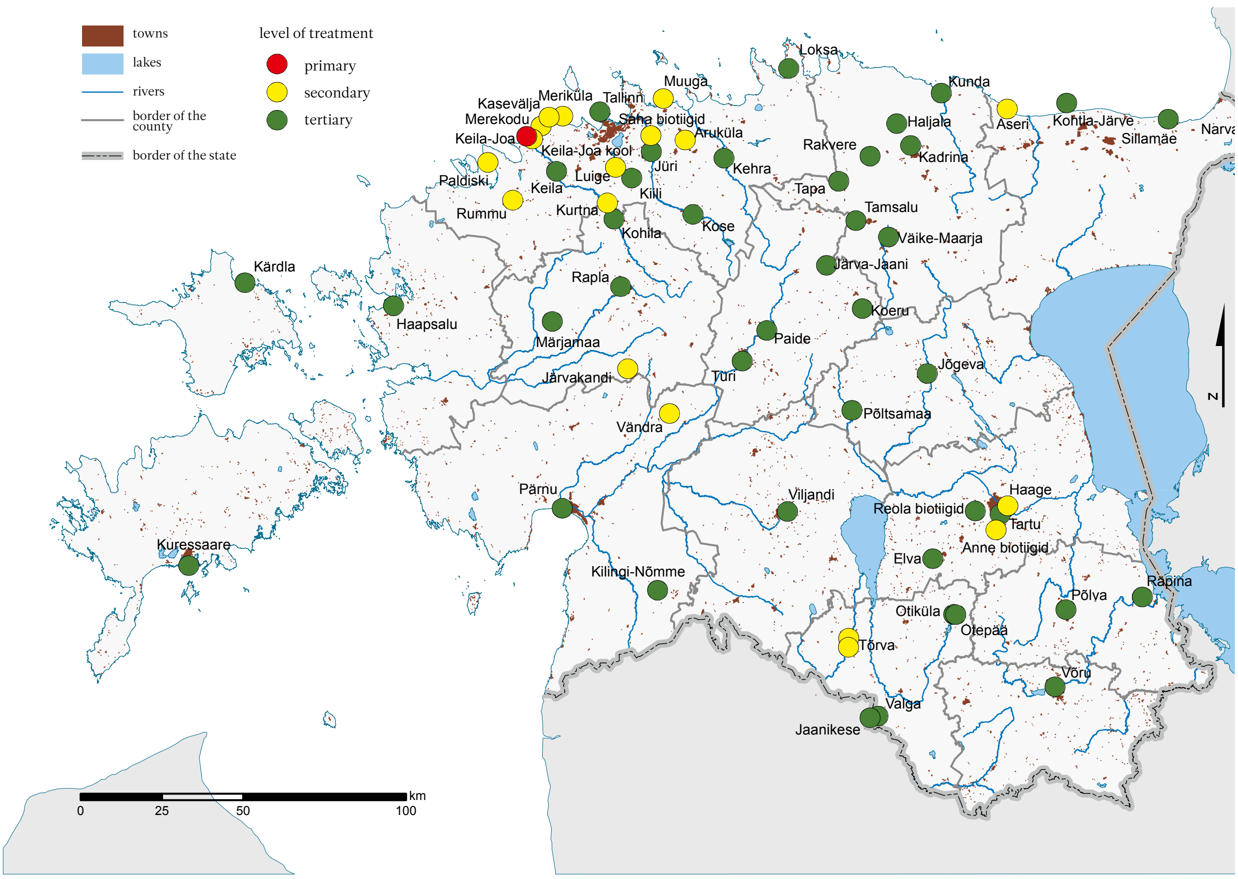


Figure 2.27. Treatment of wastewater in 2011 in agglomerations of more than 2,000 PE.

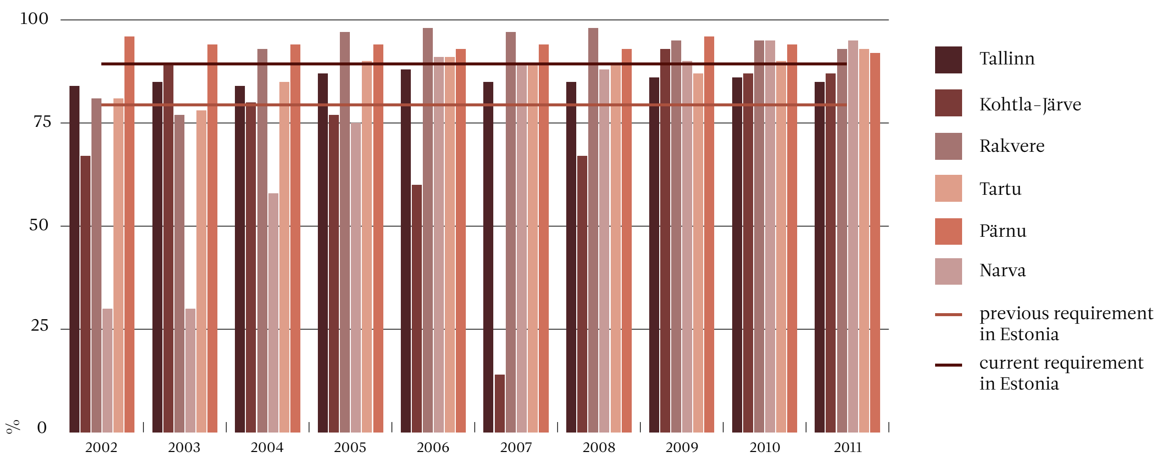


Figure 2.28. Efficiency of wastewater treatment plants over 100,000 PE (%) according to P_{total} in 2002–2011.

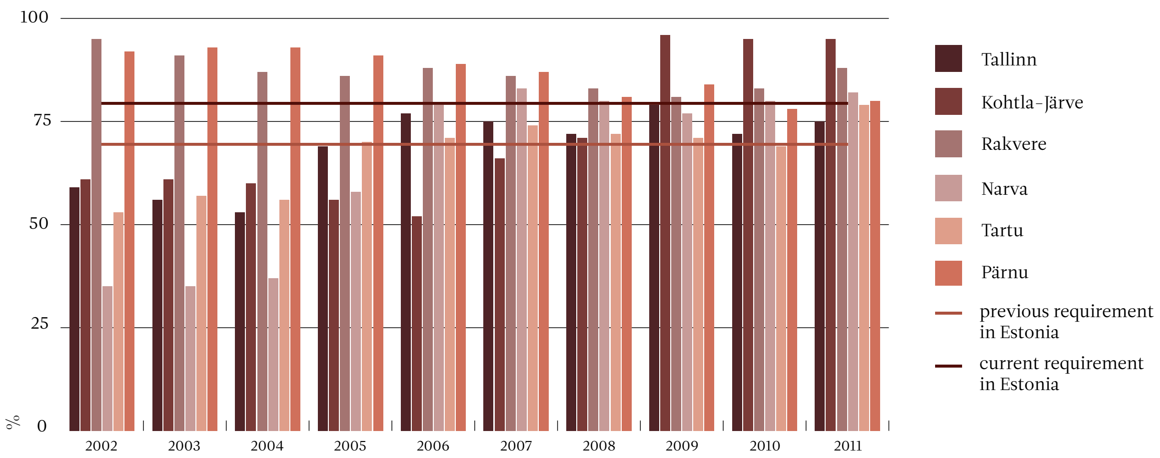


Figure 2.29. Efficiency of wastewater treatment plants over 100,000 PE (%) according to N_{total} in 2002–2011.

2.3.6 Groundwater status

The status of groundwater is assessed by bodies of groundwater. There are 25 bodies of groundwater (differentiated by main aquifers), the status of which is assessed according to a number of criteria. The status of a body of groundwater is determined according to the concentrations of Cl, SO_4, phenols and oil products as well as the concentrations of F and Fe (which are important indicators of the quality of drinking water).

While the average sulphate and chloride concentrations are below the permitted limits in all bodies of groundwater (Figure 2.30), some wells were identified in 2009–2012 where the concentration of chloride was between 600 and 800 mg/l. In most cases, such high Cl concentrations are of natural origin. The reason for the high concentration of chloride in the Voronka groundwater body in Sillamäe should be investigated separately — it may be caused by sea water intrusion to the body of groundwater. There were also single wells with sulphate concentrations between 300 and 600 mg/l. The average concentrations of iron and fluoride were below the limit value, although some samples showed higher concentrations. The average concentrations of oil products exceeded the established limits in 2009 and 2010 in the groundwater bodies of Ida-Viru, Ida-Viru oil shale Ordovician, Middle and Lower Devonian, Vasavere and Meltsiveski Quaternary (Figure 2.31). The high concentrations of oil products in these groundwater bodies may have been caused by the residual pollution areas near sampling points. The concentrations of oil products in these groundwater bodies were significantly lower in 2011 and 2012, because some of the residual pollution sources have been cleaned up completely and others will be cleaned. The average concentrations of phenols also exceeded the limit values in these groundwater bodies.

In general, the status of Estonian aquifers is good. The status of the groundwater body in Ida-Viru County and in the region of the oil shale deposit is poor because the concentrations of sulphates, phenols and oil products as well as the mineral content and hardness of water exceeds the limit values. Local pollution of groundwater has also occurred in unprotected Silurian-Ordovician and Quaternary groundwater bodies across Estonia.

In most groundwater bodies the concentration of nitrates is below 50 mg/l. In Central Estonia, where the sediment cover is very thin, a nitrate vulnerable zone (NVZ) has been designated in order to protect groundwater. The NVZ comprises Pandivere and Adavere-Põltsamaa areas. The quality of Silurian-Ordovician groundwater in the nitrate vulnerable zone (based on the concentration of NO_3) has varied significantly over the last two decades. This might be caused by the use of fertilisers in intensive agricultural production. In 1995–2006, nitrate concentration was stable, remaining in Pandivere region at 20 mg/l (Figure 2.32).

However, the nitrate concentration has increased significantly since 2006. The leaching of nitrates from soil to groundwater and surface water was facilitated by the mild winter of 2007 and the subsequent wet summer of 2008. Intensive agricultural production is also an important factor. While the concentration of nitrates decreased in the Pandivere NVZ in 2009–2010, a growing trend has been observed since 2011. Comparing periods of 2004–2007 and 2008–2011, we can see that the concentration of nitrates has increased significantly in about half of the NVZ monitoring sites (Figure 2.33). The concentration of nitrates decreased in 23% of all monitoring sites. However, the reliability of changes in nitrate concentrations in Adavere-Põltsamaa NVZ is quite low as there are too few common monitoring sites during different monitoring periods. While the samples taken in 2008–2010 show a declining trend in the concentration of nitrates, the use of fertilisers and tillage have not decreased. Therefore, the results on decreasing trend of NO_3 concentration might not be completely reliable.

From the perspective of water supply, it is important to maintain a good status of uppermost groundwater in order to avoid taking water from deeper layers where the background concentrations of fluoride and radionuclides are higher. Also, it is more expensive to take water from deeper layers and to clean it.

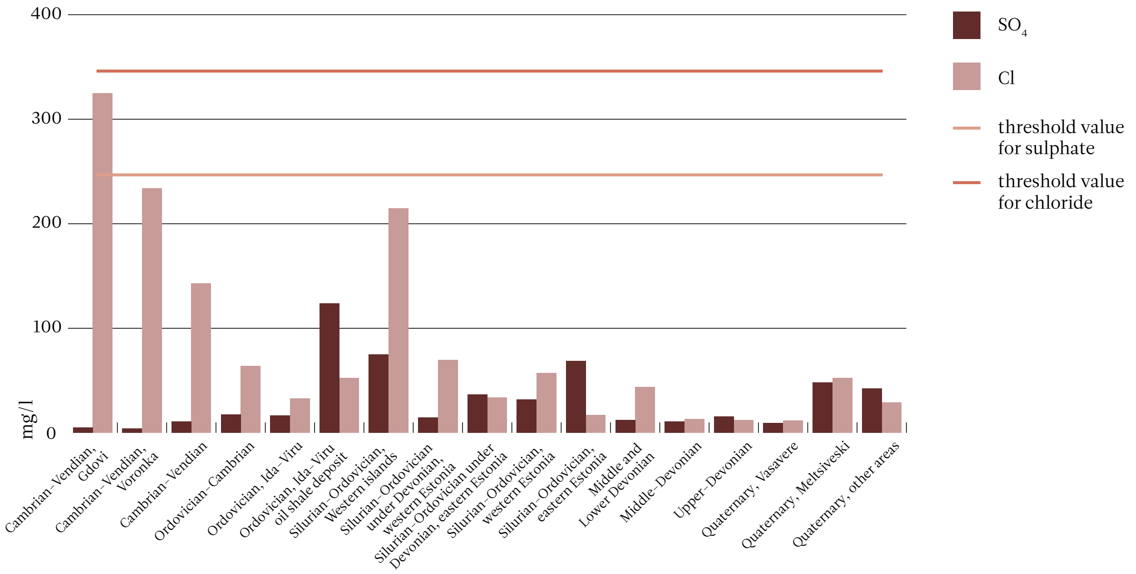


Figure 2.30. Average sulphate and chloride concentrations in aquifers in 2009–2012. Data: ESTEA.

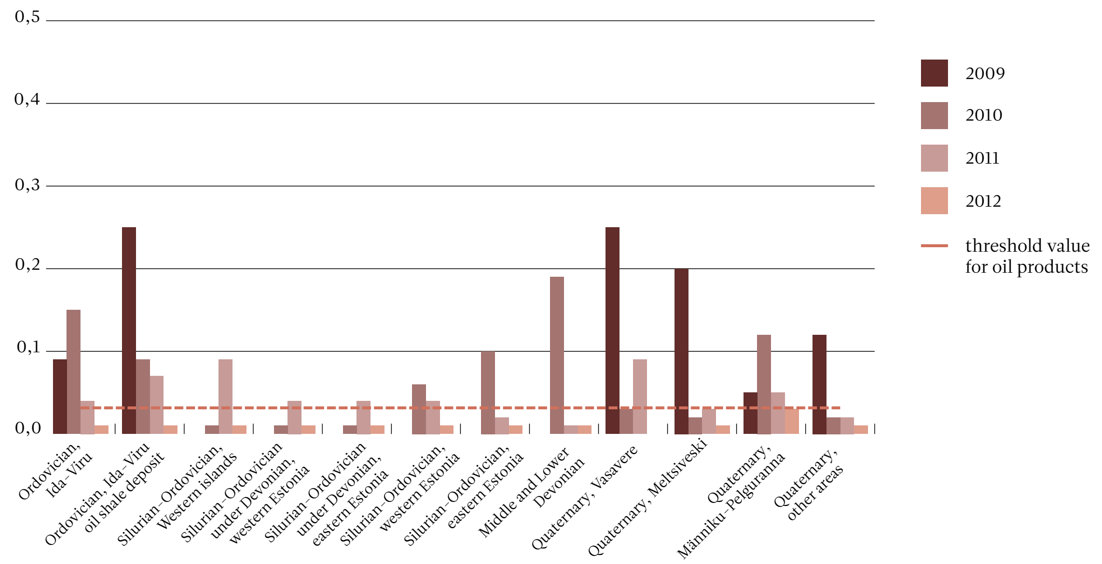


Figure 2.31. Aquifers where concentration of oil products have been determined and the average values of oil products in 2009–2012.

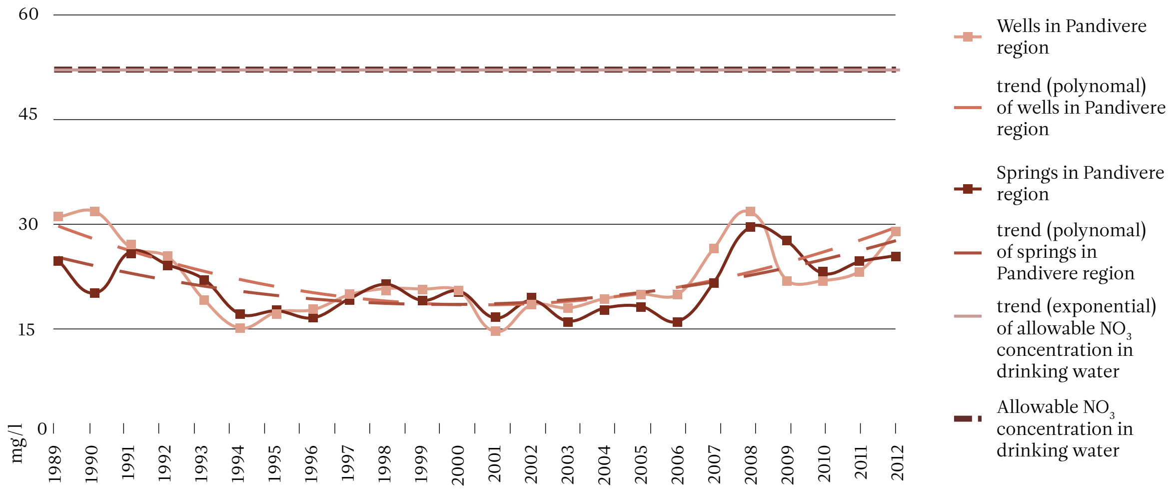


Figure 2.32. Changes in nitrate ion concentrations in upper groundwater layers in Pandivere and Adavere–Põltsamaa NVZ in 1989–2012.

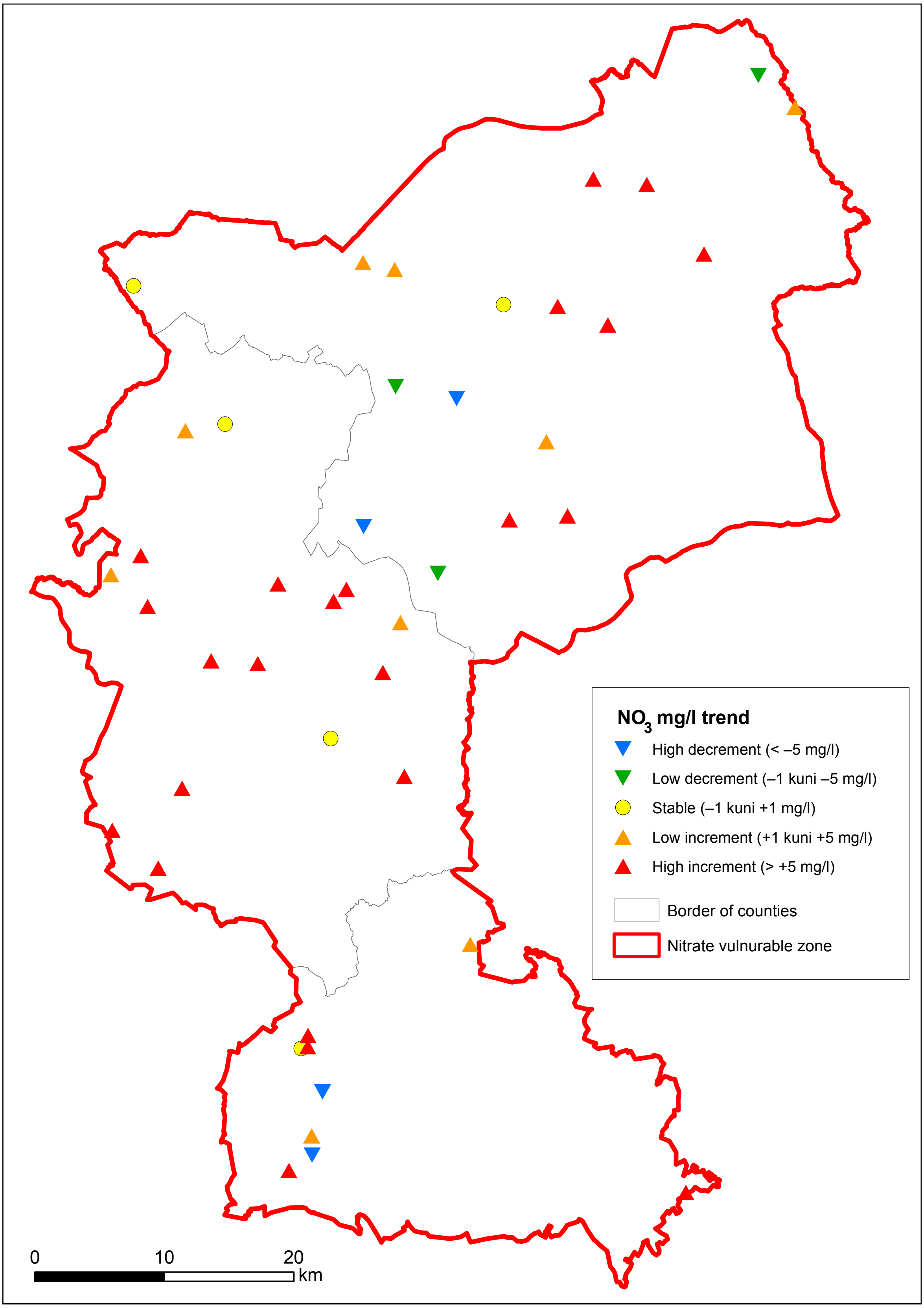


Figure 2.33. Changes in the average nitrate concentrations in monitoring sites of NVZ in 2008–2011 compared to 2004–2007. Data: ESTEA.

2.3.7 Assessing the status of surface water bodies

Water Framework Directive states that water is not a commercial product like any other but, rather, a heritage that must be protected, defended and treated, and that Member States should achieve the objective of at least good status of groundwater, surface water, coastal water and transitional water by 2015.

As the aquatic environment is mainly affected by human activities, the status of water is mainly deteriorated by eutrophication and hydromorphological changes (land improvement, impoundment of water bodies by dams and alteration of water regime). Hazardous substances are a problem in few bodies of water. This overview includes an assessment of the status of bodies of water in recent years.

The status of surface water bodies is assessed based on two components — ecological and chemical indicators. The ecological status of a water body is characterised by biological, hydromorphological and physical-chemical quality elements. The chemical status of a water body is characterised by the concentrations of 33 hazardous substances listed in the Annex X in Water Framework Directive. All elements and indicators characterising the ecological status of a water body are established by Regulation No 44 of the Minister for the Environment on surface water bodies.[4]

The ecological status is determined on a five-point scale:

- vhigh – no or very low human pressure;
- good – low human pressure;
- moderate – moderate human pressure;
- poor – high human pressure;
- bad – very high human pressure.

The chemical status is determined on a two-point scale:

- good — no hazardous substances or the concentrations of pollutants do not exceed the established limit values;
- bad — the concentrations of pollutants exceed the established limit values.

The final status of a water body is determined on the basis of the worst rated quality element (one-out-all-out-principle).

4 Regulation No 44 of 28 July 2009 of the Minister for the Environment "Procedure for defining surface water bodies and the list of surface water bodies for which the status class is to be determined; status classes of surface water bodies and the corresponding quality indicator values as well as the procedure for assigning water bodies to status classes".

2.3.8 The status of Estonian coastal waters

The Estonian coastal sea is divided into 16 bodies of water according to their physical and ecological conditions; the status of these bodies of water is determined based on four quality elements — physical-chemical parameters, phytoplankton, macroinveretebrates and benthic flora. There are two types of coastal sea monitoring activities: operational and surveillance monitoring. Operational monitoring is conducted in the four coastal water bodies with the highest human pressure — Narva-Kunda, Muuga-Tallinna-Kakumäe, Haapsalu and Pärnu bays. Operational monitoring is carried out 10–12 times a year and it covers all biological and physical-chemical parameters on which the water quality classification is based. The status of the remaining 12 coastal bodies of water is assessed 4–6 times a year during a six-year monitoring cycle. The coastal waters of Hiiu Shallows, Eru-Käsmu Bay, Hara Bay, Kassari-Õunaku Bay, Pakri Bay, Kihelkonna Bay, Väinameri Sea and Soela Strait were monitored in 2009–2011. The assessment of the status of Kolga Bay, the Gulf of Riga, Matsalu Bay and Väike väin Strait is based on the monitoring data from earlier years.

None of the 16 coastal bodies of water has a high ecological status; the status of Hiiu shallows and Kihelkonna Bay (located to the west of the islands) is good. The status of Haapsalu Bay is assessed as bad. Although the construction of the waste water treatment plant in Haapsalu was completed in 1998, the pollution that has accumulated in the bottom sediments of Haapsalu Bay is still having a negative effect because of the shallowness and poor water circulation in the bay. The status of rest of the coastal water bodies is poor (Figure 2.34).

As regards the status of various groups of biota, the status of large aquatic macroinvertebrates is good. The status of benthic vegetation is good, with the exception of Haapsalu Bay and Narva-Kunda Bay where it is poor.

The status of coastal waters is lowered by the moderate status of phytoplankton and water quality. The status of phytoplankton is good only in Hiiu Shallows and Kihelkonna Bay; in Narva-Kunda Bay, the status of phytoplankton is between good/moderate, in Haapsalu Bay it is poor and in other coastal waters moderate.

Water quality or the concentration of nutrients and transparency of water are not taken into account when assessing the ecological status of coastal waters; these indicators are considered to be supporting elements. Although the water of Narva-Kunda and Tallinn-Muuga coastal bodies of water has been assessed as good in some years, the overall status of coastal waters is moderate, except for Haapsalu Bay, which has been assessed as poor.

The overall poor status of Estonian coastal waters is caused by the nutrient loads from the territory of Estonia and also from neighbouring countries as well as the pollution that has accumulated in the Baltic Sea over decades – the whole Baltic Sea is heavily eutrophicated.

It is difficult to assess the trends in the quality and ecological status of water and to link it with changes in pressure factors because of weather changes, differences in water circulation and the inertness of the ecosystem. The last five years have seen more precipitation than the average and, therefore, rivers have carried more nutrients, in particular nitrogen, to coastal waters. An increased nitrogen concentration has been observed in Muuga-Tallinna-Kakumäe bays and Narva-Kunda bays in recent years. The highest phosphorus concentrations were measured in the early 2000s. Since then, phosphorus content has decreased slightly. Nitrogen concentration in Pärnu Bay has been stable, while the decrease in the content of phosphorus, which started in the 1990s, has stopped.

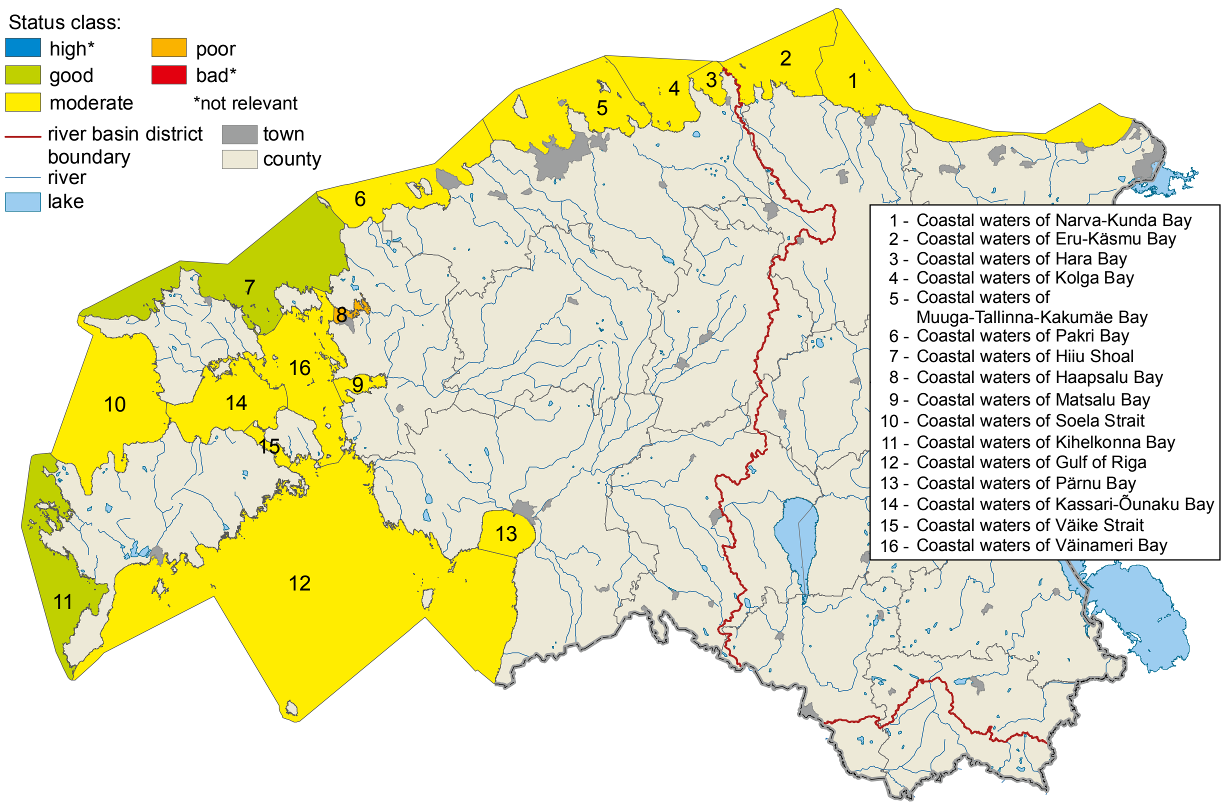


Figure 2.34. Assessment of the ecological statuscoastal water bodies in 2009–2011. Data: ESTEA.

2.3.9 Status of lakes

The ecological status of lakes was assessed on the basis of biological (phytoplankton, phytobenthos, macrophytes and macroinvertebrates) and physical-chemical (nutrients, transparency, temperature, etc.) quality indicators. The status of fish was not taken into account, as the class boundaries have still not been defined.

The assessment of the status of lakes provided in this review concerns the period 2007–2012. On the basis of the assessment, the status of the majority of Estonian lakes is either good or moderate (Figures 2.35 and 2.36). The status of 63% of lakes is good. The following four lakes (of 95 monitored lakes) were not taken into account: Kensti reservoir — drained; Laialepa Bay, Linnulaht Bay and lake Leego — there are no data for the period concerned.

The ecological status of Lake Peipsi and Lake Pihkva continues to deteriorate. The status of Lake Peipsi is moderate and the status of Lake Pihkva is poor. The difference in the nutrient content in different parts of Lake Peipsi is increasing. The flow of nutrients from the Velikaya River is still high and this increases the blue-green algae biomass. The results of sediment phosphorus resuspension in 2012 showed that the internal phosphorus pressure to Lake Peipsi exceeded the external pressure multiple times. The high water level of recent years has decreased the number of species that like humid conditions and grow in shallow water because their habitats are very limited. The total point source pollution in the northwest meander of Lake Peipsi has caused blue-green algae blooms and the abundance of filamentous algae. However, the volume of zooplankton is decreasing. The water transparency in Lake Pihkva is very bad. The status of the lake has also deteriorated due to its increased phosphorus concentration — phosphorus is probably released also from the bottom sediments of the lake.

The status of Narva reservoir has been assessed as poor. Water directed to the reservoir from the River Plyussa (from Russian side) plays a major role here. The quality of water has improved in recent years - the average concentrations of nutrients have clearly decreased (as compared with long-term data). The concentrations of phytoplankton biomass and Chl *a* indicate that Narva reservoir remains at a moderately eutrophic level. The share of zooplankton is very small and its quality as fish food is low.

The status of Lake Võrtsjärv is good. The water level in Lake Võrtsjärv has been above the average since 2008, which has had a positive effect on the lake's ecosystem. Milder winters and a decreased inflow of nutrients have improved the oxygen conditions in the lake. The pollution load on Lake Võrtsjärv and concentrations of total phosphorus have steadily decreased over the last 20 years. The diversity of phytoplankton has increased, while the amount of algae biomass (including blue-green algae) has decreased. The results of the monitoring of large invertebrates also indicate that the status of the lake is improving — the number and biomass of some species (including indicator species) have increased. The incidence of Eurasian watermilfoil (*Myriophyllum spicatum L.*) in the northern and eastern part of the lake has decreased, which also indicates that the status of the lake is improving.

The status of small lakes is mostly good. The assessment concerns 87 small lakes. Of all assessed lakes, 56 had a high status, 27 had a moderate status and the status of one lake was poor.

The lakes with high status are Lake Kirikulaht and Lake Karu in the Western islands riverbasin subdistrict and Lake Saadjärv in the Peipsi riverbasin subdistrict. The status of Lake Harku is poor; the lake also has the worst phytoplankton and Chl *a* indicators. None of the Estonian lakes status is bad.

Based on P_{tot}, Chl *a* and macroinvertebrates, nearly 30% of Estonian lakes are in a very good condition — their status is good or high. Apart from the Secchi disc transparency, 70% of all other parameters were either good or high.

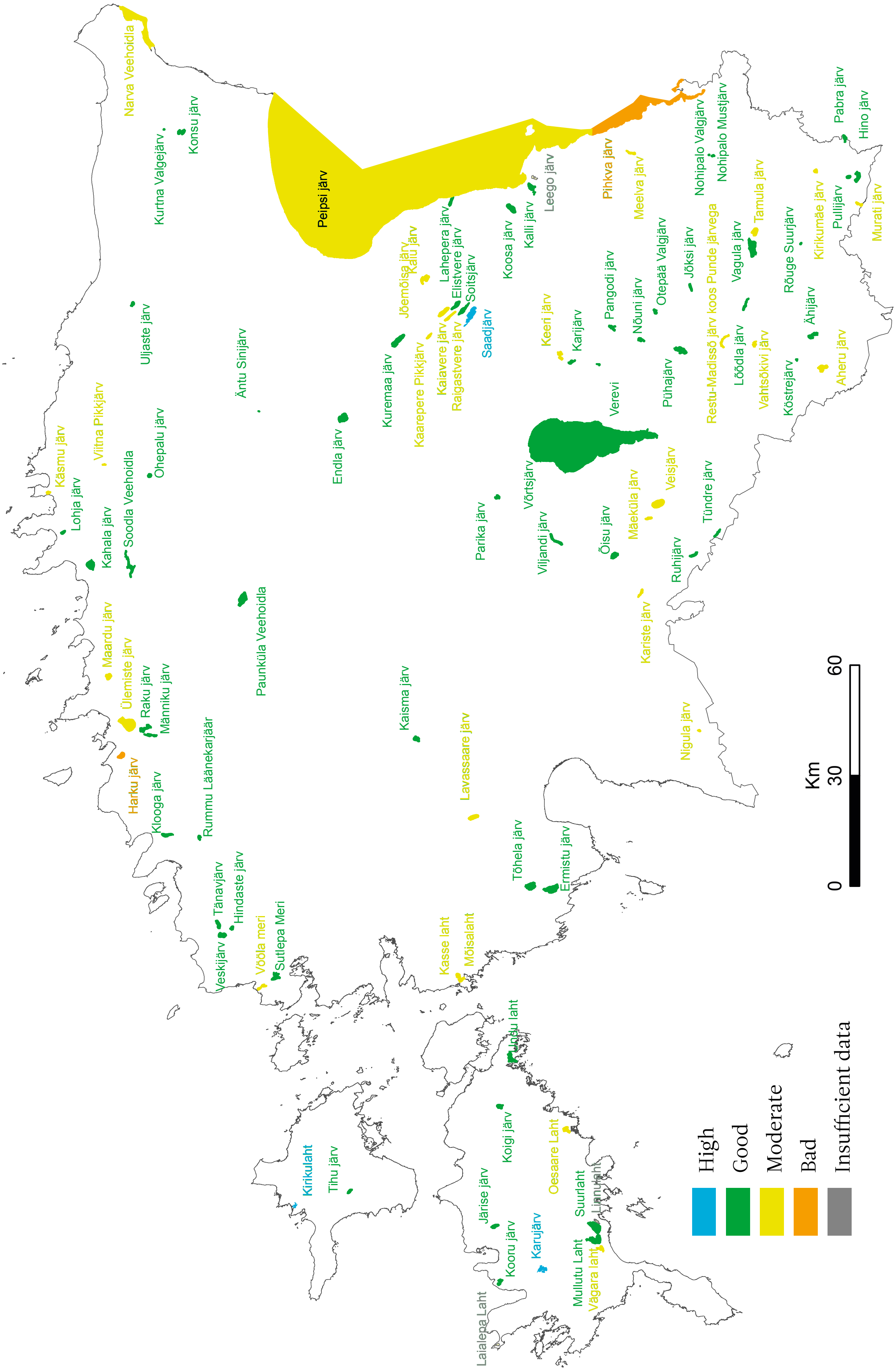


Figure 2.35. Ecological status of lakes in 2007–2012. Data: ESTEA.

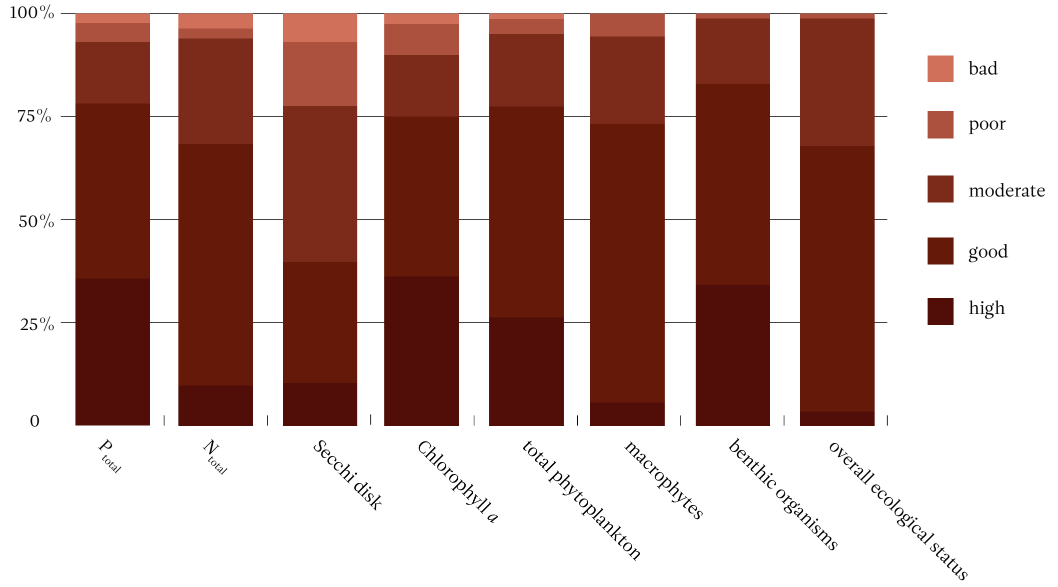


Figure 3.36. Ecological status of Estonian small lakes, 2007–2012. Data: ESTEA.

2.3.10 Status of rivers

Based on the requirements of the Water Framework Directive (WFD), Estonian rivers, streams and ditches are divided into 639 fluvial bodies of water. Fluvial bodies of water are watercourses with a catchment area of more than 25 km^2. The ecological status of bodies of water is assessed based on the following criteria: diatom, or phytobenthos, macrophytes, macroinvertebrates, fish and the quality of water. The overall status is determined according to the worst quality element.

The status of watercourses was assessed on the basis of monitoring data or, in the absence of such data, on the basis of an expert opinion on pressure factors. Comprehensive monitoring data or the data that characterised at least one biological quality element were available for 470 watercourses (74%). The status of the remaining 169 watercourses (mainly smaller brooks and ditches) was determined on the basis of expert opinions.

The ecological status of bodies of water has been assessed according to the methodology laid down by WFD for a few years. The results of the first assessment of all bodies of water was published in the previous environmental review in 2009 (based on the monitoring data collected by 2008). The last four years have added a significant amount of monitoring data (Table 2.1). In recent years, the monitoring has focused on unmonitored bodies of water where previous status assessments are with low reliability.

Table 2.1. Assessment of ecological status of Estonian fluvial bodies of water.

	2008	2012
Water quality*	50	323
Phytobenthos	104	234
Macrophytes**	0	173
Macroinvertebrates	366	438
Fish	317	313
Expert opinion	197	169
Overall ecological status	641	639

* In 2008, only the quality of water in watercourses included in the national programme for the hydrochemical monitoring of rivers was assessed.
** The status of macrophytes was not assessed in 2008.

A comparison of 2008 and 2012 assessment results is provided in Figure 2.37. To prepare a programme of measures in order to improve the status of bodies of water, the monitoring has been focused on bodies of waterwith moderatestatus during recent years. Therefore the assessments concerning quality of water, phytobenthos and macroinvertebrates are somewhat lower than in 2008. Therefore, the results should not be understood as a deterioration of the overall status of our rivers.

The quality of water in Estonian rivers has improved due to new and reconstructed waste water treatment plants (Figure 2.38).

Although the average phosphorus concentration decreased almost twofold during the period concerned, high phosphorus content continues to be a problem for Keila, Vääna, Pudisoo and Selja rivers. Compared with the excellent operation of large WWTPs, some small WWTPs are still inefficient; therefore, the status of some smaller rivers is either moderate or poor. Today, the only negative trend is the increasing nitrogen concentration in the rivers in the areas of intensive agriculture.

The fairly good water quality in Estonia's bodies of water is also confirmed by the assessment given to phytobenthos, which, of all biological quality elements, characterises the trophicity of a river the best. The status of 88% of rivers that were monitored was good or high. The situation is even better in terms of the condition of macrophytes – the status of 94% rivers that were monitored was good or high. It should be noted, however, that the status of macrophytes is only being monitored since 2009 and the relevant data are only available for about 1/4 of bodies of water.

The condition of the macroinvertebrates of our rivers is also predominantly good or high. Macroinvertebrates are sensitive to organic pollution, morphological changes of the river channel and fluctuations of the water level due to land improvement and hydroelectric power plants.

The status of fish fauna is relatively low. While the quality of water and phytobenthos characterise the part of the river upstream from the monitored stretch and macrophytes and macroinvertebrates characterise the part downstream from the monitored stretch, fish fauna is the only indicator showing the status of the whole river and its tributaries. Unlike other biological quality elements, fish is not stationary in a river; it uses different stretches during different seasons and different stages of life. Migratory species only swim to rivers to spawn and the river is the habitat of their juveniles. Therefore, fish fauna is affected most of all by barriers to migration, such as dams, and the existence or lack of fish passes. There are more than 1,000 dams (that raise the water level more than 0.3 m) in Estonian rivers. Besides obstructing the migration of fish, the construction of dams destroys rapids and valuable habitats; the water quality in reservoirs that are filled with sediments deteriorates and the uneven working regimes of hydroelectrical power stations have a negative effect on the rivers' hydrological regime. Reducing the negative impact of dams is expensive; therefore, only 40 dams have been removed or supplemented with a fish pass during the past five years.

The status of river fish and benthic fauna is also affected by land improvement. About 1/3 of the Estonian mainland is improved; half of this land is agricultural land and the other half is drained forest land. Land improvement has altered the shape (morphology) and flow regime of body of water. Straightened watercourses are directed, partially or fully, into new channels and their length has shortened. The runoff of water from drained areas is faster than natural, which makes flooding periods shorter and shallow-water periods drier. Draining lowers the water level in a river or stream; therefore, floodplains are flooded for a short time or the new watercourse has no floodplain at all. As a result, the number of fish that spawn on floodplains (pike, etc.) decreases or they disappear all together. The suspended matter that have been deposited on the floodplain are carried into the recipient river or lake/bay of the modified body of water, which in turn has a harmful effect on their status. The pebble/gravel bottom river stretches are replaced with a sandy bottom with muddy edges, while lakes and bays are filled with sediments.

Nowadays, there are few rivers in Estonia the ecological status of which is moderate or poor due to the low quality of water. In most cases, a poor or moderate status is caused by dams, land improvement and peat extraction. Such rivers are for example Pärnu, Navesti, Halliste, Kasari, Pirita, Loobu, Kunda, Pedja, Põltsamaa, Võhandu and Valgejõgi.

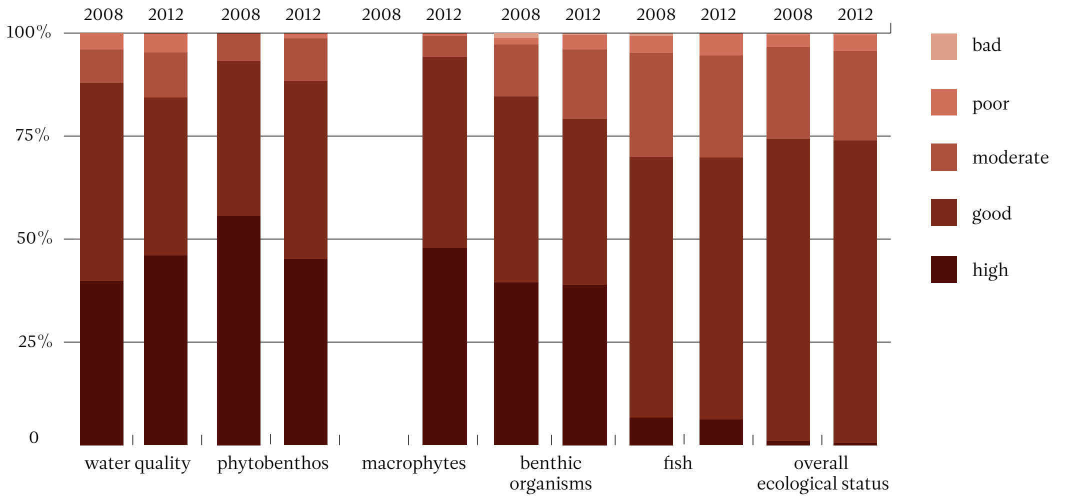


Figure 2.37. Comparison of water quality and biota indicators as well as the ecological status of Estonian bodies of water in 2008 and 2012. Data: ESTEA.

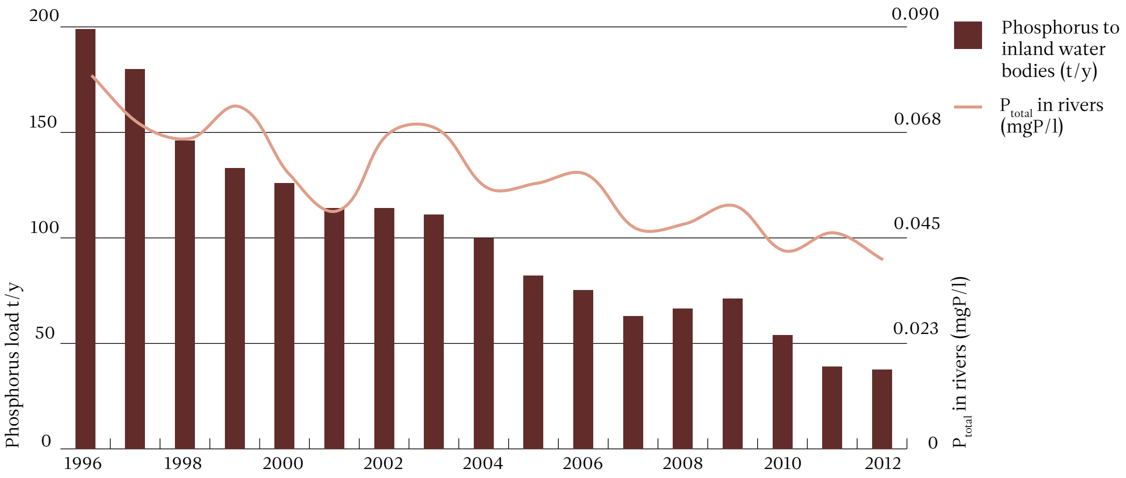


Figure 2.38. Total phosphorus loads from wastewater discharged to inland bodies of water from settlements and by industry; average phosphorus content of rivers included in the National Hydrochemical Monitoring Programme in 1996–2012.

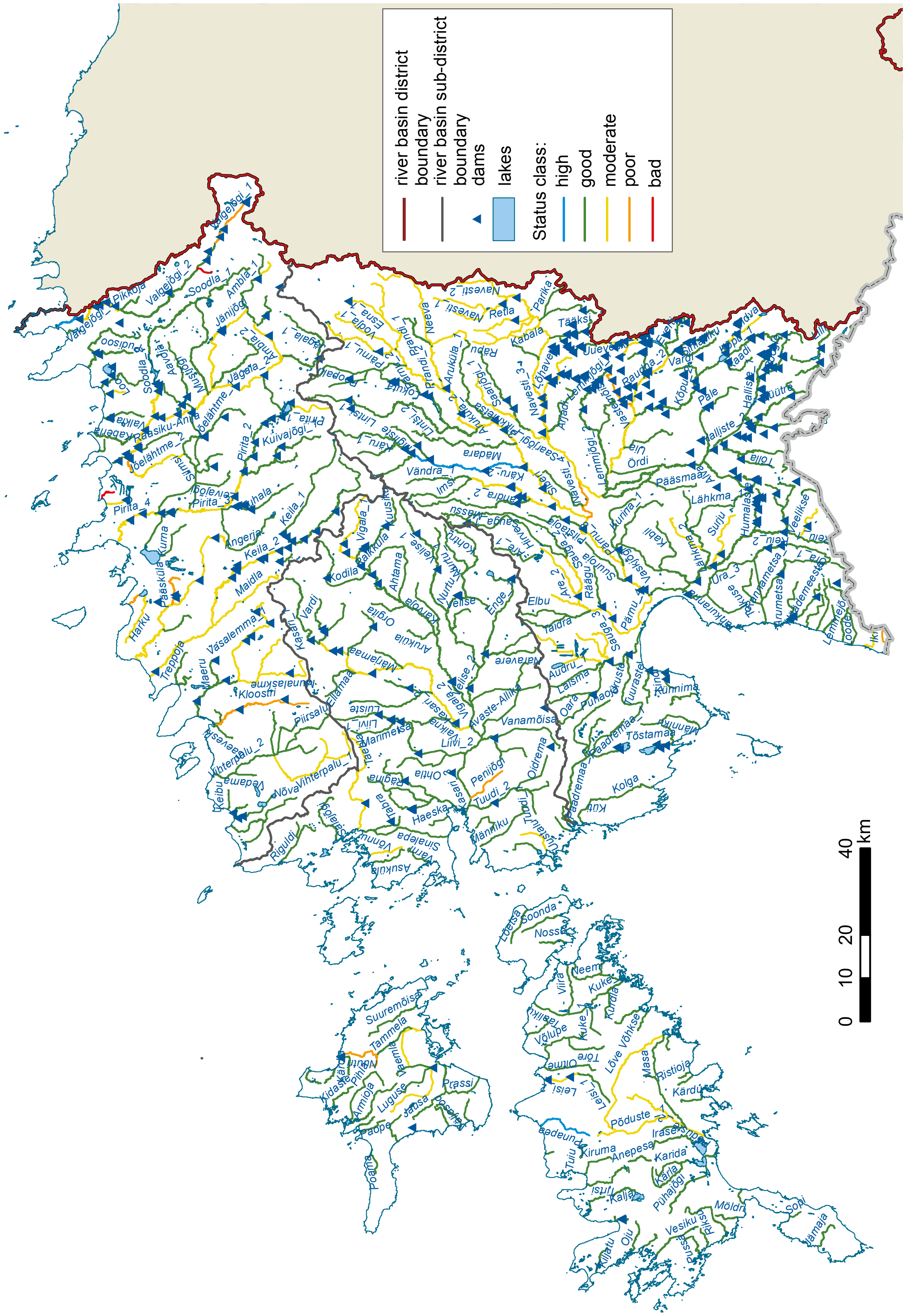


Figure 2.39. Ecological status of western Estonian watercourses. Data: ESTEA.

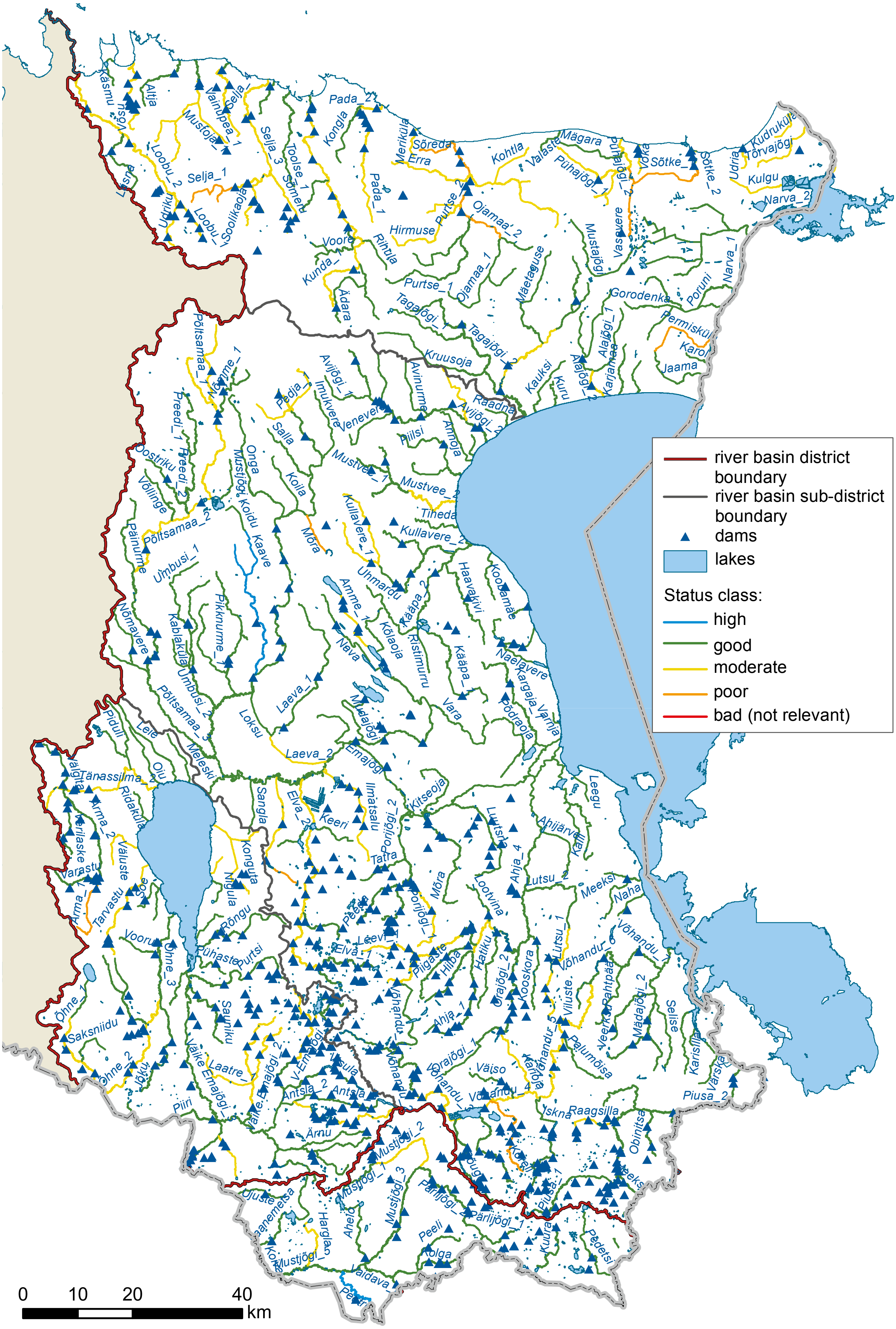


Figure 2.40. Ecological status of the bodies of water in the eastern Estonian and Koiva river basin districts. Data: ESTEA.

2.4 Fisheries

Nine countries have fishing interests in the Baltic Sea: Estonia, Denmark, Sweden, Finland, Russia, Latvia, Lithuania, Poland and Germany. In Estonia, fishing is governed by the **Fishing Act**. Besides fishing, the Act also regulates the collecting of aquatic plants and sets forth sanctions for the violation of fishing requirements. Fishing is regulated by the Fishing Rules, which determine the periods during which and the areas where fishing is prohibited, the requirements for the use of fishing gear, minimum fish sizes, by-catch conditions, etc. The fees for conservation of fishery resources are determined on the basis of the Environment Charges Act.

There are four internationally regulated fish species in the Baltic Sea: Baltic herring, sprat, cod and salmon. The specific standards for fishing for each of these species, such as quotas, fishing gear, prohibition periods and places, are established by EU regulations that are directly applicable in Estonia. Fisheries is one of the most thoroughly regulated fields in the European Union. However, those regulations do not concern fishing from inland waters. The management of fishing in Lake Peipsi, Lake Pskov and Lake Lämmijärv is based on an agreement between the Republic of Estonia and the Russian Federation. The agreement sets forth the maximum allowable catch and other measures for the conservation of fishery resources.

Estonia is a party to the United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks and to the Convention for the International Council for the Exploration of the Sea (ICES).

According to the Estonian Environmental Strategy 2030, the strategic objective of fisheries is to ensure the good condition of fishery resources and the diversity of fish species as well as to avoid the negative impacts of fishing on ecosystems.

2.4.1 Fish stocks

There are over 20,000 species of fish in the world. There are about 75 species of fish and cyclostomata in Estonia; 44 of them are fresh water fish, while the rest are migratory species.

Fish populations are in a good condition when the population is able to restock naturally in the existing environmental conditions, resisting pressure from commercial fishing, and the species maintain their characteristic age structure. Fishing has a negative effect on the ecosystem if undersize fish are caught, fish habitats are damaged, spawning is disturbed or marine mammals and birds perish in fishing nets.

In Estonia, fishing is divided into three major categories: fishing in the Baltic Sea, fishing in inland waters and deep-sea fishing.

2.4.2 Fish stocks in the Baltic Sea

The main commercial fish species in the Baltic Sea are Baltic herring, sprat, cod and salmon. Fishing for these species is regulated by establishing limits – international quotas – on catch. Quotas are established for each species annually either in tons or numbers quotas in terms of numbers are established for salmon, for instance).

After the record low of the early 2000s, the number of **Baltic herring** (the spawning stock biomass) has started to increase thanks to administrative measures and sustainable fishing. The Baltic herring stock in the Gulf of Riga is in a good condition, while the stock of **sprat** has declined. A possible reason for this is a change in the ecosystem (an increase in the number of cod). The stock of **cod** in the Baltic Sea has been at a low for some time now due to unfavourable environmental conditions and overfishing. The Council of Europe adopted a cod stocks management plan in 2007, according to which cod fishing in the Baltic Sea is to be phased out. As a result, the number of cod is increasing and the stock indicators have almost reached the long-term average. **Salmon** fishing in the Baltic Sea is primarily based on young fish raised in fish farms released into the sea, because the wild salmon population is still at an all-time low. The main reason is the obstruction of the migration of salmon, i.e. the construction of barrages and reduction of spawning areas. The resources of the most important fish species in coastal waters – **perch, perch pike and smelt** – are also not very big. These fish continue to be overfished. Besides the abovementioned species, one of the most popular commercial fishing targets is **flounder**. The flounder stocks are in good condition. The flounder stocks in the Baltic Sea increase 2–3 years after an inflow of saline water from the Atlantic, which will improve the spawning conditions. The fish stocks in the Väinameri Sea are still not doing well. The fishing intensity has decreased in the area, but the recovery of fish stocks is affected by the high natural mortality due to the increase in the cormorant (Phalacrocorax carbo) populations.

2.4.3 Fish stocks in inland water bodies

Fishing in inland water bodies is largely driven by fishing in Lake Peipsi and Lake Võrtsjärv. The primary fish species caught in Lake Peipsi is **perch pike**, the stock of which is relatively plentiful. Unfortunately, due to the poor food supply, it grows slowly. The stock of perch pike is not increasing because of the tight competition with perch and the scarcity of smelt and vendace. Therefore, perch pike catches have been low in recent years. The stocks of other major fish species, such as bream, pike and roach, are in a good condition and their catch has even increased. The abundance of cold-water fish species (whitefish, vendace, burbot and smelts) has decreased in the last decade due to unfavourable climatic conditions (lack of or transient ice cover, overheating of water in summer, etc.) and an abundance of predatory fish.

The stocks of commercially significant fish species in Lake Võrtsjärv are stable. The stocks of **eel**, which directly depend on restocking, have decreased.

2.4.4 The condition of deep-sea target species (in the Atlantic Ocean)

The stocks of **cod** in the north-eastern and south-eastern parts of the North Atlantic are either in a very good condition or have fully recovered. This strongly affects the stocks of other fish species. All other fish species in the South East Atlantic are languishing. Cod is a relatively abundant and aggressive species that overwhelms other fish species. The stocks of **shrimps** in the South East Atlantic are at a low. The main shrimp fishing area is closed and in other areas (L3, the Canada-Greenland exclusive economic zone) the stocks are decreasing. The condition redfish is also far from satisfactory, although it varies from region to region. The stocks of lesser halibut are low, yet steadily managed under a management plan.

2.4.5 Fisheries catch and fishing capacity

52,212 tonnes of fish were caught from the Baltic Sea, 2,969 tonnes from inland waters in 2012. The deep sea catch was 5,340 tonnes. The main species caught in the Baltic Sea were sprat and Baltic herring. The primary species caught in inland waters were bream, perch and perch pike. The main species fished in the oceans (the north-eastern, north-western and south-eastern Atlantic) are shrimp (about 60% of the total catch), squid, redfish and European hake as well as Greenland halibut, cod and skate.

Fish stocks as a natural capital must be kept in balance with the capital at human disposal, i.e. the fishing fleet and its fishing capacity. The excessive fishing capacity in the late 1990s put such pressure on fish stocks that the stocks have still not recovered. One means of regulating the fishing capacity is the register of fishing vessels, which was established in Estonia in 2004 and constitutes a part of the European Union's register of fishing vessels. The register includes all ships that fish in the oceans, the Baltic Sea, coastal and inland waters. Ships are divided into four categories according to the fishing area and the total length of the ship.

The indicator of fishing capacity is gross tonnage (GT), which gives an idea about the ship as a whole. Gross tonnage is not calculated for the fishing vessels on inland bodies of water, because the EU does not regulate fishing in inland waters. A total of 1,332 fishing vessels were entered in the register in 2004. As of 2006, the total number of ships was 1,411; 1,046 larger or smaller ships fished the Baltic Sea. In 2011 and 2012, the total number of ships on the Baltic Sea was 905 and 904, respectively. For example, as of 1 May 2004, the fishing capacity in the three categories (ships used on inland water bodies) was a total of 26,613 tonnes, which had fallen by the end of 2012 to 11,162 tonnes (figure 2.43). The fishing capacity has particularly declined in the Baltic Sea trawler category (4S1).

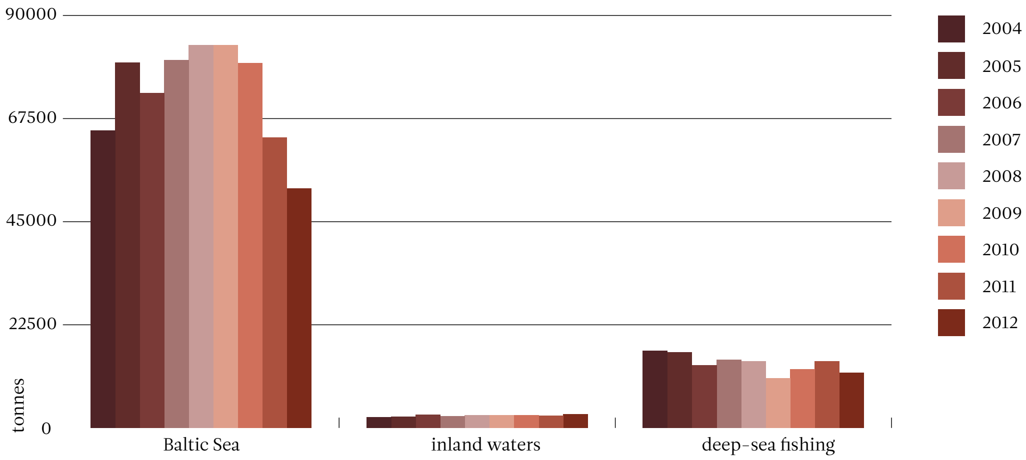


Figure 2.41. Fishery catch in 2009–2012. Note: Catches in inland waters do not include fish farming. Data: Statistics Estonia.

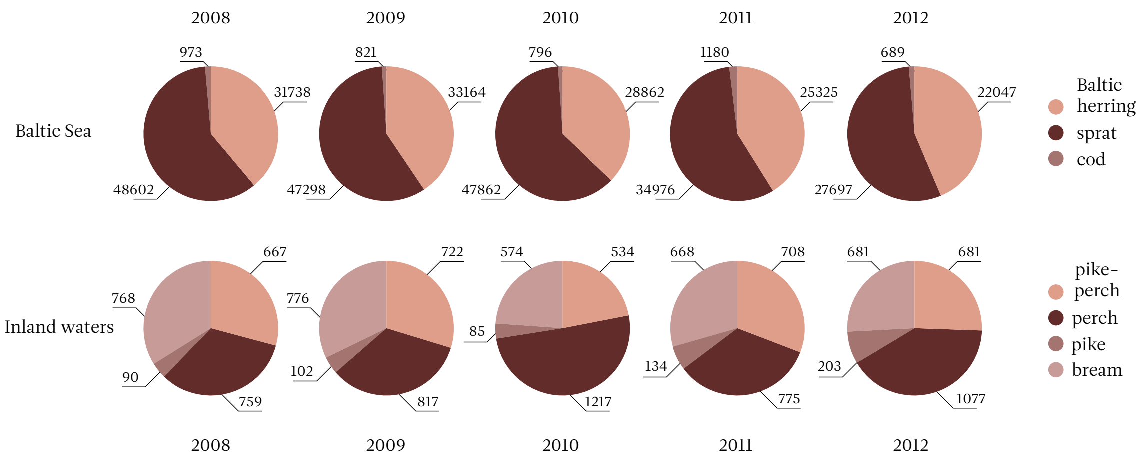


Figure 2.42. Fishing catches in 2009–2012. Baltic Sea and inland waters. Data: Ministry of Agriculture; Statistics Estonia.

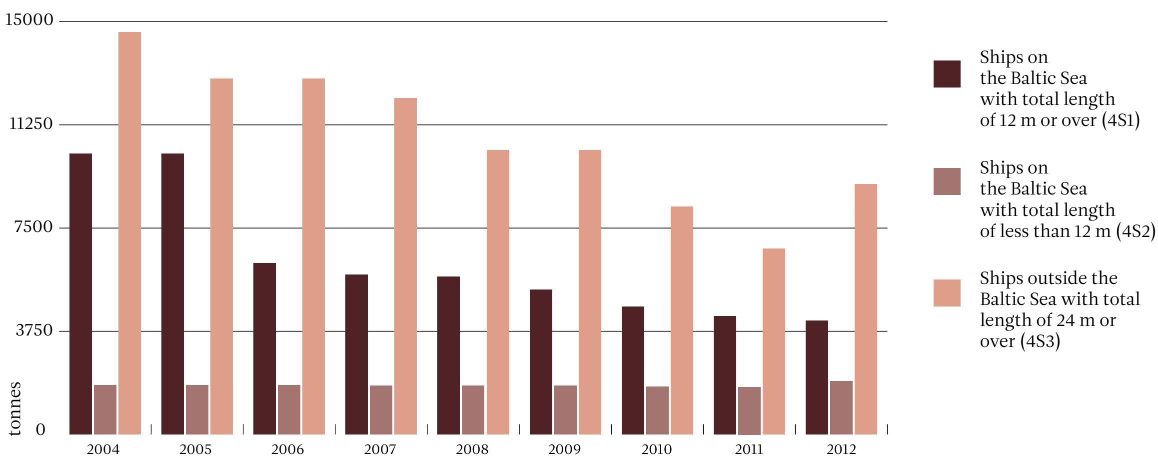


Figure 2.43. Fishing capacity of Baltic Sea fishing vessels in 2009–2012. Data: Ministry of Agriculture.

2.4.6 Fish stocking

As a result of overfishing or the lack of suitable spawning or feeding areas, many fish species are endangered and their ability to recover naturally is small. Such species include salmon, eel and whitefish. Wild populations of endangered fish species are restored or supplemented by taking inventories of spawning areas, replenishing fish stocks, ensuring access to habitats and restoring spawning areas. Fish stocking is the practice of raising fish in a hatchery and releasing them into a natural water body. One such fish species raised for the purpose of stocking is **salmon** (*Salmo salar*) — the most endangered fish species in Estonia. Poaching and weirs have significantly damaged the sensitive habitats that are required for salmon to spawn. The European Parliament and the Council are currently preparing a new multiannual plan for the Baltic salmon stock and the fisheries exploiting that stock. According to the plan, a favourable status of salmon stocks must be achieved in natural salmon rivers (the Kunda, Keila, Vasalemma and Pärnu rivers). The status of fish stocks is measured by the potential smolt production capacity. The wild smolt production should reach 50% of the potential smolt production capacity in five years after the entry into force of the regulation and 75% of the potential smolt production capacity in 10 years after the entry into force of the regulation.

Intensive salmon stocking began after the founding of the Põlula Fish Rearing Centre in 1994. Põlula is also the location of a gene bank for salmon from the River Kunda, which is the source for eggs for the production of smolt. A considerable number of salmon were tagged in the period 1997–2012. The tags on the caught fish allow us to draw conclusions as to how effective fish stocking, i.e. the introduction of juvenile fish raised in hatcheries and released into natural water bodies, has been.

Unfortunately, salmon catches – by both professional and amateur fishermen – are declining, which means that the stocking of salmon has been ineffective. One reason is the lack of spawning areas and habitats due to weirs, and another reason is presumably related to the changes in the Gulf of Finland's ecosystem. For an unknown reason, the mortality rate of smolt at sea is very high.

Another important species of fish that is being stocked is the **eel** (*Anguilla anguilla*) but the objective is of stocking to increase fishing opportunities in inland waters. As eel can no longer travel upstream from the Narva weir, which was constructed in the 1950s, eel fishing is based on the fish introduced into the Lake Peipsi hydrographic basin. The stocks of eel have dramatically decreased across Europe. Therefore, the EU established the Eel Stock Recovery Plan. The Recovery Plan entered into force in 2009. Under the Plan, Member States are required to reduce fishing efforts to ensure a reduction in eel catches by at least 50% in five years.

Besides salmon and eel, other species have been stocked, including sea trout, asp, perch pike, tench, carp, pike and crayfish.

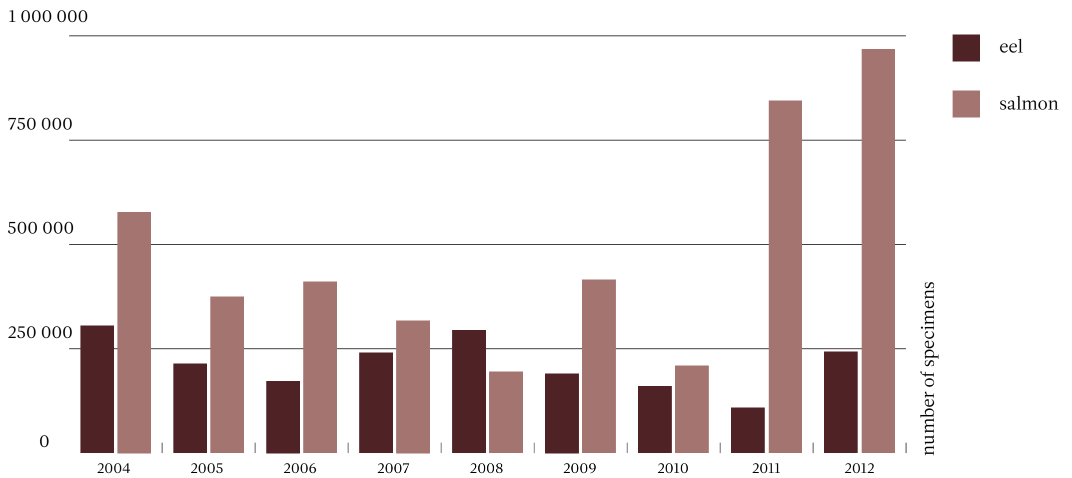


Figure 2.44. Restocking with salmon and eel in 2004–2012. Data: Ministry of the Environment.

Further reading:

- KMinistry of the Environment. Scientific reports on the status of fish stocks and on hobby fishing: *[www] http://www.envir.ee/2110*
- Ministry of the Environment. Harrastuspüügi detailsem statistika (A detailed statistics on hobby angling). *[www] http://www.envir.ee/988563*
- Ministry of Agriculture. Kutselise kalapüügi ja kalalaevaregistri andmed. (Data on professional fishing and the register of fishing vessels) *[www] http://agri.ee/index.php?id=10732*

2.5 Mineral resources

A mineral resource is a concentration or occurrence of organic or inorganic material in or on the Earth's crust in such a form and quantity and of such a grade or quality that it has reasonable prospects for economic extraction. Mineral resources are just as important for humans as food, water and air. Using the wealth found in the Earth's crust provides livelihood for tens of thousands of people in Estonia. We don't even realise the extent to which our lives depend on mineral resources that are used to produce electricity, heat and building materials; for road construction, gardening, etc.

Compared to some other countries, Estonia is rich in mineral resources. On the other hand, there are very few countries that have explored their mineral resources as thoroughly as Estonia. Our oil shale deposit is one of the largest in the world and most profoundly examined. The Rakvere phosphate rock deposit is the largest in Europe but for environmental protection and technological reasons it cannot be currently mined and used. Estonia has vast peat resources. There are also many sand and gravel quarries and plenty of carbonate stone is found in North and Central Estonia. In recent years, producers have shown more interest in shale gas, phosphate rock and iron quartzite. Depending on how deep in the Earth's crust a mineral resource is found, either surface or underground extraction is used. For example, 48% of the amount of oil shale extracted in Estonia comes from underground mines and 52% from quarries (Figure 2.45). The share of underground mining is increasing because the easily accessible oil shale resources have been almost exhausted.

The extraction of mineral resources is governed by the Earth's Crust Act and the Mining Act. Other significant legal acts pertaining to oil shale are the Ambient Air Protection Act, the Water Act, the Waste Act and the Nature Conservation Act. In 2010, the mining waste directive was transposed into Estonian law. Mining waste is waste resulting from prospecting, extraction, treatment and storage of mineral resources. The purpose of the regulation on mining waste is to prevent or reduce as far as possible any adverse effects on the environment or on human health, which are brought about as a result of the management of waste from the extractive industries, by encouraging the recovery of extractive waste by means of recycling, reusing or reclaiming such waste.

The extraction and use of mineral resources is increasingly related to the protection of the environment and sustainable development. It has been recognised that the role of the state in using the wealth found in the Earth's crust must be increased. On 21 October 2008, the Riigikogu approved the National Development Plan for the Use of Oil Shale 2008–2015. The Plan defines the state's interest in the extraction/use of oil shale. The Earth's Crust Act sets forth, based on the reasons described in the Development Plan, the maximum allowable amount of oil shale that can be extracted — 20 million tonnes per year. The primary objective of the Development Plan for the Use of Oil Shale is to ensure that the use of oil shale is as environmentally sound and economically effective as possible. The Development Plan was prepared by considering the objectives and policies of the Estonian Environmental Strategy 2030. Currently, a new strategy document is being prepared — the National Development Plan for the Use of Oil Shale 2016–2030.

The preparation of the Development Plan for Mineral Resources Used in Construction 2011–2020 has also been completed. The Plan concerns the mining and use of all limestone, dolomite rock, crystalline construction stone (which is primarily granite in Estonia), sand, gravel and clay. The Development Plan for Mineral Resources Used in Construction defines the state's interest as follows: from the perspective of mineral resources used in construction, the state's interest is to ensure the supply of high quality mineral resources used in construction to consumers, in particular to the construction sites of the state's infrastructure; to create conditions for the development of mining technology and the technology of using natural resources by implementing all measures required for their rational use and for the protection of mineral resources and the environment. A new definition was introduced — statement of security of supply — which shows for how many years consumers in a certain region are supplied with mineral resources used in construction, based on the mineral reserves in extracting permit areas for which an extraction permit has been granted and the consumption volumes of the preceding five years. The model can be used to prepare estimates for the extraction and use of mineral resources used in construction and to decide where it is reasonable to open a new extracting permit area for extraction.

2.5.1 Mineral resources with energy value

Oil shale

The most important energy-containing mineral resource in Estonia is oil shale. Over 80% of the oil shale mined is used to produce heat and power. Over 80% of Estonia's electricity is produced from oil shale. Oil shale is also used to produce heating oil, oil coke, pitch, bitumen and other by-products.

Oil shale is mined in eastern Estonia, primarily in Ida-Viru County (Figure 2.49), and recently also in Lääne-Viru County. While oil shale production has decreased compared with the early 1990s, it has been on the rise since 1999.

On the one hand, the increased use of oil shale is caused by an increase in the production of electricity; on the other hand, the demand for oil shale as a raw material used in the production of oil and chemical products has seen steady growth. The rise in the price of oil has led to an even greater interest in raw material shale oil.

Peat

Another mineral resource with energy value mined in Estonia is peat. Peat extraction and processing is the main field of activity for about 30 companies that employ more than one thousand people. There are two types of peat: well-decayed and undecayed peat. In recent years, these two types of peat have been extracted in almost equal volumes (Figure 2.46). The primary type of peat used for heating is well-decayed peat. About 60% of the extracted peat is used in horticulture and for the production of peat substrate, peat pots, bricks and blocks. Peat is also used as a bedding material in animal husbandry. The main sales item is peat substrate. About 65% of the extracted peat is exported. Estonian peat companies export their production to more than 100 countries. The amount of peat extracted depends largely on the weather (precipitation, wind, etc.). According to the data of the last seven years (2006–2012), the biggest amounts of peat were extracted in Pärnu County (33%), followed by Tartu County (17%), Harju County (11%) and Ida-Viru Country (8%). There are a number of peat extraction fields and considerable peat deposits in these counties and, therefore, also the largest amounts are permitted to be extracted (the largest annual rates of usage). The Earth's Crust Act sets forth the critical and usage rates of the peat reserves as well as the annual use rates both for Estonia as a whole and for counties. These rates are established based on the Sustainable Development Act.

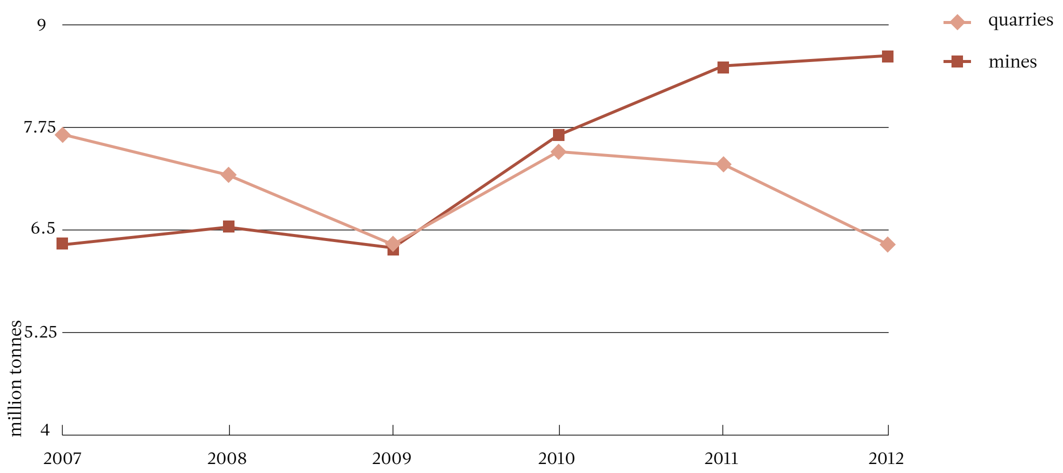


Figure 2.45. Mining of oil shale in quarries and mines, 2007–2012. The share of underground mining has increased. Source: Ministry of the Environment.

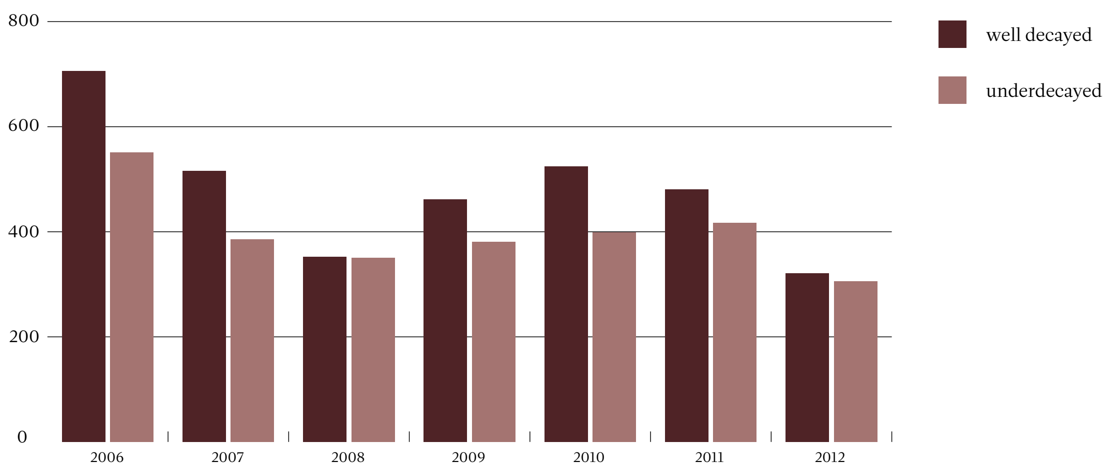


Figure 2.46. Peat extraction in 2006–2012. Data: Land Board.

2.5.2 Mineral resources used in construction

The most diverse category of mineral resources is the category of mineral resources used in construction (Figure 2.47). These resources include limestone, dolomite rock, crystalline construction stone (which is primarily granite in Estonia), sand, gravel and clay. Sand and gravel are widely used and can be found nearly everywhere. Construction sand is used in the building material industry and to make concrete and other mixes, in road construction as the base material for road embankments and as an aggregate for subbase layers; it is also used in asphalt mixes. Limestone is used in the production of crushed stone, masonry stones, pavement slabs, stairs, etc. Dolomite rock is used in the construction of buildings and roads. Due to road construction and the construction boom, the extraction of these mineral resources varies from year to year. Construction mineral resources were predominantly mined in Harju County (40%), followed by Järva County (13%) and Lääne-Viru County (6%).

Technological dolomite rock is extracted in Kurevere quarry, where the magnesium content of dolomite rock can exceed 20%. Crushed dolomite rock is exported to Finland, Germany, Sweden and Poland where it is used in the metal industry and for the production of stone wool. The biggest consumer of technological limestone in Estonia is the cement industry. Currently, cement limestone is used by AS Kunda Nordic Tsement. Limestone, crushed and mixed with clay, is the main ingredient of cement. The five year (2008–2012) average annual amounts extracted are about 330,000 m^3 of cement lime stone and 45,400 m^3 of cement clay.

The major deposits of the limestone used in the production of lime (burning limestone) are Karinu and Metsla in Järva County and Rakke, Aavere, Võhmuta and Tamsalu in Lääne-Viru County. Lime powder and hydrated lime are used as raw materials in animal fodder and fertilisers. A considerable amount of lime stone products are required for neutralising waste water and for reducing emissions from coal-fuelled power plants. A major part of limestone used in a sugar refining plant in Poland comes from Vasalemma limestone quarry. As of 31 December 2012, the number of valid mineral resources extraction permits was 597. The majority of the permits were granted for extracting sand and gravel (Figure 2.48).

The extraction of mineral resources poses a number of threats to the environment, such as noise, dust, changes in water flow, etc. The steep high working faces of quarries may pose a threat to some wild animals, while others, such as the natterjack toad, prefer man-made quarries as a habitat. Currently, the main factor disturbing the environment is the mining and processing of oil shale. The underground mining of oil shale may cause the mined areas to sink in the future. Such areas will be filled with water and transform into marshland. More waste is generated as a result of oil shale mining than can be recycled. Hills of ash, mine waste and semi-coke are formed, from which toxic substances, such as oil and phenol, are carried to the environment by rain and ash slaking water. These substances can destroy life and contaminate both the soil and surface water. 80% of the waste generated, water used and GHGs emitted into the atmosphere in Estonia is related to the oil shale industry.

Sustainable and environmentally sound mining as well as continuous and purposeful rehabilitation of the areas damaged by mining operations are very important.

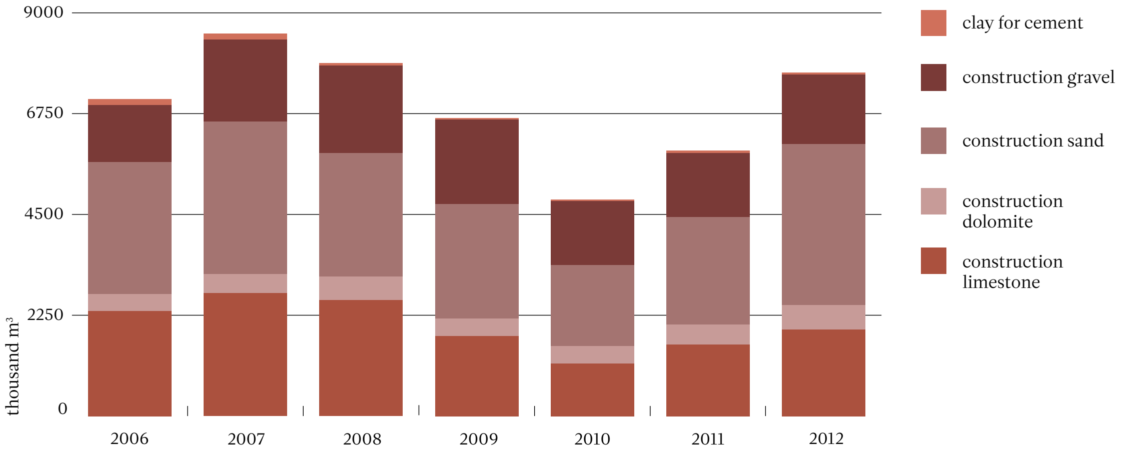


Figure 2.47. Mining of mineral resources used in construction in 2006–2012. Data: Land Board.

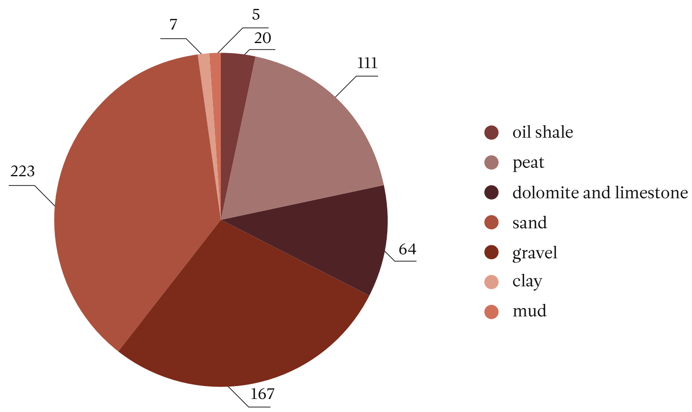


Figure 2.48. Number of valid extraction permits by resources as of 31 Dec. 2012. Data: Information System for Environmental Permits.

Sources:

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Further reading:

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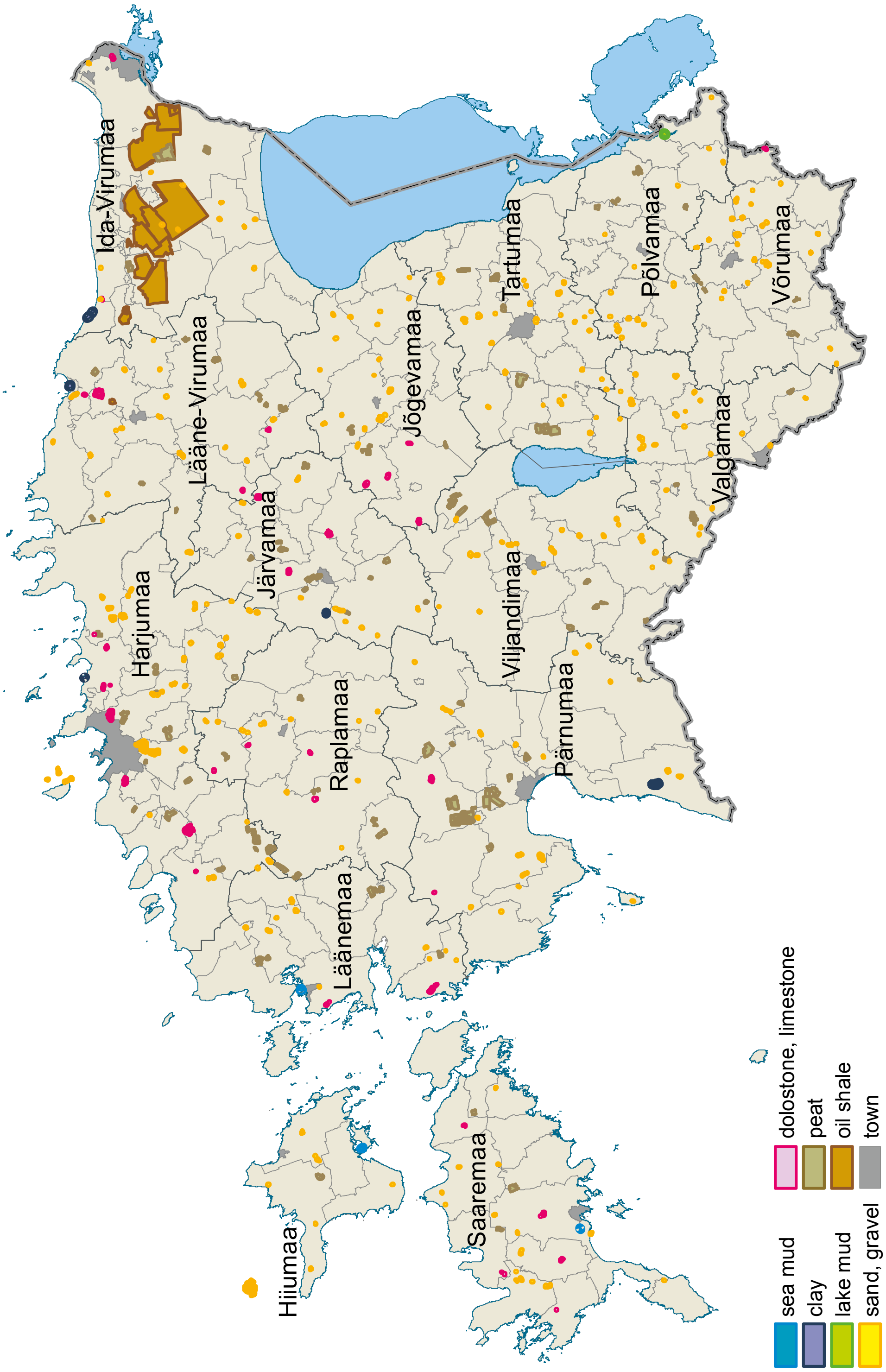

Figure 2.49. Distribution of natural resource extraction permit areas according to county in 2012. Data: Land Board.

2.6 Soil

Soil is an invaluable natural resource that provides crucial ecosystem services. The condition of agriculture and forestry, as well as the environment as a whole depends on these services. Soil is a thin layer of material on the Earth's surface, consisting of various types of organic matter. Because soil is a limited resource, we continuously need information about its composition, quality and condition.

Soil is strongly affected by agriculture, manufacturing, construction and other human activities. The impact of human activities may be positive (facilitating or maintaining the ability to function) or negative (interfering or blocking – through pollution, degradation, the covering of soil, etc.).

The knowledge about the composition and ecology of soil should be as detailed as possible (type, subtype), because soil is the material basis of terrestrial ecosystems that determine the nature of vegetation. This is especially evident in the case of forests. The term "forest site type" is used in the field of forest management. This term refers implicitly to the type of soil (through undergrowth). Although the interrelationship between soil and vegetation is less clear in the case of natural pastures, mainly because the life cycles of plants are shorter and the species composition changes more rapidly, the same principle applies – the composition of vegetation matches the composition of soil.

2.6.1 Legal background

There is no comprehensive legislation on soil protection in Estonia. The Earth's Crust Act makes a reference to soil protection, while the Land Improvement Act and the Plant Protection Act include provisions on soil monitoring. One of the objectives of the Estonian Environmental Strategy 2030 is to ensure the environmentally sound use of soil and the protection of soil against being covered as a result of construction activities.

The obligation of a recipient of agri-environmental support to determine the acidity of soil, the exchangeable P and K and organic carbon contents in soil as well as the obligation to continue keeping a field record are of seminal importance. The planning of agricultural technology and the assessment of the efficiency of the use of agricultural land are based on such local information about soil. Also, the data can be analysed in order to make land use more efficient taking into account the qualities of soil.

As soil protection has come a poor second to other environmental issues, the European Commission is planning to adopt a new framework directive on soil protection and to define soil protection obligations for Member States.

2.6.2 Services and benefits provided by soil

The most important ecosystem service provided by soil is the provision of a suitable environment for vegetation and soil biota. The formation of biomass is essentially the process of capturing the sun's energy, in which the soil-plant system acts as a solar panel. The natural terrestrial ecosystem is only efficient, sustainable and environmentally friendly if its living part matches the soil. Another important function of soil is the decomposition and transformation of organic matter that enters soil, such as litter and organic fertilisers. Soil acts as a reactor that both accumulates organic carbon and releases it together with the nutrients contained in organic matter. Besides mineralisation, secondary bioproduction may occur on account of the organic matter in soil (the increase in the mass of soil biota), which builds up humus. In the course of the decomposition of organic matter, certain compounds are rendered harmless that destroy pathogenic organisms and improve the sanitary condition.

Physical functions of soil: (1) to act as a load-bearing basis (the production and temporary storage of produce, agricultural and forestry operations with machines, the appearance of recreational landscapes); (2) to act as a porous space (a medium for plant roots, a habitat and protective space for soil biota, the preservation of seeds and spores, i.e. the preservation of the gene pool); (3) to act as a reservoir and source of water, air and nutrients (through the crumbling of the mineral part of soil and the mineralisation of organic matter); (4) to serve as a filter (filtering and cleaning water); and (5) to serve as a reservoir of waste, like a sink into which all substances that are alien to nature and may destroy its balance are poured.

Soil has a central role in the exchange of gas between land and atmosphere. By virtue of photosynthesizing organisms, a considerable amount of atmospheric carbon is accumulated in soil. On the other hand, greenhouse gases (CO_2, CH_4, N_2O etc.) that affect environmental changes are released from soil as a result of biochemical processes. Soil is also acting as a natural archive that stores information about natural processes and human activity.

The production capacity of ecosystems and the composition of organic substances depend on the nature of the soil on which these ecosystems have formed. These in turn create the conditions for the evolution of organisms.

Soil acts as a buffer that alleviates sudden changes of meteorological conditions. Soil is a body that is partly renewable, self-cleaning and can be cured. Each type of soil has its limits of tolerance within which it can restore its normal functioning.

2.6.3 Reserves of organic carbon in soils of Estonia

The reserves of organic carbon vary significantly because each type of soil has its own capacity to store carbon (Figure 2.50). The total reserve of organic carbon in the soils of Estonia is 594 ±37 Tg, 65% of which is stored in humus and 35% in subsoil; on the other hand, about 55% of the total amount of organic carbon is accumulated in mineral soils and 45% in peat soils (Figure 2.51).

The concentrations of organic carbon in soil, soil varieties and cultivation methods also differ greatly. The assessment of the condition and degradation of mineral soils based only on the organic carbon content in the upper layer may be misleading. The quality and circulation of organic carbon and the functioning of the soil related to carbon are more important that the reserves and concentration of organic carbon.

The majority of organic carbon is accumulated as a humus layer that is specific to the variety of soil; this is where the major part of the carbon in the living matter (roots, fauna, microorganisms, viruses) circulates; where the remnants of plant and animal organisms (decomposed and partially fine litter) and the molecules of organic substances (secretions, humic acids, proteins, etc.) are located. The functioning of organic carbon in soil depends on the type of soil and the quality of organic matter, as well as on the ecological conditions of the site and the technology of using the soil.

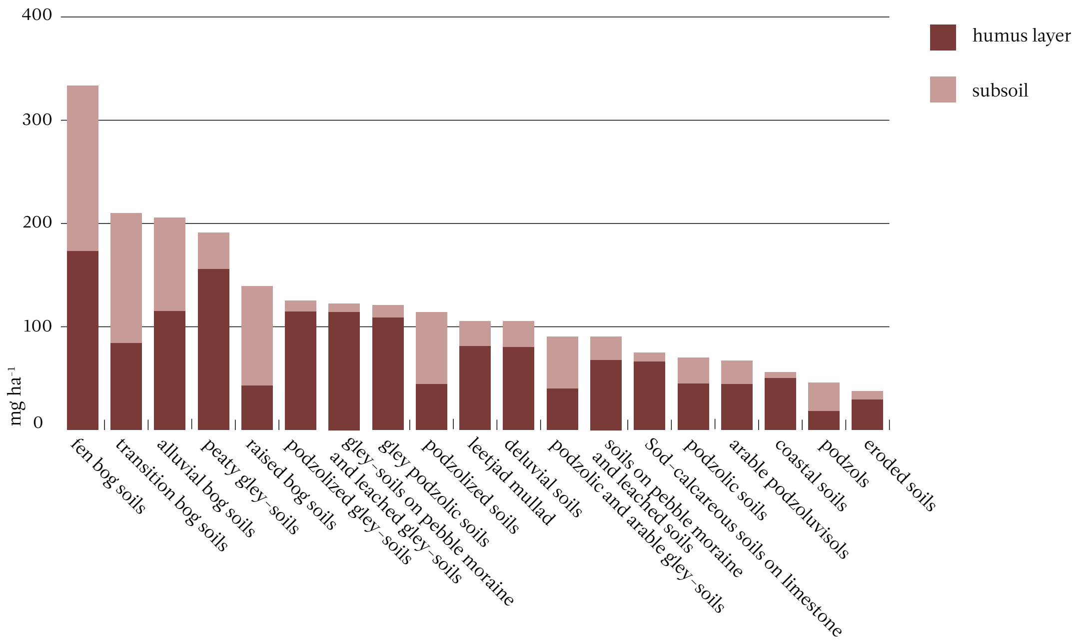

Figure 2.50. Organic carbon stocks in Estonian soils (Mg ha-1)

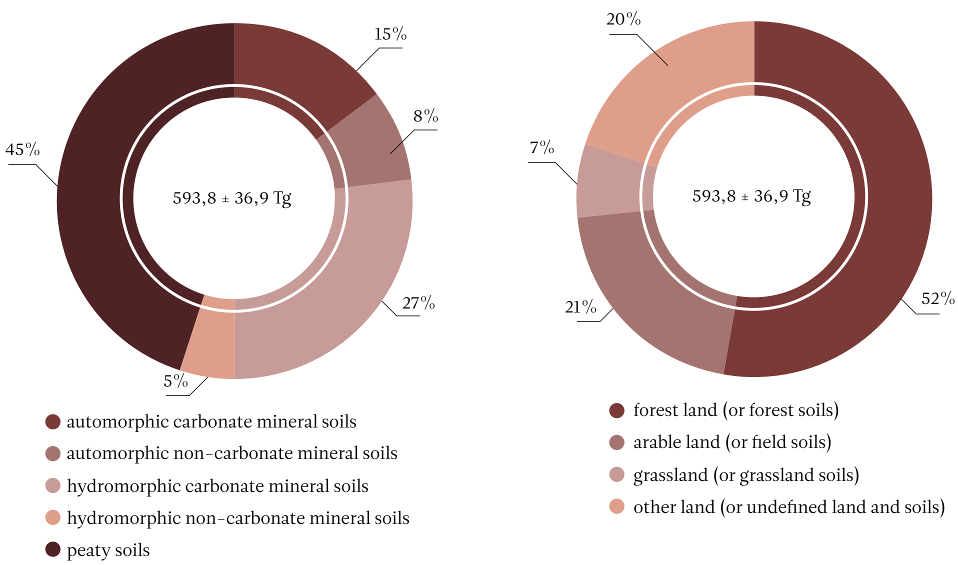

Figure 2.51 Organic carbon stocks (Tg) in Estonian soils. Remark: (1 teragram=10^{12} grams; 1 million tonnes)

2.6.4 Deficiencies of Estonian soils and soil degradation threats

The best soils in Estonia (with high agricultural value) are those that have a sandy-clayey texture and granular-clumpy structure and are rich in humus. These soils are slightly acidic or neutral biologically active soils with a thick humus horizon (28–33 cm); underneath the humus horizon is at least a 1.5 m thick layer of soil, well drained and properly aerated, carbonaceous, but moderately pebbled. The varieties of soils with these qualities are normally found only among leached and podzolised soils.

Compared with the best soils, the majority of soil varieties have some deficiencies that limit productivity. Soil deficiencies are ranked from high to low as follows (according to the surface area): excessive water (high groundwater level, vadose water) – about 50%; runoff, leaching and acidification – about 25%; topsoil and subsoil compression of topsoil and subsoil (21%); risk of erosion by water (10%); sensitive to drought (9%); too varied (7–8%); thin topsoil than contains little humus (< 5%); risk of erosion by wind (2–3%); limestone too close (< 1%); strongly pebbled (< 0.5%) and temporary flooding (< 0.1%). Naturally, the majority of wet agricultural soils have a functioning drainage system but the problems related to excessive water return when the drainage system deteriorates. Acidification can be prevented or alleviated by adding lime, but when this is no longer done, the problems return.

As regards forests, the list of soil deficiencies is completely different. However, these deficiencies affect the use of soil less. On the one hand, the ecosystem can be made more efficient by creating forest stands that have a suitable composition. On the other hand, forests grow predominantly on lands that are unsuitable for agricultural use, i.e. these are typical forest soils.

The degradation of soil is expressed by the level of productivity, intensity of substance turnover and the partial or full destruction of biological activity. Degradation may:

(1) concern the whole territory: disturbance of balanced functioning, reduced biological activity, shortage of micro-elements, the covering of soil with technical structures;

(2) occur only on agricultural soils: reduction of plant nutrients below the critical limit or nutrient imbalance, deterioration of drainage systems, compression of soil, water and technological erosion on slopes, decline in the level of cultivation because land is let to lie fallow;

(3) related only to certain soils: wind erosion of drained bog soils and sandy gleysols, accelerated mineralisation of peat on drained peaty and bog soils, prolonged flooding of floodplains, formation of ortstein in wet podzols;

(4) occurs locally: pollution by various substances, excessive water due to the destruction of natural drainage, grubbed-up land on the territories of mines, alkalisation due to airborne ash, soil is buried under waste, radioactive pollution, etc.

Compared with the southern regions of Europe, an additional deficiency of Estonian soils is low temperature (cool soils), small sum of effective temperatures and short vegetation period. Soil cover is thinner in the north than in the south. Because precipitation exceeds evaporation, the share of soils is big that are wet and acidic due to podzolisation, have stagnated substance turnover and a thin humus layer. The thin profile of soils that are located on limestone, are strongly pebbled or coastal soils makes these types of soil very sensitive to wrong management methods. However, some degradation processes that occur in Europe (desertification, salinification, irrigation risks, large-scale forest fires) are not relevant in Estonia.

2.6.5 Measures to reduce soil degradation and to ensure sustainable use and protection of soil

About 46% of Estonian soils have a very good potential fertility and good environmental protection value – both are necessary prerequisites for effective and environmentally sound agriculture.

In order to fully use the potential of soil, it should be fertilised as required. While minimal fertilisation may seem an environmentally friendly approach, too much of our natural wealth – the productivity of soil – is unused due to insufficient return of nutrients and unbalanced conditions, and more land must be used for agricultural purposes. Less than optimal productivity of soils reduces its environmental protection capacity. Based on ecological studies of soil, we need a strategy to gradually increase the fertility of soil. This strategy would serve as a basis for increasing the fertility of soil across the country and for improving the soil's environmental protection capacity.

The following significant conclusions can be drawn from the monitoring of agricultural soils: (1) direct sowing should be used carefully on slightly acidic soils that have fine and powdery texture and an unestablished structure; (2) in order to avoid the productivity reducing effect of the shortage of a single microelement, the background map of the microelement content in the humus horizon should be used more; and (3) the relatively widespread occurrence of residual pesticides in agricultural soil indicates that there is a need for integrated plant protection and it should be studied more efficiently.

From the ecological point of view, the following agrotechnical methods and principles are recommended in order to avoid or reduce soil degradation: (1) to ensure, or create conditions for, soil type specific functioning, optimal productivity, formation of humus and biological diversity as well as for maintaining the biological activity; (2) to avoid soil degradation by returning nutrients to soil; to fertilise soil on a regular basis with lime podzolic or acidic soils; to measure and adjust, if necessary, the content of microelements in soil; (3) to control the mineralisation of organic matter by adjusting air and water conditions and to avoid the compression of soil; (4) to avoid erosion caused by water, wind and technology as well as flooding in areas with kettle holes; (5) to avoid construction activities on fertile soils, to recultivate damaged land and to crumble ortstein on forest clearings; and (6) to remove sources of pollution and to avoid overgrowth by weeds. It appears from the above that the best way to protect soils is to use soil so that its sustainable functioning is ensured.

The ecologically wrong use of soil may disturb the environment in several ways. It is harmful to soil if it is not able to function properly because of the shortage or imbalance of a certain nutrient. "Starving" the soil and plants does not reduce the risk to the environment because the shortage of one nutrient may indicate that there is abundance of another nutrient element that may damage the environment if it moves out of its biological cycle. Soil may become harmful to the environment if it is not able to absorb the excessive nutrient element and it cannot be used by plants. Such a situation is caused not only by incorrect (from the perspective of both time and space) fertilisation but also by uncontrolled decomposition of organic matter and the lack of vegetation. One of the most important principles of soil protection is that soil is best protected if it is covered by well functioning vegetation.

The condition of Estonian soil is relatively good and land use corresponds to that characteristic of cool forest areas. The best soils of the region (soils that have high natural fertility, have medium texture and are moderately wet or wet) are used for agricultural purposes. Selective draining is used depending on the specifics of the region.

The soils that are unsuitable for agriculture are under forests (podzols, raised bog soils, soils with high erosion risk, etc.) or used as pastures (floodplain soils, coastal soils, etc.). However, keeping highly fertile soils in their natural state for various reasons (small fields, too many stones, long distance from settlements) is also justified.

Nowadays, it is possible to manage and protect soils at a detailed taxonomical level (i.e. at the level of soil variety) and locally, allowing each patch of soil to function in line with its qualities, while ensuring the best protection of soil.

A common misconception spread by the media is that the underuse of soil should be promoted. Moreover, no difference is made between macroelements (N, P, K, Ca, Mg, S) and microelements (Cu, B, Mn, Mo, Co, Zn, I) that are necessary to ensure the proper nutrition of plants and actual toxic substances, i.e. "cides" that are used to control weeds, pests and diseases. While the substances that are necessary to ensure that plants get all nutrients improve, if used properly, the quality of soil and yield, the pesticides that resist in soil may pollute both the soil and the produce.

Each variety of soil has the capacity to preserve organic matter (both the concentration and reserves); therefore, proper management of soil should focus on the timing and efficiency of the use of organic matter, not on increasing its concentration in soil. Also, the used organic matter should be replenished to the level that is characteristic of the variety of soil.

We should raise the awareness of land owners about proper land use and how to preserve and improve the fertility of soil. For this purpose, a system of monitoring soil and collecting information about soil should be developed. We need a system of incentives and grants that ensure the sustainable use of soil.

In the long-term, support should be linked with production, because otherwise we cannot ensure the protection and optimal functioning of soils – the functioning of soil is environmentally friendly and only useful to society if it is in line with the qualities and nature of the relevant soil variety.

The substances/nutrients that are used to ensure yield should be replenished; otherwise, the process of degradation will start and the quality of soil will decrease. To avoid this, we should introduce the integrated management of nutrients and implement crop rotation in order to ensure a symbiosis between crops and microbe communities and to find ways to restore the reserves of organic carbon in soil.

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