ASSESSMENT OF THE MONETARY VALUE OF THE EXTERNAL EFFECTS OF ENVIRONMENTAL USE IN ESTONIA, ANALYSIS

STAGE 1

SUMMARY A

MINISTRY of the ENVIRONMENT 2018

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Objectives and completed tasks

The main objectives of this project were **to define, describe and quantify (if sufficient and reliable data exists) the environmental effects of significant forms of environmental use in Estonia** and to **propose methods** for assessing the scope and intensity of these environmental effects. Thereby, the DPSIR concept (Drawing 1) was used for ensuring a systematic and comprehensive approach.

During the project, **the significance of the forms of environmental use and environmental effects included in this project was assessed** on a relative scale by using a multi-stage assessment method based on expert opinions. The dataset of human-induced pressure on the environment and status indicators affected by such pressure was organised and aggregated. This dataset was used to **assess trends in the intensity of pressure indicators as well as in changes in the status of the environment**. Human-induced changes in nature and in the indicators of human health and wellbeing were highlighted in relation to pressure and status indicators. **All the described indicators and their values have been systematically presented in the DPSIR tables annexed to the final report**. Changes in these indicators over time are presented as time series; to describe the spatial patterns, thematic maps on the pressure, status and impact indicators of the forms of environmental use were prepared (see interactive map application[1]).

Methods were proposed for mapping pressure, status and impact indicators. Suitable methods for assessing the **monetary value** of the external effects of environmental use were also mapped and described. A separate analysis was conducted on the possibility of assessing the local **environmental effects induced by carbon dioxide and other greenhouse gas emissions**, and a proposal was prepared on how to include such environmental use in the assessment of external effects. Additionally, different options for a more substantial assessment of the impact of environmental use based on the DPSIR concept were analysed and described in more detail. The **methodological and technical proposals, as well as proposed measures** for the reliable and accurate future assessment of external effects were phrased and priority areas, which should be given the most attention in the assessment of environmental effects and implementation of measures, were highlighted.

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[1] https://elle.maps.arcgis.com/apps/webappviewer/index.html?id=fc19f9580f564be3bf88afc7e02bedb6

Overview of the main results of the project

Emission of pollutants into ambient air

In the case of emission of pollutants into ambient air, this analysis highlighted fine and ultrafine particulate matter, benzo(a)pyrene and acidifying pollutants nitrogen dioxide and sulphur dioxide as the most significant pollutants. **The status of ambient air is the most significant environmental indicator in terms of human health**, and the pollutants of ambient air have the largest impact on human health, as the pollution of ambient air cannot be avoided and its effect is constant.

An increased concentration of **fine and ultrafine particulate matter** (PM_{10}, $PM_{2,5}$) in ambient air has been proved to increase the risk of heart diseases and respiratory complaints, the risk of developing endocrine disorders and some forms of cancer, as well as raised the mortality risk from cardiovascular diseases (CVD) and respiratory diseases. The entire Estonian territory is potentially influenced by the emission of fine particulate matter into the air (Tallinn 400,000; Kohtla-Järve 36,000; western islands 40,000; North-Estonia 333,000; Tartu 97,000; South-Estonia 393,000). The analysis of the changes in disease risk and mortality indicate that **morbidity risk has decreased** in all the above-mentioned cities **during the period covered by this study**.

Increased concentration of **benzo(a)pyrene** in the air increases the risk of developing ischemic heart disease and cancer. Long-term exposure may additionally cause damages to the liver, kidneys and the central nervous system; short-term exposure, however, may cause irritation of the eyes and the respiratory system, headache, dizziness, vision problems, fatigue, impaired coordination, allergic skin reactions, nausea and impaired memory. The concentration of benzo(a)pyrene has exceeded its target values for years in Tartu, but the entire Estonian territory may be considered as potentially affected by this pollutant. No data is available for a more precise evaluation of the number of exposed persons.

Increased concentration of **acidifying pollutants (NO_x, SO_2)** in ambient air increases the risk of lung damage and a decrease in functional capacity; it can increase the sensitivity of the respiratory system, cause irritation of the eyes, nose, throat and skin, as well as impact the central nervous system and increase mortality from CVD and lung cancer. The concentrations of **NO_x and SO_2** in ambient air and their emissions indicate a decline in the long-term perspective all across Estonia with a slight increase in the concentration of SO_2 and NO_x in Tartu. The main sources are transportation (NO_x) and manufacturing of electricity and heat (SO_2). The concentrations of these pollutants are significantly higher in cities in comparison with background areas (NO_X – Tallinn, Tartu, Narva, Kohtla-Järve; SO_2 – Kohtla-Järve), which is why the number of persons exposed to increased concentrations is high in these areas in comparison with the background levels. However, **this analysis indicates a higher morbidity risk only in Tartu** – SO_2-related lung cancer (up to +10 people with morbidity risk), CVD mortality (up to +100 people with morbidity risk), mortality of NO_x-related arrhythmia (up to +317 people with morbidity risk) and mortality of lung cancer (up to +117 people).

Although the quality of ambient air generally improved during the studied period, fine particulate matter **(PM_{10}) and benzo(a)pyrene (B(a)P)** still cause problems in urban environments. A major source of these substances is **stationary combustion installations**, including households with furnace heating. A high percentage of households with furnace heating concentrated in one urban area pose a risk, especially under circumstances hindering the diffusion of pollution (e.g. inversion, landscape characteristics) of concentrations above reference levels developing in ambient air, which may affect a large proportion of the population.

Regarding ambient air quality, the current **areas of assessing ambient air quality** need to be reviewed. An approximate and non-representative division of ambient air quality areas may lead to a situation where policymakers and experts leave data about pollution levels in these areas unattended, considering them non-representational of the area as a whole and seeing specific pollutant levels exceeding reference levels as a local problem. It is necessary to **prepare action plans at the level of local authorities for improving ambient air quality** for areas where reference levels are exceeded as well as to implement these plans (e.g. excessive B(a)P concentrations in Tartu).

Unpleasant odour

Direct health effect caused by **unpleasant odour is insignificant**. **Different complaints** (shortness of breath, irritation of the eyes, fatigue, stress, nausea, hoarseness of the voice, fever, muscle and joint pain), however, are **1.5 times more frequent** than in areas where this factor is absent. In Estonia, an estimated 100 thousand people remain within the zone of unpleasant odours, but this is an over-estimation caused by the overlapping of the impact zones of different objects. In certain regions, unpleasant odour is nevertheless a form of environmental use causing significant disturbances, as indicated by the data of the Environmental Inspectorate on complaints about smell that were used in this analysis. It is necessary to conduct odour measurements in the impact zones of relevant objects (**cattle, pig and poultry farming, chemical industry, manufacturing and treatment of fuels, sewage treatment**). In Estonia, **odour sensors installed at Muuga harbour in 2016** is a good example.

Vibration

Vibration is a form of environmental use which has a clear object-based effect. The scope and effect of vibration mainly depends on the physical characteristics of the propagation environment. One source of vibration in Estonia is road and railway transport. The spread of transport-induced vibration in the ground is an estimated 30–50 m. The effect of **mining-induced vibration that spreads outside the working zone** is more significant and is caused by explosion and excavation works. An estimated **30 thousand people and 13 thousand residential buildings** remain in the impact zones of limestone and dolomite as well as oil shale quarries, and **11 thousand people and 6 thousand residential buildings** in the impact zones of underground excavations. It is not currently possible to assess more precisely the impact of vibration on human health and nature, including on human wellbeing; operators should make data on executed vibration measurements available, the vibration study results from selected regions should relate to the area's geographical characteristics, and the address data in building registers should be organised and geocoded.

Noise

In terms of the **size of affected area**, the most significant **source of noise** in Estonia is road transport. The areas where reference values may potentially be exceeded due to road transport have expanded over time because of the increase in traffic intensity and related development of infrastructure and the road network. If we look at sources of noise in relation to the number of potentially affected people, then also **railway transport has high potential effect**. However, because of insufficient data, it is difficult to assess the scope and intensity of railway noise at different points in time and the relevant trends.

It is estimated that night-time road noise affects **up to 400 thousand people** across Estonia, and daytime road noise up to **345 thousand people** (including 216 thousand near main roads). The number of residents affected by night-time railway transport is **up to 300 thousand**, and up to **118 thousand people** during daytime. The number of people affected by aircraft noise is an estimated **26 thousand** during daytime and **52 thousand** during night-time (the scope of affected areas has remained stable). The number of people affected by mining noise is up to **32 thousand people** (assuming that noise spreads at approximately 300 m).

Depending on the level of noise, **people exposed to heightened noise** exhibit stress-related somatic factors: heightened stress hormone levels, changes in blood pressure, muscle spasms. Psychological disorders may develop – a feeling of frustration and isolation, sleep disorders, mental health problems. Noise above 55 dB is a health hazard, especially to older people – it causes sleep disorders and increases the risk of cardiovascular diseases. Heightened noise levels may also contribute to an increased risk of heart diseases and hypertension. It may cause sleep disorders and depression and a reduction in cognitive functions. Night-time noise also affects the risk of premature births. The value of a residential or visiting area may decline; however, aggregated data on mobility, the number of visitors and real estate prizes does not verify this for Estonia. The **effect on nature** is difficult to measure, more precise studies are necessary. In Estonia, bird species sensitive to noise include, for example, the black stork, western capercaillie and eagles. References to study results indicate that the number of birds as well as the alertness of animals and efficiency of finding food decreases in areas of impact of noise pollution.

As electronic and organised data is not readily available for assessing noise caused by railway transport, it is not possible to assess the actual status and trends within the scope of this analysis. A system for **collecting, storing and publishing railway traffic data** necessary for assessing noise levels must be introduced by the Technical Regulatory Authority. **Noise levels must be mapped** in local governments where cases of exceeding reference level benchmarks occur. Action plans for reducing noise must be prepared and executed in areas where benchmark levels are exceeded.

A common coordinated (manufacturers, legislators, the social sphere) understanding of noise norms must be created. The understanding must bring clarity into which norms apply in which areas (including forests, fields) under which conditions and what the possible exceptions are (e.g. following the norm not based on the source of noise, but based on the recipient).

Emission of pollutants into water and soil

The emission of pollutants into water and soil affects human health through drinking water and food. Long-term consumption of water with high concentrations of nitrogen compounds increases cancer risk. Drinking water with heightened nitrogen compound concentrations may be consumed from affected groundwater intakes by up to **70 thousand people.** This indicates a need for cleaning drinking water or establishing new bore wells. Currently available data does not enable the assessment of the sources of discharge of pollutants into groundwater. More than 600 thousand people live in the catchment areas of water bodies with heightened nitrogen concentrations, 300 thousand of them in East-Estonia near Lake Peipus and Emajõgi.

The most common **hazardous substances** in Estonian surface water and groundwater are petroleum products, polycyclic aromatic carbohydrates, phenols, mercury, arsenic, lead, as well as cadmium and organochlorine compounds in addition to mercury in the Baltic Sea. Herewith, disused hazardous sites are a significant source. In Estonia, 500–1000 private consumers of groundwater live in the area of impact of the 21 most important disused hazardous sites. The consumption of food and water contaminated with pollutants from these sites increases cancer risk, but also has other effects on health (neurological disorders, mental health disorders, etc.). The largest potentially affected numbers of residents appear in Ida-Viru, Lääne-Viru, Harju, and Rapla County. The most important measure is to conclude the removal of disused hazardous sites and thus reduce the exposure of the population to the listed pollutants. At the same time, residents must be ensured clean drinking water.

The entry of **plant protection products** into the earth and drinking water and into people's food through agricultural produce is related to different allergies, diabetes, neurological problems, mental health disorders, impaired function of the endocrine system, foetal development disorders, infertility, cancer, Parkinson's disease and other diseases which may become manifest in years to come. Plant protection products may end up in the human body through food, water, skin as well as breathing. Once in the earth, the chemical compounds remain there for a long time and affect the biota of the area. The use of plant protection products puts general pressure on the status of groundwater used as drinking water in Estonia as a whole with up to **10 thousand people** potentially consuming affected drinking water. The focal point is on nitrate-sensitive areas. As indicated before, this is a significant danger for human health.

Sales statistics indicate **an upward trend** in the use of plant protection products; however, the use of nearly half of sold plant protection product quantities is unknown. Therefore, it is necessary to establish, where, how much and which plant protection products are used in Estonia and to verify the causation between the status of groundwater and the use of plant protection products (the existence of a substance and its concentration in water in relation to the amounts used).

Water use (water extraction)

Water extraction was stable in Estonia during the period of this study. Negative environmental effects will be avoided in Estonia if water extraction is controlled with designated water reserves and these restrictions are respected. **Water consumption and transfer** has a significant effect in the case of **water bodies included in Tallinn's groundwater intake**, especially the discharge and water level of the Pirita river. The extraction of **cooling water for power plants** has no measured effect on human health and wellbeing or on nature. The maintenance works of land improvement systems do not usually have a significant environmental effect; the effect of establishing new systems must be assessed for each project. Most water extraction in Estonia is made up by water pumped out and lead away from oil shale quarries and underground mines (130–270 million m^3/yr.). This has an **impact on the lakes and wetlands near oil shale quarries** – for example, on Kurtna lakes (in combination with water extraction from the Vasavere intake). The environmental effect of water use on groundwater-dependent ecosystems (wetlands, lakes) and the connection to the pressure caused by environmental use and the status of the ecosystem requires further studies in problematic areas.

Barrages and barriers on water bodies

The most significant environmental effect of **barrages and barriers** is the restriction of the reproductive migration of salmon in the rivers suitable as their habitat. Only or partially because of barrages, at least 127 bodies of water do not correspond to the objectives of the EU Water Framework Directive, meaning that they have a negative status, and 14 of these bodies of water open to the coast. Larger rivers that open to the coast have a total of 10 barrages that cannot be surpassed and 5 barrages that are difficult to surpass. The most critical task is to bring clarity into the **ecological objectives of salmon rivers** opening to the coast – how many of the potential maximum number of habitats are necessary for ensuring the good status of salmon. It must be made clear if all rivers should be opened to the full extent to migration and what the cost of such action would be, considering the decreasing income from economic activities in addition to the cost of demolition or fish passages. Based on the objectives available at the moment of preparing this analysis, the morphology of 340 bodies of water should be assessed.

Land take and soil sealing

Land take causes the loss and fragmentation of natural habitats, which leads to reduced biodiversity. Loss of habitats and the deterioration of their status, including fragmentation, are the main factors of diminishing biodiversity in Europe and the world. The effect of land grabbing on biodiversity has so far not been investigated comprehensively in Estonia by using a uniform method. At the moment of preparing this analysis, land take *sensu stricto* (a specific type of land take, related to long-term or permanent occupation of land - roads, buildings, ports, airports, disused hazardous sites, wastelands) covers an area of 969 km^2 in Estonia. 467 km^2 is taken by quarrying and 339 km^2 by underground excavation. Area under cultivation covers 10,543 km^2, the area of clear cutting is 298 km^2.

Land take *sensu stricto* (NB! does not include agriculture) has acuminated into cities and industrial areas. Hence, the most intense land take pressure appears in Harju County (urbanisation) and Ida-Viru county (landfills, production areas). Long fenced traffic corridors are another land take-related pressure factor for biota – these are mainly situated in Harju County. Land take and soil sealing do not have a direct effect on humans. **Indirect effects** caused by changes in biodiversity or availability of ecosystem services and changes in their quality may have an impact on human health. The impact of land grabbing on human wellbeing manifests itself through subjective choices. As a result of land take, the views and aesthetic value of an area may change and cultural heritage may be affected; this may influence real estate prices or the attractiveness of the area for visitors. This study could not establish quantitative changes in wellbeing.

Biodiversity is directly related to the status of ecosystems – biodiverse ecosystems are generally more resilient to external pressure factors and regenerate more successfully. **The existence of functional ecological corridors,** which would facilitate the dissemination of species between natural and semi-natural biotic communities in Estonia, is the prerequisite for the **improvement in the status of protected species and the maintenance and improvement of biodiversity.** The dissemination of species is obstructed and habitats are fragmented in the areas with **high percentage of clear-cut areas**, which is why the movement of individual animals is hindered and gene exchange between different biotic communities is limited. From the perspective of forest management, significant reduction of clear-cutting would reduce general competitiveness on international markets, which is why ending clear-cutting would probably not be a sustainable option. Ecological corridors should connect larger forest masses and should be managed areas which consider the objectives of nature conservation. The locations of the corridors and the rules of managing forests in these areas should be established and these should be coordinated with different parties.

A practice for the maintenance of quarries where quarries are maintained in stages, resulting in landscape safe for people and appropriate in terms of supporting biodiversity, should be developed and implemented. A functional solution for a green network should be developed, ensuring that it considers the principles of sustainable environmental use – to ensure the development of the society in a way that preserves the availability of natural resources and a multitude of choices for future generations.

Soil sealing with a non-permeable layer or the removal of different soil layers during activities (construction works, mining) causes the deterioration in soil functions and the reduction in the area available for cultivation, as well as the availability of land for the dissemination of natural or semi-natural biotic communities and species. **Soil has an important role in different ecosystems**, being also distinguishable as an ecosystem, the status of which (i.e. its fertility) significantly depends of the soil biota. The covering or removal of soil significantly deteriorates the availability of the ecosystem services provided by soil (e.g. water infiltration and cleaning, the existence of fertile substratum for natural and cultivated plants, etc.). **A legislative system for ensuring the sustainable use of soil as a natural resource and its inclusion in the assessment of environmental effects should be developed**, especially for massive projects of infrastructure. A forward-looking use of soil as a resource with long-term planning should be introduced.

Proposals

Environmental use	Method	Measures
Emission of pollutants into ambient air	Review periodically the division of Estonian **ambient air quality areas**. **Developing opportunities for more accurate modelling** of pollution levels and pollutants – execution of periodically renewable modelling across pollutants with results available to the public.	At the level of local authorities, preparation **and execution** of **action plans for the improvement of ambient air quality** in areas where reference levels are exceeded.
Unpleasant odour		Considering the assessment of odour from **cattle, poultry and pig farming, chemical industry, fuel manufacturing and handling and sewage treatment** at the local or object level.
Noise	Aggregation and systematisation of earlier and current datasets for input necessary for **railway transport noise research.** Creating a **common coordinated understanding of reference levels for noise** that would bring clarity into which norms apply on which areas and under which conditions (e.g. in a forest, on a field) and what the possible exceptions are on the basis of the **noise source** and **recipient.**	In local governments where reference levels of noise benchmarks have been exceeded, conduct **noise mapping** and develop and implement **action plans for noise reduction.**
Vibration	**Organising and geocoding address data in building registers** to make other buildings beside residential buildings available on a km^2-grid.	Analysing **monitoring result**s of selected areas and relating data with **local geological characteristics**.
Emission of pollutants into water, nutrients		**More precise mapping of water intakes and their quality** in problem areas (dug wells, individual bore wells). Implementing the **measure programmes of water management plans.**
Emission of pollutants into water, hazardous substances	In industry, the identification of **the circulation of hazardous substances** (including plant protection products). More precise **usage statistics for plant protection products** (quantity, type) to allow analysis of the relation between the use of plant protection products and the status of groundwater.	Measure proposals must be more precisely formulated for **plant protection products** when **sufficient overview of the pressure** is available. Finalising the **removal** of important **disused hazardous sites**.
Water use (water extraction)		To explain the **connection between the pressure of water extraction and the status of ecosystems** in problem areas with studies.

Environmental use	Method	Measures
Barrages and barriers on rivers ◯	Review whether the **idenification of smaller watercourses as bodies of wate**r is always reasonable. Bring clarity into the **ecological objectives of salmon rivers opening to the coast** – how many of the potential maximum number of habitats would ensure the good status of salmon.	In the case of barriers, **impact assesment** depends on the posed objectives. In the case of the existing objectives, to **assess the hydromorphology of 340 bodies of water.**
Land take and soil sealing ◯	Systematising the data on **biodiversity. Creating a legal framework for considering soil as an environmental component for the assessment of environmental effects.** Establishing a **multi-stage management method for quarries** to create a landscape that is safe for humans and supports biodiversity.	Assessing the **efficiency of the green network** and considering giving green networks the status of special planning. Implementing additional **compensation measures** for damaged habitats. **Long-term** planning of the use of **soil as a resource**.

◯ Priority area for the assessment of environmental effects and the implementation of measures.

Propositions for all forms of environmental use for the development of technical possibilities (databases, IT, etc.)

- Making **data gathered on the basis of environmental permits** publicly available in an electronic and organised form.
- Interfacing **different state databases containing personal data** (Health Insurance Fund, Tax and Customs Board, population register) to relate data with people's medical records and employment and residential data. Implementing new data gathering methods (big data, mobile positoning, remote monitoring, including drones).
- **Gathering object-based data,** including population surveys (e.g. a state-wide sample of 1,000 people is not statistcally representational).

Propositions for the methods of assessment of environmental effects and external cost

- **To prevent external costs, the process of assessing environmental effects** could be used when **calculating potential external costs** (in the case of significant external effects).
- In the case of **loss of profit** by the society (including when public benefits are handed into private use), which can be treated as external costs, the calculation could also be part of assessing environmental effects in the case of significant environmental effects.
- The **methods for monetary value** in the annexes to the final report are suitable for calcuating external costs of environmental effects (first and foremost the **market price** method, the assessment of external costs **via made expenditure**).