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From drainage to restoration:

A new chapter for Estonia's wetlands

Photo: State Forrest Management Centre

Mires are wetlands characterised by a thick layer of continuously accumulating peat. These vital ecosystems help to maintain biodiversity, sequester carbon, and regulate water levels across the landscape. Just as forests are considered the lungs of the Earth, mires can be seen as its kidneys, playing a crucial role in purifying and storing fresh water.

By 2030, the EU aims to enhance the condition of at least 30 per cent of the continent's degraded habitats.[1] In Estonia, drained peatlands are a major source of greenhouse gas emissions and thus exacerbate climate change. Responding to this environmental challenge, the Estonia's State Forest Management Centre has launched a number of initiatives aimed at restoring the country's mires and fostering conditions conducive to peat regeneration. These efforts to mitigate environmental degradation and curb greenhouse gas emissions signal a commitment to a more sustainable future.

[1] European Commission, Directorate-General for Environment, EU biodiversity strategy for 2030: bringing nature back into our lives, *Publications Office of the European Union*, 2021.

For more information

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Drainage takes its toll on Estonia's biodiverse mires

With the climate crisis causing more droughts and floods, wetlands such as mires offer natural solutions for effectively regulating water levels. Mires sequester carbon by continuously accumulating peat, forming a distinctive ecosystem much like the world's oceans. These habitats are vital for various species throughout Europe, including the capercaillie (*Tetrao urogallus*), common crane (*Grus grus*), and carnivorous sundew (*Drosera*). Beyond their ecological significance, mires provide the ideal environment for berry picking, offering cranberries, cloudberries, and lingonberries.[2]

Mires are ideal spots for berry picking and wildlife encounters. Photo: Carmen Kilvits

Regrettably, many European mires have been impacted by human activities, including drainage, peat extraction, and land-use changes. In Estonia, the utilisation of mires for peat extraction and agricultural purposes dates back to the 17th century. Mass drainage has significantly affected the landscape's water regime, resulting in a roughly threefold reduction in open mire areas. Therefore, most of Estonia's peatlands have now been drained. This means they can no longer be considered 'living' mires, since peat formation has ceased.[3]

These abandoned peatlands, called residual mires, are the second-largest source of carbon dioxide emissions in the country, surpassed only by oil shale power plants. However, there is still cause for hope. Unlike their counterparts in central and western Europe, Estonia's residual mires can still be restored.[4]

[2] Eestimaa Looduse Fond, Mis on soo? Mis on soode roll looduses?, *Eestimaa Looduse Fond*, accessed 10 May 2024.

[3] Eesti Märgalade Ühing, Sood Eestis, *Eesti Märgalade Ühing*, accessed 10 May 2024.

[4] Eestimaa Looduse Fond, Miks soid taastada? Kuidas ja kaua läheb aega?, *Eestimaa Looduse Fond*, accessed 10 May 2024.

Reviving Laiuse: A case study in peatland restoration

At the end of 2023, Estonia's State Forest Management Centre successfully completed a seven-year project (launched in 2016) aimed at restoring the water regime on 2,000 hectares of drained, depleted and abandoned peatland. The total cost of the restoration project came in at EUR 5.8 million, with EUR 4.9 million (85 per cent) supported by the Cohesion Fund and EUR 870 000 (15 per cent) financed by the centre itself.[5]

The main objective of the project was to restore the natural water conditions characteristic of mire ecosystems, helping to increase the composition and structure of plant species that thrive in these environments. To this end, scientists collaborating on the project sowed peat moss spores in some of these restored areas. Additionally, a monitoring network was established to track improvements in the mire ecosystem.[6] Researchers from the University of Tartu monitored the impact of the restoration work and evaluated the effectiveness of the peatland restoration measure by project end.

The residual mire in the borough of Laiuse in eastern Estonia exemplifies the lasting ecological consequences of peat extraction. This mire, like many others exploited in the last century, continued to degrade long after human activity ceased at the site.

On drained peatland, exposed peat decomposes in the air, releasing carbon dioxide – an alarming 107 to 179 tonnes per year in the case of Laiuse.[7] Exploited for decades, the mire's ecosystem has suffered greatly, with vegetation struggling to reclaim the scarred landscape. These factors underscore the urgency of restoring the ecological balance of the mire and reducing its substantial greenhouse gas emissions.

Peat extraction operations in Laiuse began sometime between the 1920s and 1930s, becoming fully operational with a comprehensive drainage system by 1969. Following the collapse of the Soviet Union, the peatland was abandoned, leading to the release of carbon dioxide into the atmosphere. This continued until 2019 when the State Forest Management Centre finally began restoration work. Covering just under 36 hectares, Laiuse mire is one of the largest of the residual mires selected for restoration. Work on the mire, the first to be restored, commenced in October 2019 and finished in 2023, giving scientists the opportunity to closely monitor the site for almost four years.

Researchers reclaim the mire

One notable aspect of the Laiuse project was its dual role as both a restoration initiative and a scientific research hub. Here, a team of scientists conducted experiments aimed at optimising the mire restoration process.

Traversed by a road, the restoration area was effectively divided into two sections. The border ditch of the southernmost square was partially filled with soil, and a spillway was built to facilitate water sampling and

[5] Eelnõude infosüsteem, Toetuse andmise tingimuste kehtestamine meetme tegevuste 7.2.3 "Kuivendatud, ammendatud ja hüljatud turbaalade korrastamine" elluviimiseks ja meetme tegevuste 2014–2023 tegevuskava ja eelarve kinnitamine, *Keskkonnaministeerium,* 7 July 2016.

[6] Keskkonnainvesteeringute Keskus, Kuivendatud, ammendatud ja hüljatud turbaalade korrastamine, *Keskkonnainvesteeringute Keskus,* accessed 10 May 2024.

[7] Vooremaa, Laiuse jääksoo korrastamine, *Vooremaa*, 18 January 2022.

determine the chemical composition of the water. Notably, before the commencement of restoration work, the southern area of the intervention site had already been filled with water due to beaver activity, a state that was intentionally preserved as part of the overall strategy.

To enable research of the water-filled square, a boardwalk was constructed. But due to objections from private landowners, it was not possible to close the border ditch of the northernmost square. Instead, spillway dams were constructed along this ditch to retain water within the restoration area. In addition, embankments and boardwalks were installed around the squares to provide access for the researchers to study gas emissions, water level changes, vegetation recovery, and other parameters.

The water regimes of the two squares were interconnected with culverts installed under the service road of the intervention area, forming a balanced and integrated system. Overall, 35 embankments, approximately 1.6 kilometres of water barrier walls, and 1.9 kilometres of boardwalks were built as part of the restoration area.

These two orthophotographs, one taken in 2002 and the other 20 years later, show changes to the residual mire in Laiuse over time
Photo: Republic of Estonia Land Board

Flora and fauna make a welcome return

During the first two years of the project, vegetation growth was slow, partly due to excessively high water levels. However, this inadvertently attracted waterbirds to the research area, resulting in the dispersal of plant seeds and spores, which effectively fertilised the area. From the beginning of 2022, there was a rapid growth in vegetation, expanding as far as the shores of the low water body by 2023. Liner traps installed in the wider ditches of the western section of the peatland proved highly effective. These ditches saw an acceleration in the growth of, primarily, the common reed (*Phragmites australis*) and bulrush (*Typha latifolia*), as well as various species of sedge (*Carex*) and occasional patches of bog moss (*Sphagnum*).

Compared to its initial state, the northwestern section now boasts significantly greater vegetation cover. And despite the removal of peat ridges, a mire zone several tens of metres wide has formed along the shores of the low-water body. Additionally, vegetation in the northeastern section is notably denser than in the control area, with sedges, reeds, sphagnum moss, cranberries, and other species all flourishing. In

particular, the cranberry area is expanding at an average annual rate of 40 to 50 centimetres from the centre of the patch towards the periphery, forming continuous coverage in some places.[8]

Environmental, economic and social benefits: Mires as valuable assets

The restoration of mires provides a wide range of environmental, economic and social benefits, supporting sustainable development and the well-being of communities. Mires play a crucial role in Estonia's ecosystem, forming a biological community found abundantly in Estonia but rarely elsewhere in the Europe.[9]

Before restoration efforts began, the Laiuse residual mire emitted an average of 4.7 (3.2–8.3) tonnes of carbon dioxide per hectare annually, depending on weather and location. However, following restoration, carbon dioxide flux decreased significantly, achieving carbon neutrality within four years. The restored mire now attracts a variety of waterbirds to roost and nest in its increasingly diverse vegetation.

Recognising the importance of these ecosystems, the State Forest Management Centre is continuing its efforts to restore human-affected bogs through Cohesion Fund projects aimed at mitigating the legacy impacts of mineral extraction and processing and ensuring favourable conditions for species, habitats and landscape diversity.

The restoration of residual mires not only benefits the environment but also holds significant economic value. Well-maintained mires act as natural flood control systems or buffers, absorbing and slowly releasing excess water. This can reduce the risk of flood damage to nearby infrastructure and properties, resulting in substantial savings on flood control measures and disaster recovery.

Photo: State Forrest Management Centre

[8] Information received by email from the nature conservation specialist of The State Forest Management Centre, 20 March 2024.

[9] Eestimaa Looduse Fond, Miks soid taastada? Kuidas ja kaua läheb aega?

Depending on the location of the wetland and the recreational opportunities, amenities, flood control and storm buffering it offers, the estimated value of wetland ranges from approximately EUR 432 to 458 per hectare annually.[10]

Human well-being is intrinsically linked to the health of our natural ecosystems. Recognising this connection, the mire restoration project in Laiuse has prioritised community involvement. For instance, guided tours of the residual mire have provided locals with a first-hand glimpse into the intricate process of mire restoration, fostering a deeper appreciation and understanding of the natural environment. Not only that, but the restored mire has also turned into a popular destination for leisurely walks, promoting the physical and mental health of the local population.[11]

Despite Estonia's numerous mires and commendable efforts to restore them, almost none of the country's natural mires have been untouched by human activity. To preserve these ecosystems, all drainage of existing mires should cease immediately, and the government should set a specific deadline for ending peat extraction. As we have learned, mire restoration is possible and yields positive results. However, it remains costly and time-consuming. Therefore, more funding should be directed towards biodiversity and the protection and restoration of these unique ecosystems.

Watch this fascinating video for an insider's peak into the restoration of Estonia's residual mires.

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[10] Kirsten Schuyt, Luke Brander, The Economic Values of World's Wetland, *World Wildlife Fund*, January 2004.

[11] Kuremaa Külaselts, Räägime Laiuse jääksoo korrastamisest, *Kuremaa Külaselts*, 1 May 2022.