BONUS RETURN

Turning waste into circular solutions for the Baltic Sea

POLICY BRIEF FINLAND

Research in the River Vantaanjoki basin is assessing the role gypsum may play in reducing phosphorus run-off from farms polluting the Baltic Sea.

The Role of Gypsum Soil Amendments in Reducing Coastal Nutrient Run-off in Finland

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Phosphorus run-off from agriculture fields in southern Finland is the largest threat to water quality and living marine resources in this area of the Baltic Sea. Decades of attempts to reduce this run-off through traditional farming methods have proven inadequate. Now, a new opportunity has emerged: using gypsum as a soil amendment on agricultural fields. This reduces run-off pollution by 50%, reduces demand for virgin-mined phosphorus, and reuses industrial waste.

Extensive piloting and research are underway in Finland to document the effectiveness of this practice, and to identify any negative side effects. Modelling shows that the large-scale application of gypsum on coastal drainage areas in Finland, Sweden, Denmark and Poland offers a way to generate approximately 10% of all needed phosphorus reductions called for in the regionally endorsed Baltic Sea Action Plan. This Policy Brief summarizes the state of assessments of this farming technique and next steps needed.

One solution for two problems

Norwegian-based chemical company Yara International faces a problem at its mine in Siilinjärvi in central Finland. Large quantities of gypsum (calcium sulfate dehydrate) pile up as waste, a by-product of the company's extraction of phosphorus fertilizer from apatite rock.

Finland's stores of virgin and low-cadmium phosphate represent a rare economic asset globally. Most phosphate mining occurs outside of Europe, primarily in geopolitically sensitive regions, and most of the mined phosphate is high in cadmium, a dangerous metal not compatible with farmland application. Given the world's current reliance on mined phosphorus fertilizers, this situation raises concerns about both potential product scarcity and security risks.

At the same time, phosphorus losses in the form of run-off from agricultural fields in southwestern Finland present a major problem for the Finnish government, which has pledged its commitment to reduce pollution and restore water quality in the Baltic Sea.

Together, Yara's need to dispose of its gypsum waste and the Finnish government's policy goal of reducing phosphorus pollution spurred innovation with potential applications for coastal areas not only along the Baltic Sea region, but around the world.

Solving agricultural run-off of phosphorus is essential to restore the Baltic in Finland

Phosphorus run-off from agricultural fields is considered by HELCOM (the Helsinki Commission, or officially the "Baltic Marine Environment Protection Commission") to be a major source of nutrient load to the Archipelago Sea and the Gulf of Finland. Traditional best management practices such as buffer strips, constructed treatment wetlands, and fertilizer-reduction regimes, as well as environment-friendly cultivation practices have proven insufficient to restore water quality.

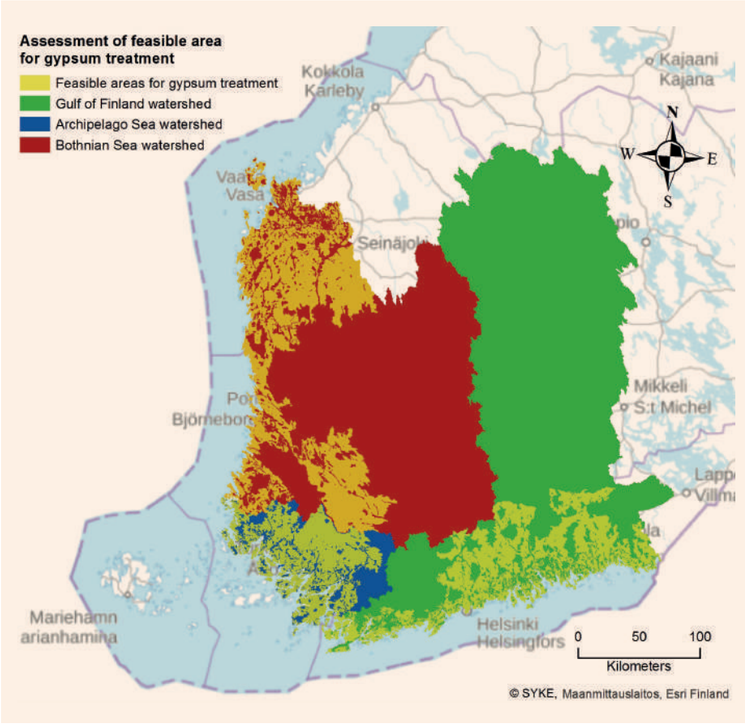
This serious problem is not unique to Finnish waterways. Throughout the Baltic Sea catchments, efforts to reduce nutrient pollution from agriculture fall far behind more successful responses, such as wastewater treatment. Both magnitudes and targeting of the traditional mitigation measures have been insufficient. Another part of the problem lies with the difficulty in adopting new ecotechnologies and practices. The relatively low cost of phosphate rock-based fertilizer, farmer reluctance to risk adopting new practices, decreased social acceptability of using sewage sludge in croplands, and entrenched government policies all play roles in suppressing ecotechnological advancement in agriculture.

Gypsum as way to transition to a circular economy for phosphorus

Yara International's waste by-product challenge spawned a search for an economically viable reuse option for its gypsum. When applied to farm fields, gypsum acts to improve soil structure, which in turn enhances phosphorus binding to soil and reduced leaching, leaving phosphorus fertilizer available to growing plants, and keeping it out of waterways. Application methods are simple and utilize traditional farming equipment and farmer acceptance of the practice in trials has been high.

Two large, independent pilot and research projects in Finland assessed the effectiveness and impact of gypsum application. Conducted from 2016 to 2018, Project SAVE worked with 55 farmers to apply and monitor gypsum usage on 1,500 hectares in the Savijoki River Basin. Funded by the University of Helsinki, the Finnish Environment Institute (SYKE) and the Ministry of the Environment through the national "circular economy key project" initiative, the project demonstrated positive results. Easily applied, gypsum improves soil structures, and reduces erosion and phosphorus losses by approximately one-half to nearby waterways.

The positive results of SAVE have encouraged more wide-scale pilot projects and assessment. Another research project is now underway, involving 3,500 hectares in the River Vantaanjoki basin. The 2018-2020 project is managed and funded by the John Nurminen Foundation, the Water Protection Association of the Vantaa River and Helsinki Region (VHVSY), the University of Helsinki, SYKE, and the Finnish government. Yara provides the gypsum, which local farmers apply in their fields.



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Gypsum spreading onto a field-block in the Vantaanjoki catchment. Photo: Jari Koskiaho

Assessing potential environmental and economic downsides

From an environmental perspective, researchers in these pilot projects have focused on assessing the potential negative impacts of sulfate loading. Approximately 18% of gypsum is comprised of sulfur, and its application to fields poses the threat of excess sulfate loading to lakes and groundwater.

Because sulfate is relatively abundant in seawater, it presents less of a risk to coastal drainage areas. In freshwater lakes, however, water with leached sulfate can increase phosphorus release from bottom sediments, thereby exacerbating eutrophication, the excessive richness of nutrients that triggers excessive plant growth in bodies of water. As a precaution, Finnish researchers do not recommend applying gypsum in lake drainage basins, or in groundwater recharge areas. Studies are not showing this to be a major concern to date, but it remains an area of active research.

Further research is also needed to evaluate the yet unknown, long-term effects of intensive gypsum application. Some scientists see this practice as a rapid way to reduce excessive phosphorus run-off in the short term. However, the long-term goal remains finding a more sustainable way to reduce soil phosphorus by decreasing the use of phosphorus fertilizer wherever it is agronomically feasible to do so. For this, development is underway for various ecotechnologies to reduce, recover and recycle carbon and nutrients (see e.g. https://mmm.fi/en/recyclenutrients). The BONUS RETURN project (https://bonusreturn.eu) is part of this effort to analyse promising ecotechnologies through systematic literature reviews, watershed modelling, serious game systems and testbeds.

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From an economic policy perspective, excitement generated by the early success of gypsum application warrants caution to avoid the potential of policy "lock-in" - whereby a singular, national focus on gypsum could hamper uptake of other viable ecotechnologies and approaches. This phenomenon is considered to be a major factor limiting the acceptance and implementation of single ecotechnologies.

The potential for large-scale use and impact

Project SAVE considers the practice of gypsum soil amendment to be a viable approach for some 540,000 hectares of farmland in the coastal river basins flowing to the Archipelago Sea (See map on page 2). These eligible farms represent about one-quarter of arable lands in Finland. Such a wide-scale application could reduce phosphorus loads to the Baltic Sea by 300 tonnes per year. Furthermore, if coastal catchments in Sweden, Denmark and Poland adopt the practice, total annual phosphorus loads could plummet by 2,000 tonnes. This means that 10% of the full phosphorus load reduction recommended by the HELCOM Baltic Sea Action Plan could be achieved through a single management practice.

Recommendations for further action

BONUS RETURN explored ecotechnologies to reduce, recycle and reuse the biomaterials of wastewater and agriculture in the Fyrisån (Sweden), Vantaanjoki (Finland), and Slupia (Poland) river basins. The Vantaanjoki case study shows that gypsum offers one way to address Baltic Sea eutrophication problems. This brief highlights the potential for upscaling gypsum use in the Baltic Sea Region as a promising component of Baltic Sea protection actions.

Project SAVE, the River Vantaanjoki project, and NutriTrade, a project of the European Union's Interreg Central Baltic Programme, offer the following policy recommendations for further action to assess and encourage implementation of gypsum soil amendment across the Baltic region:

- Development of a national plan to implement the use of gypsum in the coastal areas of Southern Finland, and to include gypsum in the national Finnish agricultural support scheme.
- Provision of government agricultural-subsidies to cover the costs farmers face in using gypsum soil amendment.
- Amendment of the EU Common Agricultural Policy (CAP) and HELCOM recommendations to promote gypsum application in the Baltic Sea catchments. The currently scheduled CAP reform for 2021 is a particularly important opportunity.
- Additional research on the economic, environmental and societal benefits of gypsum in countries outside of Finland.

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This series of three briefs describes real-world examples of policies or programmes intended to accelerate implementation of ecotechnologies that reduce nutrient losses, and encourage nutrient reuse in the three BONUS RETURN case study basins: Fyrisån (Sweden), Vantaanjoki (Finland) and Słupia (Poland).

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