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Gypsum as a soil amendment to combat land-based phosphorus load

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The Baltic Sea is heavily loaded with nitrogen and phosphorus (P) originating currently and in the past from industry, shipping, municipal wastewaters and land use. The coastal waters of Southwest Finland are eutrophic, to a large extent attributed to runoff from the sloping clayey agricultural land in the catchment. More than 1 million tons of uranium and cadmium free gypsum ($CaSO4{\cdot}2H_2O$) is generated annually in Finland in the manufacturing of phosphoric acid for fertilizers and at present it mostly ends up in a waste disposal site. Gypsum has proved to be a potential soil amendment to reduce the P load from agricultural fields. In this study the effects on gypsum on P in soil and in runoff was investigated in the laboratory, greenhouse and in a large-scale field test. - In a laboratory study, gypsum was added into a clay loam at a rate of 0, 4, 8, 12 and 16 t/ha and incubated for 30 days. According to a sorption desorption isotherm, gypsum (4 t/ha) decreased the equilibrium P concentration from 0.45 mg/l to 0.14 mg/l. When the pots were leached with 4 x 25 mm of water, the turbidity decreased substantially upon gypsum application in the first two leachates but the differences faded away later. Similarly, the concentration of dissolved P decreased in the first leachate from 0.16 mg/l to 0.09 mg/l but in the last leachate the differences were non-existent. The decrease of dissolved P in the solution phase did not have adverse effects on the growth or P uptake of ryegrass in a pot experiment. The effect of gypsum on P load is based on the increased ionic strength and Ca concentration, which decrease soil dispersion and P desorption. Owing to a rather high solubility in water (3.15 g/l), the effects are not permanent and the duration of the effect is still unknown. - Gypsum was applied at the rate of 4 t/ha to the area of 15.5 km2 of field in the Savijoki river catchment in Southwest Finland in autumn 2016. River water quality has been continuously monitored for turbidity, and samples for dissolved P have been taken manually. Gypsum amendment decreased turbidity and consequently the load of particulate P. During the first year (Nov. 2016 – Dec. 2017, 405 days, runoff 232 mm) 174 kg/km2 of particulate P was lost from the fields in the control area, while 138 kg/km2 (-21%) was lost from the area where 43% of fields were amended with gypsum. This initial decrease of particulate P load is substantial since 37% more particulate P had been lost from this area compared with the control area during a 5.5-month period before the treatment. The decrease of dissolved P was less marked, concentrations being around 30 μg/l. About 15% of gypsum has been flushed away during the first year. The monitoring will continue until 2019.