Report on possible application areas of nutrient trading in Finnish and Swedish water protection policy

Claes Ek (SLU), Katarina Elofsson (SLU) and Antti Iho (Luke)

EUROPEAN UNION
European Regional Development Fund

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Central Baltic

NutriTrade
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1. Introduction

This report aims to assess the possibilities to utilize market-based mechanisms in governmental policies to regulate nutrient pollution in Sweden and Finland, including the autonomous region of the Åland Islands. The report provides an overview of historical, current and future nutrient pollution policy, tracks the evolution of past Swedish proposals to implement trading schemes, and attempts to identify the main determinants of political (non)acceptance of economic policy instruments in nutrient management. It also discusses possible designs of nutrient trading, and evaluates the advantages and disadvantages of these designs with respect to environmental and economic performance and feasibility in relations to existing policies.

2. The situation in Sweden

In Sweden, there have been a series of ultimately unsuccessful proposals to introduce nutrient discharge trading systems over the past decade. These proposals stand in contrast to both earlier and current Swedish policy approaches on water quality, which rely heavily on legal review and permit processes (for wastewater treatment plants and industries) and environmental subsidies (for agriculture).

The environmental background to the above policy issues is the following. Based on detailed spatial modeling, the sixth HELCOM Pollution Load Compilation (Swedish Agency for Marine and Water Management, 2016a) calculated Swedish nutrient loads and compared results with country-basin-specific “Maximum Allowable Inputs” (MAI) of nitrogen and phosphorus set within the Baltic Sea Action Plan (BSAP). Results showed that Sweden is currently in compliance with all BSAP targets except two. First, the MAI for nitrogen discharges to the Bothnian Bay is set at 17 924 tons/year, but actual discharges were calculated at 19 500 tons/year. Second, the MAI for phosphorus to the Baltic Proper is set at 308 tons/year, but current discharges were calculated at 780 tons/year.

Of these unmet targets, the second is likely to be more problematic for at least three reasons. First, eutrophication is more severe in the Baltic Proper than in the

Bothnian Bay (HELCOM, 2014). Second, the limiting nutrient in the Bothnian Bay is not nitrogen, but phosphorus (Swedish EPA, 2014). Third, the calculations for the sixth Pollution Load Compilation separated total loads into anthropogenic and background loads, and found that the *background load* for phosphorus in the Baltic Proper (370 tons/year) actually exceeds the Swedish MAI to the same basin. Meeting this target is likely to prove very challenging. The present section will therefore mainly focus on phosphorus and the Baltic Proper.

According to the HELCOM Pollution Load Compilation, 40% of the anthropogenic net phosphorus load to the Baltic Proper arises within the agricultural sector. The other major sources of excess phosphorus are municipal wastewater treatment plants (22%), off-mains drainage (18%), urban stormwater runoff (10%), and industry (mostly pulp and paper; 10%). Phosphorus discharges from large wastewater treatment plants have been substantially reduced since the year 2000, mainly because of bans on using phosphates in detergents (South Baltic Water Authority, 2014b).

Beyond the BSAP targets, Sweden is also obligated by the EU Urban Wastewater Treatment Directive (91/271/EEG) and the EU Water Framework Directive (2000/60/EC) to reduce emissions of nutrients to inland lakes, rivers, and coastal waters. The Water Framework Directive requires all such water bodies to achieve good or high ecological status, including with respect to eutrophication, by 2021 or 2027. These targets are currently relatively far from being met. Within the Baltic Proper catchment area, 28% of all water bodies have yet to be classified, but of those remaining, only 48% currently have good or high ecological status with respect to nutrients.

2.1 A concise overview of Swedish eutrophication management policies

Swedish eutrophication policy goes back at least to the adoption of the Swedish Environmental Quality Act of 1969, which formed the basis of subsequent regulation of municipal wastewater treatment plants. By the time Sweden entered the EU in 1994, much progress had already been made, and the degree of phosphorus purification in wastewater treatment plants has remained stable at around 95% since the year 2000 (Swedish EPA, 2014).

Current wastewater regulation involves permit requirements for nutrient-emitting activities, set based on environmental quality standards ("EQ standards").[1] Polluting industries, aquaculture, and off-mains drainage systems[2] are also subject to this type of permit process. The implementation of more stringent regulations is likely to entail considerable administrative costs, as permits to all polluting point sources will need to be re-evaluated.

Deriving mainly from the EU Water Framework Directive (2000/60/EC), most of the standards are local in scope, and concern the environmental status of lakes, rivers, and Swedish coastal waters. With the adoption of the EU Marine Strategy Framework Directive (2008/56/EC), additional EQ standards for nutrient discharges to (and concentrations within) the Baltic Sea were added in 2012, stating that "the long-term target is that flows shall not exceed the maximal load determined within international agreements" such as the BSAP (Appendix 4, Regulation HVMFS 2012:18, Swedish Agency for Marine and Water Management).

In national legislation, the use of EQ standards is motivated within the Swedish Environmental Code (1998:808), which replaced the Environmental Quality Act in 1999. The Environmental Code also supports more specific government ordinances on water quality (2004:660) and the marine environment (2010:1341). Historically, EQ standards for eutrophication have been non-binding in the sense of requiring abatement only when environmental benefits are judged to outweigh associated costs (e.g. Swedish Agency for Marine and Water Management, 2014). A 2015 landmark ruling by the European Court of Justice (C-461/13) overturned this practice, however, making EQ standards for nutrients binding in principle (Swedish Agency for Marine and Water Management, 2016c).[3] Even then, chapter 2 (§7) of the

[1] There is also a separate set of EPA regulations for emissions of nitrogen from large wastewater treatment plants (Regulation NFS 2016:6, Swedish Environmental Protection Agency).

[2] Mid-size (201-2000 person equivalents) wastewater treatment facilities do not require permits, but are subject to notification requirements. Different municipalities apply different evaluation criteria, however, and progress has been slow in reducing nutrient discharges from such facilities, as well as from off-mains drainage systems (Swedish Agency for Marine and Water Management, 2016b).

[3] This refers to the so-called Weser ruling on plans to dredge and deepen parts of the Weser river in Germany. For an example of how this ruling has been implemented in the Swedish judiciary, see case M 8673-15: www.markochmiljooverdomstolen.se/Domstolar/markochmiljooverdomstolen/dom%20M%208673-15%20.pdf. Here the Land and Environment Court ruled that because of the perceived

Environmental Code does allow for some exceptions, for example if a polluting activity is combined with some form of compensatory measure which facilitates meeting the standard. However, it is not clear whether this rule is applied in practice for nutrient pollution (SOU 2017:34, p. 180).

Within the agricultural sector, voluntary arrangements have historically been the main policy approach.[4] The Swedish Rural development program provides funding for farmers willing to take measures to reduce nutrient runoff, such as by growing catch crops or constructing riparian strips and wetlands. These subsidies, which are intended to cover total costs to farmers, are combined with information campaigns. One such campaign is the Focus on Nutrients initiative, a collaboration between the Swedish Board of Agriculture and several partners, including the Federation of Swedish farmers, county administrative boards, and advisory firms. The aim of the project is to provide training and advice to farmers about environmental measures, so as to find potential win-win solutions that increase farmers' income while reducing nutrient runoff. So far, farmers representing one-third of total Swedish agricultural land have participated in the initiative.

2.2 EPA proposals for nutrient trading

While it is clear that Swedish policies have been effective in reducing nutrient loads, several economic studies have found that outcomes have not been cost-effective (e.g. Gren et al., 1997; Elofsson, 2010, 2012). The past decades has seen a growing interest in economic instruments capable of bringing down abatement costs, especially nutrient discharge trading systems. In 2007, the government tasked the Swedish EPA with analyzing "the possibility of having a charge system include trading with emission permits for phosphorus and nitrogen" (resolution M2007/4864/A).

The report that followed (Swedish Environmental Protection Agency, 2008) outlined a nutrient trading system aimed at equalizing marginal abatement costs across

danger of noncompliance with an EQ standard for eutrophication, environmental permits for a Swedish fish farm could be renewed only long enough for the farm to be dismantled.

[4] One exception is the Swedish tax on fertilizer nitrogen, which was abolished in 2010. Another is a set of regulations on e.g. storage capacity for manure and limits on how much fertilizer may be applied.

multiple sectors. The first component of the proposed system is that a regulated sector (e.g. municipal wastewater treatment plants) faces a binding emissions standard. Regulated agents whose emissions exceed the standard may either adopt abatement measures or buy "load permits" from the regulating authority at some price. The regulating authority uses income from selling permits to buy compensatory measures within some non-regulated sector (e.g. agriculture).[5] In this way, abatement costs within the non-regulated sector will determine the permit price, and also indirectly abatement costs within the regulated sector. Finally, a second-hand market for permits may arise among regulated agents.

In the report, the Swedish EPA stated that "it has not been possible to handle all aspects surrounding the proposal at a level of detail required for the proposal to be ready for adoption" (p. 8). A second report (Swedish Environmental Protection Agency, 2010) therefore provided more detailed analysis of the economic, legal and scientific issues pertaining to the proposed trading scheme. In particular, it identified potential conflicts between trading and (i) environmental subsidies through the Rural Development Program as well as (ii) EQ standards for inland waters.

Issue (i) arises in part because subsidies may undermine farmers' incentives to supply compensatory measures. Also, payments by the regulating authority for measures that are already subsidized likely conflict with additionality requirements within the Rural Development Program. Regarding issue (ii), the point of trading systems is to carry out load reductions (with respect to the Baltic) where they are least expensive. A potential side effect is that measures may be diverted from inland waters subject to EQ standards. While it may be possible to add special provisions to avoid such regulatory conflicts, these auxiliary rules will undermine the cost-efficiency of the trading system. The situation is especially problematic if, as is the case, EQ standards are both abundant and stringent.

The EPA report from 2010 concluded that for nutrient trading to work as intended, environmental subsidies within the Rural Development Program would need to be scrapped and the relationship between trading and EQ standards closely examined at the least. Adopting a fully functional trading system would involve a "fundamental

[5] The proposed scheme involved a reverse auction, i.e. multiple sellers competing for the opportunity to sell to a single buyer. This is a standard method for obtaining least-cost bids in public procurement.

shift in Swedish environmental policy and a regime change from regulation to market-based instruments" (p. 143).

Building on previous efforts, the Swedish EPA then presented a final proposal for a nutrient discharge trading system, called CEASAR (Swedish Environmental Protection Agency, 2012). In some respects this system scaled back the scope of previous proposals. It covered only municipal wastewater treatment plants and did not allow purchases of offsetting measures from e.g. the agricultural sector. Instead, wastewater treatment plants were to trade load reduction certificates among themselves. The certificates are best described as inverted emission permits, representing obligations to reduce emissions rather than rights to emit. Consequently, instead of a gradually lowered cap, the CEASAR system included a gradually increasing "floor" for the number of certificates that agents would be required to hold.

CEASAR went some way toward resolving conflicts with existing policies. First, because only municipal wastewater treatment plants were covered, there was no obvious risk that trading would undermine subsidies within the Rural Development Program (or vice versa). Second, CEASAR covered only nitrogen emissions.[6] EQ standards for water quality largely concern phosphorus, and include nitrogen obligations only for Swedish coastal waters, where significant synergies with BSAP targets are likely, as pointed out by the EPA.

Review comments during consultation were more favorable to the CEASAR system than to earlier proposals. Of the 37 institutions providing comments, 16 explicitly approved the proposal, while only one rejected it. Nevertheless, several responses repeated earlier concerns, highlighting the risk for the creation of hotspots, given the double impact of nitrogen emissions on the Baltic Sea and on local waters, including coastal waters.[7]

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[6] Policy instruments to reduce nitrogen emissions may seem redundant given that Sweden is currently in compliance with BSAP targets for nitrogen except in the Bay of Bothnia (recall the discussion in section 1). These targets were revised in 2013, however. Before the revision, MAIs for nitrogen were significantly lower throughout the Baltic, and in particular the Swedish nitrogen reduction target was more than twice as large.

[7] Another issue raised by some commenters (including by the Land and Environment Court, which rejected the proposal) was that trading systems may lead to adoption of some abatement measures that are inappropriate by the (earlier) conditions related to benefits and costs specified

The EPA report proposed that CEASAR should be adopted by January 1, 2016. However, after consideration in the Environment and Agriculture Committee of the Swedish parliament (report 2014/15:MJU4), the government made a decision not to adopt the system. Officially, it was stated that the current approach of regulating nitrogen and phosphorus by permit review is ”difficult to reconcile with a charge system for these emissions” and that “given that there are other more cost-effective ways to reduce emissions of nitrogen and phosphorus, the Government Office presently sees no reason to pursue the proposal further.”

2.3 Regional water quality policy efforts

Current Swedish policy initiatives mainly take place at the subnational level, not least within the five regional Water Authorities tasked with ensuring compliance with the EU Water Framework Directive. In 2014, the Water Authorities proposed a program of measures to further increase compliance in 2016-2021. Although the measures assumed to follow from the proposed program are insufficient to fully meet EQ standards for Swedish water bodies, they would likely to make a substantial difference. For instance, the South Baltic Water Authority (2014a) calculated that complying with EQ standards for lakes and rivers in the South Baltic water district requires a reduction of gross phosphorus loads by 170 tons/year. The proposed program of measures would produce reductions of 150 tons/year. Furthermore, because of synergies with reducing phosphorus loads to the Baltic Proper, the program as a whole would lead to near compliance with the relevant BSAP target.[8]

The program did not include final proposals for specific policy instruments, but instead provided recommendations to other government agencies and authorities (e.g. the Swedish Board of Agriculture, the Swedish Agency for Marine and Water Management, municipalities, and county administrative boards) on which types of policy instruments to develop and pursue (South Baltic Water Authority, 2014b). In many parts, these recommendations were consistent with previous policy

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within the Swedish Environmental Code. Our understanding is that because of the recent binding legal status of EQ standards for nutrients, this point no longer applies. There were also numerous comments on technical design issues.

[8] The difference between actual loads and the MAI for phosphorus to the Baltic Proper was calculated at roughly 10 tons/year. Note that these calculations were based on less detailed models and data than the sixth Pollution Load Compilation (Swedish Agency for Marine and Water Management, 2016a).

approaches: for instance, permit review or other command-and-control instruments were deemed adequate to reduce emissions from wastewater treatment plants and industries. For large wastewater treatment plants, however, nutrient trading (of the CEASAR type) was also mentioned as a promising way of ensuring least-cost reduction of phosphorus emissions. A large share of the recommendations focused on increasing funds for monitoring compliance.

Other parts of the proposal proved controversial. In particular, the majority of proposed physical abatement measures were within agriculture, and here there was a clear break with tradition: the proposal displayed an apparent tendency toward using command-and-control instruments rather than subsidies. For instance, the program included proposals to require farmers to construct wetlands on roughly 1.6% of the total agricultural land in Sweden (possibly by threat of state expropriation). Total costs from abatement measures on agricultural land was estimated at SEK 2 billion/year, roughly 10% of the total after-tax income of Swedish farmers.[9]

Unsurprisingly, these proposals met with heavy resistance from farmers. In October 2016, the Swedish government tasked the Water Authorities with developing a revised program of measures for the years 2017-2021, while instructing that agricultural measures should be undertaken specifically within the context of the Rural Development Program. The government also required the Water Authorities to revise previous cost-benefit analyses. Proposals incorporating these changes were presented in December 2016 (e.g. North Baltic Water Authority, 2016). In the new cost-benefit analyses, total costs to farmers are calculated at the much lower figure of SEK 36 million. The new proposal does not make specific mention of nutrient trading, citing only the potential need to develop new policy instruments for ensuring compliance with EQ standards.

Another initiative which may eventually prove important for nutrient trading is a recent government review (SOU 2017:34) on the potential for ecological

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[9] According to statistics from the Swedish Board of Agriculture (http://www.jordbruksverket.se/webdav/files/SJV/Amnesomraden/Statistik,%20fakta/Jordbrukets%20ekonomi/JO42/JO42SM1501/JO42SM1501_tabeller.htm), household mean income after transfers (incl. taxes) among farmers was approximately SEK 340 000 in 2013, and there were about 64 000 farm households. Multiplying these two figures, we end up with a little less than SEK 22 billion.

compensation e.g. in various permit processes. As already stated, in principle the Swedish Environmental Code allows permits to be granted to activities with negative environmental impacts if the impacts are compensated in some way, though this type of ecological compensation is rarely carried out at present (Swedish Environmental Protection Agency, 2015). To facilitate compensation, the report suggests a number of new policies and legal changes, including the creation of a market for compensating measures (a "compensation pool") with respect to various ecosystem services. Although the focus lies mainly on infrastructure projects and land development, the same idea applied to nutrient management is essentially equivalent to the type of nutrient trading proposed in the 2008 EPA report.

Clearly, problems related to the additionality of offsetting measures (i.e. to conflicts with subsidies within the Rural Development Program) would still need to be resolved for such a system to work. Nevertheless, establishing a legal principle of compensation would very likely work to support adoption of some manner of nutrient offsetting. The authors of the report note that there is no fundamental barrier to requiring compensation not only for new permits, but also when renewing existing permits, as in the case of municipal wastewater treatment plants (SOU 2017:34, p. 168).

3. The situation in Finland, including Åland Islands

3.1. Existing governmental policies to major nutrient pollution sources

Governmental regulation of nutrient pollution in Finland is based on permitting processes for point sources, CAP agri-environmental schemes, cross-compliance conditions for agricultural nutrient loading, and various laws, regulations and standards concerning other non-point sources such scattered settlements, peat industry or forestry. Industrial point sources and waste water treatment plants comprise about 10% and 27% of land-based phosphorus and nitrogen loading, respectively. The share of agriculture is 63% and 59%, and that of aquaculture about 2% of P and 1% of N. The rest is largely much comprised of scattered settlements and forestry.

The "hard" regulation guiding point source permitting is based on laws and regulations which comply with various EU directives such as the IE-directive (2010/75/EU; formerly known as the IPPC- directive) and the Urban Waste Water

Directive (91/271/EEC). There are some variations in actual permitted emissions. For instance, cities located by large inland lakes, such as Jyväskylä, are exempted from stringent nitrogen abatement requirements. There and also differences in individual permit levels for different industrial units. In any case, the permit levels set the unambiguous upper bounds for nutrient pollution from point sources.

In 2012, the Ministry of Environment established a voluntary recommendation scheme together with the representatives of WWTPs and Finnish communities, with the purpose of fostering nutrient abatement from WWTPs. The scheme could have been used as a background material in permitting process. However, during the operation of the scheme, only 12 permit decisions out of 150 mentioned the scheme at all. That is, its role in the permitting process remained weak. However, this may be also due to time lag in the permitting processes: during 2014 and 2015, almost 20% of the permit decisions did mention the scheme (Vesilaitosyhdistys 2015).

Agricultural non-point sources are influenced by CAP regulations. All farms receiving CAP subsidies must fulfill the cross-compliance conditions. These are the basic requirements for environmentally sound farming related to crop rotation, vegetative cover etc. In Finland, vast majority of farms and farmland also participate in the agri-environmental program. What is important for the topic of this report is that the farmers are not supposed to receive payments for the conservation actions they provide from any other sources than the Rural Development Program. At this moment there have been no investigations in the possibilities to design schemes where farmers can choose to have nutrient abatement funded by the Rural Development Program and by other schemes such as nutrient trading.[10] It is not evident how this could be solved. Therefore, the focus on the potential role of trading in governmental policies in Finland will be on point sources.

3.2 Potential supply of nutrient credits in excess of current abatement

Looking at the P and N abatement levels in Finnish industrial sources and waste water treatment plants, one can find room for intensified N removal from waste water treatment plants and for intensified P removal in industrial units.

Upgrading the N removal technology in WWTPs to remove at least 80% of the incoming N would yield reductions of about 2750 tons (more than Finland's HELCOM requirements). Increasing it further to match the most efficient facility (Viikinmäki, Helsinki) would yield reductions of 4000 tons. All these are above the current permit levels which comply with national and EU legislation. That is, there could be supply of permits. Could there be demand? Obviously, there is room for voluntary purchases of permits.

[10] However, relatively many Finnish farmers would be ready to accept market based regulatory instruments. This was seen in an actual auction trial as well as a survey following it (Iho et al 2014 and Grammatikopoulou et al 2012)

Regarding P, all WWTPs are already relatively efficient, removal rate being generally above 90%. The average removal rate in pulp and paper industry (4.3% share of land-based anthropogenic P loading) varies between 50% and 80%. Again, these loading levels are in compliance with permits which align with laws, directives and EU regulations. Intensifying P abatement to the levels of best WWTP facilities (not taking into account the technical burdens of doing so) would increase P abatement by about 75 tons. That is, pulp and paper industry could technically generate P credits by this amount. It would be about 25% of Finland's BSAP targets. [11]

3.3 Creating demand for nutrient credits – the Weser ruling and legislative revision in Åland

Despite being the very idea of nutrient trading, it is unlikely that nutrient credits could be purchased in Finland and used to exceed current pollution limits of any point source facility. First of all, this would require legislative changes. Furthermore, many facilities are located in coastal areas and close to inland lakes where the local effect of pollution matters a lot. To be politically acceptable, trading requires that pollutants mix properly within the trading area. Mixing does not have to be prefect but the effects of abatement in one location need to be unambiguous in the other location. This "hotspot" effect makes schemes with trading between point sources difficult.

However, a recent decision made by the European Court of Justice might bring about needs to make nutrient trading institutionally feasible in Finland. The decision (C-461/13) concerns deepening the Weser river in Northern Germany and is considered important because it clarifies how the Member States should interpret the ecological water quality goals set by the Water Framework Directive. Shortly, the ruling makes the WFD goals binding in the permitting process of any individual project that increases pressure (i.e. pollution) to the water body, and not just as overall management goals. Basically, member states must decline permitting projects that may cause deterioration in any given quality class (even though this would not be associated with a decline in overall ecological status class; or which may impede achieving good ecological status by the target time. Shortly, the activity may not cause a risk of deterioration or endangering the achievement of good ecological status.

[11] For calculations, see http://prezi.com/p5ewxttyuwdu/?utm_campaign=share&utm_medium=copy

Essentially, the Weser ruling makes any individual permitting process legally coupled to WFD river basin management plan. For example, a fish farm expansion should not be permitted if it increases pollution loading and the water body is below good ecological status and the water quality is the class that may prevent the water body from achieving good ecological status by the target time. Obviously, such a stringent ruling may paralyze local economies located on sea areas where their own contribution to the water quality of their water bodies is low. For Åland Islands, for example, this could mean that eventually all permit renewals are rejected unless the overall water quality of the Baltic Sea is high enough to sustain good ecological status of the water in Åland.

To remain operational, permitting authorities need a tool to allow those applying permits to offset their pollution increases with abatement actions elsewhere that would neutralize the effect on the overall pollution load to the water body.

It is still unclear how the Weser ruling will be interpreted in Finland and Sweden and how it will influence actual permitting processes. How will, for instance, the relative contribution of an individual facility to ambient water quality be taken into account in the permitting process?

I any case, it would be important to assess whether the institutional and legislative environment makes it possible to acknowledge nutrient credits in permitting process. Such a process is already ongoing with the legislation in Åland. But it also might be that the existing laws already allow permitting authorities to start acknowledging nutrient credits of the applicants. For coastal economies, this might be a crucial question.

4. Comparison of alternative possible designs of national nutrient trading schemes in Sweden and Finland

The fact that nutrient discharge trading was mentioned in the 2014 proposal of the Swedish Water Authorities indicates that economic instruments remain part of the Swedish marine and water policy discussion. Likewise, there seems to be a potential for nutrient trading in Finland, e.g., driven by the need to secure sectorial development and entry of new firms as described above. Nevertheless, only sectoral trading systems were mentioned by the Water Authorities (e.g. trade between wastewater treatment plants), and overarching multi-sector nutrient trading is still little discussed in the public debate. By examining the two policy proposals made by the Swedish EPA and comments on those, as well as the ongoing developments in Finland we have identified some reasons why this is the case.

Our assessment is that the major obstacle to trading is that large-scale nutrient trading cannot simply be applied on top of current policies. In particular, compliance with the EU Water Framework Directive is likely to conflict with the objective of meeting BSAP targets for phosphorus at least cost. Similarly, ensuring that BSAP targets are met in a cost-efficient way is likely to undermine compliance with EQ and WFD standards. Thus far, policy makers appear to believe that the disadvantages of uncertainty about the environmental performance of nutrient trading exceed the potential benefits in terms of cost savings.

Nevertheless, it is worth asking which type of trading scheme is the most promising as a first step towards a more cost-effective policy. Below we provide an assessment of three nutrient trading schemes, assuming that in all cases the main objective is to attain compliance with the BSAP targets for Sweden and Finland, respectively. When considering the feasibility of each system, we also suppose that while the systems may cover several sectors, none include measures already supported by the Rural Development Programs. Finally, we assume that the agricultural sector is not subject to abatement requirements under any system, although it may participate in offset markets.

The systems listed in the table below are: (i) partial trading, in which trading is introduced but the binding character of local EQ and WFD standards is respected (similar to the EU-ETS, where overall trading is combined with national targets and policies); (ii) a system of trading ratios that provides particular disincentives to pollute sensitive areas (the “hotspot” issue); and (iii) a system which combines EQ and WFD standards with offset markets for regulated agents (typically point sources), as in the original 2008 EPA proposal. The three alternative systems are discussed below

Table 1. Comparison of different nutrient trading schemes.

System type	**Environmental effect**	**Cost-efficiency with respect to BSAP**	**Feasibility with respect to current policy**
Partial trading	Large	Low	High
Emissions trading with trading ratios	Moderate	Moderate/high	Low
EQ standards with offset markets	Large	Moderate	Moderate (depending on design)

Partial trading. This system respects the local EQ and WFD standards and, in practice, involves trading only of nutrient reductions that go beyond the nutrient targets implicit in the standards. As we have noted, complying with all standards imply essentially that the BSAP targets are met as well. Thus, if the EQ and WFD standards are taken seriously, the scope for cost reductions in (also) meeting the BSAP targets is quite limited, so while overall environmental benefits may be large, cost-efficiency with respect to the BSAP target is likely to be very low.[12] Thus, while this system does have the benefit of entirely side-stepping regulatory conflict, it (literally) does so at considerable expense.

Emissions trading with trading ratios. This system replaces the EQ standards with nutrient trading under some set of trading ratios. These ratios are meant to address the fact that unlike carbon dioxide in the atmosphere, nutrients do not "mix uniformly" in the environment, and moreover damages from eutrophication are spatially heterogeneous. It is well established in economics that such a trading system, especially if applied to several sectors, may deliver substantial cost

[12] This assumes, of course, that EQ standards are achievable in the foreseeable future. Whether true or not, Swedish legal and policy discussions do start from this assumption (e.g. Swedish Agency for Marine and Water Management, 2016c), which is why we do as well.

reductions compared to command and control-type instruments, while at the same time taking spatial heterogeneity into account.

If the trading-ratio system aims only to deliver cost-effective compliance with the BSAP target, fewer inland waters can be expected to attain good ecological status than if all EQ standards are met (as was the case under partial trading). The trading ratios would provide some additional incentives to reduce emissions to especially sensitive areas, although it is difficult to assess how far this would go to alleviate political concerns about local water quality. What is clear is that since this system would not need to compete with EQ standards, it is likely to attain the BSAP target at significantly lower cost than under partial trading.

Offset markets for wastewater treatment plants. Finally, EQ and WFD standards could be combined with an offset market where the regulated agents buy nutrient reductions from non-regulated sectors, ideally within the same water body, so as not to jeopardize compliance with the standards. The main advantage of this system compared to partial trading is that it could encompass agriculture and other sectors that would probably otherwise not be included. In principle, this would lead to significant cost reductions.

As noted, however, conflicts with subsidies within the Rural Development Program would still need to be avoided. If it is not possible to replace subsidies with offset payments, it may still be feasible to direct offsets towards aquaculture and other non-agricultural measures, or to specifically exploit agricultural measures not covered by the Rural Development Program (e.g., spreading gypsum onto fields or reducing fertilizer application). One can note that of all the agricultural measures considered in the initial draft of the program of measures prepared by the Water Authorities, only one (adjustments to fertilizer application) is not covered by the Rural Development Program. Thus, the potential of this type of system probably depends on the emergence and success of innovative abatement measures.

5. Discussion and conclusions

Nutrient trading is known to be a cost-effective measure provided that there are sufficiently many agents in the market, policy makers set binding caps and a trustworthy path for the future development of this cap, appropriate trading ratios are defined, and systems that ensure high compliance are in place. Experience from the EU carbon trading system is available, but there is no experience from nutrient trading in Europe. This, in combination with the current large scale use of permits and subsidies to control nutrient pollution in Sweden and Finland, can make policy makers reluctant to introduce nutrient trading. Some of the reasons for the reluctance is likely to be uncertainty about the environmental performance of nutrient trading and the considerable costs for institutional change. We therefore consider nutrient trading with offset markets to be the most promising in the shorter run with regard to the combination of political feasibility, environmental effectiveness, and cost-efficiency. By implementing offset markets on the regional or national scale, Sweden and Finland would make additional environmental gains at a moderate cost. At the same time, the countries would gain experience that would be useful when considering whether to proceed with large scale institutional change in terms of adopting emission trading with trading ratios.

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