Literature review and learning from previous experiences on emissions and nutrient discharge trading outside the BSR

Katarina Elofsson, Antti Iho, Lassi Ahlvik

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1. Introduction

Emission trading is a market-based policy-instrument to tackle environmental problems and it is often seen as an alternative to emission taxes and command-and control instruments. The textbook version of emission trading has many appealing properties. Unlike command-and-control instruments, trading would lead to efficient allocation without information on polluters' abatement costs. The larger the differences in marginal costs between polluters, the higher are the potential gains from trading. Furthermore, in contrast to environmental taxes and other price-based instruments, the standard emission trading is a quantity-based instrument: the pollution levels will never exceed the pre-defined cap, such as the maximum allowable input of nutrients.

The ongoing water quality programs in North America have shown that the textbook-version of emission trading is not directly applicable in the context of water quality trading due to its specific characteristics (Shortle 2016). Of the three dozen water pollution trading programs that have been established there are only a few that are operating and many have not seen trades at all (Morgan and Wolverton 2005, Fisher-Vanden and Olmstead 2013). Water quality trading outside North America is limited, but notable exceptions include trading in Australia and New Zealand. In this deliverable we aim at identifying the potential pitfalls for water quality trading and identify success-stories to help introducing nutrient trading in the Baltic Sea catchment.

In principle, water quality trading schemes can be divided to (i) standalone instrument, referring to a standard cap and trade-markets and (ii) additional to the other regulation to promote cost-efficiency. Another way to categorize the pre-existing water quality markets is based on their market structure to (i) bilateral, (ii) clearinghouse and (iii) exchange markets (Woodward, Kaiser and Wicks 2002, Fisher-Vanden and Olmstead 2013). In bilateral programs, participates engage in one-to-one negotiations to organize trades and offsets. This may lead to significantly higher marginal abatement costs than other trading mechanisms. In addition, experience from the field of climate policy suggests that the transaction costs for bilateral trading are considerable (Michaelova et al., 2003). In clearinghouse programs the direct link between buyer and seller is broken by a clearinghouse, which may generate credits. Last, in exchange markets, credit buyers and sellers meet in a marketplace where prices are truly determined by supply and demand. A third way to characterize trading platforms is to look whether trading takes place (i) between point sources or (ii) between point and non-point sources or (iii) only between nonpoint-sources.

1.1 Potential for water quality trading

Water quality trading has been proposed as a potential solution to help reaching the environmental targets in the Baltic Sea (NEFCO 2009). In the international context of the Baltic Sea, trading would serve for two purposes. First, it would help to achieve cost-efficient implementation of the Baltic Sea Action Plan. The potential for welfare gains in reaching cost-efficiency vis-à-vis the current allocation is estimated at 500-700 million Euros or around 16 %-26 % of the total cost (Elofsson 2010, Hyytiäinen and Ahlvik 2015). The inefficiencies in Baltic Sea protection have been pointed by numerous authors (Gren et al. 1997, Ollikainen and Honkatukia 2000).

As an illustrative example of these inefficiencies, see Table 1 pointing out cost-differences for a small subset of abatement measures between countries around the Baltic catchment. There are two kind of differences in marginal costs. First, large differences remain in marginal costs remain between old (Denmark, Finland, Germany, Sweden) and new EU countries (Baltic States and Poland), which indicates that there is a large trading potential between countries. As a second observation, there are cost differences between different abatement measures within each country, and in particular between point and non-point sources. Therefore, nutrient offsetting between treatment plants and agricultural sources would be possible.

Table 1. Minimum marginal abatement costs around the Baltic Sea catchment. (Source: Hyytiäinen and Ollikainen 2012)

	Nitrogen abatement costs (Eur / kg)						
	Fertili-zation	Wetlands	Catch crops	Sedimen-tation	Treatment plants	Deter-gents	Animals
New EU	2	2	4		2		16
Old EU	4	9	6		12		34
	Phosphorus abatement costs (Eur/kg)						
New EU	1	238	433	18	10	22	1191
Old EU	0	522	703	58	51	52	950

As another advantage of water quality trading, a proper initial allocation of permits may help to promote burden sharing between countries and hence help to guarantee that all the countries find protection beneficial (Ahlvik and Pavlova 2013). This is especially useful in within Helsinki Commissions (HELCOM) in which countries are committed to polluter pays principle, and direct monetary transfers are off the table. Inability to agree on burden sharing may lead to severe delays and unnecessary environmental costs in water protection. This is demonstrated in the infamous Rhine chlorides dispute, which lasted for over 70 years before a variant of trading was established between the victim (the Netherlands) and the polluter (French factories) (Dieperink 2011).

Third, water quality trading based on exchange market or bilateral trades is a quantity-based economic instrument, which guarantees that the predetermined target is reached even under uncertainty about traders' cost structure. Therefore, trading is preferable to price-based instrument such as taxes if exceeding the abatement target is unwanted or particularly harmful (Weitzman 1979). Note, however, that if trading is organized as a clearinghouse, it is essentially a price-based system and predetermined targets cannot be guaranteed to be met. In addition, unlike exchange markets, clearinghouse does not result in balanced budget: It can lead to an unexpected financial loss or a revenue.

Trading can also be organized without regulatory driver for demand. In that case, the demand would be created by voluntary contributors and private companies. Such voluntary mechanism can be more flexible than any public policies and they can help to pick the "low-hanging fruits", that is, to promote cost-efficiency by targeting measures that are not covered by any existing regulation. Moreover, such a voluntary scheme could work as a pilot for a more comprehensive trading.

1.2 Problems with water quality trading

The first problematic characteristic with water quality trading is that the spatial location of the emission source matters for its impact on a water body. This naturally limits the size of the market and leads to market frictions and transaction costs (Liski, 2001). From polluters' point of view, the existence of transaction costs forms a coordination problem: On one hand, it is relatively cheap to enter the markets if everyone else enters and there are many other potential trading partners. On the other hand, if no-one else enters the market, entering is not profitable as it only involves the (transaction) costs but no benefits. Regulator has some power over the equilibrium in which the model ends up. For instance, by guaranteeing a fixed price the incentives to enter the marketplace increase as benefits get less dependent on the number of traders. In addition, the impact on the aquifer differs between sources near to and distant from the aquifer. Given that water typically flows in one direction, this variation in impact on the recipient can be dealt with through the introduction of a trading-ratio system, where the land area is divided into zones depending on the proximity to the targeted water body. The system can be designed according to the following: (1) each zone's emission target is taking into account the water pollution loads from the upstream zones; (2) the trading ratios are determined by the relative impact of emissions from zones on the aquifer; and (3) permits are freely tradable among dischargers across zones according to these trading ratios (Hung and Shaw, 2005). This allows for including a larger number of emissions sources in the trading scheme, thereby facilitating trade, while accounting for the variation in the impact on the recipient.

A second problem inherent in water quality trading is overlapping regulation. If trading complements existing command-and-control instruments, the gains to be had from trading are necessarily small because regulation evens the marginal costs between the sources. On the other hand, if trading can substitute existing regulation, the potential benefits are significantly larger as some sources can avoid the costly command-and-control regulation by buying permits.

A third problem is related to non-point sources which are uncertain and notoriously difficult to regulate. This is not an issue for trading between point sources, but agricultural sector is a large polluter both in the U.S. and in the Baltic Sea catchment. Moreover, the lowest-cost abatement options can typically be found among the non-point sources. There are three types of uncertainty related to non-point sources that are unwanted from social point of view, and also from the viewpoint of point source if it is legally responsible for meeting its regulatory requirement. First, uncertainty caused by natural stochasticity, such as rainfall. Second, there is an issue of noncompliance, meaning that the regulator is not certain whether the polluter will implement the measures. Third, there is technical uncertainty, that is, the uncertainty about the true effectiveness of new innovative abatement measures. Therefore including agriculture in trading programs requires the use of modelling to estimate the effects of abatement measures on water quality, as well as regular audits and visits to farms to ensure compliance. All in all, this involve transaction costs that may well exceed any potential gains from trading.

If nutrient trading is voluntary, and not driven by any regulation, it suffers less from the abovementioned problems. The coordination problem is less severe and the size of the market is not essential as the demand will be there, in form of the fund collected by voluntary contributions. The trading ratios (geographical or between sectors) need not to be defined as there is no need to make abatement units commensurate: donors are free to choose where they want to donate their money. Moreover, existing regulation need not be a problem for as long as the fund can be used to implement measures in other, unregulated sectors or countries.

However, the greatest challenge in any voluntary scheme is the creation of demand. Economic theory suggests that voluntary mechanisms are not efficient if participation is voluntary (Dixit and Olson 2000) or if individual's willingness to pay is private information (Rob 1989, Hellwig 2003). In other words, investments whose benefits exceed costs will be left unused if their funding was left only for voluntary donations; this would not happen if the project was funded by public money. However, voluntary funding is possible given that the benefits from a project are large enough compared to the costs. As another problem, a private fund may "crowd out" public environmental protection if voluntary projects replace government's investments to some extent.

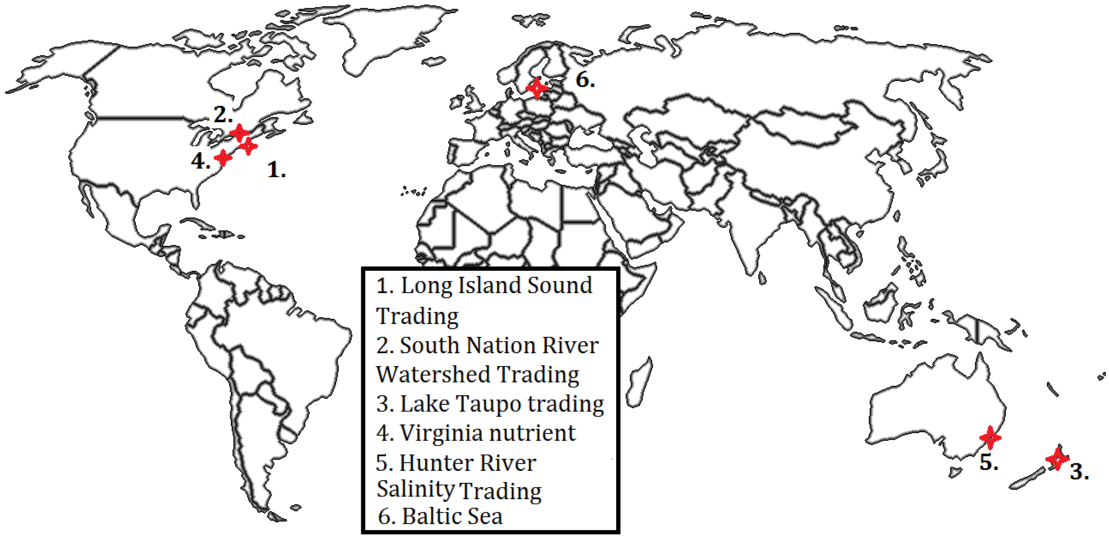

Figure 1. Location of the nutrient trading schemes analyzed in this study

2. Examples of successful trading schemes

Next, we focus on three particularly interesting trading schemes where trading has been active, and which provide examples of different market structures. The examples are located in four countries: Long Island Sound Trading and Virginia Nutrient Credit Exchange in the U.S., South Nation River in Canada, Lake Taupo

Trading in New Zealand and Hunter River Salinity Trading in Australia. Table 2 provides details of the three programs and their location is shown in Figure 1.

Table 2. Details of each considered trading programs

	Working since	Tradable good	Trading between	Structure	Participants	Permit prices
Long Island Sound Trading	2002	Nitrogen	PS-PS	Clearing-house	79 WWTPS	3-11 Eur / N kg
South Nation River Watershed	2000	Phosphorus	PS-NPS	Clearing-house	15 WWTPs and 2 industries, agriculture	200 Eur / P kg
Lake Taupo trading	2007	Nitrogen	NPS-NPS	Exchange market	Agriculture, forestry	11 Eur / N kg
Virginia Nutrient Creding Exchange	2005	Nitrogen and phosphorus	PS-PS, PS-NPS, NPS-NPS	Clearing-house, bilateral	105 point sources working under bubble permit, agriculture, oyster cultivation	6 Eur/ N kg, 10Eur/ P kg
Hunter River Salinity Trading	2002	Salinity	PS-PS	Exchange market	31 point sources	160-3800 Eur / credit

2.1 Long Island Sound Nitrogen Credit Exchange

The state of Connecticut established a nitrogen exchange market in 2002 between point sources to reach the Total Maximum Daily Load for dissolved oxygen (Connecticut Department of Energy and Environmental Protection 2016). The trading has been active and successful with 79 municipal treatment plants participating in trading. The cost savings have been estimated at 300-400 million dollars; the majority of this gain is estimated to have come from the economies of scale in wastewater treatment plants. (Connecticut Department of Energy and Environmental Protection 2010). Trading ratios were based on location of the treatment plants.

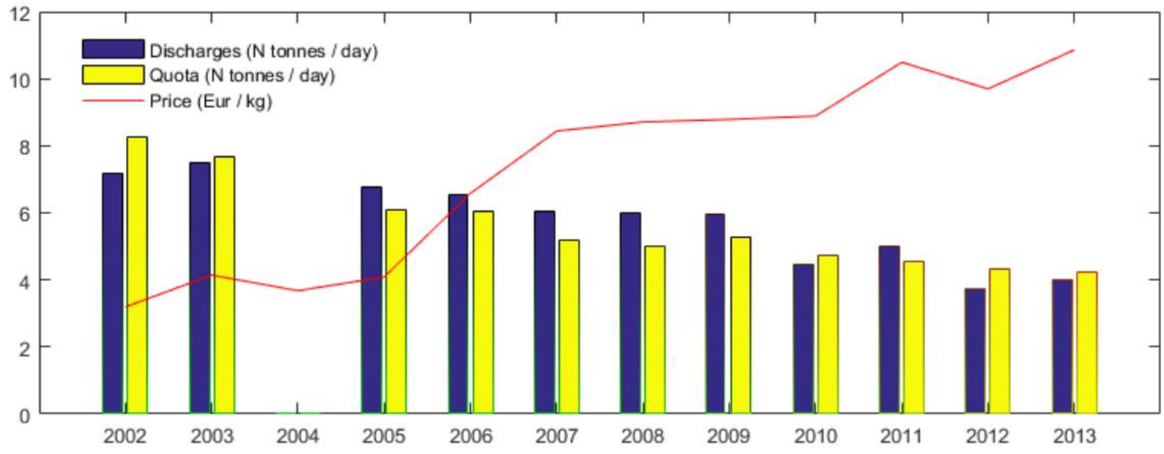

Figure 2. The prices and the discharges and quotas in Long Island Sound Trading (Source: http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325572&deepNav_GID=1635%20)

The program is structured as a clearinghouse where the price is set by the regulator based on the expected marginal costs. It follows that purchases and sales are not necessarily balanced and the structure of the market is closer to a price-based instrument than a "standard" water quality trading. On one hand, this may be a reason for active participation: treatment plants know the price beforehand, which reduces transaction costs in the market. On the other hand, uncertainty about abatement costs may preclude setting the price at the level that would meet the abatement targets (Weitzman 1979). This is illustrated in Figure 2, which shows prices set by the Nitrogen Credit Advisory Board together with the nutrient discharges as well as the nitrogen quota which is declining in time to meet the total maximum daily load by 2013. As can be seen, the quota is not met between 2005-2009 and again in 2011. The price has been set too low, which has discouraged aggregate investments. As another problem, the budget is not necessarily balanced: a too low price will create budget surplus as wastewater treatment facilities will pay the price rather than to make the necessary investments. On the contrary, a too high price will create a deficit as the clearinghouse has committed to buy an arbitrary number of offsets at the given price. It follows that a trading organized as a clearinghouse can only function if it can credibly be backed by a state or another institution with “deep pockets”.

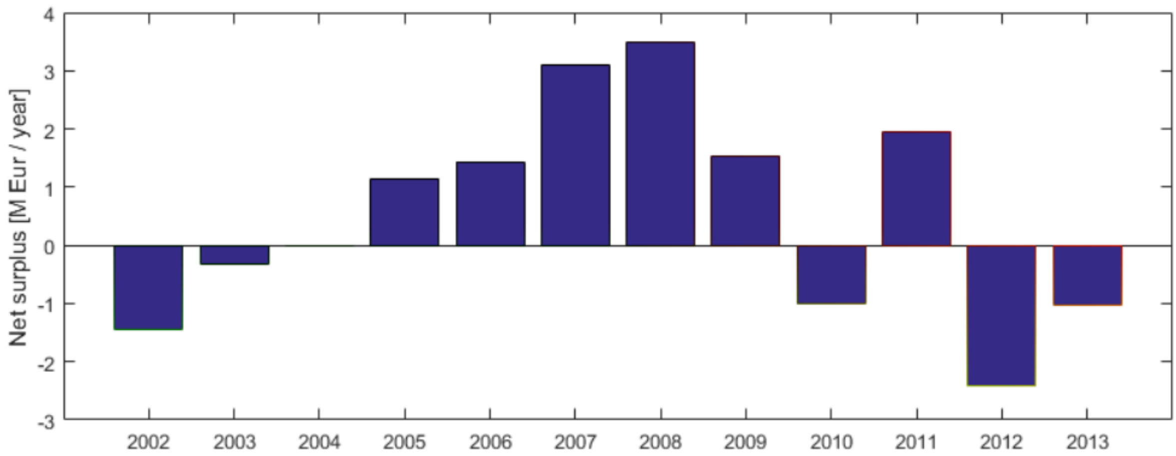

Figure 3. Net surplus or deficit produced by the Long Island Sound Trading.

2.2 South Nation River Watershed Trading

A program to reduce phosphorus load to South Nation River in Ontario, Canada, was established in 2000 and it is managed by the South Nation Conservation. The new and upgraded waste water dischargers were assigned a regulatory discharge limit of zero: their phosphorus emissions were not allowed to grow from the current level, but plants were allowed to buy emission certificate from other sources, including agriculture. From farmers’ perspective this scheme does not resemble trading as they merely receive funds to implement certain measures and management practices. Effectiveness of these measures is not based on any particular model, but on formulae derived from scientific literature (O’Grady 2011).

The program was organized as a clearinghouse where the local watershed organization collected money from dischargers and invested in non-point sources with a trading ratio of 4:1. The program covers 16 municipal and industrial point sources and it has been estimated to have reduced the abatement costs by about 40 per cent compared to the alternative regulation

(O'Grady 2010). Again, a clearinghouse structure has ensured high participation: all the point-source participants have chosen to purchase offsets rather than upgrade their treatment efficiency, despite the high trading ratio.

Certification of projects takes place in a multi-stakeholder committee, which comprises of farmers, members of industry and municipalities as well as the South Nation Conservation. The committee is responsible for setting the water quality decisions and approval of proposed projects. Other farmers work as "field representatives". They make the site visits and also make recommendations to the committee on which projects to accept. Peer-to-peer inspection seems to be a low-cost way, the average cost of site visit is around 40 euros (O'Grady 2011).

2.3 Lake Taupo Trading

A need to reduce nitrogen load to Lake Taupo, the largest in New Zealand, by 20 % led to introduction of a trading scheme in 2007 (Duhon, Yound and Kerr 2011). The program is a true exchange market where trading takes place between non-point sources, that is, agricultural producers. Farmers receive free permits based on their historical land use. The program stands out because its primary purpose is to reduce agricultural load from agriculture instead of just working as a mechanism to reduce the cost of abatement among point sources. As it is impossible to observe the actual emissions from agriculture, which is a non-point source, the emission reductions are estimated based on an OVERSEER-model. The programs puts a specific emphasis on verification: all farms provide annual accounting records to the council and farms receive visits every year or two years, depending on their status (Duhon, Yound and Kerr 2015). The annual administrative costs of the programs are 60,000 Eur.

In order to help agriculture to meet its target, the pure cap-and-trade mechanism is complemented by a public fund of 50 million Euros. The fund is financed by central, regional and local governments with 45 %, 33 % and 22 % shares, respectively, and it has been able to remove around 100 tonnes of nitrogen to the lake. The trading acrtivity is shown in Figure 4. It can be seen that trading has been rather active during most years, but a majority of the demand is created by the fund (Duhon, Yound and Kerr 2011). Therefore, although the programs is an ambitious effort to regulate agricultural sources, agriculture merely offers supply of offsets and a majority of the demand comes from the public fund.

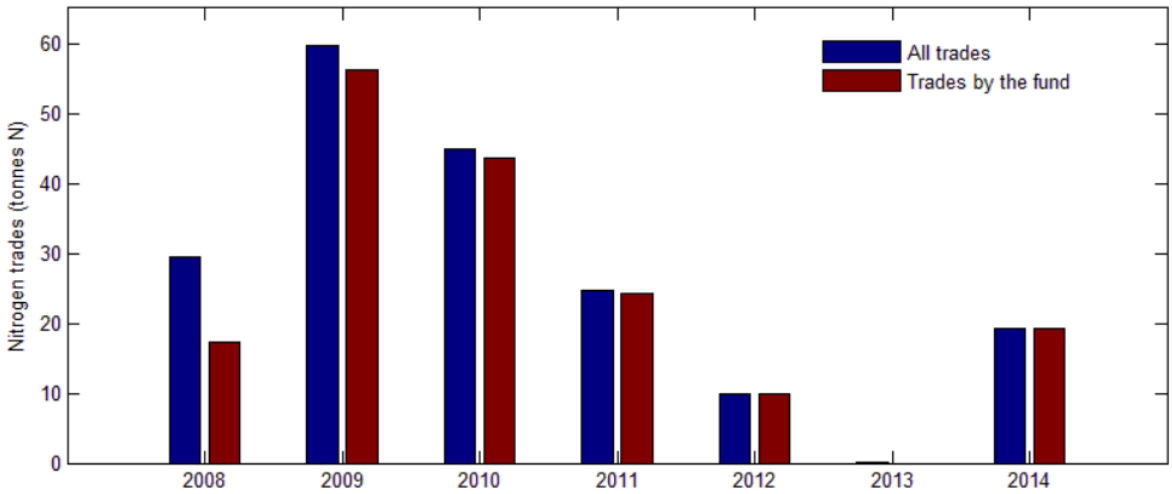

Figure 4. Private and public trading activity in Lake Taupo.

2.4 Virginia Nutrient Trading

The regulation limiting nitrogen and phosphorus loads in the Chesapeake Bay region are based on the Total Maximum Daily Load (TMDL), established in 2010 and aimed to restore clean water in the bay and the inland waters within the catchment. This was the largest ever TMDL established by the Environmental Protection Agency, covering areas from seven states, and it required nitrogen, phosphorus and sediment loads to be reduced by 25, 24 and 20 percent, respectively (US EPA 2016). To help states and sources to meet these stringent environmental goals, nutrient trading was introduced by several states, Virginia, Maryland and Pennsylvania (US EPA 2016)

In the Virginia the trading program for nutrients was introduced in 2005. Trading was allowed between point sources to meet their discharge caps, defined by the downscaling of TMDL targets. In addition, point sources were allowed to offset increased discharges from expansion due to growth from non-point sources. On top of that, the trading scheme had an element of trading between nonpoint sources, as it was possible to offset stormwater emissions by buying offsets from other nonpoint sources.

A large portion of the regulated point-sources work under a voluntary association, called the Virginia Nutrient Credit Exchange Association, including 73 owners and 105 treatment facilities. Most point sources operate under a bubble-permit, regulating the total emissions from the treatment facilities, but allowing flexibility in how abatement is distribution between members. Credit prices within the members are set by the Association, whereas trading with non-members is based on bi-lateral trades. In order for agricultural sources to be allowed to join the trading, they must need certain "best management practices", including soil conservation plans, nutrient management plans, cover cropping, livestock stream exclusion and riparian buffer installation (Virginia DEQ 2016b). Such strict baseline requirements, however, reduce the potential benefits from trading, firstly because it involves high participation costs for farmers and second, because they eat away many of the low-cost abatement opportunities (Ribaudo and Gottlieb 2011). In addition to the baseline requirements, the trading ratio between point and non-point sources is 2:1.

Certification and verification processes are organized as follow. First, officials review project proposals and certify offsets for proposals that comply with the program requirements. The approved projects are certified annually. Second, verification of a project may occur at any time. Third, point sources retain liability for compliance. Fourth, Virginia Water Quality Improvement Fund serves as a creditor of last resort if point sources fail to acquire credits alsewhere. Fifth, the effectiveness of non-point sources are based on the Chesapeake Bay Watershed Model (Branosky et al. 2011).

2.5 Hunter River Salinity Trading

Even though not a nutrient trading scheme, the Hunter river salinity trading is an important example of a successful trading scheme as it is referred to as "the most successful water quality trading program in the world" (Shortle 2013). Hunter River, located in New South Wales, Australia, is polluted by salinity from coal mines and power stations. During dry seasons, increased salinity prevents using river waters for drinking water, reduce crop yields and cause corrosion of pipelines (NSW EPA 2016). To reduce salinity in the river, a trading scheme was established first as a pilot in 1995 and then as fully operational in 2002. The scheme is managed by The New South Wales Office of Environment and Heritage. There are a total of thousand credits in the scheme, each usable for ten years, so that two hundred credits expire and are re-auctioned each year. The total allowable discharges depend on the flow of water and salinity levels in different geographical area so that the salinity concentrations remain below the pre-defined target. The members can trade permits freely between the auctions.

Perhaps the most interesting part of Hunter River trading is the auctioning mechanism that is used to sell one fifth of the total permits each two years. Figure 5 shows the average prices, as well as the total revenue created by the auction each year. The number to be auctioned is a delicate balance. If not enough permits are available, new entrants to the scheme would have to buy permits directly from the competitors. In the case of auctioning, they only need to interact with the regulator. On the contrary, if too many permits are auctioned, some participants may acquire enough credits to get market power. As only one fifth of the permits are sold each year, gaining significant market power would require participating in multiple auctions. Auctioning has other benefits too: it helps to create a uniform and market-based price for pollutants and it promotes polluter pays –approach.

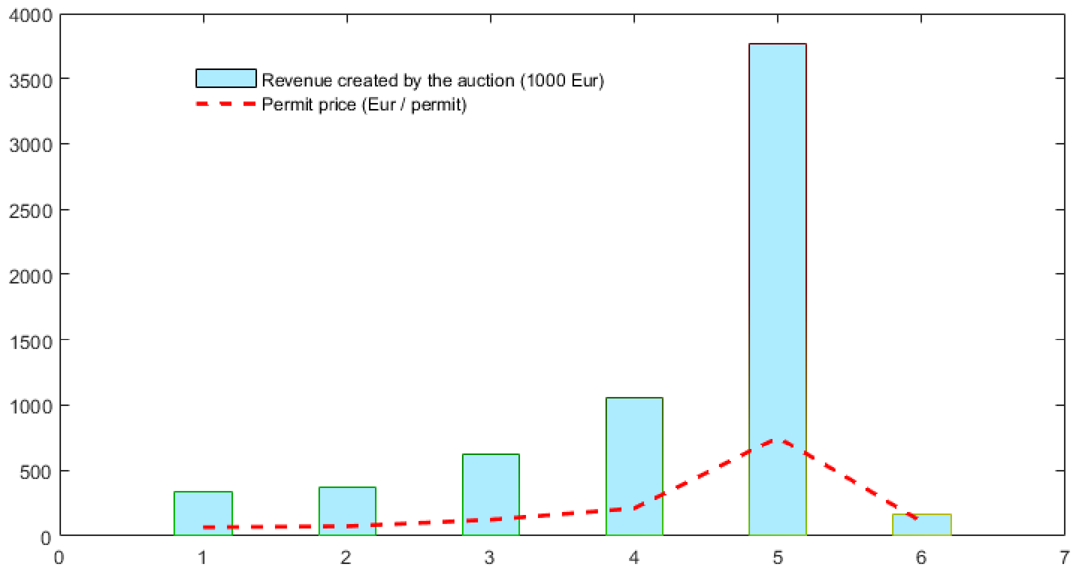

Figure 5. Permit prices, revenue created and auction cost per year. (Source: http://www.epa.nsw.gov.au/licensing/hrsts/auctions.htm)

3. Uncertainty and enforcement

Water quality trading including non-point sources is subject to at least three kind of uncertainties: (i) uncertainty due to natural stochasticity, (ii) there may be noncompliance with the rules and (iii) there may be technical uncertainty regarding the true effectiveness of a measure. Next, we will tackle these issues one by one and address the solution methods that have been proposed in the literature.

3.1 Natural stochasticity

In many water quality trading programs uncertainty is reflected in the trading ratio, meaning that uncertain reductions are considered worth less in trading than their expected value would indicate. Policy makers may have one of the two goals: (i) ensure that load reductions are made with a considerable degree of certainty or (ii) ensure that abatement targets are met with a considerable degree of certainty. In the former case, trading ratios less than one are justified as uncertainty in effectiveness of abatement measures is unwanted. In the latter case, however, it may well be that the uncertain abatement measures *reduce* load variability. This is the case if the effectiveness is strongly positively correlated with load spikes. To properly cope with load uncertainty, regulators could use trading ratios which take into account the correlation between abatement measures and the background load (Horan and Shortle 2011). Therefore, the correct ratios can as well be larger than one for measures which are uncertain but correlate positively with the background load (Shortle 1990, Horan 2001), as such measures reduce variability of the emissions.

3.2 Noncompliance

The credit sellers may not comply with the rules, meaning that they take the payment but do not implement the measure. The non-compliance may affect the reputation of the system, which in turn would lead to the collapse of trading altogether. In that respect, bilateral trading is more susceptible to this problem if the burden of enforcement would fall on the credit buyer. In contrast, in clearinghouses and exchange markets, the regulator would take care of the enforcement issue.

Literature to date has proposed several ways to resolve this issue. One way to reduce noncompliance is by auditing and fining. A theoretical literature tells us that clearinghouse structure leads to higher welfare under non-compliance and auditing than bilateral trading and exchange markets (Lappi 2016). It follows that in the context of water quality trading, clearinghouse markets would be preferred to exchange markets. Second, regulators can develop a list of “best management practices” which are required to take place before farmers can enter the market (Schary and Fisher-Vanden 2004). The flip side of this suggestion is that it increases the transaction costs to enter the market and may therefore limit the size of the market. Third, a hybrid instrument could be implemented, that is, a tax which will be paid if the source cannot deliver the promised emission reductions (Segerson and Wu 2006).

3.3 Technical uncertainty

Technical uncertainty refers to the uncertainty in effectiveness of abatement measure, which is unknown both to the regulator and to the polluter. This problem is especially true for new and innovative measures that are not well-established. Technical uncertainty could be handled by trading ratios reflecting the risk-aversion of the regulator. As another mean, regulator could fund scientific research and pilot projects to resolve that uncertainty (Fisher-Vanden and Olmstead 2013).

4. Lessons for the Baltic Sea

How should the nutrient trading for the Baltic Sea be organized? Experiments from around the world have shown that there are multiple ways to organize successful trading: there is no universally best policy and trading schemes should be tailor-made for specific circumstances. Next, we discuss the lessons that can be drawn from this literature review in the context of organizing international trading in the Baltic Sea.

4.1 Choice of the market structure

Based on the literature review, the choice of market structure seems to be an important for the success of trading mechanism. There are examples of operating schemes where trading is organized as clearinghouse and exchange markets. Clearinghouse seems to be a more suitable system in attracting potential traders and creating a sufficient trading volume. However, in the Baltic Sea context clearinghouse may face certain problems. The budget is not necessarily balanced as the value of sales may well exceed or fall short of the bought permits; see Figure 3 as an example. In the Baltic Sea the party that is organizing trading would need to have enough liquidity to provide for these sudden contingencies. Therefore, HELCOM could not be able to organize trading without financial backing from the member states.

As another alternative, loosely based on the example of the Virginia Nutrient Credit Exchange Association, the treatment plants within each region could work under a "bubble permit". Each country would set the credit price within the bubble permit, that is, work as a clearinghouse for treatment plants within their own country. Countries would then be liable to fulfil their own targets, and the EU member states could be sued under the Marine Strategy Framework Directive by failing to do so. In that case the budget balance would not be a problem, as countries would have the needed liquidity to fulfill these goals, and there would not be any transfers between the countries. Any possible trading between countries would then be either bilateral or based on an exchange markets, similarly to the trades between the members and non-members of Virginia Nutrient Credit Exchange Association.

As another alternative, the trading in the Baltic Sea Region would have to be based on bilateral trading or exchange market. With these systems, the regulator faces the challenge of how to attract a large number of buyers and sellers so that the benefits from trading would exceed the transaction costs of entering the markets. One way of assuring the potential participants that the size of the market will be large enough, members could use a fund (e.g. Baltic Sea Restoration Fund), similar to the Chesapeake Restoration Fund in Maryland, that would be either funded by the governments, or based on a "flush tax", that is, a fixed annual fee collected from people living in the catchment. If permits are auctioned among the point sources as in the Hunter River Salinity Scheme, auction revenues could be used to fund abatement measures in non-point sources.

4.2 Trading parties

Should trading take place only between point sources, or possibly between nonpoint-sources as well? Agricultural is by far the most important nonpoint polluter of the Baltic. However, nonpoint-nonpoint trading, where each farm would be a given reduction target a la Lake Taupo, does not seem politically realistic in the Baltic Sea context, where regulation of agriculture is often based on agri-environmental subsidies.

Therefore, we are left with the choice of organizing trading either strictly between point sources, or allowing for a possibility to buy offsets from non-point sources. The simplest form of trading would obviously be the one between wastewater treatment plants, where all plants would be required to fulfill certain reduction target, for instance the level of wastewater treatment recommended by HELCOM. Then, plants would choose either to comply with this regulation or to buy the required credits from other treatment plants. There is, however, a problem with this suggestion: some countries (Denmark, Germany for N&P and Sweden and Finland for P) have already fulfilled these targets so they would have to carry the burden of the new regulation. These countries could be given a stricter abatement target, but that would mean unequal treatment of different countries, which may be opposed on political grounds.

To achieve more flexibility, point sources could be allowed to buy permits also from the non-point sources, as is the case in many U.S. trading schemes as well as in the South Nation River Watershed Trading. In this case, however, there are problems with monitoring and verification. First, there would have to be a reliable model, trusted by all the participants, on which the effects of agricultural abatement measures could be based. Second, inclusion of non-point sources would mean an increasing need to verify and enforce the practices and abatement measures. Some of these issues could be addressed by trading ratios between the point and nonpoint sources. A positive trading ratio, as typically used in the existing trading schemes, the discourage trading between the two sectors so that only the “low-hanging fruits” from agriculture are exploited.

Another issue is whether to allow trading between different catchment areas and between inland and coastal sources. Trading ratios can be used also in this context. Ratios between different areas are very important as they largely determine the volume of trading in bilateral and exchange markets. The advantage of choosing trading ratios close to one is that the size of the market increases, and participants are more likely to find trading partners. The disadvantage of this is, however, the creation of pollution hot spots close to areas where abatement is relatively more expensive. Moreover, if inland waters have specific targets for one or both nutrients, the trading possibilities are further limited.

4.3 Connection to other regulation

The overlapping regulation evens the marginal costs between pollution sources and reduces the efficiency gains from trading. In some instances, for example in Lake Taupo, there was not environmental regulation before the trading was introduced and therefore trading was the standalone instrument. In contrast, however, there is a lot of existing regulation in the Baltic Sea Region. In additional to national legislation, countries have to comply with EU directives such as the Urban Wastewater Directive and the Nitrates Directive. Furthermore, nutrient trading may be overlapping with existing agri-environmental subsidy schemes and without a comprehensive reassessment of existing policies, nutrient trading would have to cover abatement measures that are outside agri-environmental schemes.

In the Baltic, the trading would have to be based on some new, stringent environmental regulation that would be introduced in the future. There seems to be a connection to the increasing regulation for the Chesapeake Bay and the consequent adoption of trading schemes to meet these targets. Similarly, if the EU would choose to assign quantitative load targets to meet the goals of Marine Strategy Framework Directive or the Water Framework Directive, so that countries could freely choose the policy instruments to meet these targets, there would be room for organized trading.

4.4 Certification and verification

If trading takes place only between point sources, the certification and verification processes are made significantly easier as the technologies are established and emissions are measurable. The international setting would not complicate matters either within the European Union: member states would be legally responsible to the Union, and therefore they would have the correct incentives to enforce and punish any non-compliance domestically.

If trading with non-point sources is allowed, the issue of certification and verification becomes more complex. In that case, the governing body would have to agree on a model on which the effectiveness of different measures is based on (such as OVERSEER or Chesapeake Bay Watershed Model), or alternatively carry out a meta-analysis based on existing literature and come up with formulas to measure the effectiveness (as in South Nation River Watershed Trading). Moreover, agricultural abatement measures would need to be verified and site visits may be required to ensure compliance. In other trading schemes, site visits are typically made every 0.5-2 years, leading to substantial transaction costs. Alternatively, to avoid huge transaction costs non-point trading could be limited to certain pre-determined measures whose effectiveness is based on good scientific understanding, where verification is easier and that are not covered by any other regulation, such as gypsum amendment, mussel farming and management fishing.

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