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An affirmation statement

I hereby declare that all the work in this paper has been by me and not published elsewhere

Short biography (50 words)

Brian is a graduate from the Royal Veterinary and Agricultural University (RVAU) in Copenhagen. He has a M.Sc. from Reading University and a Ph.D. from RVAU. Current research deals with environmental economics and the costs of reducing N- and P-leaching, ammonia emission and emission of green house gases from agriculture. He is currently involved in several projects related to analyses prior to the implementation of the Water Framework Directive in Denmark.

Abstract:

The main aim of the Water Framework Directive (WFD) is to improve the water quality in all waters in Europe and the target is described as "good ecological status", which should be reached in all water bodies by 2015 and no later than 2027. In the paper some key issues regarding the economic analyses and choice of the most cost effective measures is described. Results from preliminary analysis made by Denmark, The Netherlands and the United Kingdom are described. The findings suggest that all three countries find it difficult to achieve the goals in 2015. Instead they will postpone parts of the implementation until after 2015 to reduce overall costs, but in the Netherlands the target will not be reached by 2027. The costs for the agricultural sector in the implementation of WFD are low in the Netherlands and moderate in United Kingdom and Denmark. In the Netherlands few agricultural measures are included, although most of the nutrient loss comes from agriculture. In United Kingdom N-loses will be reduced through Farming schemes and P-losses will be reduced by 50% through Water Protection Zones. In Denmark, the measures consist of set a side, catch crops and wetlands. It is likely that the loss of direct income for Danish farmers is partly financed through a reduction in the Single Payment Scheme. The implementation of WFD is important for European farmers and so participation will have a large impact on the results and costs experienced at the farm level.

Keyword: Water Framework Directive, costs, agriculture, measures, Europe

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Farm economic consequences of clean water in Europe

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1. Introduction

The Water Framework Directive (WFD) (2000/60/EC) was implemented in legislation in the EU countries in 2003. The main aim of the WFD is to improve the water quality in all waters in Europe and the target is described as "good ecological status", which should be reached in all water bodies by 2015 and no later than 2027.

Implementation of the WFD is based full implementation of the Nitrate Directive which also aimed at improving water quality. EU reports that the water quality is slowly improving in many member states, but a number of countries (e.g. Belgium, Spain and Ireland) have not yet an acceptable implementation of the Nitrate directive (EEC, 2007). High nitrate concentration in surface water or groundwater is still found in the Netherlands, UK, Belgium, France and parts of Germany. So in countries like e.g. Ireland and UK the implementation of the WFD will co-inside with the implementation of the Nitrate directive.

The economic analysis is central to several of the analyses required in the WFD and e.g. the use of "polluter pays" principle is stated clearly. The analyses consist of three types of economic analyses. Firstly, member states have to conduct an analysis of the cost of providing water for consumers and an assessment of whether consumers pay the full cost. Secondly, a cost-effectiveness analysis is required to ensure that the selected measures achieve the environmental targets at the lowest cost. The aim of the measures is to reduce the nutrient loss to the water bodies. Thirdly, cost-benefit analysis is used to examine whether it will be too costly to reach some

targets compared with the benefits which will be obtained. If this is the case a derogation from either time or quality standards might be possible. (WATECO, 2003).

The focus of this paper is a short description of important methods used in the costs analysis preformed prior to the implementation. The paper goes on to discuss the more detailed planning of measures and costs in Denmark (DK), the Netherlands (NL) and the United Kingdom (UK), with focus on consequences for agriculture. The paper concludes with some general findings and recommendations regarding the implementation process.

2. Implementation of WFD and the economic methods used

The first step in the process is to find the distance from the likely water quality in 2015 to the target of good ecological status. Good ecological status is the second highest water quality and it allows only a slight deviation from natural conditions. The work here has help to ensure that the targets are the same in all 25 countries included in the EU.

Next step is to find measures and describe their efficiency and costs related to these. National catalogues of likely measures has been developed and this will over time be supplemented with local measures. As the WFD includes all water bodies including, streams, lakes, rivers and coastal waters, the target has to be fulfilled for them all and not just as an average at the national scale. When national decision on the implementation is made in 2010, it will be implemented in 2012 and onwards. In the subsequent sections some key economic issues are discussed:

2.1 Cost definitions

When calculating costs some minimum standard is often helpful. Comparisons of cost estimation procedure based on handbooks from UK, DK and Germany suggest that the calculations will not always include the same elements and so a comparison is relevant, especially in cross boarder analyses (RPA, 2005, Interwies et al., 2004 and MVW, 2005).

In the calculation, the direct costs of measures should be included, although some countries (e.g. UK) focus heavily on the initial investment. As seen from table 1 administrative costs are included in most analyses and in some cases the wider economic effects might be included. The trend from recent analysis in UK and DK seems to be that the annual direct costs (not welfare economic approach) and an

assessment of the administrative costs is always included. More wider economic effects are often not included.

Table 1 Summery of cost elements included in different economic analysis

	WATECO	UK	DK
Direct costs	Included	Included (financial costs)	Included (budgetary costs)
Adjustment for subsidies and taxes	Perhaps Included	Included	Included
Price adjustment (factor price -> consumer price)	Not discussed	Not included	Included
Consumer surplus	Not explicitly included	Discussed but not included	Included
Administrative costs	Perhaps	Discussed but Not always included	Discussed but often not included
Associated non-water environmental costs and benefits of measures	Included	Included when possible	Included to some extent
Wider economic effects in other sectors (income and jobs)	Partly discussed	Discussed but often not included	Discussed but often not included
Total costs are named	Economic costs	Economic costs or Social costs	Welfare economic costs

Source : Jacobsen (2007)
Remark: WATECO is a working group which gave the first description of the economic analyses. The abbreviation stands for WATer and ECOnomics (WATECO, 2003).

2.2. Cost effectiveness - single or multiple objectives

Finding the most cost efficient measures when dealing with one parameter is easy, but when dealing with multiple objectives and measures, trying to include side effects and overlap between measures, then the measures are much more difficult to rank.

The Dutch handbook recommends prioritising the measures based on their cost effectiveness using one indicator (e.g. yearly costs per kg P or eutrophication unit) (MVW, 2005). A package of measures can be compiled by selecting the measures required to fulfil the targets starting with the most cost efficient. They recommend that the interdependence between measures is noted. In the case of the Rhine they deal firstly with N, then copper and then P. When the final package is put together they might find that some pollutants are reduced more than required.

The Danish analyses also use one single cost-effectiveness indicator based on the annual costs divided by the annual effects (N or P). The ranking should be performed both with and without additional effects such as CO_2-emissions, NH_3 losses, etc. Based on this calculation, a package of measures can be compiled and a

more thorough analysis of interdependency between measures and effects on other sectors can be conducted. This double loop-analysis will take longer to perform.

On the other hand the UK and Germany do not recommend presenting a single indicator of cost-effectiveness as too much information will be lost in such a process. Instead, the UK suggests that packages including more measures are analysed based on an assessment of the effect obtained, the scale, the certainty, adaptability, practicability and side effects. Also, the monetary and non monetary costs are included in this analysis. The focus is on pair-wise comparisons, building on the most cost effective programmes of measures. How to weigh together the different attributes of each measure in the ranking is not clear. The Germans suggest that the first cost-effectiveness ranking should be based on primary effects, postponing the use of secondary effects to a later stage in order to reduce the complexity. However, a multi-dimensional criteria approach may result in the trade offs not being very explicit especially when discussed with stakeholders. .

The commission states that a single approach to cost-effectiveness analysis (**CEA) is not desirable or expected** bearing in mind that many member states have not developed CEA methodologies. However, it is highlighted that there is a need for "a harmonized, comparable and transparent approach for the application of the "exceptions". Most measures will have decreasing cost efficiency and a sensitivity analysis on the ranking is to be recommended.

2.3. Transboundary and synergy effects

The same measures will often have an overlapping effect on other measures. Furthermore there will be some up-stream / down stream effects which are important to include. These effects come if measures implemented to deal with reductions in e.g. lake 1 also has an affect on lake 2 etc. It could also be between administrative regions or countries. Here it is important to create a common understanding to ensure the most cost effective position of the measures. It could be that the most cost efficient approach is to place all measures in one country and then let the other countries pay for the effect that they gain.

2.4. Disproportional costs

It is stated in the WFD article 4 that disproportional costs may allow for a derogation from the WFD. The derogation is firstly in relation to the time (2015 or

2027) and secondly in relation to the water quality. A working group under the EU commission have tried to clarify this issue (DME, 2008). It has become clear that this issue is not only an issue of total costs over total benefits, but also the aspect of "affordability" (Görlach and Libelin, 2007). In other words, are countries willing to pay what it takes to achieve "Good Ecological Status".

As shown there are some challenges in the implementation which are likely to delay the implementation and reduce the quality of the first River Management Plans which should be produced in 2010. The paper will now look closer at the implementation in three member states with focus on agriculture.

3. The Danish Case

Since 1987 Denmark has implemented a number of plans to improve the quality of the aquatic environment. The aim has been to deduce the N-leaching to 50% compared with the 1987 level. This was achieved in 2003 (see Iversen, Michaelsen, Søndergaard and Jacobsen, 2009; Jacobsen, 2004). The Aquatic programme III, decided in 2004, was the first step toward achieving the targets laid down in the WFD. This plan included a 11% reduction in N-leaching and a 50% reduction in P-surplus compared to the 2003 levels.

In order to fulfil the WFD Denmark has chosen one parameter for each type of water body. It is the physical conditions for the streams and the nutrient looses with respect to lakes (P) and nitrogen in coastal waters (N). The analysis at the national scale was carried out in 2007-2008. The analysis consisted of 3 scenarios, where scenario 2 was the most likely target under the WFD.

The target for streams is a Danish Fauna index (DVFI) = 7 or more. In the analysis, it is assumed that 40% of all streams will not have to fulfil the "Good Ecological Status" as they are heavily modified water bodies. The length of streams which will not achieve the target in 2015 is described in table 2.

The largest part of the costs is related to the improvement of the water quality for water reaching the coastal waters. The analysis seems to show that there in 1/3 of all streams is a need for improvements, and that 50% of all lakes will not meet the target and that a 25-35% reduction in N load to costal waters is required.

Table 2. Distance to the target in 2015 for streams, lakes and coastal waters and costs in modified scenario 2 in 2008

		Distance to target	Yearly costs (Million €)
Streams	Improvements are required (km)	10.000	11
Lakes	P reduction (tonne P)	33	6
Coastal waters	N reduction (tonne N)	10-16.000	108
Sum			**126**

Source : Jensen et al., 2009.

Where the national and regional analyses were based on agricultural measurers entirely, the analysis at the local level showed that some local measures directed at non-agriculture could be more cost efficient in reducing the P losses to lakes.

The final calculations are not finished but it is likely that the costs might exceed 140 million €. On top comes costs related to non agricultural measures of about 50-60 million €. The process of fine tuning the proposal will lead to lower costs as part of the implementation might be postponed until after 2015.

Agricultural Measures

The likely measures implemented are: more wetlands, P-wetlands to reduce P losses to lakes, more catch crops and buffer strips along all lakes and streams. A total of 25-70.000 ha will be taken out of agricultural production to create wetlands and buffer strips. The reduction in agricultural area will be 1-2% and the reduction in animals around 1-2%. Reduced tillage in the autumn is another measure which might be included in the final proposal. In the Spring 2009 the Danish Government will present a plan called Green Growth which contains the implementation of measures related to both the WFD, the Habitat Directive, pesticide targets, ammonia and CO_2 emissions.

4. The Dutch Case

The Dutch introduced the MINAS system in 1998, but this has later been replaced with a system based on fertilizer norms as used e.g. in Denmark (Jacobsen et

al., 2005). The N application is still fairly high with 260-350 kg N/ha to areas with grass in 2009. The utilisation of N in animal manure is 60% compared with the 70-75% used in Denmark. The sandy soils, especially, have a problem with high levels of nitrate in groundwater (over 50 mg NO_3/l). The Netherlands has the highest N and P surplus in EU as well as intensive use of pesticides. The N-surplus has decreased substantially from 1998 to 2002 but it is still over 200 kg N/ha in most areas. Regarding phosphorous, 56% of the total agricultural area is phosphorus saturated soils.

In September 2008 the Dutch government published a report on the implementation of the WFD (NEAA, 2008). In total, 40% of the area lies below sea lewel and so a large portion of all water bodies are heavily modified or artificial. The analysis indicates that 60% of the streams, 70% of the canals, 80-90% of the lakes, 50% of the ditches and 95% of the regional waters do not have a sufficient water quality according to the WFD scheme. It is estimated that 75% of the nitrogen and phosphorus loads in the coastal zone in the Netherlands comes from other countries. This shows how important concerted action involving several countries is required.

Most measures focus on the creation of 8,000 km nature friendly river banks and over 1,000 fish passes. It includes improving 168 sewage treatment plants, 47,000 km manure free zones and changes in the agricultural use of 5,000 ha. The total packages cost 800 million € and on top come unspecified projects (300 mill. €).

The NEAA report states that nutrient losses are the largest problem, but only a few measures are related to agriculture. It seems that the measures proposed will only have a little effect on the nutrient losses to the surface water. This would indicate that the agricultural sector still has a large roll to play in forming the WFD policies. It should be noted that the program covers 2007-2027 and in doing so incorporates derogation from the 2015 deadline. The largest investments are situated in the 2010-2015 period.

The costs are mainly paid by the water authorities (58%) and local authorities/ municipalities (15%). The cost from 2027 and onwards is 390 million € per year. The water price will go up by 13% until 2027, of which 75% will be paid by households and 25% by businesses. The cost for the agricultural sector is relative low as there are few agricultural measures. The effect will be a 16% reduction in P and 24% reduction in N losses to the regional surface water in 2027 compared to 2000-2005. This is equivalent to 16 million Kg N and 1 million kg P.

However, 40-50% of the regional waters are not expected to meet the nutrient standards in 2027. The number of water bodies labelled with "Good Status" will increase from 5% to a maximum of 30-50% in 2027. Finally the share of national waters achieving "Good status" will increase from 25% to 50% in 2027. In other words, there is still some way to the target in 2027.

As the target is not met, analysis of further agricultural measures show that mining of P (P-deficit) will only reduce nutrient loads by 1 to 5%, which is why it will not improve the ecological quality greatly. It is surprising that zero P application in the Dutch report has a very minor effect on water quality, when a lot of the current problems are related to high application over a number of years. This might be due to the slow reaction of measures related to P. The current proposal will result in further accumulation of P in the soil in the Netherlands, although the accumulation will slow down. The improvement in the water quality in national waters is primarily due to measures taken in other countries (Belgium, France and Germany).

5. The UK case

The implementation of WFD in the UK will focus on P as the nitrogen has been dealt with in the Nitrate Directive. The Nitrate Directive is being implemented now and it is likely to costs around 50 million £ a year or 12 £ per hectare. It is assumed that the Codes of Agricultural Good Practice (COGAP) will be sufficient to meet the target in 70% of the cases (Defra, 2006). This practice, contains a lot of recommendations, but the control seems limited although it is linked to the Single Payment Scheme (Defra; 2009). British National Farmers Union (NFU) find that there is a problem with more nitrate vulnerable zones (NVZ), long period were slurry cannot be applied and the increased slurry storage capacity. Also requirements regarding cover crops on arable land not drilled to cereals in the autumn are described as a problem by NFU. Finally, NFU want dairy farmers to apply 250 kg N of organic nitrate per hectare rather than 170 kg N/ha. (NFU, 2008). It could be noted that several of these measures listed have been part of the implementation of the Nitrate Directive in other European countries.

In the autumn 2008 DEFRA released an Impact Assessment on the overall costs and benefits of implementing the WFD in England and Wales (Defra, 2008). The report distinguishes between two options, where option 1 is aimed at implementation in 2015, and option 2 is a phased implementation in order to ensure a cost-effective approach meeting all WFD requirements by 2027. The measures

included in option 1 but not in option 2 rely on exemptions from the WFD. More detailed assessment of costs and benefits will be ready in December 2008 and finalized in December 2009.

In the new assessment the annual costs of implementing the WFD over a 43 year period are £ 2,400 million in option 1, and the benefits are £ 950 – 1,700 million. In option 2 the costs are £ 900 million and the benefits are £ 650 – 1,200 million (DEFRA, 2008). It seems likely that the UK will choose option 2. For agriculture the focus with respect to WFD is on Phosphates and a 50% reduction in losses is required using Water Protection Zones. Loss of income could be around £5,000 per farm for cropping farms (Defra, 2008). Future measures might be required as there is a rising nitrate trend.

6. Conclusions

The paper has looked at some important aspects of the implementation of the WFD and the costs involved for countries and farmers, using DK, NL and UK as examples.

The findings suggest that all countries find it very difficult to achieve the goals in 2015 and therefore are considering a phase approach in order to postpone parts of the implementation, as this will reduce overall costs. NL is the only country that states that there will still be some distance to the goal in 2027, but it might also be the case for other countries when more detailed analyses are carried out.

The role and costs for the agricultural sector in the implementation of WFD is low in NL and moderate in UK and DK. In NL 75% of the nutrient loss will come from agriculture and yet there is very few measures aimed at reducing the nutrient losses. In UK the focus with respect to agriculture in on reducing P, but it seems uncertain whether the use of code of practices will give the sufficient improvement with respect to nitrogen losses. It seems likely that measures aimed at N-losses will be included in the British WFD program at a later stage. In DK the measures such as set a side, catch crops and wet lands seems likely to meet the target, but history have shown that the implementation procedure is very important for whether the expected result is achieved. In DK it is likely that the loss of direct income is partly financed through a reduction in the Single Payment Scheme.

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