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# European and national regulations and policies that impact nutrient concentrations in European waters (including freshwater and sea)

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## 1. Introduction

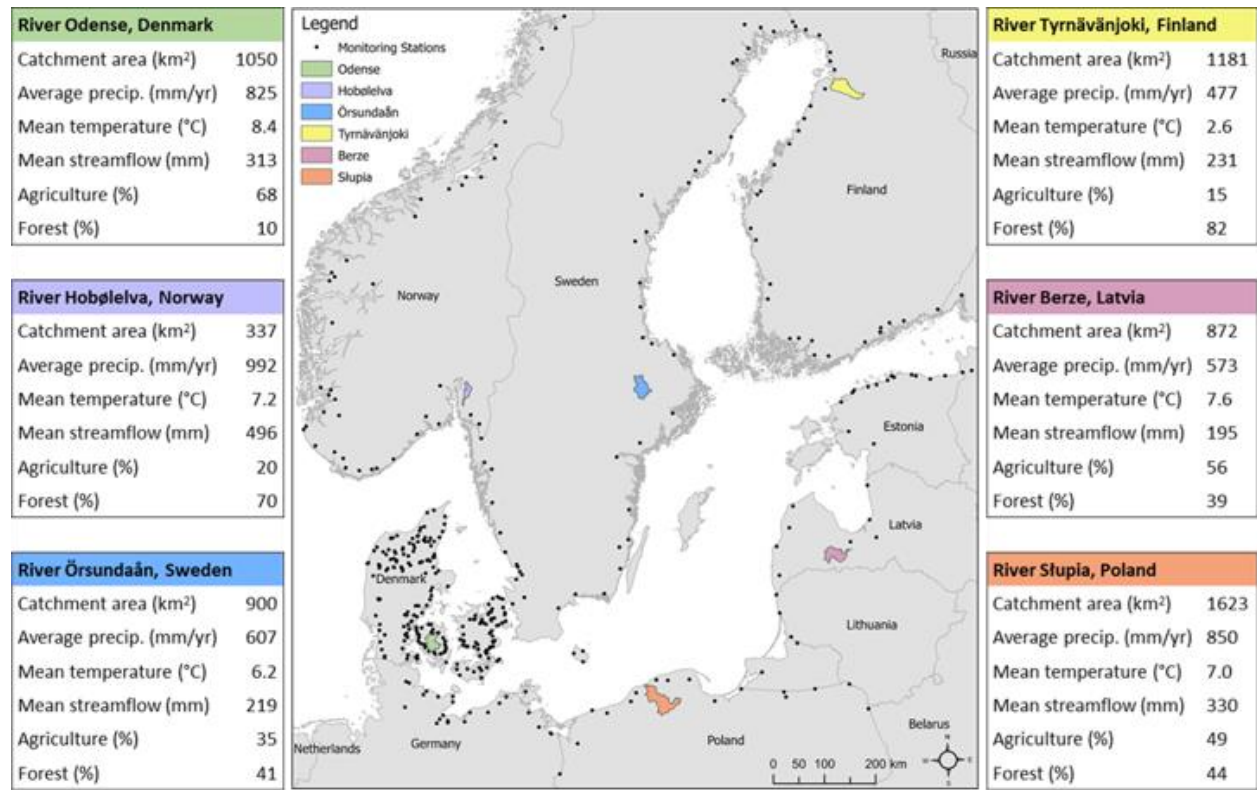
Nitrogen (N) and phosphorus (P) emissions from agricultural land cause eutrophication and deterioration of surface waters. The main sources of anthropogenic inputs of N and P in the Baltic Sea are land-based sources within the Baltic Sea catchment area (Elofsson, 2010). Agriculture is the main source of nutrient pollution in the Baltic Sea. Approximately 95 % of the nitrogen load and 93 % of the phosphorus load enter the Baltic Sea from the catchment area as a run-off carried by the rivers (Svedsen & Gustafsson, 2021).

The European Commission has published a staff working document concerning the links between the CAP and the Green Deal (GD), which states that its objectives are already in line with the focus of the GD in relation to food systems (European Commission, 2020). The document also stresses the importance of the CAP strategic planning process in which the GD objectives are examined. In the process, member states are required to give the Commission an account of the GD targets related to agriculture. Thus, from the point of view of the fulfilment of GD objectives, the phase of national strategic planning is central. Additional targets are included in the Farm to Fork strategy and the biodiversity strategy. CAP 2023–27 will be a key instrument in achieving the GD objectives of the Farm to Fork and biodiversity strategies (European Commission, 2023). Consequently, low coherence between these policies may affect the achievement of GD objectives, which will also impact implementation at the national level.

A Horizon EU project called NORDBALT-ECOSAFE focuses on a region in Europe that offers ideal conditions for developing an innovative methodology to set safe ecological boundaries for nutrients, quantify nitrogen (N) and phosphorus (P) sources and pathways and efficiently reduce nutrient emissions down to a level that meets the safe ecological nutrient boundaries. These boundaries are supporting the achievement of good ecological status in rivers and lakes. The project is a coordinate or support research action that includes activities and policies (networking, exchanges, access to research infrastructures, studies, conferences, etc.) that it is intended to support the policies of the EU Commission for near-future environmental management.

The overarching aim of NORDBALT-ECOSAFE is to ensure that N and P concentrations and loadings in water bodies in the Nordic-Baltic region are reduced and will remain within safe ecological boundaries in the different categories of water bodies such as rivers, lakes, transitional

and coastal waters. One important part of the project is to reach out to regional/local and national stakeholders at regional meetings in our six case study catchments (Figure 1).



**Figure 1.** NORDBALT-ECOSAFE study areas

The NORDBALT-ECOSAFE consortium consists of eight institutes and will develop and demonstrate innovative methods and establish best practices to improve current river basin management and governance. These methods and best practices will support regional governance structures to implement the most suitable measures to meet the ecological nutrient boundaries.

The objective of this report is to provide an overview of all relevant EU directives related to nutrient management and show how the different Nord-Balt Ecosafe countries (Norway, Sweden, Finland, Denmark, Latvia, Poland) are implementing these policies including the related national policies. Although urban wastewater is an important nutrient source in certain areas, the main focus in this report is the agricultural emissions and how they can be reduced to levels compatible with good ecological status in line with WFD requirements.

## 2. EU level regulations and policies on the management of N and P emissions

Many European level policies exist on the management of agricultural emissions to reduce their impact on aquatic environments. Examples of such EU policies and its implementation range from the Nitrates Directive (91/676/EEC) and National Action Plans, the Water Framework Directive (2000/60/IEC) and River Basin Management Plans, to the Industrial Emissions Directive

(2010/75/EU) and the application of Best Available Technology. These EU regulations are implemented through national legislation.

The Nitrates Directive (European Council, 1991, Directive 91/676/EEC) regulates water protection in agriculture by preventing nitrates from agricultural sources from polluting surface waters and by promoting the use of good agricultural practices. Nationally, it is implemented by the Nitrates Regulation (527/2014). Several national legislations guide the water protection of the agricultural sector.

The Common Agricultural Policy (CAP) is the main instrument for promoting agriculture and its financing in the European Union (EU). The CAP has a significant impact on water protection in agriculture, which is based on the environmental payment system and includes the CAP as part of the agricultural subsidy system. The subsidies are nationally described in CAP plan for 2023–2027, in each member state. Under the CAP reform, water protection measures are included in the eco-scheme and environmental payment system.

**Table 1.** EU regulations and policies for N and P emissions reduction on aquatic environments

The name of regulation or policy	The aim of regulation or policy
<b>Regulations and policies with direct impact</b>	
The Water Framework Directive 2000/60/EC & national river basin management plans	Prevent deterioration and enhance status of aquatic ecosystems
The Marine Strategy Framework Directive [ <i>Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy</i> ]	Maintain good environmental status in European seas
The Nitrates Directive 91/676/EEC	Protect water quality and promote good farming practice
Common Agricultural Policy and national CAP strategic plans	Promote food security, sustainable use of natural resources, rural livelihoods
Industrial Emissions Directive [ <i>Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions</i> ]	Integrated pollution prevention and control of industrial emissions, e.g., chemical industry producing fertilizers for agricultural production
Groundwater Directive [ <i>Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration</i> ]	Prevent and control groundwater pollution by assessment criteria of good groundwater chemical status and criteria for identification and starting point of upward trend

Urban Wastewater Directive [ <i>Council Directive 91/271/EEC concerning urban wastewater treatment</i> ]	Protect the water environment from the adverse effects of discharges of urban wastewater and from certain industrial discharges
Waste Framework Directive [ <i>Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives</i> ]	Treating and managing waste in the EU
Directive on port reception facility [ <i>Directive 2019/883 of the European Parliament and of the Council of 17 April 2019 on port reception facilities for the delivery of waste from ships, amending Directive 2010/65/EU and repealing Directive 2000/59/EC</i> ]	Port reception facilities for the delivery of waste from ships
<b>Regulations and policies with indirect impact</b>	
Public Procurement Directive 2014/24/EU and national public procurement law and policy	Increase transparency and fairness, environmental protection, societal welfare
Taxonomy Regulation 2020/852/EU	More investments to sustainable economic activity

**Water Framework Directive**

Since its enactment in 2000 the Water Framework Directive (2000/60/EC; WFD) regulates the ecological condition of rivers, lakes, transitional waters, coastal waters and groundwater, aiming to achieve good status for all water bodies. Ecosystem based management (EBM) was introduced by the directive, which required member states to divide river basin management in Europe to novel administrative units of river basin districts (Kaika & Page, 2003; Voulvoulis et al., 2017). The directive aims to establish adaptive management through a cyclical approach of 6-year planning cycles of River Basin Management Plans (RBMPs), which are drafted in a planning process that involves extensive public consultations. EU member states were required to produce RBMPs and programme of measures (PoM) for the implementation cycles of 2009–2015, 2016–2021 and 2022–2027. The implementation of the WFD is assessed in the implementation report, which European Commission reports to the European Parliament after each RBMP-cycle. The report is based on the member states assessments on the progress of implementing the PoM’s of the RBMP’s.

By adopting a holistic approach, the directive aims at achieving Good Ecological Status (GES) of all the water bodies by 2015 or by the latest in 2027. All pressures affecting aquatic ecosystems should be accounted for being it both point sources and diffuse sources (Squintani and van Rijswick, 2016) and reduced to achieve good status unless exemptions are applied. The ecological status of European waters is monitored and assessed based on the ecological status classification

system. This classification is based on Biological Quality Elements, as well as physico-chemical and hydro-morphological quality elements, which should show only a low level of distortion caused by human activity (WFD Annex V). This slight deviation from reference conditions will ensure well-functioning ecosystems, keeping most of their natural biodiversity.

The non-deterioration clause regulates all the waters. Member states are required by the clause to implement all the necessary measures to prevent deterioration of water bodies in their territory (WFD Article 4.1(a)(i); 4.1(b)(i)). The GES and non-deterioration requirements are both legally binding the EU member states. This means that new projects cannot be permitted if they will cause long-lasting deterioration of status. This was the reason behind the decision of Court of Justice of the European Union (CJEU), the Weser-ruling (CJEU C-461/13; Paloniitty 2018; Soininen and Platjouw 2018). The ruling refers to the environmental objectives and the non-deterioration clause of the WFD, which are legally binding for the EU member states.

### **Marine Strategy Framework Directive**

The Marine Strategy Framework Directive (2008/56/EC; MSFD), adopted on 17<sup>th</sup> of June 2008, has been established for the protection and sustainable use of marine ecosystems. The MSFD functions as an environmental pillar of the Integrated Maritime Policy of the EU, aiming at sustainable growth of maritime sectors (Galgani et al., 2013). Like the WFD mentioned above, the MSFD introduces adaptive management approach with a 6-year planning cycle. The directive sets a target to achieve Good Environmental Status (GES) of the EU's marine waters by 2020 and the target must be reviewed by 2023 (art. 23 of the MSFD). The MSFDs ecological goals are to be fulfilled under general international law and through the regional sea's conventions (In the Baltic Sea region, Baltic Marine Environment Protection Commission, HELCOM, in the North-East Atlantic, OSPAR Commission, which refers to Oslo and Paris Conventions, in the Mediterranean, the Mediterranean Action Plan of the United Nations Environmental Programme, UNEP-MAP).

The directive states that by establishing ecosystem-based approach (Berg et al., 2015; van Leeuwen et al., 2012), priority should be given to achieving and maintaining GES in all community's marine environment, continuing its protection and preservation and preventing subsequent deterioration (MSFD Preamble 8). According to the MSFD (Annex I) the GES is reached by low deterioration by human impact of the following factors: 1) biological diversity; 2) the level of non-indigenous species; 3) populations of commercial fish and shellfish; 4) elements of marine food webs; 5) eutrophication; 6) sea floor integrity; 7) alteration of hydrographical conditions; 8) contaminants; 9) contaminants in fish and seafood for human consumption; 10) marine litter; 11) introduction of energy, including underwater noise.

### **The Nitrates Directive**

Since its enactment in 1991 the Nitrates Directive (ND; 91/676/EEC) has been the main reference for water protection from nitrates contamination that results from over-exploitation of agricultural land. The directive aims to protect water quality across Europe, and to prevent nitrates from agricultural

sources that pollute ground and surface waters, and to promote use of good farming practices. The directive aims to do so by a) monitoring nitrate concentrations of water bodies; b) designating Nitrate Vulnerable Zones (NVZs), and c) by establishing codes of good agricultural practices and measures to prevent and reduce water pollution from nitrates.

Member states have been asked to designate Nitrate Vulnerable Zones (NVZs), that are areas likely to contribute to contamination of surface or ground water. These zones concern waters, where the concentration of nitrate exceeds the limit of over 50 mg/l, as well as all surface water bodies that are eutrophic or at risk of becoming eutrophic in the near future, if no action is taken (Art. 3.1 and Annex 1, point A.3)<sup>1</sup>. On the non-vulnerable zones, Member states can propose a set of measures to be implemented voluntarily. These measures are about time periods and weather conditions for fertilizer use.

The ND is one of the Statutory Management Requirements of the Common Agricultural Policy that European farmers are obliged to respect to receive subsidies. In case of non-compliance with the ND requirements, benefits are reduced accordingly. High level of nitrates concentration results from nitrogen compounds from fertilizers and manure leaching into the groundwater and runoff from agricultural land to the surface waters. The ND has decreased N leaching to the surface and ground waters and to the atmosphere (Velthof et al., 2014). In Nitrate Vulnerable Zones, the nitrate levels are exceeded because of failure in ground water management, rather than lack of knowledge or available water protection techniques (Musacchio et al., 2020). Similarly, in surface waters that are eutrophic or may become eutrophic in the near future, the nitrate levels are exceeded because of failure in surface water management.

### **Common Agricultural Policy (CAP)**

Launched in 1962, EU's Common Agricultural Policy (CAP), has aimed to increased agricultural productivity, a fair standard of living for communities employed in agriculture, stabilised markets, secured availability of food supplies, and fair prices to consumers. Environmental objectives have arrived later, such as goals related to climate change mitigation and sustainable natural resource management. Common Agricultural Policy (CAP) and the National Strategic Plans (NSPs) promote environmental and water protection at the EU level and set environmental standards and measures that the farmer must fulfill to receive subsidies, referred to as cross-compliance mechanism. The implementation of the Nitrates Directive is bound to the cross-compliance mechanism of the CAP.

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<sup>1</sup> ANNEX I CRITERIA FOR IDENTIFYING WATERS REFERRED TO IN ARTICLE 3 (1) A. Waters referred to in Article 3 (1) shall be identified making use, inter alia, of the following criteria: 1. whether surface freshwaters, in particular those used or intended for the abstraction of drinking water, contain or could contain, if action pursuant to Article 5 is not taken, more than the concentration of nitrates laid down in accordance with Directive 75/440/EEC; 2. whether groundwaters contain more than 50 mg/l nitrates or could contain more than 50 mg/l nitrates if action pursuant to Article 5 is not taken; 3. whether natural freshwater lakes, other freshwater bodies, estuaries, coastal waters and marine waters are found to be eutrophic or in the near future may become eutrophic if action pursuant to Article 5 is not taken.

CAP is divided into two pillars of income support and rural development. Pillar I, which covers 75% of the funding consists of decoupled support payments and production related support. The funding for Pillar I derives from the EU's budget and the subsidies are directed to production-related renewal of agricultural sectors. Pillar I direct payments consist of basic payment, support for greening, young farmer support, and production-related subsidies to certain sectors of products.

Pillar II consists of the 25% of the funding and it supports rural development with support payments that are funded jointly by the EU's rural development funds and national funds. Pillar II subsidies are more directed to specific target areas, such as less-favourable regions, agri-environmental schemes, organic farming and animal welfare. Pillar II subsidies for rural development include payments for less-favourable areas, agri-environmental payment for participating in agri-environmental schemes, and subsidies for organic farming and animal welfare. Most of the support payments are paid as area subsidies. Participation in CAP is not mandatory for farmers although to be eligible to CAP payments farmers must follow cross-compliance conditions, legal requirements, and the conditions for greening.

Each member state must develop a national strategic plan for the upcoming CAP programmatic period of 2023-2027 (European Commission, 2023). The plan defines the measures and the requirements of their national agricultural policy, and the plans will be approved by the EU. These country-specific agri-environmental climate schemes are voluntary for farmers but mandatory for member states. The scheme includes mandatory requirements on the balanced use of nutrients such as limits for nitrogen and phosphorus fertilization and the use of herbicides, and parcel-specific measures such as buffer strips and plant cover on arable land on winter. It offers compensations for the farmer for taking the measures by providing an area-based payment. The payment has an upper limit. Additional part of the EU support system, which comes in addition to the above payments, funds non-productive investments, e.g., establishing a wetland to stop released nutrient and to promote biodiversity. The agri-environmental climate scheme receives funding from the EU and national funds. The new programmatic period aims to increase the role of environmental and climate measures, although the total CAP funding from the EU will be reduced.

CAP promotes water protection at the EU level and sets environmental standards that the farmer must fulfill to receive subsidies, which are referred to as cross-compliance mechanism. The cross-compliance mechanism of CAP has several benefits for European biodiversity and environmental condition in agricultural landscapes, such as habitats protection, animal welfare and developing standards and practices for good agricultural and environmental condition. These cross-compliance conditions include statutory requirements, such as the good agricultural and environmental conditions (GAECs) and the regulation of nitrogen application (Nitrate Directive). Following the cross-compliance conditions is a pre-requirement for the farmer to be eligible to most of the support payments. Regardless, receiving payments, all farmers must comply with the statutory management requirements (SMR). The SMR include EU rules on public health, animal and plant health and animal welfare and the environment.



## **Common Fisheries Policy (CFP)**

The Common Fisheries Policy (CFP) has been a precursor of the European Green Deal and its related strategies, as it combines environmental, social, and economic objectives. The main aim of the CFP is to ensure fisheries and aquaculture sectors long-term sustainability, availability of food supplies and a fair standard of living for communities. The CFP considers the whole value chain from contribution of fisheries and aquaculture to the coastal communities to food security and the protection of marine environment.

CFP does not regulate N and P sources, but fisheries activity has an impact on internal load. Fisheries activities impact the marine ecosystems through seabed disturbance, bycatch of sensitive species and effects of food webs. Vice versa, the poor status of marine ecosystems impacts the economic activities related to fisheries and aquaculture and the social well-being of fishing communities. CFP has principles of ‘maximum sustainable yield’ to reduce negative impacts of fishing on marine ecosystems and ‘landing obligation’ that requires that all catches, also the unwanted ones should be quantified and landed to ensure compliance with the CFP. Also increased coherence between the CFP and other EU environmental legislation, such as Marine Strategy Framework Directive and Bird and Habitats directives are aimed at.

## **Industrial Emissions Directive**

The Industrial Emissions Directive (Directive 2010/75/EU; European Commission, 2024a) is the main EU policy instrument on pollutant emissions from industrial installations. The aim is to achieve a high level of human health and environmental protection by reducing harmful industrial emissions in the EU. The directive introduces a permit system (art. 14), to ensure compliance with the general principles (art. 11) and with the environmental quality standards (art. 18). The permit sets emissions limits for polluting substances that contribute to the protection of soil, water, and air. The permit requirements also include rules on soil, water and air protection, monitoring requirements for emissions and waste and on risk management. The measures established with the permit requirements should also consider long-distance emissions.

The directive establishes an integrated approach, which refers to that the permit must take the whole environmental performance of the plant into account, including water, land, waste, use of raw materials, energy efficiency, noise, security, and restoration of site. The permit conditions must be based on Best Available Techniques (BAT), although the directive allows flexibility. The directive contains requirements for environmental inspections and public participation for decisions.

## **Groundwater Directive**

Groundwater Directive (Directive 2006/118/EC) prevents and controls groundwater pollution from harmful substances. The directive sets assessment criteria on good chemical status of groundwaters and criteria for identification of an upward trend and a starting point for that. Groundwater is considered to have a good chemical status, when the measured or predicted nitrate

levels do not exceed 50 mg/l. Active pesticide ingredients should not exceed 0.1 µg/l or 0.5 µg/l for all measured pesticides. Levels of certain high-risk substances are below threshold values set by Member states. Such substances are ammonium, arsenic, cadmium, chloride, lead, mercury, sulphate, trichloroethylene and tetrachloroethylene. The concentrations of any other pollutants should conform to the definition of good chemical status of the Water Framework Directive, as set in the Annex V. In case a value set in the groundwater quality standards is exceeded, investigation should confirm that this does not pose any significant environmental risk.

### **Urban Wastewater Directive**

The Urban Wastewater Directive (UWWTD) (Council Directive 91/271/EEC; European Commission, 2024b) aims to protect human health and the environment from untreated wastewater. The directive introduces measures to protect the environment from wastewater discharges and to ensure that domestic and industrial wastewater is properly collected, treated, and discharged. The directive was adopted in 1991 and during the 30 years of enforcement water quality in European rivers and lakes improved a lot. Wastewater treatment plants have been built with the support of EU funding in the EU member states.

### **Waste Framework Directive**

The Waste Framework Directive (2008/98/EC; European Commission, 2024c) sets waste management principles and definitions of waste, recycling, and recovery. It aims for waste management, that does not cause harm to human health and the environment, causes no risk to water, air, soil, plants, or animals, causes no nuisance through noise or odours and does not affect countryside or places of special interest.

### **Directive on port reception facility**

Directive on port reception facilities for the delivery of waste from ships (2019/883/EU), aims to protect marine environment against the negative effects from discharges of waste from ships. The measures to reach the directive's objectives include improving the availability and use of adequate port reception facilities. Member states must ensure appropriate waste reception and handling plans are in place. Ships are required to deliver an 'advance waste notification' to the authority designated for this purpose by the member state.

## 3. Regional N and P policies in northern European member states and Norway

### *Denmark*

*Denmark* is one of the most intensively farmed countries in the world with 61% of total land area cultivated. 36% reduction in N losses from Danish agriculture from 1990 to 2004 was a world record, and that was because of the long list of mandatory measures. During the period of 1985-2003 five action plans were implemented in Denmark, most of them following up on the nitrate Directive (from

1992). In these national action plans the following main measures were adopted in Danish agriculture as mandatory rules for all farmers in Denmark:

- Land use management through the fertilizer accounting system.
- Obligation to prepare fertilizer accounts in the fertilizer accounting system.
- Farms may not apply more nitrogen for fertilizer purposes than the fertilizer quota calculated for the farm (the economic optimal rate) based on crop specific norms evaluated every year.
- 240,000 ha mandatory catch crops
- Individual additional catch crops requirement for certain holdings
- A maximum of 170 kg N per hectare per planning period of manure.
- Application of liquid manure may only be done by trailing hoses, foot/shoe applicators or injection.
- Application of fertilizers must be carried out using a technique that ensures uniformity of spreading.
- Period when liquid livestock manure shall not be applied (harvest to 1<sup>st</sup> February).
- Ban on applying fertilizers to sloping areas within a certain distance to surface waters.
- Ban on applying fertilizers to soil that is water-saturated, flooded, frozen or snow-covered.
- Ban on applying fertilizers in a way that could risk surface loss to water courses.
- Requirements for the design of stables, stalls, and other facilities for animals to ensure that groundwater and surface water is not polluted.
- Requirements to the capacity of storage facilities for livestock manure (9 months).
- Requirements for storage of fertilizers.
- Requirements for the material used for construction of storage containers.
- Requirements to the frequency of emptying and maintaining the facilities for storing livestock manure.
- Farmers need permission for water intake for irrigation. Permissions are issued for a limited period.
- Demand of 75% and 70% N use efficiency of pig and cow slurry
- Demand for more catch crops in catchments to vulnerable estuaries, protected groundwater and Natura 2000 N vulnerable ha

Since 1998 lake and wetland restoration was added to the list of measures as a nature-based solution to reduce the N and P pollution. During the period of 2011-2015 mandatory 9 or 10 m buffer strips along all streams and lakes were requested in Denmark by the Buffer strip Act, which was removed again from 2016.

Since 2016 Denmark had targeted catch crops implemented in river basins under WFD where there is a requirement of reduction in N loadings (now ca. 340,000 ha). These catch crops can be substituted by the farmer with other measures such as: early seeding of winter crops; in between

crops; set aside; set aside buffer strips; energy crops; precision farming and N-quota reductions. The targeted catch crops programme is open for farmers to seek funding for establishing them in fields every year. A map showing how large a percent of fields in a river basin should be in catch crops is published yearly. The first round where farmers seek catch crops is voluntary and payment is given to farmers per ha. If the measures have not been applied to enough fields (ha) in each river basin to fulfill the demands in the map – then a second round is started with mandatory catch crops without payment. This is done every year and last year Denmark had 340,000 ha with catch crops under this targeted programme. This will grow in the coming years. The total number of ha's with catch crops in Danish agriculture with the four existing rules is more than 600,000 ha – with 95,000 ha being some of the other measures farmers can adopt from the list given above.

In Denmark funding exists under 'collective measures' for afforestation, rewetting of peat soils and restored wetlands and lakes. Constructed wetland programme is supported by several catchment officers that assist farmers in finding suitable areas – the main reason for farmers to take part is that this was a promise from 2015 when they were allowed to increase their fertilization level to the 'normal' EU standard after a period with a mandatory reduction on 10% that increased to 20% in 2015. The program is open for farmers to apply for constructed wetlands once every year and a map shows where in DK farmers can make these constructed wetlands. So, the farmers volunteer as the pressure is to implement again a mandatory under fertilization standard (lower than economic optimum) in Denmark by politicians. The constructed wetland programme is fully paid for from EU funding – 650,000 Dkr per ha constructed wetland made by a farmer.

For farmers volunteering to give up farming in areas that is restored to wetlands and lakes, a pressure exists from 2015 that if they do not allow enough wetlands to be restored then they are not fulfilling the promises given to the politicians that they were allowed to fertilize more from 2016. The wetland programme is run mainly by Danish municipalities and the Nature Agency. Areas are recruited through one or several land consolidation programmes run by a state agency that buys up one or more farms in the area to exchange areas with farmers on a voluntary basis. A new programme (mainly for climate but also for N) is to rewet 100,000 ha low lying organic soils in Denmark before 2030. This programme is fully compensated.

### **Danish example: catch crop regulations**

Denmark, as other countries with large-scale animal farming, has a major challenge and target in significantly lowering its nutrient emissions. Catch crops are one option. Since 1999, introduced as part of the Danish implementation of the EU Nitrates Directive, catch crops on a certain percentage of farmed areas have been mandatory in Denmark. Today, four different catch crop regulations are introduced, the major ones being agricultural catch crops and targeted catch crop regulations. The main aim of catch crops is to reduce the leaching of nitrate-N from agricultural fields. They are sown in the late summer after harvest and ploughed down in the winter or early spring, the allowed date being dependent on soil type. The total Danish agricultural area with catch crops has increased from 138.000 ha in 2005/06 to 513.000 ha in 2021/22 (Blicher-Mathiesen et

al., 2023). The effect of catch crops in Denmark has been measured in controlled plot experiments and reported in Eriksen et al., 2020, Table 2, which presents the annual reduced leaching of nitrate-N from agricultural fields following implementation of catch crops on two main soil types and two farming systems that have different production quantities of animal manure. The 18 and 25 kg N/ha is the reduction in N leaching obtained from having catch crops as compared to no catch crops after main crop - so the effect of catch crop as a mitigation measure!

**Table 2:** Effect of catch crops in Danish animal farms

	<80 kg N/ha in manure		>80 kg N/ha in manure	
	Clay soil	Sandy soil	Clay soil	Sandy soil
<b>Catch crop effect</b>	12 kg N/ha yr	32 kg N/ha yr	24 kg N/ha yr	45 kg N/ha yr

Today, the animal catch crop regulations apply to animal farms that have more than 10 ha field, produce more than 30 kg N/ha in animal manure, and are located in a vulnerable coastal catchment (NATURA 2000) or catchment with increases in animal production and having demands for N-reductions under the WFD. Each year a map is produced by the state showing the percentage of catch crops needed under animal catch crop regulation.

The targeted catch crop regulation was introduced in 2017, and every year a new map is introduced for the percentage need for catch crops in Danish coastal river basins. Farmers can then in the first phase every year voluntarily apply for growing catch crops in the coastal catchments. If the yearly target for catch crops in each catchment is not met through the first, voluntary round, a second round with mandatory catch crop demands in the catchment will be introduced to farmers. During the voluntary round, farmers will be compensated for establishing catch crops, but no support is given in the second mandatory round.

Instead of targeted catch crops, farmers can choose among several alternative nature-based solutions or mitigation measures. These include in-between crops, energy crops, early seeding of winter cereals, set-aside land, buffer strips along streams and lakes, precision farming, reduction in farm N quota, or the use of unused N quota from previous year. Each alternative measure has its exchange rate with catch crops. The system thus provides farmers flexibility and as such is cost-efficient as farmers can choose and combine measures that they consider reasonable and affordable.

*Norway*

In Norway, only 3 % of the country is agricultural land, which is one of the reasons for a national policy to improve self-sufficiency of food. This may potentially conflict with the environmental

goals of the WFD, especially when it comes to using fertile land for other purposes, such as buffer zones, floodplains or restored wetlands.

### **The legal system governing agricultural measures**

Norway is not a member of the EU, but the country transposed the EU WFD to a Norwegian regulation (“Vannforskriften”) in December 2006. Four national laws constitute the legal basis for the regulation: The Plan and Building Act, the Law on Pollution, the Law on Biodiversity, and the Water Resources Act. The first of these ensures that the WFD plans are authorized through the same system as other management plans.

Norway has also implemented the Nitrate Directive in selected parts of the country, i.e., in catchments draining to the Oslo Fjord, including the entire catchment of the Rivers Glomma and Haldenvassdraget, as well as catchments draining to the inner Oslo Fjord. The CAP has not been implemented in Norway, but the country has its own regulations to ensure environmental measures in agriculture, which are outlined below.

Other laws that are not directly related to the implementation of the WFD, but still relevant, include the **Land Act**, issued in 1995<sup>2</sup> with its **Regulation of Production Grants** from 2014<sup>3</sup>. This instructs that production grants can be given per area of cultivated land but with two requirements: that the cultural landscape is not degraded, and that the farmers maintain a natural buffer zone between agricultural land and streams with annual water flow. This buffer zone should be wide enough to prevent runoff to water bodies under normal water flow and should be at least 2 m wide, as measured horizontally from the streams’ normal water level. For large rivers, it can be argued that these 2 m are hardly more than the stretch from the river to the brink of the riverbank. Other environmental mitigation measures are not legally required on a national scale, but instead, a set of regional environmental funding schemes are in operation (see below). This, therefore, is a system of carrot rather than whip, i.e., economic incentives rather than legal demands.

Recently, however, a set of **regional regulations** on mitigation measures in agriculture are being issued, as a response to the ecological disaster in the Oslo Fjord, caused by excess nutrient losses from especially agriculture and sewage. One such regulation is already issued in the (former<sup>4</sup>) county of Oslo and Viken. The regulation on **regional environmental requirements for agriculture** was issued in January 2023<sup>5</sup> and has requirements related to buffer zones with grass cover (or in less critical areas, fields in stubble over winter) and reduced tillage (especially near drainage systems, in flood prone and erosion prone areas). In selected, critical areas, at least 60% of the agricultural land should be in stubble over winter, or be covered with grass, cover crops or

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<sup>2</sup> <https://lovdata.no/dokument/NL/lov/1995-05-12-23>

<sup>3</sup> <https://lovdata.no/dokument/SF/forskrift/2014-12-19-1817>

<sup>4</sup> The County of Viken was a short-lived, large county consisting of 3 former counties plus Oslo (which is its own county). From 1 January 2024, the Viken County was again split up into the former four counties. However, the planning for 2024 was done in 2023, when the old Viken still existed, and this report therefore refers to planning mechanisms done by the old county of Oslo and Viken.

<sup>5</sup> <https://lovdata.no/dokument/LF/forskrift/2022-12-06-2182>

similar. Two other counties (Innlandet, and Telemark & Vestfold) also have rivers draining to the Oslo Fjord and are presently working on similar regulations.

The requirement that 60% of the fields should not be ploughed in autumn has been tested once before, in 2009–2012, amongst others in the case catchment of NORDBALT ECOSAFE, the Vansjø-Hobøl Catchment. The purpose was to protect eutrophic water bodies with toxic algae blooms. The regulation was removed again in 2013, for political reasons. During the years the regulation was in operation, the proportion of fields with no autumn tillage increased to 80–90% of the total agricultural area. After 2013, however, the proportion dropped to 50–60%.

Traditionally, Norwegian mitigation measures have concentrated on reducing losses of phosphorus, since the clay-rich soils in the agricultural areas have high natural contents of phosphorus, and since phosphorus is the limiting nutrient for freshwaters. However, the recent collapse of the ecological conditions in the Oslo Fjord has caused a new interest also for nitrogen reduction measures. Conservation tillage and cover crops are important measures in this regard, as is fertilizer planning (systematically quantifying the need for plant nutrients for the individual agricultural crop at each farm field).

### **Regulations that finance environmental measures in agriculture**

Although Norway is not implementing the CAP, there are many similar measures that are implemented in Norwegian agriculture. The Norwegian funding system is called the Regional Environment Plan (RMP), and its purpose is to stimulate to increased implementation of environmental measures in agriculture. In addition to measures related to water, the financing also covers activities to improve the cultural landscape, cultural heritage, recreation facilities, emissions of climate gases to air, and plant health.

Since the Norwegian agriculture varies a lot from county to county, each county has its own RMP-regulation. The variability of the agriculture is due to conditions such as topography, soil and climate, and has resulted in a policy and financing system where cereal production is encouraged in areas where the soils are best suited for this, whereas animal husbandry is channeled to areas with poorer soils or climate for cereal production. NORDBALT ECOSAFE's Norwegian case area is situated in the former county of Viken which includes areas with soils well suited for cereal production. The Regional Environment Plan for 2024 (Statsforvalteren I Oslo og Viken, 2024) for this region will fund the following measures:

- No-till after harvesting of fields in autumn,
- Grass cover in areas exposed to flood and erosion,
- No-till in flood-prone areas,
- Direct sowing for winter cereals and winter oil seeds,
- Grass-covered water ways and grass-strips across long slopes (to reduce soil erosion in ravines and slopes),
- Grass-covered buffer zones in fields,
- Grass-covered, un-fertilized buffer zones in meadow, without pesticide application,

- Maintaining (existing) constructed wetlands/sedimentation ponds,
- Measures related to more environment-friendly spreading methods of animal manure

In addition to the RMP, the Norwegian funding system also includes the so-called ‘Special Environmental Measures in Agriculture’ (abbreviated SMIL). These are aimed at more physical, hydrotechnical installations, such as improving drainage pipes and establishing constructed wetlands/sedimentation ponds.

### **Norwegian example: regulations for grass-covered buffer zones along streams**

Vegetated buffer strips along streams in agricultural areas are controlled by several Norwegian regulations and economic incentives, and some of these can seem contradictory. The **Water Resources Act (2001)**<sup>6</sup> is of particular interest since its §11 states that ‘a limited, natural vegetation zone to reduce runoff and be a habitat for plants and animals, should be maintained along water courses with annual water flow’. It does, however, not stipulate any width of the buffer zone, and the word *maintain* and not *establish* is interesting, since the much older **Land Act (1995, §9)**<sup>7</sup> says that ‘Cultivated land must not be used for other purposes than agricultural production’. In other words, if a riverbank is used for food production at present, the Land Act stipulates that it should be used for food production also in the future. The background for this paragraph is the need to protect soils suitable for agricultural production in Norway. However, it is not totally prohibited to change the land use in cultivated soil; the second part of this paragraph states that the Agricultural Ministry can, in particular cases, give permission for other uses of agricultural land than food production after a comprehensive evaluation. On the other hand, if the riverbank *already* has trees and bushes, it is not allowed to remove these in a width of 6 m, as stated in the **Regulation of Cultivation of New Land (2021)** (this regulation is also under the Land Act).

The fact that farmers only receive production grants for land areas on which they produce food or fodder, means that buffer zones with natural vegetation represent a net loss of income for farmers. Very often, therefore, trees and bushes are only found to a limited degree close to the streams, and then most often in the two-meter-wide zone governed by the Regulation of Production Grants. Whereas there are funding schemes for buffer zones with grass production, there are no economic or regulatory incentives to establish natural buffer zones with trees and bushes, except that compensations can be granted for the price of seedlings.

Blankenberg and Skarbøvik (2020) mapped farmers’ views on several types of buffer zones. Often, buffer zones are viewed as a “necessary nuisance”. Necessary because of the environmental benefits, but a nuisance since the soil in these areas is usually fertile and well suited for cereal production. Most farmers preferred grass instead of trees in the buffer zones, due to issues such as shadow on the fields, the risk of weeds, pests, and diseases, or clogging of drainage pipes. However, an exception was a smaller group of farmers that had enrolled in a tree-planting scheme.

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<sup>6</sup> <https://lovdata.no/dokument/NL/lov/2000-11-24-82>

<sup>7</sup> <https://lovdata.no/dokument/NL/lov/1995-05-12-23>



It is possible that these were more positively disposed to trees in the first place, but when asked they listed none of the problems that the other farmers had feared, perhaps pointing to a traditional skepticism towards trees that is only partly justified.

### *Sweden*

Agriculture constitutes around 8% of land use in Sweden and the agricultural sector remains insignificant. Sweden had deregulated its agricultural sector in 1990 and joined the EU in 1995 (Daugbjerg, 1997). Because of its northern location and the agricultural reforms, the country has had major challenges with the profitability of agriculture. Sweden has been paying Nordic Aid which can be granted to agriculture north of the 62 parallel. The agri-environmental measure payments have been generous, and funding been allocated to improve water quality, targeting reduction of nitrogen and phosphorus load. The payment model compensates for a wide range of agri-environmental measures and has contributed to the survival of also comparably small, diverse, and less intensively managed farms that are characteristic of Sweden and support the mixed forest and farm landscapes (Eksvärd & Marquardt, 2018; Granvik et al., 2012). Most Swedish farmers are highly dependent on the agricultural support schemes payments for their survival, although the agri-environmental payment scheme is not well like among Swedish farmers.

In Sweden there are several regulations, mitigation measures and environmental subsidies introduced that target the nutrients from the agricultural sector. EU Nitrates Directive, Water Framework Directive and Groundwater Directive set limitations in nitrate concentrations in surface waters and ground waters and the framework for improved water status. National laws, such as the Miljöbalk 5 kap. (1998:808) implement the above-mentioned directives and define the details for e.g., spreading of fertilizers or area with winter grown crops. Local restrictions might exist, for example in recharge areas for drinking water supplies. Vattenmyndigheterna are the regional authorities together with Länsstyrelsen implementing the WFD in the 5 water districts of Sweden.

CAP subsidies are coordinated by the Board of Agriculture and maintained by the County Administrative Boards. These include the farm subsidy, environmental annual subsidies, and the investment subsidies, such as payments for investments. There are also national subsidies to encourage local water management projects (LOVA) and local nature management projects (LONA).

Advisory programs with the focus on nutrients aim at capacity building among farmers in nutrient management and other measures. They are financed by CAP, and they should benefit both the environment and the farmer. There are also subsidies for the catchment officers that facilitate communication between farmers, agricultural advisors, and authorities. The main aim of these communication activities is to implement relevant mitigation measures in the catchment. Their financing varies but could derive from LOVA or municipality.

There are several measures in place that combat nutrient flow from agriculture (CAP reform profile Sweden 2020):

**Buffer zones:**

Grassed buffer zones along water courses, adapted buffer zones in the field and grassed waterways can be established. Requirements to receive financial compensation include sowing the riparian strip no later than the spring of the first year of installation and keeping a width which ranges from a minimum of 6 to a maximum of 20 meters. The application of fertilizers is forbidden, and the strip shall not be modified until the end of the commitment period that is valid for 5 years.

**Fertiliser application (manure, organic and inorganic fertilisers):**

Fertilizers are only allowed to be applied on arable land, not pasture. Seasons allowed for spreading depend on whether the site is in nitrate vulnerable zones or climate region and on field conditions such as clay content, slope, distance to open water or whether the field is water saturated, snow covered or frozen. The fertilizers should be applied on growing crops or incorporated in bare soil within 4 hours. The maximum fertilizer limit is 22 kg P ha<sup>-1</sup> per year as an average for 5 years.

**Manure:**

There are limitations in livestock density, approximately 1 LU/ha. In addition, there are rules for storage capacity adapted to type of manure, crop rotation and region.

**Winter green soil cover on arable land:**

The winter green soil cover rule applies only in southern Sweden and varies between 50 and 60% depending on region defined as covered with crops or un-cultivated in autumn.

**Catch crops and cover crops:**

Catch crops are implemented against nitrogen leaching from arable land and cover crops to sequester carbon in the soil and to improve soil fertility. Medium crops account for 113–141 EUR/ha and catch crops 130–156 EUR/ha.

**Spring ploughing and tillage:**

Spring tillage accounts for 61–71 EUR/ha (Farm Europe, 2022).

There are also additional agricultural advisory programs and subsidies targeted at nutrient management, such as phosphorus ponds, two-stage ditches, controlled drainage, and structural liming. Measures are targeted at the soil structure management. Establishing wetlands is supported by additional programs. The farmer union in Sweden has highlighted that the farmers do more environmental measures than those that are subsidized and documented. Wetlands are implemented voluntarily without public payment and field drainage and soil structure is improved, which is beneficial to production and the environment.

Farmers in general want to contribute to improved water quality and most of them have a very good knowledge of how nutrient leaching can be reduced from the farm in everyday management.

Especially measures that benefit farm economy as better counting on nutrient balances are implemented. The process for applying subsidies is time-consuming and could be an obstacle to participating in the eco-scheme.

### *Finland*

Finland joined the EU in 1995 and has since then been part of the EU's common agricultural policy. In Finland there has been four programmatic periods from 1995–1999, 2000–2006, 2007–2013, 2014–2020, and then transitional phase from 2021 to 2022. The new programmatic period will run from 2023 to 2027. Because of the Northern location, the programmatic measures have been focusing on direct payments. Environmental measures have been introduced as part of the cross-compliance mechanism. The environmental payment system is voluntary for farmers, 86% of whom are committed to the system in Finland (Kipinä-Salokannel & Mäkinen, 2022).

Alongside the Common Agricultural Policy, mitigation measures and the following support mechanisms are based on following regulation and policies: Water act 587/2011, implementing the WFD (2000/60/EC), Degree of the Council of State on limiting certain emissions from agriculture and horticulture (1250/2014) implementing the Nitrate Directive (91/676/EEC), agricultural phosphorus regulation (entered into force on 17th of January 2023. It is based on the Fertilizer Act (711/2022) article 6).

In the RBMP, the suggested agricultural measures are firmly related to the environmental payment system, which is the main financial mechanism for decreasing the nutrient load of agriculture (Kipinä-Salokannel & Mäkinen, 2022). Regarding the funding of water protection measures, one of the targets in the RBMP for agricultural water protection is the targeting of CAP project subsidies for water protection measures (Ibid.). The agricultural measures under the RBMP and MPM focus on promoting and targeting the implementation of CAP measures.

In addition to the agricultural subsidy system, water protection in agriculture is promoted through project activities. They play a significant role, as water protection measures under the environmental payment system alone are not sufficient to improve water quality (Laurila et al., 2022). The Ministry of the Environment funds nutrient recycling and water protection programmes. Gypsum treatment of fields has been carried out through the Gypsum Project (Elinkeino- liikenne- ja ympäristökeskus, 2023).

Main measures in place have been listed in Finnish Food Authorities' (Ruokavirasto, 2023) guide to cross-compliance.

### **Buffer strips:**

Buffer strips covered with vegetation should be left uncultivated and at least 3 meters wide on the side of the watercourse. Subsidy for a unit of buffer strips is 350 EUR/ha. The vegetation on buffer strip can consist of herbaceous plants or other plants than woody plants. Use of pesticides and

fertilizers is prohibited. Exceptions for the use of pesticides can be applied and are granted by the Regional Centre for Economic Development, Transport and Environment (ELY center). Previously, before the 2023 programmatic period 1 meter buffer strips were also demanded along the main drainage, but this condition has been removed.

#### **Use of fertilizers:**

Fertilizers should be spread on the field in such a way that there is no runoff into the water and the subsoil is not compacted. Fertilizers should never be applied to snow-covered, frosted, or waterlogged soil. If you spread manure or organic fertilizer products on the field, the manure must be mulched, or the field plowed within a day of spreading. If you spread manure or an organic fertilizer product to the plant with a hose spreader or as a scattered application, mulching is not required. If your field has plant cover over the winter, manure and organic fertilizers may be spread from 15th of September onwards.

Use of fertilizers is prohibited five meters closer to a water body. In the zone of next five meters, spreading of manure and organic fertilizers is prohibited unless the field is plowed within a day. Grazing of domestic animals is allowed along water bodies.

Follow the maximum limits given for soluble nitrogen used in nitrogen fertilizers. For barley, oats, and mixed grains there are 160 kg/ha on mineral soils and 120 kg/ha on organic soils. Fertilize the growing area on a basis based on the plant, soil type and yield level.

Apply phosphorus fertilizer evenly on entire growing area based on plant type, soil fertility and yield level. The main rule for phosphorus fertilizer use is that 100% of the total phosphorus contained in manure and fertilizer products is considered. If you use only livestock manure for phosphorus fertilization you can use slightly larger amounts of nutrients for cereals, oil crops, legumes and grasses. The manure exception may not be used closer than 25 meters to a water body. The manure exception is in use until 1<sup>st</sup> of January 2025.

Follow the manure storage regulations. Animal farms must have manure storage, which should have a capacity for storing manure which has accumulated over 12 months except for manure that stays on the pasture during grazing season. In the case of cattle, manure left on the pasture for a maximum of four months can be considered for this exception.

#### **Storage of dry manure in exceptional situations:**

You can openly store dry manure with a dry matter content of 30%, if needed for technical or hygienic reasons. A technical reason for the exception is, for example, a cellar malfunction or breakdown of manure equipment. Hygienic reasons for the exception are for example a pathogen, such as salmonella, listeria, or another disease. The hygienic reason for open storage must always be approved by a veterinarian.

#### **Minimum winter plant cover:**

Keep a minimum of 33% of your field area with plant cover from autumn to the following spring. The requirement cannot be met with fields under permanent grass cover. Subsidy for winter plant cover is granted to an area kept uncultivated or with defined uncultivated plants from a certain date in autumn until the sowing in the next spring. You must keep the plant covered from 31<sup>st</sup> of October until 15<sup>th</sup> of March next spring. You must annually report the areas you have kept in plant cover with a fall report in Vipu service. You can report areas with plant cover lightly cultivated areas of grass plants, areas of cereals, buckwheat, quinoa, oilseeds, fiber crops, legumes, and seed spices, as well as the mixed crops. Lightly cultivated area is accepted if the cultivation is done with a cultivator, disk harrow, flexible tine harrow, spade roller harrow or roller aerator in one run. The subsidy is paid for those hectares eligible for direct support. The subsidy for winter plant cover is 50 EUR/ha.

### **Collector plants:**

As part of the environmental scheme, collector plants are cultivated during the growing season as an underplant for an annual production plant or after harvesting the production plant. The seeds of the collector plant or plant mixture must be sown evenly over the entire growing area. Subsidy can be paid annually for a maximum of 30% of the area eligible for the benefits. The subsidy is 97 EUR/ha.

### **Soil fertility survey:**

As part of the cross-compliance requirements a soil fertility survey must be taken at least every five years. Soil type and fertility class are analyzed with the survey.

### **Manure analysis:**

Do a manure analysis every five years. In the analysis of soluble nitrogen, total nitrogen and total phosphorus content of manure should be measured. Keep the data of manure analysis and the product information of organic fertilizers so that you can present them to supervisory authority when requested.

### **Promotion of circular economy:**

The farmer commits to spread slurry, urine, liquid fraction separated from slurry or liquid organic fertilizer on the field or to add organic material from outside of the farm with dry matter content of at least 20% on the field. The minimum quantity of substances to be applied on the field is 15 m<sup>3</sup>/ha and of substance containing more than 20% dry matter is 10 m<sup>3</sup>/ha. The subsidies can be paid annually for a maximum of 80% of the eligible area and the payment is 37 EUR/ha.

### **Runoff management:**

As part of the environmental measures, runoff management responds to the needs identified in the water management plans to regulate the groundwater level in fields with peat and acidic sulfate soil to slow down composting of peat and to prevent acidic leaching. Ground water level

management is done with drainage control, submersible pumps, or a drainage water recirculation system. Only one of the activities is eligible for a subsidy and during the breaks in farming activities the groundwater level must be kept at its maximum. The subsidy for control drainage is 77 EUR/ha and for submersible pumps and drainage water recirculation 214 EUR/ha.

### *Poland*

Agriculture is one of the economic cornerstones of Poland. The profitability of the agricultural sector is comparably good, and it has been increased with the modernization of agriculture, especially in the milk, pig, and beef sector. Since 2002 Polish agro-food industry has been supported by the resources and finances from the European Union. In 2004 Poland joined the EU and became part of EU's Common Agricultural Policy.

Poland implements EU Nitrates Directive, EU WFD, EU Groundwater Directive and EU CAP, including environmental funding scheme for farmers. Policy measures to increase the use of mitigation measures (MM) and nature-based solutions (NBS) are established with several documents. River Basin Management Plans and the Program of Measures target water pollution by nitrates from agricultural sources and aim to prevent further pollution. The so-called Nitrate Program was adopted by the Polish Council of Ministers (it was published in the Official Gazette on February 7, 2023 (item 244)). The program implements the EU Nitrates Directive with the primary task of reducing the impact of the agricultural sector on the status of surface and groundwater through rational fertilizer management, which will reduce the outflow of nutrients into waters.

In Poland, several MM and NBS are being taken to reduce nutrient runoff from agricultural areas. Within the Nitrate Program, rational fertilizer management is promoted to reduce the outflow of nutrients into waters. The program also supports application of NBS and other mitigation measures such as mulching, subsoiling, riparian buffer zones, use of catch crops.

The 2<sup>nd</sup> cycle of RBMP introduces multiple measures that are included within the river basin management framework, such as damming and retention of underground and surface water, increasing disposable water resources for agricultural production (e.g., small retention reservoirs) and increasing soil retention (e.g., ponds). RBMPs introduce measures for improving water quality, targeting the nutrients, e.g., in floodplains and areas of intensive farming by runoff and erosion management, targeting nutrient runoff and erosion of soils and watercourses.

There are measures introduced in national documents that are consistent with the 2<sup>nd</sup> cycle of RBMP, such as the plan for counteracting the effects of drought regarding activities aimed at normalizing water relations in catchments, improving the quantitative state of water, and protecting and increasing natural retention, restoring natural flow conditions.

In Poland, the National Surface Water Restoration Program (NSWRP) aims to improve the condition of waters with restoration activities by identifying priority areas of low surface water quality based on the degree of transformation of the aquatic ecosystem and other conditions of the water body.

National Municipal Wastewater Treatment Program (NMWTP) introduces measures to reduce eutrophication of waters (VI cycle of the Program). The catalog of good practices for hydrological and maintenance works promotes good practice about activities for sustainable and economical management of water resources.

Set of recommendations for Code of Good Agricultural Practice (CGAP) targets water pollution by nitrates from agricultural sources, promotes measures related to, among others, more efficient fertilization, improving soil properties, reducing leaching of pollutants from agricultural areas, and creating and maintaining buffer zones and retention zones in agricultural areas.

There is also a good agricultural practice advisory code on reducing ammonia emissions, which promotes activities related to appropriate nitrogen management, considering the nitrogen cycle, methods to reduce ammonia emissions from livestock production, including animal housing methods, and systems and low-emission fertilizer storage and application techniques for reducing emissions during application.

#### 4. Discussion

Currently applied **mitigation measures** to curb agricultural nutrient emissions in the EU are mainly based on the WFD, the Nitrates Directive, and CAP, which are implemented differently in each country. In this report we have scrutinized the European and national policies and regulations relevant for mitigating N and P emissions from agricultural sources. We have compared the implementation of these directive and regulations and the measures adopted in Norway and four EU member states: Denmark, Finland, Sweden, and Poland.

Several environmental policies have been implemented in the European Union to decrease nitrogen (N) emissions from agriculture. Both nitrogen and phosphorus (P) are included in the WFD. This is important, as phosphorus is the most important nutrient causing eutrophication of rivers and lakes (Schindler et al. 2016). Velthof et al., (2014) have shown that the implementation of the Nitrates Directive has during its 30-year implementation decreased leaching of N to ground and surface waters and to the atmosphere as gaseous emissions. The directive has potential for further nutrient emission reduction, because of the tightening requirements. One of the objectives of ND is to decrease eutrophication of surface water by nitrogen emission reductions. However, if only nitrogen is reduced, while phosphorus-emissions remain, this will not reduce the eutrophication problems in most rivers and lakes, as phosphorus is the most important nutrient causing eutrophication in freshwater bodies.

CAP environmental payment scheme and codes of good environmental practice are significant government-led voluntary approaches for reducing emissions to soil, water and air and play a role in reducing N and P emissions. In this report, we have not approached voluntary measures by companies, agricultural entrepreneurs, including farmers and NGOs.

As discussed above, EU member states implement the WFD, the Nitrates Directive, and the environmental measures of the CAP through their national plans. National rules exist for farmers on fertilization, manure storage and dissemination, buffer strips, catch crops, collector plants, soil properties and tillage, mulching requirements, minimum winter plant cover, hydrotechnical measures, rewetting peat soils and the promotion of circular economy.

There are differences in implementation of CAP scheme in terms of which measures have been emphasized.

*Denmark* is one of the most intensively farmed countries in the world. The Danish example of the EU Nitrates Directive implementation relied on catch crop schemes being introduced throughout the country. The catch crops in place are supported by regulations and policies that demand a certain percentage of agricultural and targeted catch crops for farmed areas in Denmark. With the catch crops, leaching of nitrate-N from agricultural fields has been reduced, which contributes to water protection. Wetlands and buffer strips are also employed as a NBS, but the administrative processes have been criticized by various stakeholders for being lengthy and complicated. The Danish reduction in N losses (36% from 1990 to 2004) was a world record, and that was only possible because of the extensive list of mandatory measures. Therefore, Danish catch crop example can act as a best practice, that could be implemented elsewhere in regions suffering from high N concentrations in waters.

In *Finland* the CAP programmatic measures have been focusing on direct payments. Additional policies and regulations are in place, such as the new national regulation on the use of P fertilizers and manure (64/2023). In Finland, as part of the CAP measures, the importance of minimum winter plant cover has been emphasized. The area which receives subsidies for this environmental measure has been increasing. Also, structural liming and other measures that target soil structure management have been implemented. Because of the high fertilizer's prices, the farmers are not using the maximum allowed amount of fertilizers but instead the amount the plants need. The 1 m buffer strip requirement along main drainage systems as a requirement for CAP subsidies was removed in 2023, although the measure was applied by the farmers previously.

In *Sweden*, alongside the implementation of CAP measures, additional agricultural advisory programs and subsidies have targeted at the nutrient management. From these measures structural liming has targeted the soil structure management. Some of these measures have gained popularity among farmers, for example subsidies for the renovation of drainage systems had more applicants than there was funding. The Swedish authorities saw it as a drawback that they cannot reward measures under the CAP, i.e., they cannot pay more in subsidies than the measure costs, not even in areas where the measure is highly effective. The farmer union in Sweden has highlighted that the farmers do more environmental measures than those that are subsidized and documented. Wetlands are implemented voluntarily and without public payment and field drainage and soil structure is improved which is of benefit for the production but also the environment.



In *Poland* the focus of agricultural policy has been on modernizing agricultural sector and increasing its profitability. Information on the impacts of diverse ways to manage land and incentives for the application of nature-based solutions and mitigation measures is needed. Embedding nature-based solutions and agricultural mitigation measures in broader, strategic policies, such as strategies on climate change mitigation and adaptation, green infrastructure and biodiversity are all based on an ecosystem approach. Restructuring of rural areas, especially in agro-tourism, should be supported under EU and national programs and funds. Investments should be channeled to infrastructure for environmental protection, and environmental content should be introduced in educational programs at different levels. Farmers should be compensated for their activities that enhance the ecosystem services for everyone.

*Norway* is not part of the EU but implements the EU WFD in Norwegian law. The Nitrate Directive is implemented in catchments draining to the Oslo Fjord, a water body with huge environmental problems. The country is not implementing CAP but has its own regulations and policies to ensure uptake of environmental mitigation measures. On a national scale, economic incentives have been the main instrument to encourage mitigation measures, with fewer legal requirements. On a regional and local scale, however, legal regulations have been issued to maintain buffer zones and apply conservation tillage. Lately, such regulations are implemented in counties that drain to the Oslo Fjord, as an attempt to reduce nutrient losses to the fjord.

## 5. Conclusions

To conclude:

- Reaching a **safe nutrient** concentration and load in the Nordic-Baltic region requires river basin level management, national efforts, and local action, including also lakes and coastal waters.

Each country should set water quality targets including nutrient concentration targets based on the WFD and national laws, determine possible solutions and measures based on newest science, and uptake binding regulation and/or sufficient financial incentives in addition to accessible information to reach the environmental targets. Reforming food systems and protecting water are best done in co-creative and continuous multi-stakeholder processes. Running a comprehensive program is challenging but necessary. When planning food system regulations and policies, societies should consider how all actors including agricultural input suppliers, farmers, food companies, food traders, consumers, and specifically investors can be targeted with regulations and incentives.

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