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Horizontal Coherence for Agricultural Nutrient Emissions Mitigation Policies: A Comparison of Denmark, Finland, Sweden, Poland and Norway

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Abstract

This paper examines the horizontal policy coherence of key EU and national legislation on agricultural nutrient emissions. It focuses on the EU's regulatory framework for agricultural nutrient management, which consists of several environmental directives and framework policies and purely national regulations and policies. Additionally, the paper studies these policies in four EU member states (Denmark, Sweden, Finland, and Poland), and Norway and how they promote changes in agricultural practices through mandatory or incentivized mitigation measures. Our findings suggest that coherent policies with clearly defined and binding targets are needed to mitigate nutrient emissions from agricultural sources, setting water conservation as a priority in European agricultural policy. Policy coherence should be addressed in national implementation, which consists often of heterogeneous and constantly changing rules for farmers with each country setting their priorities on different measures to mitigate agricultural nutrient emissions.

Keywords: Policy coherence, policy implementation, eutrophication, agricultural nutrient emission

1. Introduction

Eutrophication in the coastal areas of the Baltic Sea, the Atlantic, and the North Sea in Norway is driven by anthropogenic stressors.[1] Agricultural nutrient emissions, consisting to a large part of nitrogen (N) and phosphorus (P) from agricultural lands, are major contributors to algal blooms and oxygen depletion in marine ecosystems.[2] The primary sources of anthropogenic N and P inputs in the Baltic Sea and North Sea are land-based, with agriculture being the dominant contributor.[3] Nutrient pollution from agricul-

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[1] Eutrophication has major impacts on aquatic ecosystems and negatively affects their ecological status and changes the ecological communities with naturally occurring species to communities dominated by species tolerant to nutrient pollution. See e.g., K. Karlson, R. Rosenberg and E. Bonsdorff, Temporal and spatial large-scale effects of eutrophication and oxygen deficiency on benthic fauna in Scandinavian and Baltic waters—a review. In H. Barnes, R.N. Gibson, M. Barnes and R.J.A. Atkinson, Oceanography and marine biology. An annual review, Volume 40, CRC Press, London, 2002), pp. 427–489, and M. Szymczak-Żyła, M. Krajewska, A. Winogradow, et al., Tracking trends in eutrophication based on pigments in recent coastal sediments. Oceanologia 2017; 59(1), 1–17.

[2] A. Lagus, J. Suomela, G. Weithoff, K. et al., Species-specific differences in phytoplankton responses to N and P enrichments and the N: P ratio in the Archipelago Sea, northern Baltic Sea. Journal of Plankton Research 2004; 26(7), 779–798.

[3] Baltic Sea Action Plan addresses the eutrophication by combining latest scientific knowledge and management. HELCOM. 2021. Baltic Sea Action Plan 2021 update. October 2021. Helsinki Commission, Helsinki. For further

ture derives from diffuse sources, and therefore pollution control is challenging. The nitrogen surpluses have remained high in Northern and Central Europe, with no significant improvement in past 30 years.[4] In response, the European Commission has emphasized the need for stronger measures to prevent nutrient-related water pollution, particularly from N and P.[5]

To address this issue, the European Union (EU) has implemented a comprehensive framework of directives, regulations, and policies to protect water resources from agricultural nutrient pollution. Key EU legislation includes the Water Framework Directive (WFD, 2000/60/EC)[6], the Marine Strategy Framework Directive (MSFD)[7], the Nitrates Directive (ND)[8], the Groundwater Directive (GWD)[9], and the Common Agricultural Policy (CAP)[10]. Additionally, international and regional agreements, such as the Helsinki Convention (HELCOM) for the Baltic Sea and the Oslo-Paris Convention (OSPAR) for the North-East Atlantic, aim to mitigate eutrophication by regulating nutrient emissions into freshwater, coastal, and marine environments.[11] National policies, including those governing phosphorus fertilizer use, further contribute to efforts in controlling agricultural nutrient pollution.

The European Commission has published a staff working document concerning the links between the CAP and the European Green Deal (EGD), which states that its objectives are already

reading see e.g., M.V. Brady, M.S. Andersen, A. Andersson, et al., Strengthening the policy framework to resolve lax implementation of the Baltic Sea Action Plan for agriculture. Ambio 2022; 51, 69–83, and K. Elofsson, Cost-effectiveness of the Baltic Sea action plan. Marine Policy 2010; 34(5), 1043–1050.

4 F. Platjouw, I. Nesheim, and C. Enge, Policy coherence for the protection of waste resources against agricultural pollution in the EU and Norway. RECIEL 2023; 32, 485–500.

5 Commission (EU) 'Report from the Commission to the Council and the European Parliament on the Implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources based on Member State reports for the period 2016–2019' (Communication) COM(2021) 1000 final, 11 Oct 2021.

6 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy. Official Journal 22 December 2000 L 327/1.

7 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. Official Journal 25 June 2008 L 164/19.

8 Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources. Official Journal 31 December 1991 L 375.

9 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. Official Journal 27 December 2006 L 372.

10 Legal foundations of the Common Agricultural Policy are established in the "Treaty on the Functioning of the European Union." Consolidated version of the Treaty on the Functioning of the European Union. Official Journal 26 October 2012 C 326, P. 0001 – 0390, and in Regulation (EU) 2021/2116 of the European Parliament and of the Council of 2 December 2021 on the financing, management and monitoring of the common agricultural policy and repealing Regulation (EU) No 1306/2013, Official Journal 6 December 2021 L435 and in other applicable regulations.

11 HELCOM convention, Baltic Marine Environment Commission, The Baltic Sea joint comprehensive environmental action programme. Baltic Sea Environmental Proceedings, 1993; 48, 1–133, and OSPAR convention, Convention for the protection of the marine environment of the North-East Atlantic of 22nd September 1992, entered into force on 25th March 1998, 32 ILM 1072; 1993, Fur further reading see, e.g. M.S. Andersen, A. Andersson, M. Brady, et al., The Helsinki Convention's agricultural nutrient governance: how domestic institutions matter, Journal of Baltic Studies, 2023; 54(3), 443–466; M.H. Thorsøe, M.S. Andersen, M.V. Brady, et al., Promise and performance of agricultural nutrient management policy: Lessons from the Baltic Sea. Ambio, 2022; 51(1), 36–50; N. Tynkkynen, P. Schönach, M. Pihlajamäki and D. Nechiporuk, The governance of the mitigation of the Baltic Sea eutrophication: Exploring the challenges of the formal governing system. Ambio, 2014; 43, 105–114; R. Varjopuro, E. Andrulewicz, T. Blenckner, et al., Coping with persistent environmental problems: systemic delays in reducing eutrophication of the Baltic Sea. Ecology and Society, 2014; 19(4), 48.

in line with the focus of the EGD in relation to food systems.[12] The EGD advances a vision that by 2050, air, water and soil pollution is reduced to levels no longer considered harmful to health and natural ecosystems and that respect the boundaries our planet can cope with.[13] To structure the progress towards this ambition, the EGD and the related EU zero pollution action plan[14] establish specific targets for 2030 addressing required levels of reduction of different types of pollution in different parts of the environment. According to this document, by 2030, EU should reduce nutrient losses by 50%, the use and risk of hazardous chemical pesticides and the sale of antimicrobials for farmed animals and in aquaculture. Considering the marine environment, it is at risk of being polluted by diffuse pollution of nutrients and chemicals originating mostly from land-based sources.[15]

The document also stresses the importance of the CAP strategic planning process in which the EGD objectives are examined. In the process, Member States are required to give the Commission an account of the EGD targets related to agriculture. Thus, from the point of view of the fulfilment of EGD 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 EGD objectives of the Farm to Fork and biodiversity strategies.[16] Consequently, low coherence between these policies may affect the achievement of EGD objectives, which will also impact implementation at the national level.

Policy coherence refers to the relationship between policies or policy sectors.[17] The concept is closely linked to the effective implementation of environmental policies, which is a widely debated topic in the European policy domain due to the horizontal and vertical fragmentation of EU institutions and the Member States' policies.[18] Several studies have examined effective implementation, coherence, and compliance within EU law.[19] Fewer studies have focused on mitigation measures to reduce nutrient losses from a comparative legal perspective. Our starting point is that policy coherence can lead to more efficient implementation of environmental legislation, although its evaluation depends on the time horizon and the objectives considered. While numerous policies and regulations apply to protection of water resources from agricultur-

[12] European Commission. European Commission staff working document, Analysis of links between CAP Reform and Green Deal SWD (2020) 93 final.

[13] European Commission, 2025. Zero Pollution Action Plan. <https://environment.ec.europa.eu/strategy/zero-pollution-action-plan_en>. Accessed on 12 August 2025.

[14] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Pathway to a Healthy Planet for All EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil (COM(2021) 400 final).

[15] European Environmental Agency, Marine messages II: Navigating the course towards clean, healthy and productive seas through implementation of an ecosystem-based approach. EEA Report 17/2019.

[16] European commission, Farm to fork strategy, 2025. <https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en>.

[17] For the definition of coherence see, M. Nilsson, T. Zamparutti, J.E. Petersen, et al., Understanding Policy Coherence: Analytical Framework and Examples of sector–Environment Policy Interactions in the EU. Environmental Policy and Governance, 2012; 22(6), 395–423.

[18] K. Hogl, E. Kvarda, R. Nordbeck and M. Pregernig, (Eds.), Environmental Governance: The Challenge of Legitimacy and Effectiveness. Edward Elgar Publishing, Cheltenham, 2012.

[19] C. Knill and A. Lenschow, (Eds.), Implementing EU environmental policy: New directions and old problems. Manchester University Press, 2000; C., Knill and D. Liefferink, Implementation effectiveness of EU environmental policy. In C., Knill and D. Liefferink (Eds.), Environmental politics in the European Union, Manchester University Press, 2013, pp. 145–161, and U. Sverdrup, Compliance and conflict management in the European Union: Nordic exceptionalism. Scandinavian Political Studies 2004; 27(1), 23–43.

al nutrient pollution, there is a need for higher level of policy coherence across the European, national and regional policies to support implementation of these policies.

The aim of this paper is to study the horizontal policy coherence[20] of key EU and national legislation on agricultural nutrient emissions by scrutinizing the objectives of multiple policy sectors towards the objectives of the EGD. Research has primarily focused on the challenges of transposing EU law into national law.[21] However, here, the paper will focus also on the horizontal policy coherence between two policy subsystems: water quality, as part of environmental policy, and agricultural policy as a sectoral policy. This paper studies policies that mandate or support the implementation of N and P mitigation measures, as well as nature-based solutions (NBS). NBS are defined as living solutions inspired and supported by nature, utilizing resources efficiently and adaptively to address societal challenges while providing economic, social, and environmental benefits.

The paper focuses on the EU's regulatory framework for agricultural nutrient management, which consists of several environmental directives and framework policies as well as purely national regulations and policies, such as those concerning phosphorus fertilizer use. To understand horizontal and vertical fragmentation of the EU and national policies the paper focuses on the nutrient mitigation policies in Northern European countries. To study horizontal coherence of the EU agricultural nutrient management policies, it first analyzes the coherence of EU environmental legislation related to agricultural nutrient emissions in the EU. As a second step it compares agricultural nutrient emission mitigation policies in four EU member states (Denmark, Sweden, Finland, and Poland), and Norway. Norway, as a non-EU country, partially follows EU environmental policies (e.g. the WFD) while implementing its own agricultural policies. The paper lists main legislation implementing the agricultural nutrient management policies in each member state and Norway in Appendix 1. Our research questions are:

1. How are EU agricultural and environmental policy instruments and objectives targeted towards the aims of mitigating N and P emissions?
2. What kind of horizontal policy coherence challenges exist when targeting water and agricultural environmental policies towards mitigating N and P emissions?
3. How are these policies implemented in Denmark, Finland, Sweden, Poland and Norway?

2. Conceptual and methodological approaches

Policy coherence has been defined as a policy attribute that reduces conflicts and promotes synergies between different policy areas to achieve jointly agreed-upon objectives.[22] Policy coherence for sustainable development has gained increasing scholarly attention.[23] Horizontal coher-

[20] K. Kurze and A. Lenschow, Horizontal policy coherence starts with problem definition: Unpacking the EU integrated energy-climate approach. Environmental Policy and Governance, 2018; 28(5), 329–338.

[21] C. Demmke, S.F. Deakin, Towards effective environmental regulation: innovative approaches in implementing and enforcing European environmental law and policy. New York University School of Law, 2001.

[22] Nilsson, et al., n 17.

[23] M. S. Righettini, and R. Lizzi, How scholars break down "policy coherence": The impact of sustainable development global agendas on academic literature. Environmental Policy and Governance, 2022; 32(2), 98–109; J., Meadowcroft, Who is in charge here? Governance for sustainable development in a complex world. In Governance for sustainable development (pp. 107–122). Routledge, London, 2013; F. Platjouw, et al., fn 4.; Keijzer, N., EU Policy Coherence for Development: From Moving the Goalposts to Result based Management? European Centre for Development Policy Management 2010. Single European Act [1987] OJ L169/1 art. 30(2)(d)),

ence is linked to support and synergies to achieve shared objectives across individual policies, e.g. agricultural and biodiversity policies.[24] Vertical coherence refers to interplay between directives' national and local implementation that support reaching shared objectives. Horizontal policy coherence can be studied by comparing multiple policy sectors on EU, national or local scale. I focus on horizontal policy coherence of agricultural nutrient mitigation policies from European to local scale. In the EU, this involves e.g. coherence between the Farm to Fork Strategy and the Biodiversity Strategy, both components of the EU Green Deal, and the CAP. Norway, as a non-EU country, partially follows EU environmental policies while implementing its own agricultural policies.

Policy coherence is therefore expected to lead to more efficient implementation of environmental policy mixes, although its evaluation depends on the time horizon and the objectives considered[25]. Traditional policy analysis often focuses on the effectiveness of policy implementation within a single policy area, while the policy mix approach examines coherence within a given policy sector or across sectors.[26] "Policy mix," refers to a policy area where a combination of policy instruments is applied, influenced by instruments from other sectors.[27] It is important to note that a sectoral policy can be effective in achieving its own objectives without being coherent with other policy areas and their goals. Coherent policymaking can navigate trade-offs and synergies across multiple policy goals and sectors.[28]

Policy coherence can be analyzed by focusing on policy outputs, integration, evaluation, and the implementation of policy instruments and objectives. Policy outputs have been distinguished between policy objectives and policy instruments.[29] Policy integration analysis is particularly focusing on upstream policy making processes related to formulation of policy objectives and instruments. Policy evaluation refers to *ex ante* or *ex post* analysis of certain policy areas by applying certain criteria and forming policy recommendations.[30] Policy implementation refers to the arrangements by authorities and other actors enforcing policy instruments.[31] In the context of EU policy implementation 'layered' understanding of coherence including the

called on the EU to act as 'a cohesive force in international relations', the Treaty on European Union [1992] OJ C191/1 art. C established that the 'The Union shall in particular ensure the consistency of its external activities as a whole in the context of its external relations, security, economic, and development policies'.

In the European context, policy coherence was introduced as a concept in the Maastricht Treaty of 1992 and further developed in Lisbon Treaty of 2009. Coherence is also one of the OECD evaluation criteria for sustainable policies, see also: OECD/DAC Network on Development Evaluation, Better Criteria for Better Evaluations. Revised Evaluation Criteria. Definitions and Principles for Use"; OECD, Better Policies for Sustainable Development. A New Framework for Policy Coherence, 2016.

[24] M. Nilsson, et al., fn 17.

[25] K. Kurze, et al., fn 20.

[26] L. Kanger, B.K. Sovacool, M. Noorkõiv, Six policy intervention points for sustainability transitions: A conceptual framework and a systematic literature review. Research Policy, 2020; 49(7), 104072.

[27] S. Oberthür, T. Gehring, (Eds.), Institutional interaction in global environmental governance: Synergy and conflict among international and EU policies. Mit Press, 2006.

[28] P. Antwi-Agyei, A.J. Dougill, L.C. Stringer, Assessing coherence between sector policies and climate compatible development: Opportunities for triple wins. Sustainability 2017; 9(11), 1–16; M. Nilsson, N. Weitz, Governing trade-offs and building coherence in policy-making for the 2030 agenda. Politics and Governance 2019; 7(4), 254–263; Z. Shawoo, A. Maltais, A. Dzebo, J. Pickering, Political drivers of policy coherence for sustainable development: An analytical framework. Environmental Policy and Governance 2023; 33(4), 339–350.

[29] P. Hall, Policy paradigms, social learning, and the state: the case of economic policymaking in Britain. Comparative Politics 1993; 25, 275–296, and M. Nilsson, et al., fn 17.

[30] A. Crabbé, Leroy, P., The handbook of environmental policy evaluation. Earthscan, Routledge, 2008.

[31] M. Nilsson, et al., fn 17.

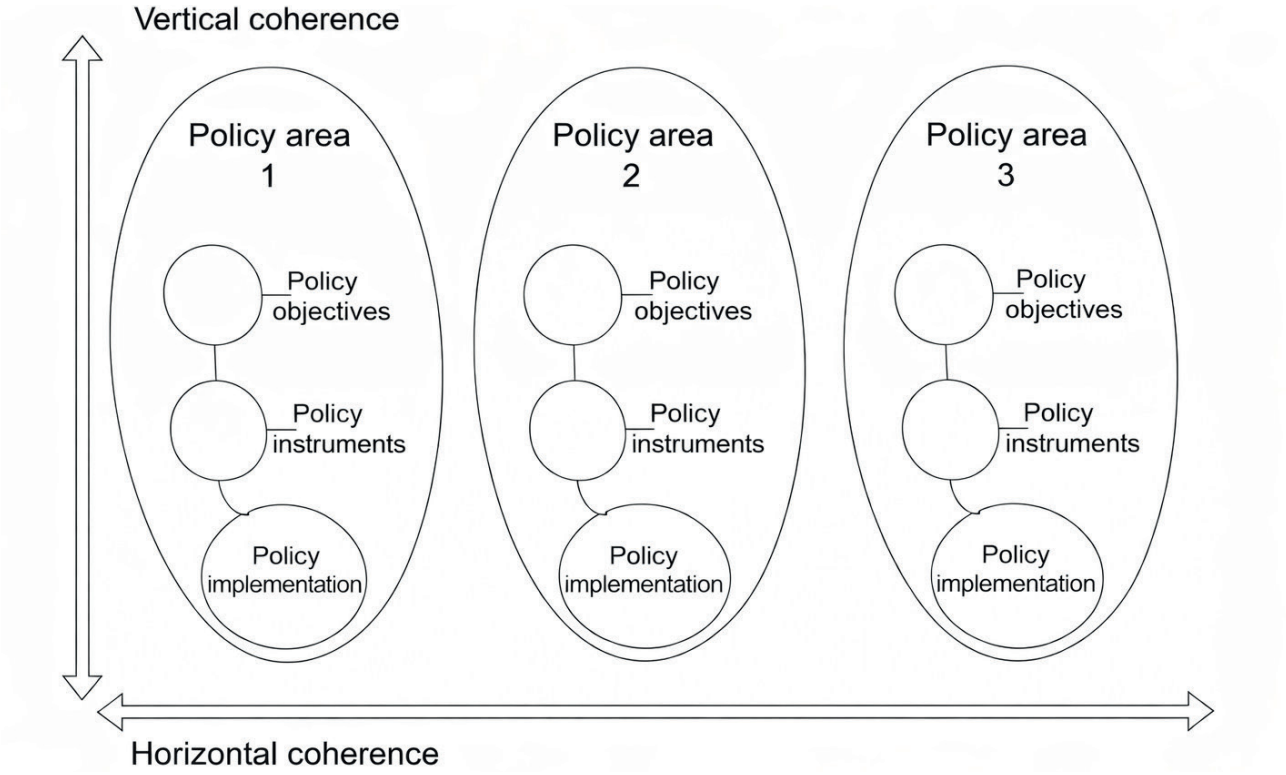

Figure 1. Policy coherence and implementation of European policies.

horizontal and vertical interactions therein aim to capture the interaction between EU and national level policy.[32] The multilevel governance of the EU reflects at least to some extent the analytical layers from objectives to instruments to implementation (Figure 1). The overarching objectives and instruments are designed on European level, whereby more specific instruments and implementation are defined at the Member State or regional level.

3. Agricultural Nutrient Emission Policies

3.1 EU Water Framework Directive

The Water Framework Directive (2000/60/EC; WFD), enacted in 2000, governs the ecological status of rivers, lakes, transitional waters, coastal waters and groundwater across Europe. Its primary objective is to ensure that all European surface and groundwater bodies achieve good status by 2015 or, at the latest, by 2027. The directive introduces ecosystem-based management (EBM), requiring member states to organize river basin management in Europe to river basin districts.[33] It promotes adaptive management[34] through a cyclical approach of 6-year planning cycles of River Basin Management Plans (RBMPs), which are developed through an extensive public consultation process. Adaptive management has

[32] M. Nilsson, et al., fn 17; I. Bache, M. Flinders, Multilevel governance and environmental policy. Oxford University Press, Oxford, 2004; A. Jordan, A. Schout, The coordination of the European Union. Oxford University Press, Oxford, 2006.

[33] M. Kaika, and B. Page, The EU Water Framework Directive: Part 1. European policy-making and the changing topography of lobbying. European environment, 2003; *13*(6), 314–327; N. Voulvoulis, K. D. Arpon, and T. Giakoumis, The EU Water Framework Directive: From great expectations to problems with implementation. Science of the Total Environment, 2017; 575, 358–366.

[34] *Adaptive management* has been promoted through the EU water policy for the past decades: C., Pahl-Wostl, Adaptive and sustainable water management: from improved conceptual foundations to transformative change. International Journal of Water Resources Development 2020; 36(2–3), 397–415.

been defined as an environmental management process that integrates environmental with economic and social understanding.[35] EU Member States are mandated to establish RBMPs and programme of measures (PoM) for the implementation cycles of 2009–2015, 2016–2021 and 2022–2027. The European Commission evaluates the WFD's implementation through an implementation report, submitted to the European Parliament after each RBMP-cycle. The report is based on member states assessments of their progress in implementing the PoM's of the RBMP's.

All pressures affecting aquatic ecosystems should be accounted for and reduced to achieve good status unless exemptions are applied.[36] All waters are regulated by the non-deterioration clause, by which Member States are required 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 status of waters is monitored and assessed based on a classification of ecological status into high, good, moderate, poor, and bad.[37] The ecological status assessment is based on physico-chemical and hydro-morphological quality elements, which must meet certain levels to safeguard a functioning ecosystem. The status classification relies on Biological Quality Elements, which should show only a low level of distortion caused by human activity (WFD Annex V). Both the good ecological status and non-deterioration requirements are legally binding for EU member states, as confirmed by the Court of Justice of the European Union in the Weser ruling (CJEU C-461/13). States must consider WFD requirements when permitting new projects that impact water quality.[38]

3.2 EU Marine Strategy Framework Directive

The Marine Strategy Framework Directive (2008/56/EC; MSFD), adopted in 2008, aims to protect and ensure the sustainable use of marine ecosystems. As the environmental pillar of the EU's Integrated Maritime Policy, it supports sustainable growth in maritime sectors[39]. The directive sets a target to achieve Good Environmental Status of the EU's marine waters by 2020, with a scheduled review for 2023 (Article 23 of the MSFD). According to the MSFD (Annex I) the good ecological status is reached by low human-induced deterioration of key areas, such as biodiversity, presence of non-indigenous species, populations of commercial fish and shellfish, marine food webs, eutrophication, sea floor integrity, alteration of hydrographical conditions, contaminants, marine litter and underwater noise. Agricultural nutrient emissions significantly contribute to eutrophication, which

[35] C.S., Holling, Adaptive environmental assessment and management, John Wiley and Sons, New York, 1978, and L., Hasselman, Adaptive management; adaptive co-management; adaptive governance: what's the difference?. Australasian Journal of Environmental Management; 2017, 24(1), 31–46.

[36] L. Squintani, and H. van Rijswick, Improving legal certainty and adaptability in the programmatic approach. Journal of Environmental Law, 2016; 28, 443–470.

[37] A.S. Heiskanen, W. Van de Bund, A.C. Cardoso and P. Nõges, Towards good ecological status of surface waters in Europe-interpretation and harmonisation of the concept. Water science and technology, 2004; 49(7), 169–177; I. Zacharias, P. Liakou, and I. Biliani, A review of the status of surface European waters twenty years after WFD introduction. Environmental Processes, 2020; 7(4), 1023–1039.

[38] T.M. Paloniitty, The (In) Compatibility between adaptive management and law: Regulating agricultural runoff in the EU, Juvenes Print Oy, Helsinki, 2018, and N. Soininen and F.M. Platjouw, Resilience and adaptive capacity of aquatic environmental law in the EU: An evaluation and comparison of the WFD, MSFD, and MSPD. In D. Langlet and R. Rayfuse (eds), Ecosystem Approach in Ocean Governance and Planning. Brill Nijhoff. 2018, pp. 17–79.

[39] F. Galgani, G. Hanke, S. Werner and L. De Vrees, Marine litter within the European marine strategy framework directive. ICES Journal of marine Science, 2013; 70(6), 1055–1064.

is closely linked to the ecological status of the marine environment.

Its implementation follows an ecosystem-based approach[40], prioritizing the attainment and maintenance of good ecological status across all community's marine environments, ensuring their protection and preservation and preventing further degradation (MSFD Preamble 8). Member States are required to follow an adaptive management approach that involves a reiterative six-year cycle for the development of Programme of Measures (PoM) to achieve good environmental status (art. 13 MSFD). They are also expected to establish monitoring programmes for ongoing assessment and regular updating of targets to achieve Good Environmental Status (art. 11 MSFD).

3.3 EU Nitrates Directive

The Nitrates Directive (ND; 91/676/EEC)[41], enacted in 1991, has guided water protection from nitrate contamination that results from nitrogen compounds in fertilizers and manure leaching into groundwater and runoff from agricultural land into surface waters. The directive aims to promote good farming practices and prevent nitrate pollution from agricultural sources. It regulates the monitoring of nitrate concentrations in water bodies, requires designation of nitrate vulnerable zones, defined as land-areas that drain into polluted waters or waters at risk of pollution, and which contributes to nitrate pollution. The ND also establishes codes of good agricultural practices and requires measures to prevent and reduce water pollution from nitrates. The nitrogen vulnerable zone concern waters that are eutrophic or could contain >50 mg/l of nitrates due to agricultural activities and all surface water bodies that are at risk of becoming eutrophic soon, if no action is taken (Art. 3.1 and Annex 1, point A.3). In Nitrate Vulnerable Zones, excessive nitrate levels are primarily due to shortcomings in groundwater management rather than a lack of knowledge or available water protection techniques.[42] Similarly, in eutrophic or potentially eutrophic surface waters, nitrate exceedance stems from ineffective surface water management. In non-vulnerable zones, Member States shall establish voluntary measures, primarily focused on regulating fertilizer use based on specific time periods and weather conditions.

3.4 Groundwater Directive

The Groundwater Directive (GWD; Directive 2006/118/EC) aims to prevent and control groundwater pollution from harmful substances. The directive sets assessment criteria on good chemical status of groundwaters and for identification of an upward trend. Groundwater is considered to have a good chemical status, when the measured nitrate levels do not exceed 50 mg/l, active pesticides do not exceed 0.1 μg/l or 0.5 μg/l, and levels of certain high-risk substances are below threshold values set by Member States.[43] In the GWD, the concentrations of any other pollutants should conform to the definition of good chemical status as outlined in Annex V of the WFD. If a value set in the groundwater quality standards is exceeded, an

[40] T. Berg, K. Fürhaupter, H. Teixeira, L. et al., The Marine Strategy Framework Directive and the ecosystem-based approach–pitfalls and solutions. Marine pollution bulletin, 2015; 96(1–2), 18–28, and J. Van Leeuwen, L. Van Hoof and J. Van Tatenhove, Institutional ambiguity in implementing the European Union marine strategy framework directive. Marine Policy, 2012; 36(3), 636–643.

[41] Fn 8.

[42] A. Musacchio, V. Re, J. Mas-Pla, E. Sacchi, EU Nitrates Directive, from theory to practice: Environmental effectiveness and influence of regional governance on its performance. Ambio, 2020; 49, 504–516.

[43] Such substances are ammonium, arsenic, cadmium, chloride, lead, mercury, sulphate, trichloroethylene and tetrachloroethylene.

investigation must confirm that it does not pose any significant environmental risk.

3.5 EU Common Agricultural Policy (CAP)

The Common Agricultural Policy (CAP), established in 1962, is the primary instrument for promoting and financing agriculture in the EU.[44] It aims to enhance agricultural productivity, ensure a fair standard of living for farming communities, stabilize markets, secure food supply availability, and maintain fair consumer prices. Environmental objectives, such as climate change mitigation and sustainable resource management, have been introduced in CAP reform in 1992. Since then, the CAP has undergone several reforms introducing new environmental objectives to the payment scheme including water protection measures.

The CAP 2023–2027 includes the greening of agricultural systems through eco-schemes that provide incentives for climate-friendly and environmentally friendly agricultural practices. Despite an overall reduction in EU funding, the programmatic period aims to strengthen environmental and climate measures, with objectives to address reduced pollution, biodiversity, climate change mitigation and adaptation, and sustainable natural resource management. At the EU level, CAP promotes water protection and enforces environmental standards that farmers must meet to receive subsidies through conditionality, also previously referred to as the cross-compliance mechanism.[45] All farmers—whether receiving payments or not—must adhere to Statutory Management Requirements (SMRs), which cover EU rules on public health, animal and plant health, animal welfare, and environmental protection. Good Agricultural and Environmental Conditions (GAECs), apply to farmers receiving area-based support in form of CAP payments. Eco-schemes go beyond the conditionality baseline by supporting farmers in adopting sustainable farming practices that minimize harmful impacts of agriculture on environment and climate.[46] This mechanism supports activities, such as organic farming or agroforestry that benefit European biodiversity and agricultural landscapes by safeguarding habitats, improving animal welfare, and establishing good agricultural and environmental practices.

Each EU Member State must develop a national strategic plan for the 2023–2027 CAP programmatic period, outlining agricultural policy measures and requirements. These plans are subject to EU approval, and they include country-specific conditionality requirements and eco-schemes that are mandatory for Member States but voluntary for farmers. CAP national strategic plans include measures such as balanced nutrient use (limits on nitrogen and phosphorus fertilization), herbicide restrictions, two-stage ditches and channels, buffer strips, grassed waterways and winter plant cover on arable land. Many of the measures function as NBS, that can be implemented on a farm level and that provide solutions to address quality of water. Additionally, CAP funds support non-productive investments, such as establishing wetlands to reduce nutrient runoff and enhance biodiversity.

[44] European Commission, The common agricultural policy at glance. 2024a. <https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-glance_en>. Accessed on 2 Feb. 2024.

[45] Conditionality. Linking income support to respect for European Union rules. <https://agriculture.ec.europa.eu/common-agricultural-policy/income-support/conditionality_en>. Accessed on 20 Feb. 2026.

[46] Eco-schemes. Sustainable land use, rewarding farmers for taking care of the climate, landscapes and the environment, and animal welfare. <https://agriculture.ec.europa.eu/common-agricultural-policy/income-support/eco-schemes_en>. Accessed on 20 Feb. 2026.

4. Comparison of Northern European countries

4.1 Denmark

Denmark is among the most intensively farmed countries in the world. As an EU Member State, it implements all major directives mentioned above – the WFD, MSFD, ND and GWD as well as the CAP. Denmark implements the WFD in four river basin districts and the RBMPs emphasize reducing nitrogen and phosphorus to improve water quality through measures, such as catch crops schemes and establishing wetlands. Since 1991, as part of implementation of the ND, Denmark has introduced a nationwide catch crop scheme, and extended its coverage supported by regulations requiring a specific percentage of agricultural land to be dedicated to these crops. This approach has successfully reduced nitrate-N leaching from fields and helped to protect Denmark's water resources. From 1990 to 2004, Denmark achieved a world-record 36% reduction in nitrogen losses, made possible by a comprehensive set of mandatory measures and until 2014 almost 50%.[47] As a result, the Danish catch crop model serves as a best practice that could be applied in other regions struggling with high nitrogen concentrations in water. The CAP plan, approved in August 2022, allocates significant resources to sustainable agriculture and rural development, with a strong focus on mitigating nitrogen and phosphorus pollution. Denmark was among the Member States that fully implemented the GAEC 8—a conditionality requirement for farmers to set aside 4% of their agricultural land.

4.2 Finland

In Finland, agricultural land accounts for approximately 7% of the total land area.[48] Due to its northern location, farming is not highly profitable, however, the country maintains a high level of self-sufficiency in agricultural production, with food security as a key focus of its agricultural policy. Since joining the EU in 1995, Finland has implemented the WFD, MSFD, ND, and other relevant regulations, along with the CAP. There are seven river basin districts in the mainland and one in Åland. The RBMP align proposed agricultural measures with the CAP programmatic measures which in Finland have primarily focused on direct payments. The CAP environmental payment scheme serves as the primary financial tool for reducing nutrient runoff from farming. Additional policies and regulations, such as the new national regulation on phosphorus fertilizer and manure use (64/2023), have been introduced. As part of the CAP measures, Finland has emphasized the importance of maintaining minimum winter plant cover, with an increasing number of hectares receiving subsidies for this environmental practice. Structural liming and other soil structure management measures have also been implemented. Due to high fertilizer prices, farmers are using only the amount needed by crops rather than the maximum permitted. In addition to agricultural subsidies, water protection in farming is supported through various project initiatives that significantly contribute to improving water quality. For instance, Finland's Ministry of the Environment funds a nutrient recycling programme and a water protection initiative, under

[47] T. Dalgaard, et al., Policies for agricultural nitrogen management–trends, challenges and prospects for improved efficiency in Denmark. Environmental Research Letters, 2014; 9(11), 115002, and H.T. Anker, Agricultural nitrate pollution – regulatory approaches in the EU and Denmark. Nordic Environmental Law Journal, 2015:2.

[48] J. Tiainen, et al., Biodiversity in intensive and extensive grasslands in Finland: the impacts of spatial and temporal changes of agricultural land use. Agricultural and Food Science, 2020; 29(2), 68–97.

which gypsum treatment has been applied to fields in the Archipelago Sea catchment area.[49]

4.3 Sweden

Agriculture accounts for less than 10% of Sweden's total land use.[50] Sweden joined the EU in 1995 and follows the WFD, MSFD, ND, and GWD, which regulate nitrate concentrations in surface and groundwater. These directives are enforced through national legislation, including Chapter 5 of the Environmental Code (Miljöbalk 1998:808). Sweden implements the WFD across five river basin districts. CAP is implemented through farm subsidies, payments for investment and environmental mitigation measures and it funds the agricultural advisory program Focus on Nutrients. In addition to supporting various initiatives to enhance water quality, the agri-environmental payment model has helped sustain small, diverse farms with low-intensity management practices, particularly within mixed forest–farm landscapes.[51] In Sweden, in addition to implementing CAP measures, various agricultural advisory programs and subsidies have been introduced to improve nutrient management. Among these measures, structural liming has specifically focused on enhancing soil structure. Some measures have been particularly popular among farmers, for example, subsidies for drainage system renovations received more applications than available funding. National subsidies support local water management projects (LOVA) and local nature conservation initiatives (LONA). Farmers undertake also many environmental initiatives beyond those that are subsidized or officially documented, such as improvements to field drainage and soil structure. Wetlands, for instance, are established with the national and also voluntarily without public funding.

4.4 Poland

In Poland, agricultural policy has primarily focused on modernizing the sector and improving its profitability. The country implements the WFD, MSFD, ND, and GWD through national legislation as well as CAP. RBMPs and their PoM address nitrate pollution from agriculture by implementing nutrient management, runoff and erosion control, and water retention measures to improve water quality and support sustainable farming.[52] Poland's Strategic Plan emphasizes direct payments over environmental needs, which is why it appears insufficient to respond to environmental and climate demands. The Code of Good Agricultural Practices recommends measures such as efficient fertilization, soil and water protection, erosion control, and advisory code additional measures for ammonia emission reduction to address agricultural pollution. To support the implementation of the above-mentioned directives, there is a need for more information on the impacts of different land management practices, as well as incentives to encourage the adoption of nature-based solutions and mitigation measures. Integrating these solutions into broader strategic policies—

[49] E. Albrecht, A. Belinskij, E. Heikkilä, Policy coherence for ecosystem-based management: Implementing EU water and marine policies in the Archipelago Sea. Marine Policy, 2025; 171, 106427.

[50] European Commission, Sweden – CAP Strategic Plan, (2024c). Accessed on 11 February 2025.

[51] K. Eksvärd, K. Marquardt, From change to transition? Learning from environmental protection activities in Sweden. Agroecology and Sustainable Food Systems, 2018; 42(2), 189–209, and M. Granvik, G. Lindberg, K.-A. Stigzelius, E. Fahlbeck, Y. Surry, Prospects of multifunctional agriculture as a facilitator of sustainable rural development: Swedish experience of Pillar 2 of the Common Agricultural Policy (CAP). Norsk Geografisk Tidsskrift – Norwegian Journal of Geography, 2012; 66(3), 155–66.

[52] M. Piniewski, et al., How effective are River Basin Management Plans in reaching the nutrient load reduction targets? Ambio 2021; 50, 706–722.

such as climate change mitigation and adaptation strategies, green infrastructure planning, and biodiversity conservation—follows an ecosystem-based approach. The EU and national funding programs require redirecting towards supporting rural restructuring, particularly in agro-tourism. This would include targeting investments in constructing environmental protection infrastructure. Environmental education is needed, and this could be incorporated into curricula at various levels. Additionally, compensating farmers for practices that enhance ecosystem services would benefit the society.

4.5 Norway

In Norway, agricultural land makes up only 3.5% of the country[53], yet, enhancing food self-sufficiency is a national priority. Norway is not a member of the EU but has incorporated the EU WFD into its national law in December 2006 through the Framework for Water Management regulation. The legal framework for implementing the WFD and Norway's *Regulation on Framework for Water Management* is based on four national laws: the *Planning and Building Act*, the *Pollution Control Act*, the *Nature Diversity Act*, and the *Water Resources Act*. While the latter three specifically address water-related environmental concerns, the *Planning and Building Act* ensures that RBMPs are integrated into the broader planning system. Additional legislation also governs agricultural activities. The ND is implemented in catchments draining into the Oslo Fjord, a water body facing significant environmental challenges. In response to nutrient-driven ecological decline in the Oslo Fjord, new regional regulations in Oslo & Viken[54] mandate practices such as grass-covered buffer zones, reduced tillage, and winter plant cover. While Norway does not implement the CAP, it employs its own regulations and policies and economic incentives to promote environmental mitigation measures. Many of these measures are included in Regional Environmental Programs – regional environmental funding schemes with similar measures as in national CAP plans. At the national level, economic incentives have been the primary tool for encouraging such measures, with relatively few legal requirements. However, at regional and local levels, regulations have been introduced to enforce buffer zones and conservation tillage.

5. Assessing the Horizontal Coherence of Agricultural Nutrient Emission Policies

When evaluating the coherence of directives targeting water quality, the WFD and MSFD are largely coherent with each other's objectives, although some overlap exists, particularly in the management of coastal areas. The geographical scope of these plans overlap with coastal waters up to one nautical mile. While the WFD addresses inland, transitional, and coastal surface waters as well as groundwaters, the MSFD focuses on marine ecosystems. It serves as an environmental pillar of the Integrated Maritime Policy of the European Union, aiming for sustainable growth in maritime sectors.[55] Like the WFD, the MSFD employs an adaptive management approach with a 6-year planning cycle[56], however their timeline for implementation differs.

The WFD mandates the drafting of River Basin Management Plans (RBMP) and PoM, while the MSFD provides the foundation for the Marine Management Plan (MMP) and associated measures. Both RBMPs and MMPs introduce multi-sectoral measures to combat eutrophica-

[53] NIBIO, Areal barometer for Norway, 2024. Accessed on 11 October 2024.

[54] Forskrift om regionale miljøkrav i jordbruket, Oslo og Viken, No. 2182 of 06 December 2022.

[55] F. Galgani, et al., fn 39.

[56] J. Van Leeuwen, et al., fn 40.

tion, including legislative actions, financial guidance, and increased information and research. MSFD allows more freedom in terms of measures implemented under the directive. There is also a clear connection between the Baltic Sea Action Plan (BSAP) of HELCOM and the RBMP and MMP measures in the Baltic Sea region.[57] However, the effectiveness of these measures has been undermined by their voluntary nature and the challenges of achieving cross-sectoral cooperation. Regardless of the water quality objectives, reducing agricultural nutrient emissions and improving water quality is behind the schedule.[58] The European Commission monitors WFD implementation and published its 6th implementation report in 2021, concluding that agriculture is a major driver for failure to achieve good status in EU water bodies.[59]

The ND, along with its national implementation, has successfully reduced nitrogen leaching into groundwater, surface waters, and the atmosphere.[60] It is also one of the Statutory Management Requirements of the Common Agricultural Policy. Non-compliance with the ND requirements leads to a proportional reduction in agricultural subsidies. The measures required under the ND are mostly also required to be included in the programmes of measures (PoM) in the WFD (Annex VI, Part A). Therefore, the objectives of ND are to a large degree coherent with the other directives compared here. Further reductions could be achieved through stricter requirements[61], as demonstrated by significant progress in Denmark. The Danish example of nutrient emission reductions through successful implementation of ND shows that it is possible to move towards safe nutrient boundaries through environmental legislation. In contrast, P use in agriculture has not been as strictly regulated by the EU.[62] However, some Member States, such as Finland, have implemented national regulations to address this gap.

Agricultural policy has often been studied as a separate sector, with findings that the CAP subsidy scheme and its cross-compliance mechanism are overly complex and inefficient.[63] The agri-environmental schemes of the CAP have faced criticism for the lack of effectiveness in achieving environmental outcomes.[64] There are several reasons for this inefficiency, including the management of nutrient loading and the uneven distribution of costs and benefits.[65] Re-

[57] Ibid.

[58] European Environment Agency, 2018. European waters: Assessment of status and pressures 2018. EEA Report no. 7/2018, Publications Office of the European Union, Luxembourg, 2018; L. Carvalho, E.B. Mackay, A.C. Cardoso, et al., Protecting and restoring Europe's waters: An analysis of the future development needs of the Water Framework Directive. Science of the Total Environment 2019; 658, 1228–1238, and N. Voulvoulis, et al., fn 33.

[59] European Commission, Report from the Commission to the Council and the European Parliament on the implementation of the Water Framework Directive (2000/60/EC), the Environmental Quality Standards Directive (2008/105/EC amended by Directive 2013/39/EU) and the Floods Directive (2007/60/EC), COM(2021) 970 final, Brussels, 15.12.2021, 2021.

[60] G.L. Velthof, J.P. Lesschen, J. Webb, et al., The impact of the Nitrates Directive on nitrogen emissions from agriculture in the EU-27 during 2000–2008. Science of the Total Environment, 2014; 486, 1225–1233.

[61] Ibid.

[62] K. Heyl, Reducing Phosphorus Input into the Baltic Sea—An Assessment of the Updated Baltic Sea Action Plan and Its Implementation through the Common Agricultural Policy in Germany. Water, 2023; 15(2), 315.

[63] G. Pe'er, S. Lakner, R. Müller, et al., Is the CAP Fit for purpose? An evidence based fitness-check assessment. Leipzig, German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, 2017.

[64] C. Rega, and A. Spaziante, Linking ecosystem services to agri-environmental schemes through SEA: A case study from Northern Italy. Environmental Impact Assessment Review, 2013; 40, 47–53.

[65] S. Wuijts, M. Graversgaard, C. Van Den Brink, et al., Protection of water resources from agricultural pressures: Embracing different knowledge domains in governance approaches. Environmental Policy and Governance, 2025; 35(2), 201–213.

ducing administrative burdens and increasing farmer participation have been recommended to solve the lack of effectiveness in the agricultural sector.[66] Participation of farmers in agricultural practices that aim at water quality improvement is a necessity, and conditionality requirements aim to ensure this. Additional initiatives have been developed to further reduce pressure on water ecosystems. Also, implementation should include practical guidance and monitoring of outcomes. The main challenge lies in financing, subsidies, and effectively targeting these resources to the most problematic areas.

The countries' studies in this paper have introduced national legislation and additional measures to overcome this challenge. Finland has introduced additional policies and regulations, such as the phosphorus regulation and funds project activities such as the gypsum project. Also, Sweden funds additional measures, such as LOVA and LONA that have encouraged restoration and construction of wetlands. In Poland additional measures include information guidance for agro-tourism, however, additional incentives targeting the water quality would be needed. Norway implements the WFD separately and has its own regulations and economic incentives for the agriculture sector in Regional Environmental Programs.

6. Conclusions

This paper has studied the horizontal policy coherence[67] of key EU and national legislation on agricultural nutrient emissions in Northern Europe. It focused on the EU's regulatory framework for agricultural nutrient management consisting of several environmental directives and framework policies and purely national regulations and policies, such as those concerning phosphorus fertilizer use. The analysis included European, sea basin-level (HELCOM), and national laws and policies addressing agricultural nutrient emissions.

The primary coherence challenge lies in aligning the environmental objectives of the WFD, the MSFD, and the ND, with the agricultural payment scheme under the CAP. The absence of strong legal linkages between CAP and WFD creates a fragmented policy landscape. This variability risks falling short of the European Green Deal's nutrient reduction target and undermines progress toward the WFD's 2027 "good status" deadline. Without stronger policy coherence, which is established through binding nutrient reduction targets, alignment of CAP payments with water protection objectives, and exclusion of harmful subsidies, the EU's ambition to achieve zero pollution from agriculture will remain out of reach.

This paper suggests that improving the status of European waters requires greater policy coherence and stronger support for implementation. Improving coherence between EU environmental legislation and agricultural policies requires integrating environmental policies into core economic frameworks. The CAP objectives could be aligned with EU Green Deal's objectives to a larger extent. Although the WFD aims to build bridges across policy sectors, the implementation by Member States leaves much of its potential unexplored.[68]

[66] N. El Benni, C. Ritzel, K. Heitkämper, et al., The cost of farmers' administrative burdens due to cross-compliance obligations. Journal of Environmental Planning and Management, 2022; 65(5), 930–952.

[67] K. Kurze, et al., fn 20.

[68] S. Wuijts, et al., fn 65.

Appendix 1.

Legislation and policy instruments	Sources
Denmark	
Act on Environmental Protection	Bekendtgørelse af lov om miljøbeskyttelse; nr 1218 of 2019
The Danish Livestock Farming Act	Bekendtgørelse af lov om husdyrbrug og anvendelse af gødning m.v.; nr 1020 of 2018
Act on agricultural use of fertilizers and plant cover	Bekendtgørelse af lov om jordbrugets anvendelse af gødning og om plantedække; nr 388 of 2016
Act on water planning	Lov om vandplanlægning; nr 126 of 2017
The Danish Action Plans for the Aquatic Environment (APAEs); the Danish Nitrates Action Programme, RBMPs, CAP strategic plan 2023–2027	
Finland	
Environmental Protection Act	Ympäristönsuojelulaki; 527/2014
Act on Organizing the Water Management	Laki vesienhoidon ja merienhoidon järjestämisestä (1299/2004)
Water act	Vesilaki 587/2011
Degree by the Council of State (931/2000) on reducing the nitrates pollution on water from agricultural sources, RBMPs, CAP strategic plan 2023–2027, main measures are listed in Finnish Food Authorities guide to cross-compliance	
Sweden	
The Environmental Act	Miljöbalk 808/1998
The Ordinance on Water Management	Vattenförvaltningsförordning 2004:660
Environmental quality objectives	Svenska miljömål, 2009/10:155
Central authority regulations, National programme to achieve nutrient reductions, RBMPs, CAP strategic plan 2023–2027	
Poland	
Environment Protection Law	Prawo ochrony środowiska; nr 62, 2001
Water Law	Prawo wodne; 1566, 2017
Degree by the Ministry of the Environment (23 Dec 2002) on criteria designating vulnerable zones subjected to pollution by nitrate from agricultural sources; Degree by the Ministry of the Environment (23 Dec 2002) on action programme aimed at limitation of nitrogen outflow from agricultural sources; Polish Action Programme, RBMPs, CAP strategic plan 2023–2027	
Norway	
The Pollution Control Act	Lov om vern mot forurensninger og om avfall (Forureningslove); nr 6 of 1981
The Land Act	Lov om jord (jordlova), nr 23 of 1995
The Water Resources Act	Lov om vassdrag og grunnvann (vannressursloven), nr. 82 of 2000
The Planning and Building Act	Plan- og bygningsloven, nr. 71 of 2008
The Nature Diversity Act	Naturmangfoldloven, nr 100 of 2009