ENHANCING THE VIETNAMESE LEGAL FRAMEWORK FOR SUSTAINABLE WATER RESOURCE MANAGEMENT IN AGRICULTURE: EXPERIENCE FROM THE EUROPEAN UNION AND THE NETHERLANDS

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ABSTRACT

Water is a vital human resource and is indispensable in daily activities and economic production. However, agricultural activities in Vietnam have been increasing pressure on water resources, mainly due to the overuse of fertilisers, pesticides, pollution from livestock farming, and unsustainable farming practices. These factors contribute to the degradation of water resources, endangering both ecosystems and public health. Sustainable agricultural practices and effective water resource management are essential for long-term sustainability. As a predominantly agricultural nation, Vietnam has increasingly recognised the importance of sustainable agricultural development, with an emphasis on reducing environmental pollution and safeguarding water resources for future generations. Despite efforts to regulate pollution and protect water resources, Vietnam's legal framework remains insufficient and lacks comprehensive enforcement mechanisms, resulting in continued water pollution from agricultural activities. This paper examines the regulatory frameworks of the EU and the Netherlands, the jurisdictions that have successfully integrated sustainable water management and agricultural policies. By analysing their legal approaches and enforcement strategies, the study proposes recommendations for enhancing Vietnam's legal framework to support sustainable water resource management. The insights from this analysis could also benefit other ASEAN countries, particularly in addressing transboundary water pollution in the Mekong River, a critical resource for regional sustainability.

Keywords: Sustainable management, water resource, agriculture, Vietnam, EU, Netherlands.

1. INTRODUCTION

In Vietnam, there is a network of more than 2,360 rivers that are longer than 10 kilometres, including 109 main rivers that create 16 river basins [1]. Water resources have transformed the country into one of the world's leading agricultural exporters. However, the heavy reliance of agriculture on water, accounting for 70-80% of total freshwater consumption, presents significant challenges [2] has placed unprecedented pressure on this finite resource. In the context of climate change and rapid urbanisation, the development of the legal framework for managing water resources in agriculture is a prerequisite for ensuring sustainable agricultural development.

1.1. Positive aspects of Vietnamese law on agricultural water resource management

Vietnam has enacted a robust and multi-layered legal framework aimed at controlling and protecting water resources alongside promoting sustainable agricultural development. The Law on Environmental Protection 2020 provides the cornerstone for environmental pollution control, specifically regulating water quality monitoring, safeguarding natural water sources, and setting mechanisms to respond to pollution incidents. Building on this, the Law on Water Resources 2023 introduces strengthened provisions on water supply for agriculture, water quality protection, pollution prevention, wastewater discharge control, water use fees, and exploitation monitoring. It also emphasises the role of communities and water users in sustainably managing water resources through. Meanwhile, the Law on Irrigation 2017 addresses the management, protection, and effective operation of irrigation infrastructure crucial for agricultural production, detailing responsibilities for water use and maintenance. Specific sectoral laws complement this general framework: the Law on Crop Production 2018 governs fertiliser use, pesticide control, and chemical residue management in agriculture, while the Law on Animal Husbandry 2018 regulates waste management and environmental protection in livestock farming, encouraging biosecure and sustainable models. These laws are further detailed through sub-law instruments, such as Decree No. 84/2019/ND-CP and its amendment Decree No. 130/2022/ND-CP, which set out comprehensive fertiliser management rules. Additionally, Circular No. 25/2024/TT-BNNPTNT specifies permitted and banned pesticides, ensuring tighter control over agricultural chemicals.

Collectively, this legal architecture establishes an integrated, cross-sectoral system reflecting Vietnam's commitment to protecting water resources, mitigating environmental risks, and promoting ecological, efficient, and sustainable agricultural development. In addition, Vietnam has begun to align its agricultural development with sustainable water resource protection. Reflecting the rising emphasis on sustainable agriculture, the country has made initial progress in managing agricultural water resources, notably by enhancing technical standards, tightening environmental regulations, and strengthening inspection and monitoring mechanisms. Organic and circular farming models are increasingly promoted across various localities, especially in major agricultural regions. Through legal frameworks and national as well as sectoral water resource plans, Vietnam has demonstrated a clear commitment to the sustainable use of water. These advances signify a strategic shift towards integrated, long-term agricultural development that balances productivity with water conservation.

Overall, Vietnam is steadily building a policy environment that fosters environmentally responsible agriculture, with water resource protection and efficient use standing out as central priorities for a sustainable, green agricultural sector.

1.2. Shortcomings of agricultural water resource management

Despite notable progress in policy and legal development, Vietnam is facing significant shortcomings in managing agricultural water resources.

Firstly, there is no clear regulation holding farmers accountable for pollution from fertilisers and pesticides. Although farmers are the primary users of water in agriculture, limited awareness and unsustainable practices have led to widespread overuse of chemicals. Vietnam consumes around 10 million tonnes of fertilisers annually, 75% of which are inorganic [3]. Pesticide use averages 2 kg of active ingredients per hectare per year, much higher than neighbouring countries (0.2 - 1 kg/ha) [4]. Despite this, legal documents like Circular No. 25/2024/TT-BNNPTNT and Decree No. 84/2019/ND-CP focus more on product listings and administrative procedures than field-level use control. As a result, unchecked agricultural runoff has become a key contributor to environmental degradation, as seen in Vinh

Long, where agricultural runoff accounts for 15,925 tonnes of pollution [3], and An Giang, where coliform levels exceed safe limits by up to 7.02 times [5].

Secondly, Vietnam lacks a dedicated legal framework to coordinate agricultural water management in the context of climate change. While several laws address irrigation and disaster prevention, there is no integrated mechanism for water allocation, monitoring, or intersectoral coordination. The impact is evident: in the Central Highlands, 27,925 hectares of crops were affected by drought in May 2024 [6]; meanwhile, floods in late 2024 caused damages of over VND 84,900 billion, submerging more than 200,000 hectares of rice fields [7].

Thirdly, there is no sustainable financial mechanism to support water management in agriculture. Although Official Letter No. 2756/NHNN-TD issued by the State Bank of Vietnam, dated 15 April 2025 launched a VND100 trillion credit programme, funding remains fragmented across sub-sectors and lacks a focus on sustainable water use. No dedicated legal instruments currently incentivise the adoption of water-efficient or pollution-reducing practices [8].

Fourthly, private sector involvement in water management is still limited. Decree No. 94/2017/ND-CP restricts irrigation system operations to state monopolies, and no comprehensive PPP framework exists. In June 2024, Vietnam expressed its intention to issue a circular guiding PPP investment in wastewater and drainage [9], however, no draft has been released to date. Without a legal foundation, public-private collaboration remains minimal.

In summary, the lack of a specialised and coordinated legal framework, alongside regulatory, financial, and stakeholder engagement gaps, continues to hinder Vietnam's pursuit of sustainable agricultural water management. Closing these institutional and regulatory deficiencies is essential to strengthen climate resilience and safeguard national agricultural productivity.

2. LITERATURE REVIEW

2.1. Review of established research on agricultural water resources management

Research on sustainable agricultural water resource management has gained increasing attention in recent decades. Existing studies can be grouped into four main strands:

Firstly, Agricultural Water Management Challenges and Solutions. Vietnam's agriculture faces major water management challenges due to inefficient irrigation and weak governance. Tran Duc Vien (2023), *Development of Vietnamese Agriculture: Issues and Some Solutions* (Communist Review), highlights overexploitation of water resources and inadequate governance, recommending reforms based on international practices like efficient irrigation and policy improvements, though lacking guidance on contextual adaptation [10]. Le Viet Phu (2023), *Water Value, Irrigation Policy, and Implementation Hazards in Vietnam's Rural Economy* (ScienceDirect), estimates irrigation water's economic value (US$0.01–0.56/m³), and critiques the 2008 irrigation fee waiver for reducing conservation incentives, especially in rice farming (up to 8,000 m³/ha per crop). The study also notes climate-related risks like floods and droughts in the Mekong Delta and the impacts of upstream hydropower dams. With agriculture consuming 73% of national water use, sustainable management is increasingly urgent [11]. Additionally, Quy Nhan Pham – Ngoc Ha Nguyen – Thi Thoang Ta and Thanh Le Tran (2023), *Vietnam's Water Resources: Current Status, Challenges, and Security Perspective* (MDPI), develops a water security framework, considering availability, exploitation, pollution, and management. It underscores transboundary challenges and the

food–energy–water nexus, noting that Vietnam's agricultural water use competes with other sectors, necessitating integrated governance solutions [12].

Secondly, Sustainable Flood Risk Management and Water Governance. Faith Ka Shun Chan – Liang Emlyn Yang – Gordon Mitchell et al (2022), *Comparison of Sustainable Flood Risk Management by Four Countries – the United Kingdom, the Netherlands, the United States, and Japan* (Copernicus Publications), highlights the Netherlands policy as a model for integrating flood control with adaptive governance [13]. Kinh Bac Dang – Thi Thanh Hai phan – Thu Thuy Nguyen et al (2022), *Economic Valuation of Wetland Ecosystem Services in Northeastern Part of Vietnam* (Knowledge and Management of Aquatic Ecosystems), highlights the role of wetlands in water purification, flood control, and biodiversity conservation, all of which support agricultural sustainability [14]. In the Southeast region of Vietnam, Phong Nguyen Thanh – Thinh Le Van – Tuan Tran Minh et al. (2023), *Adapting to Climate-Change-Induced Drought Stress to Improve Water Management in Southeast Vietnam* (MDPI), apply two hydrological models, MIKE NAM and MIKE HYDRO BASIN, to assess water balance under various drought scenarios in the La Nga–Luy River basin. MIKE NAM, a conceptual rainfall-runoff model, simulates the transformation of rainfall into runoff within a river basin, while MIKE HYDRO BASIN serves as an integrated tool for basin-scale water resource analysis and planning. The study identifies subbasins vulnerable to severe drought, underscoring the importance of adaptive water allocation strategies. These findings suggest that integrating advanced modelling tools can enhance water resource management and contribute to more sustainable agricultural practices in drought-prone areas of Vietnam [15].

Thirdly, Legal and Policy Framework for Water Management. Quy Nhan Pham – Ngoc Ha Nguyen – Thi Thoang Ta – Thanh Le Tran (2023) propose amending the Law on Water Resources to support Integrated Water Resources Management, calling for stricter water extraction controls, better water quality protection, and stronger institutions via capacity-building and international cooperation. They also address transboundary complexities and the food–energy–water nexus [12]. Huynh Vuong Thu Minh – Gowhar Meraj – Pankaj Kumar et al. (2025), *Assessment of long-term rainfall trends and variability in the Vietnamese Mekong Delta: implications for water resources management strategies* (Springer), analyses rainfall from 1978–2022, revealing annual and wet-season declines (e.g., Ca Mau: –7.582 mm/year), with dry-season increases in some inland areas. The study recommends upgrading irrigation infrastructure and storage to adapt to climate shifts, ensuring sustainable water use in agriculture and aquaculture, particularly for agriculture and aquaculture in the Mekong Delta [16].

Fourthly, several scholarly works have focused on the improvement of the legal framework for the sustainable management of agricultural water resources in Viet Nam and Southeast Asia. A significant body of literature has proposed reform directions and institutional innovations to enhance the legal framework governing water resource management in both Viet Nam and the broader ASEAN region. These recommendations are often informed by the experiences of developed countries and demonstrate their relevance and adaptability to developing contexts such as Viet Nam and ASEAN. Devlaeminck David J. (2024), *Perspectives and Prospects for International Water Law in the ASEAN Region: Is There an ASEAN Way to Transboundary Water Cooperation under International Law?* (Sage Journals), analyses the potential development of a regional legal instrument for the governance and equitable sharing of the Mekong River's transboundary water resources. Drawing from binding and non-binding instruments under the Lancang–Mekong Cooperation framework between China and its neighbouring countries, the author suggests that ASEAN should foster consensus on transboundary water governance, regardless of whether the cooperation mechanisms are binding or non-binding in nature [17]. Mai Thi Thu Hue (2023), *Enhancing*

the Legal and Policy Framework for Efficient Water Resource Management (Journal of Environment), examines the existing legal regulations and implementation practices concerning water resource management in Viet Nam. Based on the country's practical context, the article puts forward legal reform proposals aimed at achieving unified water governance and safeguarding water security [18]. Ha Tan Linh, Duong Thi Truc, Nguyen Thanh Binh, and Van Pham Dang Tri (2025), in *Assessing Water Governance Trends and Challenges at a Local Level – An Application of the OECD Water Governance Framework in Soc Trang Province, Viet Nam* (Water Governance: Current Status and Future Trends), apply the OECD Water Governance Framework, comprising twelve key principles, to the provincial context of Soc Trang. Their research underscores the comprehensive nature of the OECD framework and its relevance in local water governance, particularly through its focus on three core components: the legal framework (what), institutions (who), and instruments (how). These components reflect core principles of effectiveness, efficiency, trust, and stakeholder engagement [19]. Dang Xuan Phuong (2015), in *Shaping New Institutions on Water Governance for Viet Nam* (Vietnam Law & Legal Forum), analyses the institutional development of Viet Nam's water governance framework and proposes several context-specific reforms. Key recommendations include renewing the composition and working methods of the National Council on Water Resources, drawing on international experience to design a river basin–scale coordination mechanism suited to national characteristics, restructuring state power relations based on territorial divisions, and strengthening water resource governance through integrated river basin planning and decentralised, multi-level basin organisation strategies [20].

2.2. Research gaps and the contribution of the study

Despite growing attention to agricultural water governance in Vietnam, several critical gaps persist:

First, there is limited research on adapting international best practices, such as EU or Dutch models, to Vietnam's legal and institutional context, which is marked by fragmented governance, outdated irrigation systems, and minimal use of reclaimed water.

Second, many studies stop at diagnosing problems without offering concrete, feasible reform strategies. Detailed, actionable roadmaps for integrating water management into policy remain scarce.

Third, the role of ecosystem services, vital for water purification, flood control, and biodiversity, is underexplored in both research and law. Wetland degradation in Northeast Vietnam, for instance, threatens agricultural water security, yet legal or policy frameworks seldom incorporate ecosystem-based approaches.

These gaps highlight the need for more solution-oriented, context-specific research to inform sustainable water governance reforms in Vietnam. This study evaluates Vietnam's legal and policy framework for agricultural water resource management, benchmarking it against international standards, particularly those of the EU and the Netherlands. It identifies reform priorities and presents actionable recommendations in three key areas: aligning domestic law with global best practices, developing strategies for water reuse and flood control, and integrating ecosystem services into national policy. By addressing fragmented governance and outdated infrastructure, the study aims to strengthen climate resilience and water security. The findings offer an evidence-based roadmap for legal reform to support sustainable agriculture and adaptive water governance in Vietnam.

3. METHODOLOGY

To examine sustainable agricultural water resource development and evaluate Vietnam's legal framework against international standards, the study employed four interrelated qualitative methods:

Firstly, Analytical Method. This core method examined the structure, content, and effectiveness of Vietnam's legal framework - particularly the Law on Water Resources (2012), the Law on Irrigation (2017), and related regulations. It focused on water use rights, irrigation governance, licensing, and financial mechanisms to identify gaps and overlaps.

Secondly, Comparative Legal Method. Vietnam's legal system was compared with those of the Netherlands and the EU, selected for their experience in integrated water management, codified rules on water reuse, and institutional relevance. The analysis explored regulatory approaches, enforcement, and decentralised governance.

Thirdly, Case Study Method. In-depth case studies were conducted to illustrate how agricultural water resource management has been successfully implemented in specific contexts to illustrate how legal and institutional reforms enhance agricultural water management.

Fourthly, Synthetic Method. This integrative approach synthesised findings to develop evidence-based recommendations, combining legal analysis and institutional practices into a reform model adaptable to Vietnam and potentially other ASEAN countries.

In addition, expert commentaries and prior empirical studies on climate vulnerability, irrigation financing, and agricultural water demand were reviewed to provide a more holistic understanding of the practical implications of legal reforms. The combination of these methods ensured that the research remained both legally rigorous and policy-relevant.

4. DISCUSSION

4.1. The EU Legal Insights on agricultural water resource management

The EU has significantly reduced water pollution over recent decades through strict environmental directives regulating wastewater collection, treatment, and discharge. From 1990 to 2014, Biological Oxygen Demand fell by 62%, nitrogen discharges by 40%, and phosphorus emissions by 50% [21]. Phosphorus emissions, another nutrient responsible for water eutrophication, were also reduced by 50%, from 0.2 million tonnes to 0.1 million tonnes [22]. The combined effect of policy measures, technological advancements, and enforcement mechanisms has led to measurable improvements in the quality of the EU's surface and coastal waters [22]. The Water Framework Directive (WFD)has encouraged countries like Germany and Spain to improve their irrigation systems, reducing water and fertiliser usage by 30%.

The WFD is the cornerstone of the EU's water policy. It emphasises integrated water resource management based on river basins, treating river basins as the fundamental management unit rather than administrative boundaries. The WFD requires member states to prevent the deterioration of water quality, ensuring a "good" status both chemically (with pollutant concentrations below the established thresholds) and ecologically (with healthy aquatic ecosystems). If these standards are not met, member states must implement corrective measures and report the reasons for non-compliance. The WFD requires the analysis of the characteristics of each river basin, assessing the impact of human activities (including agriculture), and conducting an economic evaluation of water use. This is particularly crucial for agricultural pollution, as agriculture accounts for 40 - 50% of freshwater consumption in the EU [23]. The WFD stipulates that each member state must develop and implement River

Basin Management Plans (RBMPs), which include specific measures to control pollution from agriculture, such as reducing the use of fertilisers and pesticides, improving irrigation systems, and protecting wetlands to maintain ecological functions and restore buffer zones. These RBMPs must be updated every six years.

The Nitrates Directive was introduced to reduce water pollution from nitrates originating from agricultural sources, particularly chemical fertilisers and livestock waste, to protect groundwater and surface water from eutrophication, which causes harmful algal blooms and deterioration of water quality. Member states must include specific measures in their Action Programmes, such as establishing buffer zones near water sources, developing nutrient management plans, and conducting regular water quality monitoring. The Nitrates Directive also provides detailed guidelines on good agricultural practices, including the proper storage of manure and the use of technologies to reduce nitrogen emissions. The directive has compelled countries to enhance monitoring in areas affected by nitrate pollution, leading to significant achievements. The Groundwater Directive focuses on protecting the chemical quality of groundwater, particularly from pollutants such as nitrates and pesticides. At the same time, the directive requires regular monitoring of groundwater quality and implementing measures to prevent the intrusion of pollutants, such as controlling the use of fertilisers and pesticides near aquifers and establishing buffer zones around agricultural land.

The EU also has introduced the Water Reuse Regulation, which promotes the reuse of treated urban wastewater, mainly for agricultural irrigation, to reduce pressure on freshwater resources. The regulation establishes minimum quality standards for reused water, including limits on microorganisms, heavy metals, and nitrates. the quality classes of reused water vary depending on the crop type. In Spain, this regulation has promoted wastewater reuse in Murcia, reducing freshwater demand for agriculture by 20% in 2023 [24]. In addition, the EU has implemented a range of stringent monitoring and enforcement mechanisms to ensure compliance with water resource protection regulations in agriculture. The European Environment Agency (EEA) plays a central role in monitoring water quality and reporting on progress towards the objectives of the WFD. Through indicators such as nitrate concentrations in groundwater, the number of river basins achieving "good" status, or the level of pesticide use, the EEA provides periodic data to the European Commission and publishes reports assessing the compliance of individual Member States. Based on this data, the European Commission may initiate infringement procedures against countries failing to fully meet their legal obligations, including referring cases to the Court of Justice of the EU. Several cases have seen countries like Germany and Spain brought before the court for inadequate control of agricultural pollution, leading to nitrate levels exceeding thresholds in groundwater or failure to update river basin management plans as required.

Another key factor is the integration of environmental policy into agricultural policy. Since the Common Agricultural Policy (CAP) reform, the EU has made significant strides in linking direct financial support for farmers to stringent requirements for environmental protection, climate action, and water resource conservation. The "greening" mechanism has been introduced, requiring farmers to implement three main measures to qualify for approximately 30% of the direct payment budget. Firstly, farmers must maintain permanent grasslands under Good Agricultural and Environmental Conditions (GAECs) standards to protect soil from erosion, enhance soil structure, and sequester carbon. Secondly, crop diversification is required to ensure soil fertility, reduce the risk of soil degradation, and limit reliance on harmful pesticides and chemical fertilisers. Thirdly, farmers must establish and maintain Ecological Focus Areas under GAEC 1, such as buffer zones along rivers, lakes, canals, green strips or fallow land to filter agricultural runoff before it enters natural irrigation systems. These buffer zones are critical in preventing the leaching of nitrates and other toxic chemicals from fertilisers. Additionally, Regulation (EU) No 1306/2013 establishes the cross-

compliance mechanism, whereby farmers must meet Statutory Management Requirements (SMRs) and GAECs to qualify for direct payments and certain rural development support. Specifically, SMR 1 mandates compliance with the Nitrates Directive, while GAEC 1 prohibits direct cultivation near water sources without preventive measures, such as establishing buffer zones or green strips, to minimise the risk of pollution from fertilisers and pesticides. Regulation (EU) 2021/2116 stipulates that non-compliance with "eco-conditionality" requirements will result in severe financial penalties. For instance, if farmers cultivate near water sources without establishing buffer zones as required by GAEC 4, they may face reductions in direct payments ranging from 5% to 100%, depending on the severity of the violation. Additionally, the EU has developed the European Agricultural Fund for Rural Development to finance projects that improve irrigation infrastructure, construct rainwater storage tanks, restore wetlands, and train farmers in sustainable water management.

4.2. The Netherlands legal insights on agricultural water resource management

Firstly, the Netherlands has implemented strict measures to control pesticide discharge into water resources. The Netherlands has implemented a robust regulatory framework for fertiliser and pesticide use. Under the Sustainable Plant Protection Action Plan (in effect since 2012), pesticide users must hold a five-year professional licence, granted only after passing a certified examination. Distributors must also meet strict professional qualification standards. Pesticides and residue must be stored on impermeable surfaces or in secure containers. Discharge into surface water or municipal drains is strictly prohibited; mixing areas must have no drainage systems. Water used to clean spraying equipment may only be released onto uncultivated land, never into surface water or municipal systems [25].

Secondly, the Netherlands has established stringent fertiliser and livestock waste management regulations. The Fertiliser Act 2022 and the Nitrate Action Programme regulate nitrogen and phosphate emissions from livestock farming. These regulations set out detailed provisions on the timing, conditions, and prohibited areas for manure application, as well as guidelines for fertilisation methods and limits on nutrient discharge to reduce runoff into irrigation systems, rivers, and lakes. The law defines the types of fertilisers permitted, requiring strict compliance with standards on composition and intended use. It also imposes maximum thresholds for nitrogen, phosphate, and ammonia content, and prohibits the use of fertilisers that fall below approved quality standards. Emission limits are prescribed based on specific agricultural conditions to minimise nitrogen pollution, while phosphate use is subject to similar controls, reinforcing the overarching aim of protecting water resources [26]. This approach exemplifies how legal regulation of agricultural inputs can align farming practices with environmental goals, promoting green, circular, and sustainable agriculture.

Thirdly, the Netherlands strongly emphasises the governance and efficient distribution of agricultural water resources. As a low-lying country with a dense river network, the Netherlands has built a comprehensive legal framework to ensure safety against flood risks and maintain a stable freshwater supply, prominently featuring the Water Act and the Delta Programme. The Water Act sets safety standards for flood protection systems, including requirements on the height and durability of dikes, which are determined based on the flood probability for each geographic area. Water management in the Netherlands is conducted on a river basin basis. It requires the annual adjustment of flood protection works based on the calculation of average flood levels and the resilience capacity of dikes. The Delta Programme serves as a national strategy addressing flood protection, freshwater supply, and climate adaptation; it is updated yearly and reported to Parliament, allowing flexible, evidence-based adjustments [27]. The regulations on water management are designed to serve two primary purposes: (i) water must be integrated into the landscape following a straightforward spatial

planning process, and (ii) water must be retained and stored, and land must be drained when necessary. In addition, the Netherlands established a separate water management authority at the central level. Oversight is provided by the Ministry of Infrastructure and Water Management, while Water Boards (Waterschappen) - independent, democratically elected regional bodies - manage local water quality, grant discharge permits, oversee irrigation, and collaborate with farmers on water-saving practices [13] [28]. These Boards possess financial autonomy through taxation powers, ensuring transparent and effective regional water resource management.

Fourthly, the Netherlands has effectively promoted the involvement of businesses and farmers in water management through a robust PPP model. This approach has been widely applied in water infrastructure projects, including irrigation and wastewater treatment, typically under Design–Build–Finance–Maintain contracts that allow private sector participation in both investment and operation. A notable example is the Schiphol–Amsterdam–Almere (SAA) programme, the largest PPP project in the Netherlands over the past decade, aimed at enhancing transport infrastructure and water management sustainably [29]. Additionally, Dutch water organisations and companies participate in the Water for Green Partners for International Business programme - a collaboration among the Netherlands government, Dutch Greenhouse Delta, the Water Authority, supported by Dutch embassies in Oman, Saudi Arabia, and the UAE, and the Netherlands Enterprise Agency - focused on sustainable agricultural water resource solutions [30]. The Water Boards model exemplifies a long-established community-based governance system, with representation from farmers, businesses, and residents, ensuring transparency and consensus in decision-making. Stakeholder participation in Water Boards' planning is increasingly recognised as crucial for integrated and adaptive water management and is sometimes mandated by higher regulatory authorities [31]. Moreover, programmes like the Deltaplan Agrarisch Waterbeheer encourage farmer cooperation with water authorities through regional planning and policy implementation, successfully engaging many farmers and horticulturists in sustainable water management practices [32].

Lastly, Schematic Conceptualisation of the Dutch Water Management Regime. The Dutch water management regime can be conceptualised as an interconnected web of actors, paradigms, collective rules, technological infrastructure, and tools. These components form a coherent system, with strong internal alignment and logic, which simultaneously enables and constrains interventions within the water system. The schematic representation of this regime, as presented in Rutger van der Brugge et al (2007), *Facing the Adaptive Management Challenge: Insights from Transition Management* (Ecology and Society), offers a clear and insightful illustration of a decentralised, multi-level approach to water governance [33]. The model underscores the pivotal role of regional water boards (waterschappen), autonomous public institutions legally empowered to manage water quality, quantity, and flood protection. A distinctive feature of the Dutch system lies in its institutionalised democratic governance structure. Stakeholders from diverse sectors, including agriculture, industry, environmental advocacy, and local residents, elect representatives to water board councils. This participatory model incorporates diverse interests, fostering inclusive, equitable, and context-sensitive water management decisions. The schematic highlights the dynamic link between national policies and regional implementation, upholding subsidiarity. Integration of research institutions, policy networks, and continuous learning underscores the model's reflexive and adaptive governance, essential for sustainability.

5. CONCLUSION

5.1. Leveraging the EU's experiences on agricultural water resource management

Drawing on lessons learned from the EU, particularly regarding integrated nutrient management, pollution control, and regulatory design, holds strong potential to enhance Vietnam's water governance framework.

First, management and planning must be established for each individual river basin. Vietnam's environmental budget, allocated through recurrent expenditures and the medium-term public investment plan under Decision No. 1251/QD-TTg (2023), remains modest. Meanwhile, rural farmers face low incomes, with the average monthly per capita income at only VND 4.17 million (around USD 2,000 annually) [34]. These financial constraints necessitate solutions that are both cost-effective and adapted to local economic conditions. Compounding this challenge is Vietnam's traditional reliance on administrative boundaries in water resource management, which hinders effective coordination across provinces within the same river basin. This fragmentation leads to inefficiencies and increased pollution, mirroring problems the EU encountered prior to adopting the WFD. To overcome these issues, the implementation of RBMPs is proposed, prioritising the Mekong River Basin, a region critically important for agriculture and severely affected by pollution. Practical measures include: (i) Deploying low-cost water quality monitoring technologies to improve pollution tracking; (ii) Establishing ecological buffer zones using native bamboo species to intercept fertiliser and pesticide runoff; and (iii) Promoting drip irrigation systems through subsidy programmes that provide equipment free of charge to farmers, accompanied by training courses organised at agricultural cooperatives to enhance sustainable farming practices, reduce irrigation costs, and increase rice yields. To ensure feasibility given farmers' limited incomes, these interventions should be supported by international investment funding. Pilot projects should focus on provinces with advanced agricultural infrastructure and strong rice production traditions, such as An Giang in the Mekong Delta. These measures promise multiple benefits: lowering water pollution and treatment costs, improving agricultural productivity and farmer incomes, boosting rice export value, and strengthening Vietnam's position in the global agricultural market.

Second, smaller polluted areas need to be identified, and the sale and use of fertilisers in these zones should be restricted. In Vietnam, excessive fertiliser use has caused severe water pollution and environmental damage. The authors propose that Vietnam start by identifying NVZs in the most nitrate-polluted areas, especially the Mekong Delta. Key measures include limiting nitrogen fertiliser use based on local soil and crop conditions, subsidising organic fertilisers to promote sustainable practices, and establishing ecological buffer zones using native bamboo to reduce runoff. To address farmers' low incomes, the programme should provide precision fertiliser application equipment free of charge and offer training through agricultural cooperatives. Financial constraints may be mitigated by focusing on low-cost solutions, including using locally sourced materials to construct buffer zones and applying simple technologies for water quality monitoring. Pilot projects in provinces with strong agricultural capacity, such as Dong Thap or An Giang, would optimise resource use and ensure practical outcomes.

Third, groundwater monitoring must be implemented to mitigate the impact of pesticides. In Vietnam, groundwater is vital for clean water supply, especially in rural areas, but contamination from agricultural nitrates and pesticides is a growing problem. This issue is heightened by climate change, which increases reliance on groundwater as surface water becomes scarcer. The authors propose that Vietnam starting by establishing specific quality thresholds for groundwater, focusing on nitrates and pesticides, to ensure public health safety and the sustainable use. The proposal includes implementing groundwater quality monitoring

in areas where groundwater is the primary source for domestic use and agricultural production, particularly in the Central region. Specific solutions include using low-cost portable testing kits to detect contamination quickly and effectively, and establishing ecological buffer zones with indigenous nipa palm, a plant capable of absorbing pollutants and preventing chemical runoff into aquifers. Public awareness should be raised through free community training on groundwater pollution impacts and local protection methods, encouraging active local participation. Vietnam should prioritise affordable technologies and local materials like nipa palm to ensure cost-effectiveness and sustainability. Protecting groundwater in the Central region can serve as a model for nationwide programs, helping Vietnam meet international environmental standards amid economic integration and climate change challenges.

Fourth, the reuse of urban wastewater for agricultural irrigation should be implemented. Freshwater scarcity in Vietnam, especially in the Central Highlands, has severely impacted the coffee industry [35]. Rapid urbanisation offers potential for urban wastewater reuse, but limited state budgets hinder large-scale treatment [36]. Farmers also lack awareness of recycled water benefits, requiring training and support. The authors propose establishing small-scale wastewater treatment plants in regions with high irrigation demands, such as the Central Highlands. These plants would focus on treating urban wastewater for reuse in irrigation, ensuring that the water quality meets health and environmental protection safety standards. To accommodate the low income of farmers, the programme should subsidise the cost of recycled water, thereby alleviating the financial burden on local communities. Training courses on safety and recycling water use techniques should also be organised to raise awareness and ensure their effective application in practices. Vietnam should prioritise affordable, locally adapted treatment technologies and focus initial efforts on urban centres like Buon Ma Thuot, strategically located near coffee plantations to optimise water distribution. This approach will reduce irrigation costs, improve crop yields by ensuring stable water supply during dry seasons, mitigate economic losses from drought, enhance Vietnam's coffee export competitiveness, and protect freshwater resources.

Fifth, financial support mechanisms for agriculture must be established to encourage sustainable practices. In Vietnam, severe water pollution from intensive agriculture, particularly in the Mekong Delta's 2,4 million hectares of farmland with heavy fertiliser use, has increased nitrate and pesticide contamination, raising water treatment costs and harming public health and fisheries. Limited environmental budgets and low incomes of smallholder farmers (around USD 2,000 annually) restrict investment in sustainable practices. Low awareness of pollution impacts and eco-friendly methods like buffer zones and crop rotation further hinder progress, highlighting the need for education and support. Targeted budgetary policies should encourage sustainable farming by providing direct subsidies or financial aid for ecological buffer zones, organic fertiliser use, and crop rotation. The state should also supply discounted or free organic fertilisers, quality seeds, and water-saving irrigation technologies in key regions. Funding for training and technical assistance through cooperatives and agricultural centres is essential to build farmers' capacity. Additionally, dedicated funds offering low-interest or interest-free loans would help smallholders invest in environmental protection infrastructure, such as wastewater treatment and secure chemical storage.

Sixth, provide handheld water quality testing kits to enable regular, on-site monitoring of water pollution. Vietnam has already issued surface water quality standards under QCVN 08:2023/BTNMT, classifies surface water into four quality levels - A (good), B (moderate), C (poor), and D (very poor) - to guide its use and protect aquatic ecosystems. Level A water is suitable for domestic use, swimming, and recreation after treatment; Level B for industrial and agricultural use after treatment; Level C, which is odour-free, for industrial purposes after treatment; and Level D is limited to water transport and other low-quality uses.

However, to ensure these standards are effectively upheld, it is essential to conduct regular and rigorous monitoring using handheld test kits. These kits, costing approximately VND 2 - 5 million per dozen, enable quick identification of polluted or substandard water sources, allowing timely remedial action. To effectively implement the water quality standards set out in QCVN 08:2023/BTNMT, local government agencies should receive targeted training to conduct routine water testing using handheld kits at least every six months in key agricultural areas. Regular monitoring would enable the prompt identification of substandard water bodies and facilitate the designation of NVZs, allowing for timely intervention and the application of targeted water reform policies. This approach not only ensures data-driven management of water pollution but also strengthens the effectiveness of sustainable agriculture support programmes linked to environmental protection.

Table 1. Vietnam's Water Quality Indicators to evaluate water pollution

Parameter										Level
pH	BOD_5 (mg/L)	COD (mg/L)	TOC (mg/L)	TSS (mg/L)	DO (mg/L)	Total Phosphor TP (mg/L)	Total Nitơ TN (mg/L)	Total Coliform (CFU or MPN/100 mL)	Coliform Thermotolerant (CFU or MPN/100 mL)	
6,5 - 8,5	≤ 4	≤ 10	≤ 4	≤ 25	≥ 6,0	≤ 0,1	≤ 0,6	≤ 1.000	≤ 200	A
6,0 - 8,5	≤ 6	≤ 15	≤ 6	≤ 100	≥ 5,0	≤ 0,3	≤ 1,5	≤ 5.000	≤ 1.000	B
6,0 - 8,5	≤ 10	≤ 20	≤ 8	> 100 and no floating debris	≥ 4,0	≤ 0,5	≤ 2,0	≤ 7.500	≤ 1.500	C
< 6,0 or >8,5	> 10	> 20	> 8	> 100 and floating debris present	≥ 2,0	> 0,5	> 2,0	> 7.500	> 1.500	D

5.2. Leveraging Netherlands' experience on agricultural water resource management

5.2.1. Supplement regulations on managing fertiliser and pesticide use in agriculture

Vietnam's pesticide regulation under Circular No. 25/2024/TT-BNNPTNT focuses on approved active ingredients but lacks comprehensive rules on use, storage, distribution, and residue management. Most farmers are untrained, leading to misuse and rising water pollution, especially in rice-growing regions. Drawing from the Netherlands' integrated model of regulation, education, and supplier engagement, Vietnam should adopt a dedicated Decree covering the full lifecycle of pesticides. This Decree should set technical standards, define personnel qualifications, and establish environmental safeguards to effectively manage pesticide use and protect water resources:

Firstly, individuals using or trading pesticides must obtain a Professional Practice Licence (PPL), granted only after passing a competency exam covering: (i) pesticide operation and toxicity; (ii) safe storage, transport, preparation, and application; and (iii) legal obligations for environmental and human health protection, particularly regarding water, soil, and ecosystems. Training and certification should be provided by accredited institutions, with regular state inspections. PPL holders must also ensure facilities meet minimum standards, including: (i) pesticide storage on impermeable floors with proper roofing and safe distances

from residences, drinking water, and canals; (ii) designated cleaning areas for spraying equipment with compliant wastewater collection and treatment; and (iii) adequate personal protective equipment and detailed pesticide usage records.

Secondly, organisations involved in distributing, storing, and trading pesticides should be subject to detailed regulations on human resources, internal management, and technical conditions. Specifically: (i) internal regulations must govern the handling of agricultural chemicals, including receipt, storage, distribution, and spill or loss management; (ii) at least one person holding a valid PPL must be appointed as technical supervisor responsible for chemical safety; and (iii) warehouses and transport systems must comply with national standards for chemical safety, fire prevention, and environmental protection.

Thirdly, the PPL should be valid for five years and renewal contingent upon completion of knowledge updates and a professional re-evaluation covering new legal requirements, environmental safety standards, and advanced technical methods. Renewal could be tied to a continuing education credit system. The Decree should also specify clear penalties for violations of pesticide use, storage, or distribution rules, including PPL revocation, suspension of operations, administrative fines, and compensation for environmental or public health damage where applicable.

5.2.2. A robust legal framework for the management of fertilisers and livestock waste

Adopting key principles from Dutch regulations, Vietnam urgently needs a comprehensive legal framework focused on protecting water resources and controlling agricultural emissions through five main pillars:

Firstly, legal limits on the amounts of nitrogen and phosphate permitted per unit area are to be flexibly adjusted according to geographic regions, crop types, seasons, and soil nutrient absorption characteristics. Total cumulative emissions from agricultural land and the carrying capacity of adjacent surface water ecosystems must be considered, ensuring thresholds for eutrophication are not exceeded.

Secondly, fertiliser and livestock waste application should be strictly restricted to appropriate periods within the cropping season. Prohibiting application during fallow or rainy periods, when crop uptake is minimal, will help prevent nutrient runoff into water bodies.

Thirdly, the mandatory adoption of low-emission fertilisation methods, such as direct injection into the soil or combining fertilisation with surface covering to minimise volatilisation and runoff, should be regulated; simultaneously, the planting of cover crops during dry seasons or post-harvest periods should be encouraged and gradually mandated as a biological measure for nutrient retention and soil erosion control.

Fourthly, legal responsibilities must be established for farms and agricultural households to develop and implement soil nutrient management plans tailored to cultivation characteristics, crop types, and actual needs. These plans must be maintained, periodically updated, and subject to supervision and inspection by competent authorities, laying the foundation for digitalizing agricultural emission controls.

Finally, technical annexes should accompany the regulatory framework, detailing permissible nitrogen and phosphate content in fertilisers and livestock waste for specific agroecological zones. These limits should be based on nutrient-emission balance principles, developed in consultation with scientific research institutions, and regularly updated.

It is also essential to amend the Law on Crop Production and related regulations to integrate water quality protection as a mandatory criterion in fertiliser and livestock waste management, on par with cultivation standards and food safety. This would help establish a

robust system for controlling agricultural chemical inputs, crucial for preventing water pollution at its source and supporting a shift towards ecological, circular agriculture resilient to climate change.

5.2.3. An integrated water resource management mechanism for agricultural production

As Vietnam's agriculture faces increasing climate risks and remains the largest water user, a dedicated legal framework is essential to manage agricultural water allocation effectively. Vietnam should develop a Decree on agricultural water management:

Firstly, a regulatory mechanism must be established to allocate agricultural water based on climate zones, cropping seasons, and irrigation system capacity. This system should link to meteorological and hydrological data, drought forecasts, and reservoir levels, enabling timely adjustments to irrigation flows that minimise crop losses and reduce flood risk pressure.

Secondly, monitoring capacity for agricultural water quality and quantity, both surface and groundwater, should be enhanced, prioritising water-scarce, flood-prone, and intensive agricultural areas. Monitoring should be organised by hydrological clusters or river basins, incorporating early warning systems and real-time data updates for effective water allocation.

Thirdly, national technical standards for rational water use by crop type and cultivation method should be introduced, providing a legal basis for controlled allocation. Water-saving irrigation technologies (e.g., drip irrigation, demand-based rotational irrigation) should be promoted and gradually mandated to reduce losses.

Fourthly, the direct discharge of untreated agricultural wastewater into irrigation systems, rivers, or natural retention areas must be prohibited, with stricter penalties for pollution, especially upstream or in concentrated irrigation zones.

Fifthly, a specialised rural water environment monitoring network should be developed for water quality surveillance, real-time flow regulation, and pollution tracing. A shared data system connecting central and local agencies will facilitate regional coordination and rapid policy responses during emergencies such as droughts, saltwater intrusion, and floods.

Sixthly, establish a General Department of Water Resource Management under the Ministry of Agriculture and Environment as the central body responsible for data aggregation, annual water regulation planning, water zoning, drought prioritisation, extreme event response, and efficient allocation across agricultural ecological zones. This agency will coordinate emergency responses by integrating provincial data and liaising with local Departments of Agriculture and Environment.

Finally, issue technical guidelines for the design, operation, and regular evaluation of irrigation works, reservoirs, and internal canal systems. These infrastructures must allow flexible regulation, storage during rainy seasons, and controlled flood discharge, while integrating into national disaster risk management and water resource regulation frameworks.

5.2.4. Legal framework for PPP in the sustainable development of water resources

Vietnam should proceed with developing a Circular to guide PPP investment in drainage, wastewater treatment, and waste management. This Circular should clearly outline key elements to promote sustainable agricultural water resource development:

Firstly, the Circular should clearly define capital sources for PPP investments in agricultural water management, encompassing investors' equity, financial institution loans, and state contributions via the State budget and environmental sanitation fees.

Secondly, it must specify the particular sectors open to private investors under PPP contracts, such as wastewater treatment from livestock activities and drainage for fertiliser- and pesticide-intensive farms, explicitly excluding management of irrigation works. Where access to irrigation infrastructure is necessary, the Circular should set clear limits and detailed procedures for obtaining approval from competent authorities.

Thirdly, the Circular should designate a lead agency responsible for interpreting and implementing the decree and overseeing investor selection under PPP mechanisms. With the merger of the Ministry of Agriculture and Environment, this provides an opportunity for unified water resource governance. The future establishment of the General Department of Water Resource Management should anticipate a gradual transfer of PPP cooperation duties.

Finally, bidding and investor selection procedures must be transparent and well-regulated. Selection criteria should prioritise investors with proven experience in environmental and sustainable development projects, while allowing foreign investors, especially from countries with established water cooperation, to participate. Given the environmental nature of these investments, appraisal processes may be lengthy; however, to attract investors, a streamlined procedure is recommended, minimising administrative burdens and focusing chiefly on assessing investors' environmental qualifications.

To optimise resources and enforce policy effectively, a phased roadmap is proposed, aligned with institutional readiness and urgency. In the short term, priorities include key legal reforms - drafting a Decree on Pesticide Use and Trade Management, amending the Law on Crop Production to add water protection standards, and piloting pesticide training and certification in the Mekong and Red River Deltas. Research institutions should develop technical annexes on nutrient thresholds to support regulation. In the medium term, focus should shift to institutional consolidation: establishing national licensing and inspection systems for pesticide use, issuing a legal framework for fertiliser and livestock waste with mandatory nutrient plans, creating regional water monitoring networks, and piloting real-time water allocation in high-stress areas. Finalising a Circular guiding PPP investment in drainage and agricultural wastewater treatment is also vital. In the long term, priorities include institutionalising governance under an expanded General Department of Water Resource Management, mandating nationwide water-saving irrigation and low-emission fertiliser methods, and fully digitalising agricultural water management. This sequenced roadmap supports efficient, sustainable reform with strong legal, institutional foundations.

5.3. Proposed measures for ASEAN on agricultural water resource management

Vietnam and many ASEAN member states heavily depend on the Mekong River. The shared reliance on this critical waterway highlights the interconnectedness of ASEAN countries regarding water resource use, agricultural productivity, and regional food systems. Despite this profound interdependence, ASEAN lacks a unified legal framework that could serve as the foundation for integrated water resource management in agriculture. Unlike the EU, which has adopted the comprehensive WFD to harmonise water governance across member states, ASEAN's approach remains fragmented. No regionally binding instrument sets out common principles, technical standards, or coordinated strategies for managing transboundary water resources or addressing agricultural water pollution. This legal and technical vacuum poses serious challenges, particularly when dealing with transboundary impacts such as water quality degradation, competition over water allocation, and agricultural runoff, directly affecting the Mekong's ecosystems and livelihoods. ASEAN should consider progressively developing a comprehensive and harmonised legal framework for agricultural water resources. Such a framework would create common legal standards and establish mechanisms for data sharing, joint monitoring, and coordinated action in managing shared

river basins like the Mekong. In parallel, ASEAN should work towards creating a specialised regional cooperation mechanism dedicated to coordinating and governing the Mekong River's water resources. This mechanism should promote the active and equitable participation of all member states, aiming to ensure fair distribution of water, preserve the natural hydrological regimes essential for agriculture and ecosystems, and strengthen capacity for water regulation during critical periods of flooding and drought, thus mitigating adverse impacts on agricultural production and food security. Moreover, ASEAN should promulgate a unified regional regulatory framework specifically targeting agricultural outputs that affect water quality. This framework should include binding rules on the responsible use of fertilisers and pesticides to minimise residual pollutants entering water bodies; standards for the management and treatment of agricultural waste discharged into the Mekong River and its tributaries. In this regard, ASEAN can help reduce reliance on chemical inputs, improve farm-level economic sustainability, and ensure the long-term protection of water resources, thus contributing to a greener and more resilient agricultural sector. Ultimately, constructing a coherent and coordinated legal, technical, and institutional system for sustainable water resource management in agriculture will empower ASEAN to adapt proactively to climate change impacts. It will enhance the region's strategic position on the global map of water security and sustainable agricultural development, positioning asean not merely as a bloc of emerging economies but as a responsible and forward-looking actor in global environmental governance.

REFERENCES

1. Open Development Vietnam. - Rivers and Lakes, Open Development Vietnam (2018). Available at: https://vietnam.opendevelopmentmekong.net/vi/topics/rivers-and-lakes/
2. Hoang Y. - Water Use Efficiency in Vietnam Is Only One-Tenth of the Global Average, Financial - Investment Newspaper (2020). Available at: https://thoibaotaichinhvietnam.vn/hieu-qua-su-dung-nuoc-o-viet-nam-bang-110-trung-binh-the-gioi-66538.html
3. Bao, V.Q., Van Toan, P., Van Tuyen, N. et al. - Understanding watershed sources of pollution in Vinh Long Province, Vietnamese Mekong Delta. Discover Applied Sciences **6** (2024) 310. https://doi.org/10.1007/s42452-024-06013-x
4. An L. T. - Current status of pesticide use in Vietnam, VTC Holdings (n.d). Available at: https://vtcholdings.vn/thuc-trang-su-dung-thuoc-bao-ve-thuc-vat/#Thuc_trang_su_dung_thuoc_bao_ve_thuc_vat_o_Viet_Nam
5. Tran T. K. H., & Nguyen T. G. - Analysis of Surface Water Quality in Upstream Province of Vietnamese Mekong Delta Using Multivariate Statistics, Water **14** (12) (2022). https://doi.org/10.3390/w14121975
6. Han T. - Responding to Drought to Sustain Agricultural Production, Nhan Dan Online (2024). Available at: https://nhandan.vn/ung-pho-han-han-de-duy-tri-san-xuat-nong-nghiep-post811091.html
7. Trung N. - Natural Disaster Damages in 2024 Are More Than Nine Times Higher Than in 2023, Agriculture & Environment Magazine (2024). Available at: https://nongnghiepmoitruong.vn/thiet-hai-do-thien-tai-nam-2024-gap-hon-9-lan-so-voi-nam-2023-d737869.html
8. Ky P. - Fifteen Banks Join VND100 Trillion Credit Package for the Agriculture, Forestry, and Fisheries Sectors, VnEconomy (2025). Available at:

https://vneconomy.vn/co-15-ngan-hang-tham-gia-goi-tin-dung-100-nghin-ty-dong-cho-linh-vuc-nong-lam-nghiep-va-thuy-san.htm

9. Vietnam Water Supply and Sewerage Association. - Early Guidance on Investment Activities under the PPP Model in the Drainage Sector, Water Magazine (2024). Available at: https://tapchinuoc.vn/som-huong-dan-hoat-dong-dau-tu-theo-phuong-thuc-ppp-trong-linh-vuc-thoat-nuoc-17524060508505452.htm
10. Tran D. V. - Development of Vietnamese Agriculture: Issues and Some Solutions, Communist Review (2023). Available at: https://tapchicongsan.org.vn/kinh-te/-/2018/828917/phat-trien-nong-nghiep-viet-nam--van-de-dat-ra-va-mot-so-giai-phap.aspx
11. Phu L. V. - Water value, irrigation policy, and implementation hazards in Vietnam's rural economy, Water Resources and Economics **43** (2023). https://doi.org/10.1016/j.wre.2023.100229
12. Pham Q. N., Nguyen N.H., Ta T.T. & Tran T.L. - Vietnam's Water Resources: Current Status, Challenges, and Security Perspective, Sustainability **15** (8) (2023) 6441. https://doi.org/10.3390/su15086441
13. Chan F. K. S., Yang L.E., Mitchell G., et al. - Comparison of sustainable flood risk management by four countries – the United Kingdom, the Netherlands, the United States, and Japan – and the implications for Asian coastal megacities, Natural Hazards and Earth System Sciences **22** (8) (2022). https://doi.org/10.5194/nhess-22-2567-2022
14. Dang K. B., Phan T. T. H., Nguyen T.T. et al. - Economic Valuation of Wetland Ecosystem Services in Northeastern Part of Vietnam, Knowledge and Management of Aquatic Ecosystems **423** (2022) 12. https://doi.org/10.1051/kmae/2022010
15. Thanh, P. N., Le Van, T., Minh, T. T., Ngoc, T. H., Lohpaisankrit, W., Pham, Q. B., Gagnon, A. S., Deb, P., Pham, N. T., Anh, D. T., & Dinh, V. N. - Adapting to climate-change-induced drought stress to improve water management in Southeast Vietnam, Sustainability **15** (11) (2023) 9021. https://doi.org/10.3390/su15119021
16. Huynh V. T. M., Meraj G., Kurmar P. et al. - Assessment of long-term rainfall trends and variability in the Vietnamese Mekong Delta: implications for water resources management strategies, Discover Environment **3** (58) (2025). https://doi.org/10.1007/s44274-025-00233-7
17. Devlaeminck D.J. - Perspectives and Prospects for International Water Law in the ASEAN Region: Is There an ASEAN Way to Transboundary Water Cooperation Under International Law?, Journal of Current Southeast Asian Affairs **44** (1) (2024) 125-147. https://doi.org/10.1177/18681034241262802
18. Mai T. T. H - Enhancing the Legal and Policy Framework for Efficient Water Resource Management, Journal of Environment (3) (2023). https://tapchimoitruong.vn/chuyen-muc-3/hoan-thien-chinh-sach-phap-luat-de-quan-ly-hieu-qua-tai-nguyen-nuoc-28669
19. Ha T. L., Duong T.T., Nguyen T. B. & Van P. D. T. - Assessing water governance trends and challenges at a local level - An application of the OECD Water Governance Framework in Soc Trang Province, Vietnam, Water **17** (3) (2025). https://doi.org/10.3390/w17030320

20. Dang X. P. - Shaping new institutions on water governance for Vietnam, Vietnam Law & Legal Forum. Available at: https://vietnamlawmagazine.vn/shaping-new-institutions-on-water-governance-for-vietnam-3703.html

21. European Environment Agency - Nutrients in freshwater in Europe (2024). Available at: https://www.eea.europa.eu/en/analysis/indicators/nutrients-in-freshwater-in-europe

22. European Commission. - Evaluation of the Urban Waste Water Treatment Directive (2020). Available at: https://commission.europa.eu/publications/evaluation-urban-waste-water-treatment-directive_en

23. European Environment Agency. - Water and Agriculture: Towards Sustainable Solutions, European Environment Agency Report 17/2020 (2020). Available at: https://www.eea.europa.eu/en/analysis/publications/water-and-agriculture-towards-sustainable-solutions

24. Truchado P., Gil M. I., López C. et al. - New standards at european union level on water reuse for agricultural irrigation: Are the Spanish wastewater treatment plants ready to produce and distribute reclaimed water within the minimum quality requirements?, International Journal of Food Microbiology **356** (2021) 109352, https://doi.org/10.1016/j.ijfoodmicro.2021.109352

25. Government of the Netherlands - Dutch action plan on sustainable plant protection, FAOLEX (2012). Available at: https://faolex.fao.org/docs/pdf/net192139.pdf

26. OECD Agriculture and Food Policy Reviews. - Policies for the future of farming and food in the Netherlands, OECD (2023). Available at: https://www.oecd.org/content/dam/oecd/en/publications/reports/2023/06/policies-for-the-future-of-farming-and-food-in-the-netherlands_c632ba3d/bb16dea4-en.pdf

27. Van Alphen J. - The Delta Programme and updated flood risk management policies in the Netherlands, Journal of Flood Risk Management **9** (4) (2016) 310–319. https://doi.org/10.1111/jfr3.12183

28. de Graeff J. J. - Water Boards in the Netherlands, Session 3 of Institutional Innovations towards Integration of Irrigation and Drainage Management (2012). https://edepot.wur.nl/215025

29. Terpstra J., Klijn M. & van den Boogaart S. - A General Introduction to Public-Private Partnerships in the Netherlands, Houthoff (2023). Available at: https://www.lexology.com/library/detail.aspx?g=f0448cc1-9102-4f8f-9f3d-f1676a051a7e

30. van Buchem M. - Join the Water for Green PIB Initiative, Netherlands Water Partnership (2024). Available at: https://www.netherlandswaterpartnership.com/news/join-water-green-pib-initiative

31. Lamers M., Ottow B., Francois G. & von Korff Y. - Beyond Dry Feet? Experiences from a Participatory Water-Management Planning Case in the Netherlands, Ecology and Society **15** (1) (2010) 14 . https://doi.org/10.5751/es-03204-150114

32. Deltaplan Agrarisch Waterbeheer. - Task Force Agricultural Water Management (n.d). Available at: https://agrarischwaterbeheer.nl/task-force-agricultural-water-management/

33. van der Brugge, R., and R. van Raak. - Facing the Adaptive Management Challenge: Insights from Transition Management, Ecology and Society **12** (2) (2007) 33. https://doi.org/10.5751/es-02227-120233

34. General Statistics Office of Vietnam. - Press Release on the Results of the 2023 Household Living Standards Survey (2023). Available at: https://www.gso.gov.vn/tin-tuc-thong-ke/2024/04/thong-cao-bao-chi-ket-qua-khao-sat-muc-song-dan-cu-nam-2023/b

35. Virac. - Vietnam's Coffee Market Faces Challenges amid Soaring Coffee Prices in Early 2024, Virac (2024). Available at: https://viracresearch.com/thi-truong-ca-phe-viet-nam-doi-dien-thach-thuc/

36. General Statistics Office of Vietnam - Press Release on the Results of the 2024 Mid-Term Population and Housing Census (2024). Available at: https://www.gso.gov.vn/du-lieu-va-so-lieu-thong-ke/2025/01/thong-cao-bao-chi-ket-qua-dieu-tra-dan-so-va-nha-o-giua-ky-nam-2024/

TÓM TẮT

HOÀN THIỆN KHUNG PHÁP LÝ VIỆT NAM VỀ QUẢN LÝ BỀN VỮNG TÀI NGUYÊN NƯỚC TRONG NÔNG NGHIỆP: KINH NGHIỆM TỪ LIÊN MINH CHÂU ÂU VÀ HÀ LAN

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Nước là nguồn tài nguyên thiết yếu đối với con người, đóng vai trò không thể thay thế trong đời sống hằng ngày và các hoạt động sản xuất kinh tế. Tuy nhiên, các hoạt động nông nghiệp tại Việt Nam đang gia tăng áp lực lên tài nguyên nước, chủ yếu do việc lạm dụng phân bón, thuốc bảo vệ thực vật, ô nhiễm từ chăn nuôi và các phương thức canh tác thiếu bền vững. Những yếu tố này góp phần làm suy thoái nguồn nước, đe dọa đến hệ sinh thái và sức khỏe cộng đồng. Do đó, thực hành nông nghiệp bền vững và quản lý hiệu quả tài nguyên nước là yêu cầu cấp thiết cho sự phát triển lâu dài. Là một quốc gia có nền kinh tế chủ yếu dựa vào nông nghiệp, Việt Nam ngày càng nhận thức rõ tầm quan trọng của phát triển nông nghiệp bền vững, trong đó nhấn mạnh đến việc giảm thiểu ô nhiễm môi trường và bảo vệ nguồn nước cho các thế hệ tương lai. Mặc dù đã có nhiều nỗ lực trong việc kiểm soát ô nhiễm và bảo vệ tài nguyên nước, khung pháp lý hiện hành của Việt Nam vẫn còn thiếu sót, chưa có cơ chế thực thi đồng bộ và hiệu quả, dẫn đến tình trạng ô nhiễm nguồn nước từ hoạt động nông nghiệp vẫn tiếp diễn. Bài viết này phân tích các khung pháp lý của Liên minh châu Âu và Hà Lan – những khu vực có thành công trong việc lồng ghép chính sách nông nghiệp với quản lý bền vững tài nguyên nước. Thông qua việc phân tích các cách tiếp cận pháp lý và chiến lược thực thi của các quốc gia này, nghiên cứu đề xuất một số khuyến nghị nhằm hoàn thiện khung pháp lý của Việt Nam, hướng tới quản lý tài nguyên nước hiệu quả và bền vững. Những kết quả nghiên cứu cũng có thể mang lại giá trị tham khảo cho các quốc gia ASEAN khác, đặc biệt trong việc giải quyết vấn đề ô nhiễm nguồn nước xuyên biên giới tại sông Mê Kông – một tài nguyên quan trọng cho sự phát triển bền vững khu vực.

Từ khóa: Quản lý bền vững, tài nguyên nước, nông nghiệp, Liên minh châu Âu, Hà Lan.