JOURNAL OF WATER AND LAND DEVELOPMENT
e-ISSN 2083-4535
Polish Academy of Sciences (PAN) Institute of Technology and Life Sciences – National Research Institute (ITP – PIB)

JOURNAL OF WATER AND LAND DEVELOPMENT
DOI: 10.24425/jwld.2025.153534
2025, No. 64 (I–III): 221–229

Restoration is an investment. Comparing restoration costs and ecosystem services in selected European wetlands

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RECEIVED 26.09.2024 ACCEPTED 12.03.2025 AVAILABLE ONLINE 27.03.2025

Abstract: Wetland restoration aims to restore key environmental functions to degraded ecosystems, but it comes with costs, which can hinder public acceptance of restoration. However, the benefits we gain from restoration can be valued higher than the costs of restoration, making restoration an investment. This study aimed to analyse the costs of wetland restoration projects implemented in selected European countries. We analysed 100 projects implemented between 1996 and 2019. Results showed increasing numbers of wetland restoration projects implemented in Europe since the early 21st century. The total budgets for wetland restoration projects rose in the years reviewed, increasing the average project budgets. The average cost of restoring 1 hectare of wetland in the 100 projects analysed was 9,084 EUR·ha^{-1}, which, including the amortisation rate of actions implemented to restore wetlands, allowed us to estimate the average unit cost of wetland restoration to 227 EUR·ha^{-1}·y^{-1}. Available information on the average values of ecosystem services provided by wetlands (estimated to be 4,011 EUR·ha^{-1}·y^{-1}) allowed us to conclude that the value of sustainably managed wetlands is from ten to fifty times higher than the average wetland restoration costs. Our findings indicate that wetland restoration should be considered an investment, as the revenue the society gains from reestablished wetlands outweighs the costs of their restoration. These findings contribute to the international discussion on wetland restoration's role in boosting environmental and economic resilience, underscoring the need for regular restoration efforts to benefit ecosystems, economies, and societies.

Keywords: ecosystem services, management, peatland, restoration, riparian, valuation

INTRODUCTION

Wetlands, transitional zones between land and water, have historically been undervalued and often considered wastelands. Perceived as neither fully aquatic nor terrestrial, they were dismissed as unproductive areas unsuitable for human use. This misconception led to the widespread conversion of coastal and inland wetlands for agriculture, urban development, and other land uses. Fragmentation, drainage, and habitat destruction followed, with global development introducing additional pressures such as nutrient pollution, chemical runoff, tourism, and infrastructure expansion (e.g., dams and dikes). Compounding these threats, climate change has further disrupted wetland ecosystems through altered hydrological cycles and extreme weather events. The consequences of this historical disregard are stark: over half of the world's wetlands have been lost since 1900, with estimates suggesting losses of up to 87% since 1700 (Davidson, 2014).

Europe has experienced the most severe wetland decline, with land-use changes transforming vast areas for agriculture and urbanisation over centuries (Siuta and Nedelciu, 2016). By the 20th century, remaining wetlands – often within protected areas – continued to degrade due to aquaculture and infrastructure pressures (Čížková *et al.*, 2013; Tóth *et al.*, 2020). These habitat losses not only diminish biodiversity but also disrupt valuable ecosystem services, including water retention, carbon sequestration in peat soils, and pollutant filtration by buffer zones (Strzęciwilk, Stachowicz and Grygoruk, 2022). Despite their undervaluation, wetlands are among the world's most productive ecosystems, delivering diverse benefits that support millions of people locally and globally (Barbier *et al.*, 1997). These benefits include freshwater access, carbon storage, flood protection, and biodiversity preservation.

However, the ongoing loss of wetlands has created critical vulnerabilities, threatening freshwater availability and increasing flood and drought risks (Ramsar, 2015). The pressing need to address these vulnerabilities has led to a global push for wetland restoration, with initiatives like the Ramsar Convention and EU LIFE Program emphasising the ecological and societal value of these habitats (CBD, 2015; CINEA, no date). The EU LIFE Program, established in 1992, has become the largest funding instrument for environmental and climate action in Europe, co-funding thousands of wetland restoration projects. These projects have preserved wetlands and their ecosystem services, which collectively contribute over EUR12 tn annually to global economies (Costanza *et al.*, 1997; Siuta and Nedelciu, 2016).

Effective wetland restoration can mitigate the impacts of land-use changes, floods, and droughts while supporting biodiversity and climate resilience (Szałkiewicz, Jusik and Grygoruk, 2018). Failing to restore degraded ecosystems risks significant losses in ecosystem services and increased restoration costs in the future (Aubert, McDonald and Scholl, 2022). The success of restoration efforts hinges on a clear understanding of wetland hydrology, soil, and topography, which informs appropriate techniques for protection and rehabilitation (Patten, 2006). Analysing past restoration projects provides valuable lessons on overcoming challenges and optimising outcomes. Comprehensive data on the costs, results, and future projections of restored sites can guide strategic actions and inform policymakers, ensuring effective use of resources.

In this study, we performed an economic and environmental analysis of selected wetland restoration projects conducted in the EU. Specifically, we aimed to: (1) identify and evaluate the scope of wetland restoration projects within the EU; (2) determine whether these projects are part of comprehensive restoration strategies or remain isolated actions; (3) assess the financial contributions of EU and national resources to wetland restoration; and (4) calculate the average cost of wetland restoration to estimate the value communities are willing to invest for long-term benefits. Finally, (5) we compared the costs of wetland restoration with the estimated value of ecosystem services of wetlands which allowed us to highlight the economic efficiency of wetland restoration.

MATERIALS AND METHODS

This study utilised a questionnaire composed of both open-ended and closed-ended questions, alongside official reports collected from the European Commission (EC) LIFE Program database and available online sources. The open-ended questions (Tab. S1) focused on gathering detailed information such as the size of the restored area, the associated restoration costs, the types of wetlands restored, and the restoration methods employed. The closed-ended questions addressed topics such as the entity responsible for the project, local community involvement, monitoring of project outcomes, and whether the restoration efforts were part of a larger strategic restoration plan.

The questionnaire was distributed to over 140 specialists engaged in wetland restoration projects across Europe. These specialists, along with their respective projects, were identified through the EC LIFE Program, which is the European Union's primary funding instrument for environmental and climate action, established in 1992. As part of the LIFE Program, specialists are required to prepare official reports after each project (Fig. S1). These reports summarise project activities and results for a general audience and provide an official record of the outcomes. Given that most of the projects in this study were LIFE-funded, the specialists cross-referenced their questionnaire responses with the relevant official project reports. Upon receipt of the completed questionnaires and collection of available reports, the data (Tabs. S2, S3, S4, S5) were analysed. The first step involved tallying the number of projects, which were categorised by their project completion date. An analysis of the structural composition of the wetland restoration projects followed, focusing on whether the projects involved active participation from local authorities and communities, whether their outcomes were monitored, and whether the projects were part of larger restoration strategies or plans.

Next, the spatial scale of each project was analysed. Responses were categorised based on the restoration measures applied to various wetland types, including bogs and mires, freshwater wetlands, coastal wetlands, grasslands, and forests. This analysis also included a breakdown by the completion year of the restoration projects. Furthermore, the entities responsible for the projects were categorised into the following groups: Regional, National, NGO, Private Investors, and Other. The final analysis also included an examination of EU co-funded projects, as well as an analysis of the average funding allocated to wetland restoration for each of the analysed periods. Using the data gathered from the questionnaires, the unit costs of wetland restoration projects were calculated, expressed in EUR per hectare ($EUR{\cdot}ha^{-1}$). This calculation was based on the reported project costs and restored wetland areas.

Wetland restoration projects generally involve technical interventions that create lasting assets. These assets typically depreciate gradually over time, and thus an annual depreciation rate (amortisation) was applied to estimate the per-hectare annual cost of wetland restoration. By Polish legal regulations, the annual depreciation rate for permanent assets, such as hydrotechnical structures, drainage systems, and land reclamation, is set at 2.5%. This implies a lifespan of 40 years for such assets (1 year per 2.5%) (Szałkiewicz *et al.*, 2018). Given that this depreciation rate is similar to the EU average, it was applied in this study to estimate the yearly average cost of wetland restoration per hectare. While this provides an approximate value, it is a crucial metric for understanding the long-term economic investment in wetland restoration, which delivers a wide range of services, including water purification, carbon storage, biodiversity conservation, food production, and climate change mitigation.

Wetland ecosystem services remain an important topic in the international environmental management discussion (Eric *et al.*, 2022; Petsch *et al.*, 2023; Strzęciwilk, Stachowicz and Grygoruk, 2023; Makrickas *et al.*, 2023). Even though the "average" value of wetland ecosystem services is inherently impossible to quantify due to vast differences between particular wetlands, their contemporary status, area, and data available, such attempts were already made in the literature to highlight the value of these ecosystems (e.g., Groot de *et al.*, 2012). In our study, we performed a similar analysis to find the general, yet probable, average value of wetland ecosystem services to compare its order of magnitude to the precisely quantified cost of wetland restoration calculated in this study. Concerning this, we performed the standard literature review and listed values of selected ecosystem services of wetlands, predominantly from Europe, but also, when feasible, from other continents. The average unit value of wetland ecosystem services (expressed in EUR·ha^{-1}·y^{-1}) was calculated as an arithmetic mean of the retrieved individual values. Values provided in the original studies in USD were re-calculated to EUR using the conversion ratio from the date of submission of the revised version of this manuscript (January 2025; 1 USD = 0.97 EUR). We considered this simplifying assumption applicable in our study, as the goal of this analysis was to find the order of magnitude of the average value rather than the accurate number.

RESULTS

Raw data were obtained from 24 countries, resulting in 100 wetland restoration projects deemed valid for this analysis. These projects were distributed across Europe, with 51 projects in Western Europe (e.g., Austria, Belgium, Germany, Spain, and the UK), 21 in Central and Southern Europe (e.g., Bulgaria, Italy, Poland), and 28 in Northern Europe (e.g., Denmark, Finland, and Sweden). The geographic distribution is visualised in Figure 1.

Since the start of the 21st century, there has been an increase in the number of wetland restoration projects across the European countries for which data was analysed. Particularly after 2000, reflecting growing awareness of wetland degradation and the importance of restoration initiatives. This trend is illustrated in Figure 2. Active community participation was reported in 76% of projects, with stakeholders involved in planning, monitoring, and decision-making processes. Monitoring mechanisms were implemented in nearly all projects (97%), although the scope and consistency of monitoring varied. Additionally, 52% of the projects were part of larger regional or national strategic plans, while 48% were standalone initiatives. Figure 3 summarises these findings. Restoration efforts targeted five main habitat types: peatlands (e.g. raised bogs, peat bogs, transitional mires, and quaking bogs, fens), freshwater wetlands (e.g. lakes, marshes), coastal wetlands (e.g. coastal lagoons, coastal meadows, lakes), forests (alluvial forest) and grasslands (e.g. wet grasslands, wet meadows). Peatlands accounted for the majority of recent projects due to their cost-effectiveness and high ecological value. Coastal and freshwater wetlands were restored less frequently but represented critical habitats for biodiversity and climate resilience. Figure 4 shows the distribution of restoration projects by habitat type over time.

Regional authorities were responsible for managing 39% of the projects, followed by NGOs (29%) and national organisations (19%). Private investors and consortia contributed to 13% of projects, primarily in coastal wetlands, where restoration costs are highest (Fig. 5). Over time, regional authorities dominated early efforts, while NGO and private sector participation increased significantly after 2010 (Fig. 6).

EU LIFE Program funding played a critical role, covering an average of 60% of the total costs for each project. National governments and NGOs provided additional funding (30%),

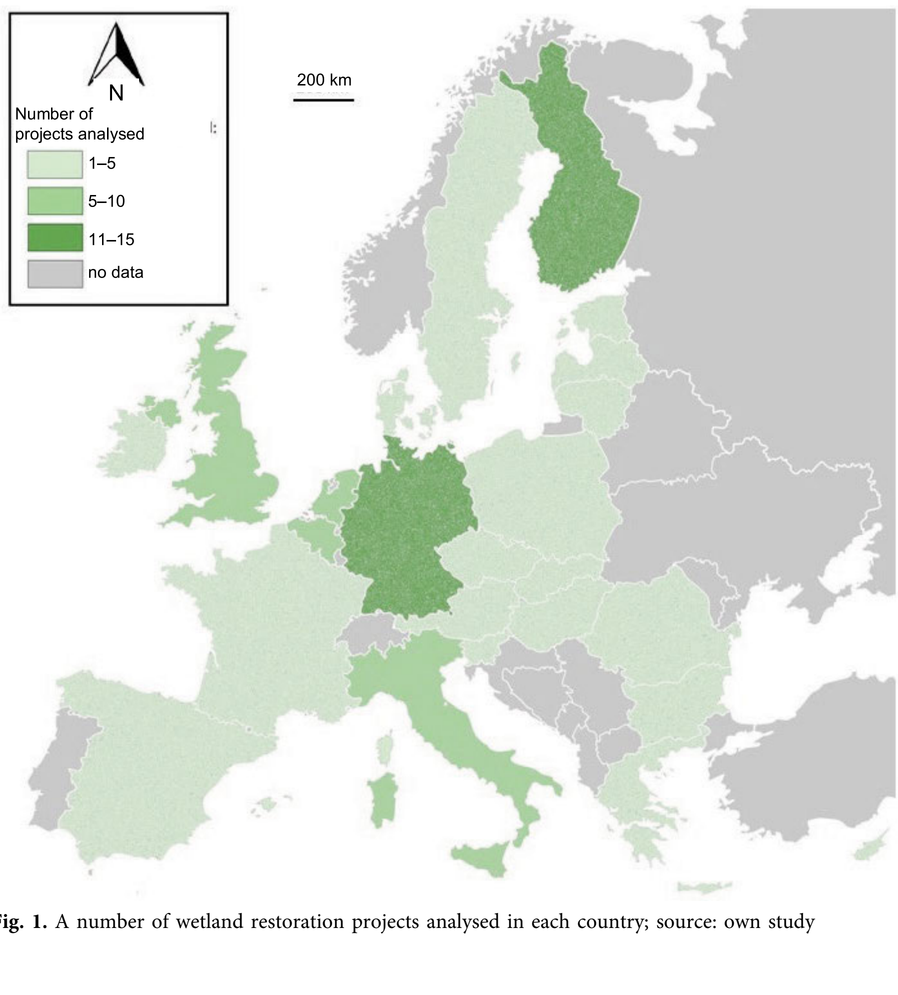

Fig. 1. A number of wetland restoration projects analysed in each country; source: own study

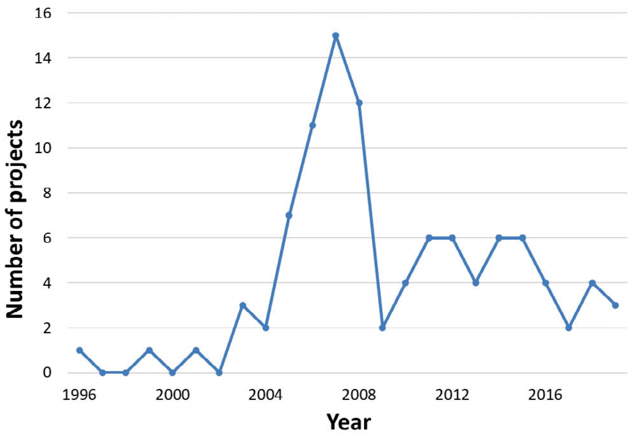

Fig. 2. Number of wetland restoration projects implemented over the period 1996–2019; source: own study

Fig. 3. The share of analysed projects: a) that involved local communities in their design/implementation, b) results of which were systematically monitored, c) that were incorporated into a broader wetland restoration strategy (e.g., national); source: own study

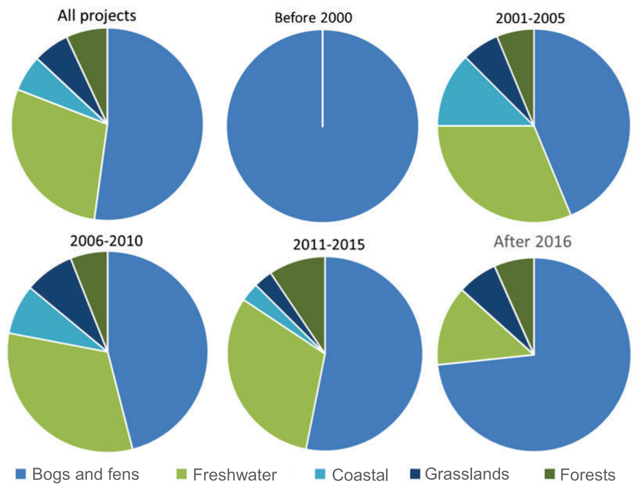

Fig. 4. The share of projects in designated periods targeting restoration activities in bogs and mires, freshwater, coastal, grasslands, and forest habitats; source: own study

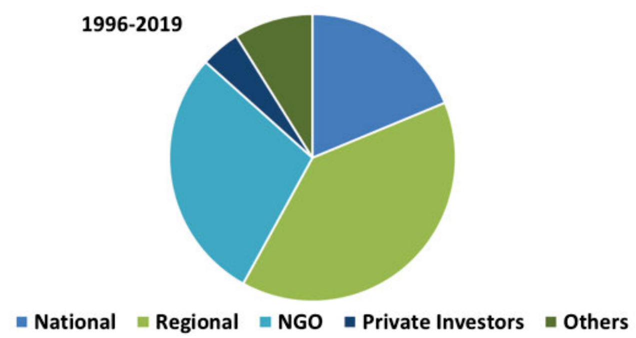

Fig. 5. The overall proportion of entities implementing wetland restoration during the examined period; source: own study

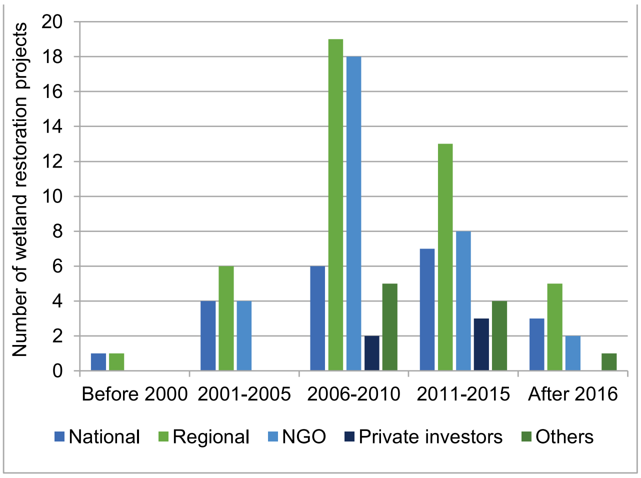

Fig. 6. Types of organisations responsible for carrying out specific wetland restoration projects within the analysed time frames; NGO = non-governmental organisation; source: own study

while private investors contributed 10%. Over time, EU contributions remained relatively stable but varied by wetland type, with coastal wetlands receiving the largest share due to their high restoration costs and strategic importance (Fig. 7). Once the total budgets for the wetland restoration initiatives and their areas of impact were taken into account, calculations were made to determine those initiatives' average unit value per hectare of restored wetland (Fig. 8a, b). It has been shown that, on average, the cost to restore 1 hectare of wetland was 9,084 $\mathrm{EUR \cdot ha^{-1}}$, with a range from 2,561 $\mathrm{EUR \cdot ha^{-1}}$ (before the year 2000) to 9,811 $\mathrm{EUR \cdot ha^{-1}}$ (after the year 2016) – Figure 8a, b. As there were no clues to exclude outlying values, they were considered in the results. Outlying values refer to projects that restore freshwater and coastal habitats. Despite the presence of outliers, the differences in wetland restoration costs per unit across the analysed periods were insignificant. This observation suggests that, despite significant variability in wetland restoration unit costs from site to site and depending on the measures applied, they stayed relatively stable across Europe during the period from 1996 to 2019.

Analyses of wetland restoration initiatives unit costs concerning the habitat type (bogs and mires, freshwater, coastal), showed that the differences were more significant among these groups than those between the time frames (Fig. 9a). Costs of bogs and mires habitat restoration (5,938 $\mathrm{EUR \cdot ha^{-1}}$) turned out to be lower than the restoration of freshwater and coastal ecosystems (14,631 $\mathrm{EUR \cdot ha^{-1}}$ and 15,589 $\mathrm{EUR \cdot ha^{-1}}$, respectively). Open water and lagoons require different types of restoration work than bogs or fens. The wide definition of wetlands makes it hard to prepare a proper assessment of the costs of restoration of those habitats. This is why in the next step; new analysis should focus on more narrow criteria so the comparison of restoration measures can be made among different types of wetland ecosystems. Based on the assumed depreciation costs (2.5% per annum) it was revealed that the average annual cost of wetland restoration calculated based on 100 projects analysed was as high as 227 $\mathrm{EUR \cdot ha^{-1} \cdot y^{-1}}$ (Fig. 9b).

The literature search conducted allowed us to estimate the average value of wetland ecosystem services (Tab. 1). The collected values represent both individually estimated values of ecosystem benefits for individual wetlands (e.g. Grygoruk *et al.*,

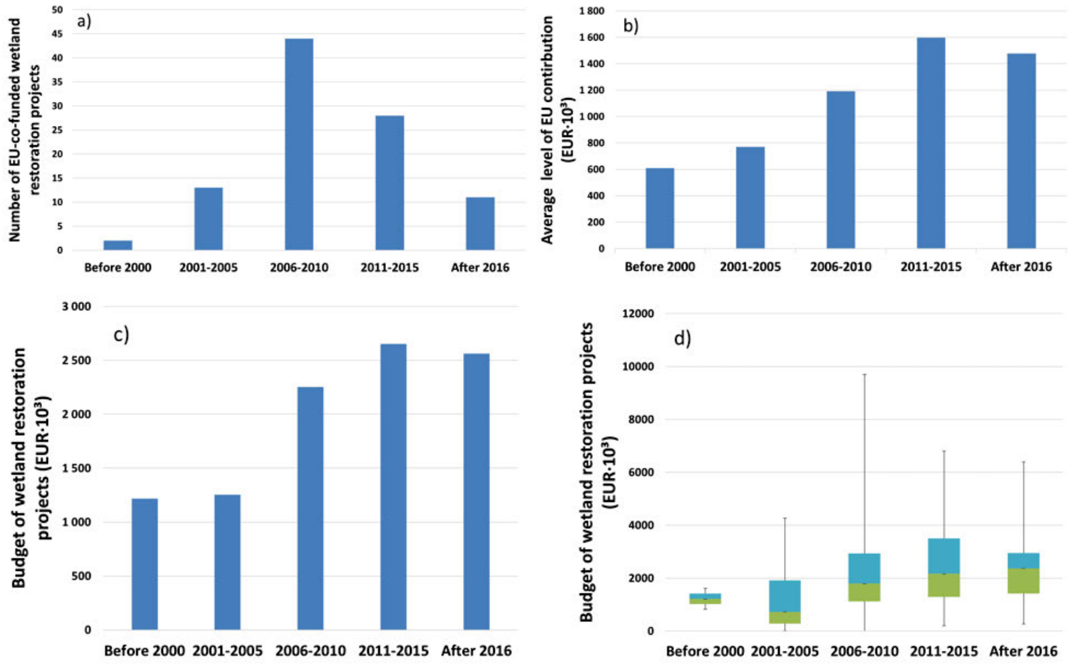

Fig. 7. EU-funded wetland restoration projects: trends and financial overview: a) number of projects co-funded by the EU, b) average values of European contribution for each period, c) budget of wetland restoration projects, box-plot chart of budget of wetland restoration projects; the box represents the interquartile range (from the 25th to the 75th percentile), the vertical line within the box denotes the median, and the whiskers indicate the maximum and minimum values; source: own study

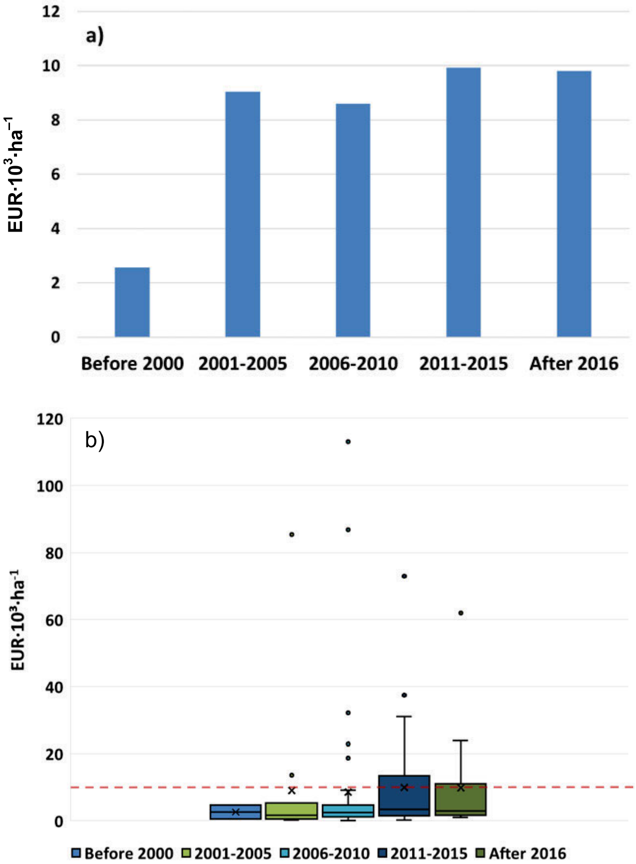

Fig. 8. Distribution of unit costs (EUR·10^3·ha^{-1}) for wetland restoration projects over specific periods: a) bar diagram, b) box-plot chart; the box spans the 25–75% range, "×" marks the average value, the vertical line within the box shows the median, whiskers denote the maximum and minimum values, and dots indicate outliers; the red dashed line represents the average costs of restoring 1 ha of wetland ecosystem; source: own study

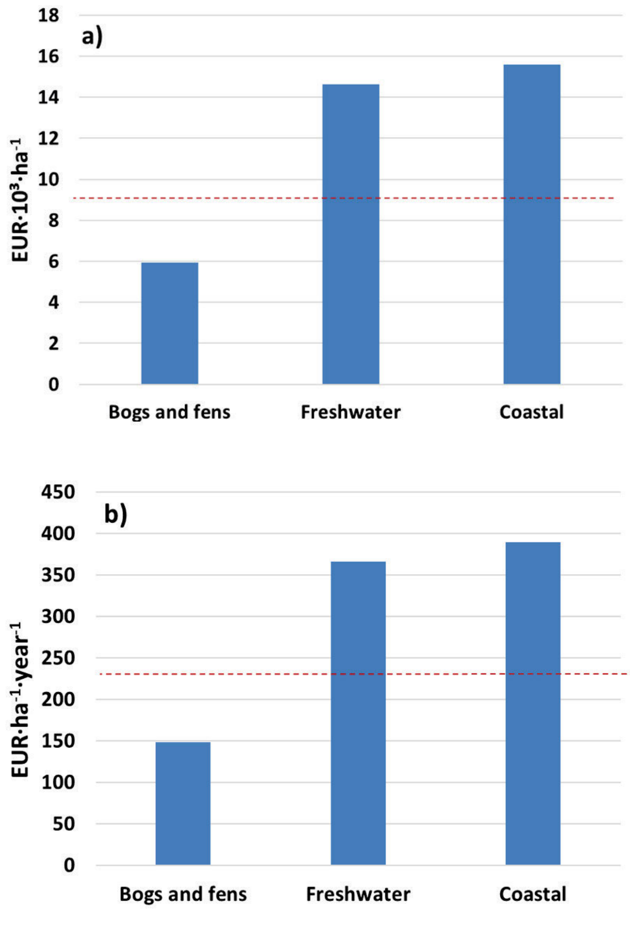

Fig. 9. Unit cost distribution of wetland restoration projects about various wetland habitat types: a) per 1 hectare (EUR·10^3·ha^{-1}), b) annual cost per 1 hectare (EUR·ha^{-1}·y^{-1}); the red dashed line = the average costs; source: own study

Table 1. Values of ecosystem services of wetlands retrieved from the available literature resources

No.	Reference	Country/ region	No. ecosystem services quantified	Original value		Re-calculated value (EUR·ha^{-1}·y^{-1})
				value	currency	
1	Belayev, Pugacheva and Korneeva (2022)	Russia	10	156	USD	151
2	Groot de *et al.* (2012)	International	NA	16,534	USD	16,038
3	Eric *et al.* (2022)	Germany	NA	117	USD	113
4	Eric *et al.* (2022)	United Kingdom	NA	11,216	USD	10,880
5	Liu *et al.* (2023)	Europe	5	442	EUR	442
6	Grygoruk *et al.* (2013)	Poland	1	741	EUR	741
7	Makrickas *et al.* (2023)	Lithuania	4	582*	EUR	582
8	Strzęciwilk, Stachowicz and Grygoruk (2024)	International	2	3,141	EUR	3,141
Average value						**4,011**

* value for natural wetlands.
Source: own study.

2013; Belayev, Pugacheva and Korneeva, 2022; Eric *et al*., 2022; Makrickas *et al*., 2023) and averaged values of a larger number of wetland ecosystem benefits related to one hectare of their area (Groot de *et al*., 2012; Strzęciwilk, Stachowicz and Grygoruk, 2023). The arithmetic average of the collated values of ecosystem services in various wetland ecosystems was 4,011 EUR·ha^{-1}·y^{-1} (minimum value 113 EUR·ha^{-1}·y^{-1}, maximum value 16,038 EUR·ha^{-1}·y^{-1}). The obtained average value of wetland ecosystem services is one order of magnitude higher than the cost of restoring one hectare of wetland, calculated from the analysis of 100 wetland restoration projects.

DISCUSSION

The presented results provide insights into the costs and benefits of wetland restoration projects in Europe. Despite the large number of projects analysed and general, yet accurate assessment of the order of magnitude of average value of wetland ecosystem services, several limitations should be acknowledged, which may inform the interpretation of results and guide future research efforts. The presented analysis relied on data from questionnaires and official reports, primarily sourced from the EU LIFE Program database. Some projects were excluded due to incomplete data, such as missing information on costs or restored area sizes. Additionally, newly initiated projects were omitted, as their outcomes could not yet be evaluated. These limitations highlight the need for standardised, accessible reporting systems to ensure the availability of consistent data for future analyses. Although the study encompassed 100 projects across 24 countries, certain regions and wetland types were underrepresented, particularly in southern and eastern Europe. Language barriers and limited access to non-English documentation further constrained the comprehensiveness of the dataset. Expanding geographic and habitat-specific data coverage is essential for capturing a more balanced understanding of wetland restoration efforts across Europe.

Restoration costs varied significantly between wetland types and regions due to differences in methodologies, local labour costs, and ecological conditions. While in this study are calculated only the average costs of restoration and the average value of wetland ecosystem services, these figures do not fully capture the complexities of restoration across diverse settings. Developing region-specific cost frameworks and conducting more granular analyses will provide greater precision in economic evaluations.

Wetland restoration efforts vary widely by habitat type, each presenting unique challenges and opportunities. In our study, peatlands accounted for the majority of projects, likely due to their relatively low restoration costs and immense carbon storage potential (Tóth *et al*., 2020). Over the analysed period, the share of peatland (bogs and fens) restoration projects steadily increased, reaching nearly 75% of all projects analysed after 2016.

Although less frequently restored, freshwater riparian wetlands play a crucial role in improving water quality, mitigating floods, and supporting biodiversity. These ecosystems provide essential services that benefit both the environment and human communities, highlighting the importance of their conservation and restoration efforts.

A most likely explanation for the fact that restoration costs of riparian wetlands are higher than in peatlands is that they need complex hydrological interventions and earthworks (such as dyke relocation). However, at the same time, the benefits provided by these habitats in terms of water purification and flood control make them an essential part of integrated watershed management strategies. Restoration of coastal wetlands is the most expensive but also the most critical, particularly in regions vulnerable to climate change impacts such as flooding and erosion. Coastal wetlands provide valuable ecosystem services that protect human settlements, combat climate change, support fisheries, and enhance biodiversity (Bertolini and Mosto da, 2021). The high restoration costs associated with these wetlands are justified by the usual requirement of planning complex saltwater-freshwater interactions as well as the application of cutting-edge design technologies.

Restoration costs varied significantly across regions, reflecting differences in local economic conditions, restoration techniques, and the extent of wetland degradation. These variations highlight the need for region-specific strategies and funding mechanisms tailored to local conditions. Interestingly, over the analysed period (1996–2019), budgets for wetland restoration projects increased considerably. Unit costs of restoring an average of 1 hectare of a wetland before the year 2000 were equal to some 2,100 $EUR·ha^{-1}$, whilst after 2016 it nearly reached 10,000 $EUR·ha^{-1}$. Such a five-fold increase in costs cannot be explained by the ongoing inflation on the European markets, but rather by the fact of increasing complexity of projects and higher demands for planning and communication activities that must remain an important element of wetland restoration procedures (Grygoruk and Rannow, 2017).

A significant proportion of the projects (48%) were standalone efforts rather than part of larger, coordinated strategies. This lack of integration can limit the effectiveness of restoration efforts and may lead to fragmented conservation outcomes. It also indicates, that nearly half of the projects analysed were not implemented as a part of a larger (e.g., national) strategy.

Future restoration initiatives should prioritise coordination at the regional or national level, aligning individual projects with broader conservation goals to achieve more comprehensive, sustainable outcomes.

One of the primary challenges identified in this study was the lack of standardised monitoring data across projects. While nearly all projects implemented some form of monitoring, the quality and consistency of data varied widely. Usually, the monitoring schemes applied in the project analysed covered only a short time spanning from some two years before the project implementation up to three years after the technical interventions implemented as restoration activity. Due to the temporal variability of the ecological status of ecosystems subjected to restoration resulting from their spontaneous reaction to both environmental conditions (e.g., meteorological variability, species shifts (Bączyk *et al.*, 2016), long-term (i.e., longer than 10 years) monitoring is essential to assess the sustainability of restoration efforts and the continued provision of ecosystem services. Future restoration projects should include standardised reporting frameworks and long-term monitoring plans to ensure the desirable, appropriate status of wetlands subjected to restoration. Although most projects implemented monitoring systems, the quality, duration, and consistency of these systems varied. Long-term ecological and economic outcomes of restoration efforts were often underreported, limiting the ability to assess sustainability.

The amortisation rate applied in this study (2.5%) to calculate the average annual unit cost of restoration was based on Polish legal regulations for permanent assets. While it aligns with EU averages, it may not fully reflect regional differences in infrastructure durability or restoration contexts. Restoration activities oriented toward wetland improvement overwhelmingly consist of technical interventions, such as damming of water in dry peatlands (Stachowicz *et al.*, 2025), earthworks to restore marshy buffer zones (Jabłońska *et al.*, 2020), and the whole habitat with its full range of functionalities in case of some coastal wetlands (Bertolini and Mosto da, 2021), the use of depreciation rates for technical works as equivalent to restoration seems legitimate. A similar assumption was made in the work of Szałkiewicz, Jusik and Grygoruk (2018), which allowed for a similar analysis in the case of river restoration. The assessed average value of benefits of wetland ecosystems on a European scale is certainly not representative. This is because it was made based on more than a dozen available literature sources quantifying the monetary value of selected ecosystem benefits. However, an attempt to assess this value yielded an approximate result of more than 4,000 $EUR·ha^{-1}·y^{-1}$, which is an order of magnitude higher than the estimated unit annual cost of restoring 1 hectare of wetland (227 $EUR·ha^{-1}·y^{-1}$). Thus, a comparison of the values obtained allows us to conclude that the benefits that society derives from wetland restoration, despite the significant cost of restoration projects, are much greater than the expenses incurred. What is more, this gain, expressed in terms of the absolute difference between restoration expenditures and the benefits derived from the proper functioning of wetlands, can be optimised through the use of more cost-effective restoration measures (e.g., peat dams – Stachowicz *et al.* (2025) – instead of concrete structures requiring design and maintenance – Grygoruk *et al.* (2015)). Similar conclusions were drawn by Stachowicz *et al.* (2022) and Jabłońska *et al.* (2020).

The presented analysis of wetland restoration costs and the literature-based valuation of the average value of wetland ecosystem benefits led to the determination of wetland values. On one hand, under the assumption that wetland restoration is carried out under market economy conditions (and this was the case for the 100 LIFE projects analysed), so one can venture to say that the obtained value of 227 $EUR·ha^{-1}·y^{-1}$ represents the equivalent annual cost of wetland restoration which mirrors the societal willingness to pay for restoring or maintaining wetlands in a proper condition that allows the existence of natural diversity and socially and economically useful functions of these ecosystems. On the other hand, the valuation of ecosystem services of wetlands made based on the value of the functions performed by wetland ecosystems reaching 4,011 $EUR·ha^{-1}·y^{-1}$ represents the amount that the society would have to pay to receive a similar revenue as the one provided by wetlands.

This value, yet much higher than the equivalent annual cost of wetland restoration, is still – likely – underestimated. Most studies published in the field of wetlands ecosystem services usually focus on a few services at most (Clarkson, Ausseil and Gerbeaux, 2013; Belayev, Pugacheva and Korneeva, 2022; Makrickas *et al.*, 2023; Strzęciwilk, Stachowicz and Grygoruk, 2024) leaving most of the services unevaluated. Keeping this fact in mind and comparing the given two values one could conclude that the real funds spent on restoring appropriate functions of wetlands are an investment, as the annual revenue obtained from wetlands is much higher than the amounts spent on wetland restoration. Future research should focus on expanding our understanding of wetland restoration across diverse ecological and socioeconomic contexts. Conducting comparative studies of wetland restoration efforts across different continents will help identify region-specific best practices and effective restoration techniques. Developing standardised metrics for the economic valuation of ecosystem services provided by wetlands will improve cost-benefit analyses and facilitate decision-making at the policy level. Longitudinal studies are needed to assess the long-term effectiveness of restoration projects, particularly in terms of ecosystem service provision and carbon sequestration. These studies will provide valuable insights into the sustainability of restoration efforts and inform future projects. Future studies should consider adapting depreciation rates to account for site-specific factors. To overcome these challenges and build upon the findings of this study, we suggest that the development of a standardised reporting framework is required for efficient quantification of outcomes from wetland restoration projects, both in terms of economic revenue and environmental efficiency. It is likely, that the valorisation of ecosystem services will become one of the key measures of wetland ecosystem restoration success in the years to come.

CONCLUSIONS

This study underscores the critical role of wetland restoration in climate change mitigation, biodiversity conservation, and the provision of essential ecosystem services. The findings demonstrate that wetland restoration is not only ecologically beneficial but also a cost-effective investment, with significant economic returns in the form of ecosystem services. The average cost of restoring one hectare of wetlands in Europe was 9,084 EUR, providing the equivalent annual cost of wetland restoration at the level of 227 EUR$\cdot$ha$^{-1}\cdot$y^{-1}. The calculated average annual value of wetland ecosystem services based on the literature review is equal to 4,011 EUR$\cdot$ha$^{-1}\cdot$y^{-1}, and is one order of magnitude higher than the discussed herein restoration costs. This comparison allows us to state that the restoration of wetlands should be considered an investment, as the revenues the society gains from the appropriately managed wetlands are much higher than the costs of their restoration.

The Nature Restoration Law (Regulation, 2024), which is entering European legislation, requires the implementation of rapid environmental restoration measures. Given the numerous benefits provided to society by wetlands, it seems that accelerating the restoration of these ecosystems on a continent-wide scale should not face any clear public resistance. Criticism of wetland restoration in Europe stems mainly from the desire to continue overexploiting them mainly for agricultural purposes as fodder production areas. The research results presented here clearly indicate that at the level of communication of the necessity of wetland restoration, the investment nature of this activity should be indicated, taking the emphasis off messages based on natural diversity. While the overriding goal of wetland conservation will always remain the maintenance of wetlands in a good ecological state, emphasising the role of wetlands in providing measurable and socially and economically important functions, as well as their proper economic valuation, allows for increased acceptance of wetland conservation.

SUPPLEMENTARY MATERIAL

Supplementary material to this article can be found online at https://www.jwld.pl/files/Supplementary_material_Strzeciwilk.pdf

ACKNOWLEDGMENTS

We would like to thank Achim Schäfer for a constructive critique of an earlier version of the manuscript.

FUNDING

This research was carried out in the framework of the European Union's Horizon Europe WET HORIZONS project, grant agreement no. 101056848.

CONFLICT OF INTERESTS

All authors declare that they have no conflict of interests.

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