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Policies and practices impacting the implementation of nature-based solutions: a comparative study of ponds and pondscapes in eight countries

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Nature-based solutions (NBS) are increasingly suggested to address biodiversity decline and climate change. However, many ecosystems are hardly used as NBS, including ponds and pondscapes. We therefore examine how policies and practices affect their implementation as NBS. Using a content analysis of policy documents and stakeholder inputs, we assess the policy context in eight countries but also zoom in on policies and practices in seventeen pondscapes. We derive three key insights: first, a protective status for a pond or pondscape interlinks with other enabling factors for NBS implementation, and protection and conservation should therefore be considered more often as NBS. Second, there is a shortage of, especially long-term, financing. Third, local leadership should be nurtured to overcome a lack of institutional cooperation and stakeholder awareness as well as fragmented land ownership. Beyond that, we show that implementation barriers interlink and interventions should therefore address several barriers simultaneously.

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Keywords: barriers; enabling factors; NBS implementation; policy analysis; ponds and pondscapes

1. Introduction

'Nature-Based Solutions' (NBS) have become increasingly popular to tackle the challenges of the Anthropocene (Frantzeskaki *et al.* 2020; Nesshöver *et al.* 2017), such as climate change, biodiversity loss, and ensuring human well-being. Broadly, NBS as a concept means working with nature for simultaneous biodiversity and societal benefits. A range of actions can qualify as NBS, including creating, restoring, and managing ecosystems. Some also deem ecosystem protection or conservation with little to no intervention NBS (Cohen-Shacham *et al.* 2016; Eggermont *et al.* 2015; Seddon *et al.* 2021). Yet, while the concept has gained popularity, a broad-based use of a diversity of ecosystems as NBS has not materialized but has focused on a select few (Seddon *et al.* 2021).

One type of ecosystem that is hardly used as NBS is ponds[1] and pondscapes (i.e. networks of ponds and surrounding terrestrial habitats) (Boothby 1997; Cuenca-Cambronero *et al.* 2023; Hill *et al.* 2018). While ponds are occasionally subsumed under wetlands or lakes (Richardson *et al.* 2022; UNESCO 1994), their distinct morphology and water chemistry, in fact, sets them apart from other wetland types and larger standing water bodies (i.e. lakes), possessing particular ecosystem structures and functions (Richardson *et al.* 2022). Ponds can sustain rare and endangered species and can function as refuge habitat in altered landscapes (Hill *et al.* 2021). In addition, ponds, and particularly pondscapes,[2] despite their relatively small size, can provide significant Nature Contributions to People (NCPs), including water storage to alleviate droughts or floods, water quality improvements, educational opportunities, and more, but to do so often rely on active management (Bartrons *et al.* 2024; Cuenca-Cambronero *et al.* 2023). Instead, however, ponds are disappearing and deteriorating (Gozlan *et al.* 2019; Kristensen and Globevnik 2014), due to human activities and climate change in both rural (Sayer 2014; Sayer and Greaves 2020) and urban areas (Oertli and Parris 2019). Due to their small size, ponds are especially vulnerable to even minor changes in surrounding land use (Boix *et al.* 2012; Søndergaard, Jeppesen, and Jensen 2005). Also, sometimes ponds are constructed for food production purposes (Fiener, Auerswald, and Weigand 2005; Rao *et al.* 2017; Sønderup *et al.* 2016), but with neglect for potential benefits for biodiversity, undermining the intended multifunctionality of NBS (Bartrons *et al.* 2024; Blicharska and Johansson 2016; Cuenca-Cambronero *et al.* 2023).

Several studies have highlighted political, socio-economic, and cultural barriers as underlying factors for the slow diffusion of NBS (e.g.; Deely *et al.* 2020; Dorst *et al.* 2022; Frantzeskaki *et al.* 2020; Kabisch *et al.* 2016; Nelson *et al.* 2020; Raška *et al.* 2022; Sarabi *et al.* 2020). Barriers, including inadequate regulations, a lack of financing, low stakeholder awareness, can obstruct NBS implementation. Likewise, some authors have highlighted strategies to overcome barriers by nurturing enabling factors (Kabisch *et al.* 2016; Tozer *et al.* 2022; van der Jagt *et al.* 2023; Wamsler *et al.* 2020). However, current research largely focuses on the implementation of NBS generally, and especially in European urban areas (with some exceptions, see Raška *et al.* 2022). Since implementation is highly dependent on the governance context as well as the potential NBS itself (Dorst *et al.* 2022; Raška *et al.* 2022; Tozer *et al.* 2022), it is vital to increase the resolution of research efforts and focus on particular ecosystems as NBS—especially on the ones that are vulnerable to anthropogenic pressures but

potentially offer a multitude of benefits in many different (including non-urban) landscapes, like ponds and pondscapes (Cuenca-Cambronero *et al.* 2023; Hill *et al.* 2021; Søndergaard, Jeppesen, and Jensen 2005).

In fact, research has shed light on barriers affecting ponds as one of many possible NBS for climate change adaptation, Studies show the relevance of policies from multiple governance levels and their respective interpretation on the ground (Linnerooth-Bayer *et al.* 2015) and assume that implementation challenges for ponds differ from those for wetlands and lakes (Raška *et al.* 2022). However, the research focuses either on a particular political context (Linnerooth-Bayer *et al.* 2015) or is based on expert judgment (Raška *et al.* 2022). There is a paucity of studies that provide an in-depth empirical account of barriers and enabling factors for pond and pondscape NBS across a variety of contexts and drawing on stakeholder experiences, which could help to identify levers for implementation.

In this paper, we, therefore, examine how policies and practices constitute barriers and enabling factors for the implementation of pond and pondscape NBS. By policies, we understand binding laws, regulations, ordinances, etc., and non-binding strategies, management plans, declarations of intent, etc. Policies provide an overarching framework for NBS implementation (Sarabi *et al.* 2020; van der Jagt *et al.* 2023). However, actual activities on the ground ("practices") can be in line with, in addition to, or contrary to policies, and are likewise decisive. By assessing both, we gain a holistic picture of factors affecting the implementation of ponds and pondscapes as NBS.

Specifically, our qualitative comparative analysis covers pondscapes in eight countries—subject to different land uses and governance regimes, and at different stages of the NBS implementation cycle (Raymond *et al.* 2017).[3] We identify common barriers and enabling factors, as well as idiosyncrasies, that help to explain why NBS implementation takes its course or not. Considering that barriers are often interdependent (Dorst *et al.* 2022; Raška *et al.* 2022), and that addressing one barrier, or a subset of barriers, may unlock a virtuous cycle (Tozer *et al.* 2022), we also assess prevalent relationships between them.

2. Analytical framework: barriers and enabling factors

Some scholars have recently subsumed the issues that can generally affect NBS implementation under sets of categories of barriers and/or enabling factors (Deely *et al.* 2020; Dorst *et al.* 2022; Frantzeskaki *et al.* 2020; Kabisch *et al.* 2016; Nelson *et al.* 2020; Raška *et al.* 2022; Sarabi *et al.* 2020; Tozer *et al.* 2022; van der Jagt *et al.* 2023; Wamsler *et al.* 2020). However, no definitive set of categories has emerged. Therefore, for our analysis, we synthesize seven categories based on the literature (see Table 1). Each category can contain both barriers and enabling factors.

Importantly, a set of barriers can compound to form another barrier or, vice versa, one barrier may have cascading effects on multiple other barriers (Raška *et al.* 2022). At the same time, barriers and enabling factors are contextual and vary in their importance and presence (Dorst *et al.* 2022; Raška *et al.* 2022; Tozer *et al.* 2022). This implies that barriers and connections between them need to be investigated on a case-by-case basis (Sarabi *et al.* 2020) because efforts to nurture enabling factors may otherwise prove futile (Dorst *et al.* 2022). Ultimately, more than one intervention may be necessary, so that multiple interlocking barriers can be addressed (Tozer *et al.* 2022; van der Jagt *et al.* 2023).

Table 1. Definitions of common categories of barriers and enabling factors.

Category	Definition	Sources
Goals, objectives, and targets	Overarching policy goals guide action and set the direction in which a society or system shall develop. Policy objectives are outcomes to be achieved in support of the goal. A policy target is a specific level set for the chosen objective. Each can explicitly or implicitly support or adversely affect NBS implementation.	Kabisch *et al.* 2016; Tozer *et al.* 2022
Legal standards and regulations	Legal protections (i.e. statutory designations) for particular ecosystems or areas, land tenure and associated rights/duties, zoning policies, and other legal classifications of ecosystems that may impact their state or potential to be used as NBS.	Deely *et al.* 2020; Dorst *et al.* 2022; Raška *et al.* 2022; Tozer *et al.* 2022; van der Jagt *et al.* 2023
Financing	Funds necessary and available to implement NBS. This includes funds loaned, invested, granted, donated, earned, or levied.	Deely *et al.* 2020; Dorst *et al.* 2022; Raška *et al.* 2022; Sarabi *et al.* 2020; Tozer *et al.* 2022; van der Jagt *et al.* 2023
Management approaches and tools	Strategic planning capacities and focus of policy-makers, as well as day-to-day ability of managers to maintain the state of NBS and ensure the compliance of key actors with practices permitted by law.	Deely *et al.* 2020; Dorst *et al.* 2022; Kabisch *et al.* 2016; Nelson *et al.* 2020
Institutional capacities and cooperation	Resources and expertise of institutions involved in/(potentially) responsible for NBS. It includes their ability to cooperate across governance sectors and levels, alongside with rapport with key actors.	Deely *et al.* 2020; Dorst *et al.* 2022; Frantzeskaki *et al.* 2020; Kabisch *et al.* 2016; Nelson *et al.* 2020; Raška *et al.* 2022; Sarabi *et al.* 2020; Tozer *et al.* 2022; van der Jagt *et al.* 2023; Wamsler *et al.* 2020
Stakeholder awareness and engagement	Awareness of NBS benefits of stakeholders and their involvement in engagement processes through which they can influence NBS implementation.	Deely *et al.* 2020; Dorst *et al.* 2022; Frantzeskaki *et al.* 2020; Nelson *et al.* 2020; Raška *et al.* 2022; Sarabi *et al.* 2020; Tozer *et al.* 2022; van der Jagt *et al.* 2023; Wamsler *et al.* 2020
Knowledge development and transmission	Understanding of NBS benefits as well as efforts to expand and disseminate the knowledge.	Deely *et al.* 2020; Dorst *et al.* 2022; Kabisch *et al.* 2016; Nelson *et al.* 2020; Raška *et al.* 2022; Sarabi *et al.* 2020; Tozer *et al.* 2022; van der Jagt *et al.* 2023

3. Methodology

3.1. Research design and strategy

We employed a qualitative small-*n* case study methodology to, on the one hand, (1) examine in depth the barriers and enabling factors for the implementation of pond and pondscape NBS and, on the other hand, (2) be able to identify prevalent patterns across cases (Halperin and Heath 2012). Our sample[4] consisted of a total of seventeen pondscapes in eight different countries (see Table 2 for more information), capturing a variety of circumstances under which pond and pondscape NBS are or may be implemented. Specifically, the pondscapes:

- Are subject to different policies governing their state and use as NBS (e.g., some are located in and some outside the European Union);
- Are exposed to, or integrated in, a variety of land uses;
- Are at different stages of NBS implementation;
- Have different land tenure relationships.

In each country, we assessed relevant policy documents and organized one stakeholder workshop. Combining the analysis of documents and stakeholder inputs helped to capture barriers and enabling factors embedded in both policies and practices. Although the analysis focused on the policy context of the pondscapes (i.e. local), we also assessed relevant regional and national policy contexts. This is due to two factors: First, many of the selected pondscapes are impacted by higher-level policies, which therefore also indicate effects on the implementation of ponds and pondscapes NBS more broadly. Second, stakeholders present at the workshops provided insights beyond the pondscape-level (see Sections 3.2 and 3.3 for more information). In any case, this multilevel sampling strategy is not atypical in qualitative research, as it can yield rich information on differences and commonalities between overarching trends (country/region level) and singular cases (pondscape level) (Onwuegbuzie and Leech 2007).

Stakeholders were invited to the workshops based on two main criteria: (1) familiarity with the respective pondscape or with policies that can directly or indirectly impact pondscapes in a given region or country, and (2) interest in the respective pondscape or pondscape NBS generally. Also, if relevant, stakeholders from different governance levels were invited. Participating stakeholders included representatives of public authorities and civil society organizations (CSOs), private landowners, interested citizens, and researchers. Most stakeholders had had relationships with the researchers or were recommended by other stakeholders.

3.2. Data collection

From February 2022 until March 2023, data were gathered from policies, *via* inputs from local researchers (also co-authors), and at workshops organized for each pondscape. Specifically, we conducted the following steps to assemble the final dataset:

- Step 1A—*Mapping the political and socio-economic context*: Co-authors familiar with the respective pondscapes described main land uses, conflicts, stakeholders, and implemented or planned NBS for each pondscape;
- Step 1B—*Mapping the policy space*: The same co-authors compiled a long list of policies potentially impacting NBS implementation in their pondscape;

Table 2. Overview of basic information on the pondscapes selected for in-depth analysis.

Country (region)/ acronym	Pondscape	Landscape and main surrounding land use	Stage of NBS implementation	Reason for NBS (besides general biodiversity and human health enhancements)	Land tenure	# Of ponds
Belgium (Flanders)/BEL	Gete Vallei	Rural (agricultural, partly nature reserve)	NBS implementation; engagement of stakeholders; monitoring	Water management (water retention)	Mostly private	41
	Pikhakendonk			*No additional reasons*		62
	Tommelen	Urban (nature reserve)			Public	144
Denmark/DNK	Fyn Islands	Rural (agricultural)	NBS implementation; engagement of stakeholders; transfer and upscale; monitoring	Economic opportunities (subsidies); water management (pollution management)	Mostly private	>30
	Lystrup	Peri-urban (mixed use)		Climate change adaptation (flood management)	Mostly public	>14
Germany (Brandenburg)/ GER	Schöneiche	Peri-urban (mostly agricultural, partly urban, partly nature reserve)	NBS implementation; engagement of stakeholders	Water management (water retention)	Mostly private	26
United Kingdom (England)/GBR	Pinkhill Meadows	Rural (floodplain)	NBS implementation; engagement of stakeholders; transfer and upscale; monitoring	*No additional reasons*	Private	>50
	Water Friendly Farming (WFF)	Rural (agricultural)		Climate change adaptation (flood management); water management (drinking source for livestock)		120
Switzerland (Geneva)/CHE	Bois de Jussy	Rural (agricultural and woodland, partly nature reserve)	NBS implementation; engagement of stakeholders	Climate change adaptation (atmospheric cooling; flood management); water management (water retention)	Mostly public	69
	Rhône genevois	Peri-urban (agricultural and woodland, partly nature reserve)		Climate change adaptation (atmospheric cooling)		46

Spain (Catalonia)/ESP	Albera	Rural (agricultural)	NBS implementation; engagement of stakeholders; transfer and upscale; monitoring	Climate change adaptation (flood management); water management (water retention)	Mostly private	23
	La Pletera	Coastal and peri-urban (nature reserve)	NBS implementation; engagement of stakeholders; transfer and upscale; monitoring	Climate change adaptation (flood management); climate change mitigation (carbon sink)	Public	22
Turkey/TUR	Gölbaşı Düzlüğü	Peri-urban (mixed use)	NBS design; engagement of stakeholders; monitoring	Climate change adaptation (flood management); water management (water retention)	Mostly public	50
	Imrahor Valley			*No additional reasons*	Private	12
	Lake Mogan				Mostly private	10
Uruguay/URY	La Pedrera	Rural (prairies or native grasslands for cattle production)	NBS implementation	Water management (pollution management)	Private	18
	Sierra de los Caracoles (S.d.l.C.)					30

- Step 2—*Preliminary analysis of key policies*: We conducted an analysis of key policies at national and local levels following predefined protocols[5] (see the Annex in the Online Supplementary Materials for a list of analyzed policies and templates for analysis).
- Step 3—*Drafting of synopsis*: Based on the information gathered in previous steps, we drafted a synopsis of the main insights for each pondscape.
- Step 4A—*Validating main insights during workshops (between November 2022 and March 2023)*: The synopses also functioned as a script for the presentation of main insights to stakeholders and contained discussion/validation questions.
- Step 4B—*Group work on barriers and enabling factors*: During the workshops we conducted a break-out activity, asking stakeholder groups to deliberate the relevance and effects of barriers and enabling factors in their respective contexts. Scoring on a Likert scale was used, but to stimulate discussion rather than collect quantitative data (see Online Supplementary Material for an example of a template).

The heterogeneity of the pondscapes studied did not allow for pre-definition of a specific set of policies and instead required reliance on the first-hand experience of experts on the ground. We cannot rule out that we unintentionally omitted or overstated the significance of certain policies. In this context, the workshops helped us to validate collected information. Also, stakeholders largely confirmed the policy selection, in isolated cases pointed out additional policies to be assessed and elaborated in detail on the actual practices in line with or outside written policies.

At the workshops, we recorded the main discussion points in writing. Collectively, the synopses and workshop minutes formed the dataset for a qualitative content analysis.

3.3. Data analysis

Data were assessed through qualitative content analysis (Figure 1), guided by the categories of barriers and enabling factors introduced in Section 2. Initially, we coded data excerpts to those overarching categories. Over subsequent rounds of coding, we deduced sub-categories (Mayring 2000). For example, "Management Approaches & Tools as a barrier" was then broken down into "day-to-day management," and ultimately, "insufficient biophysical monitoring."

Importantly, we also identified "potentially enabling factors." These factors are currently not propelling NBS implementation, but were identified in written policies or constitute a "wishlist" of stakeholders; and nurturing them could advance pond and pondscape NBS.

Since barriers and respectively, (potentially) enabling factors frequently interlink, we recorded these relationships. There are a vast number of idiosyncratic relationships between barriers/(potentially) enabling factors across cases. However, through gradually grouping instances of relationships under categories of higher coding levels, we identified some recurring relationships between categories and/or sub-categories.

Generally, we strove to triangulate findings from our preliminary analysis with inputs from stakeholders. However, occasionally, language in policies is vague and workshop discussions emphasized other matters. Also, some recorded statements were imprecise. Under these circumstances, the analysis was validated with co-authors

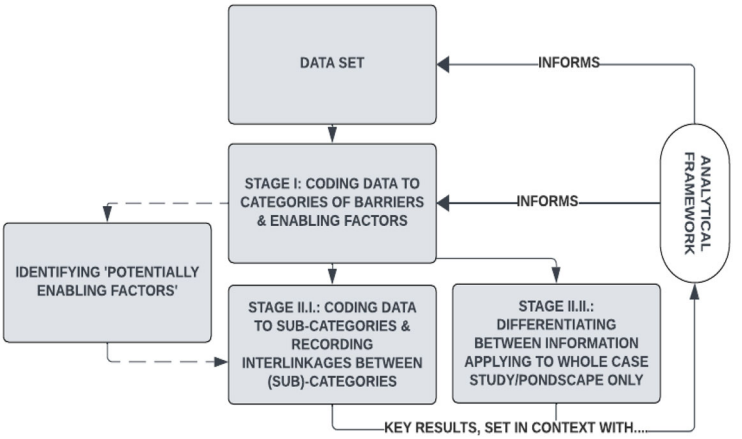

Figure 1. The data analysis process. This is a simplified representation. In reality steps happen simultaneously and/or iteratively.

familiar with a given context. If no definitive interpretation was possible, the data were omitted from the final analysis.

If applicable, we recorded whether information corresponded to a specific pondscape or to a broader regional or national context. This allowed for a nuanced analysis, partly because some pondscapes investigated in-depth have long been under the stewardship of dedicated stakeholders and may not be representative of the broader context.

4. Results

4.1. Barriers, enabling factors, and potentially enabling factors

Below, we present a synthesis of the results, differentiated by the overarching categories of barriers and (potentially) enabling factors. For a detailed overview of which barrier and (potentially) enabling factor emanated from which data sources please refer to the Online Supplementary Material. Relationships between categories are especially illuminated in Section 4.2. If a pondscape or region (e.g. Brandenburg, Catalonia) is mentioned explicitly, the information is specific to that entity and not necessarily applicable to the whole country.

4.1.1. Goals, objectives, and targets

Policy goals, objectives, and targets still predominantly form a barrier to NBS implementation. If at all, policy objectives mostly emphasize the maintenance of pond or pond-like habitats. Using (pond and pondscape) NBS for their non-biodiversity benefits is a less prevalent objective. Pond-specific targets remain especially rare (Figure 2).

Currently, in half of the studied countries, policy goals focus on extracting economic value from nature. Likewise, land uses harmful to the biophysical condition of ponds are prioritized (at least de facto) over biodiversity objectives in all cases. Some stakeholders hope policies would abandon an economic growth paradigm (La Pletera, ESP; GER), or at least include a stronger appreciation of natural capital (BEL; GBR; TUR).

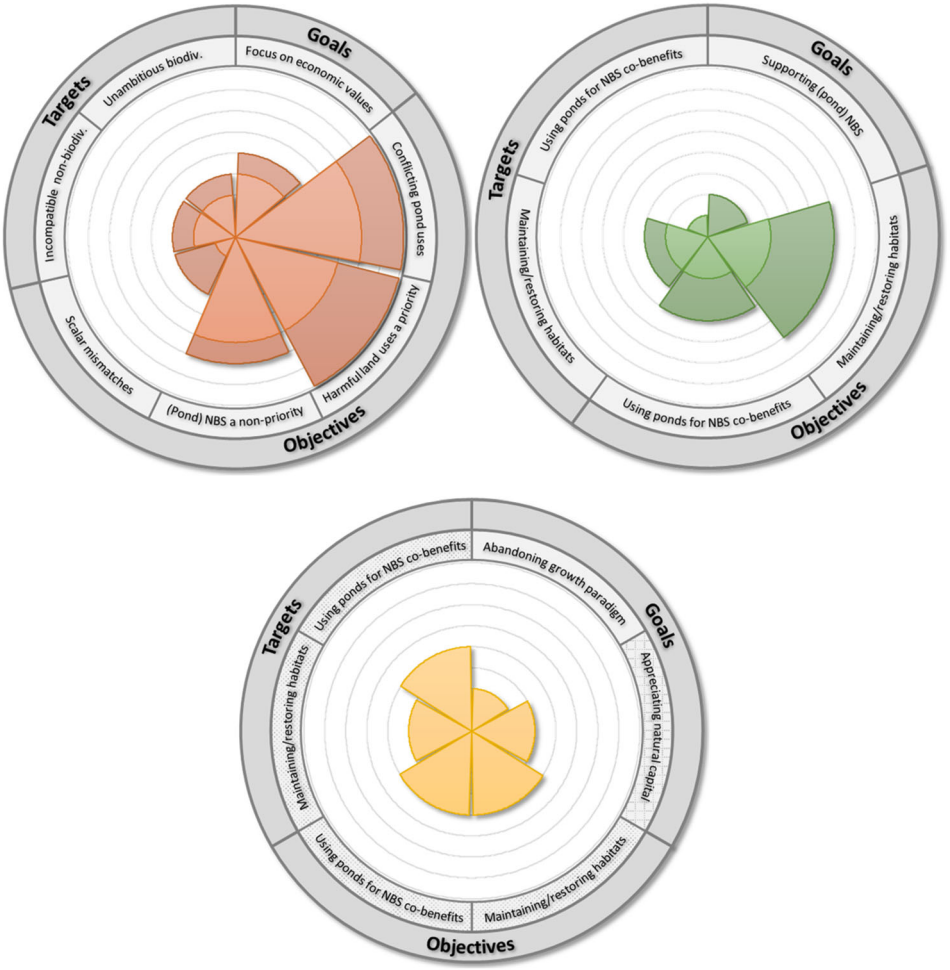

Figure 2. Barriers (red), enabling factors (green), and potentially enabling factors (yellow) linked to "Goals, objectives, and targets" across case study countries.
Note: The further out an element protrudes, the higher its prevalence across cases (i.e. element touching the ring signifies a prevalence in 8/8 countries). A dark shade means a phenomenon was only found in the pondscape(s) we investigated in-depth in a respective country. Also, subcategories under potentially enabling factors were only mentioned by stakeholders (no pattern), only found in policies (dotted), or both (chequered). Colour online.

Moreover, NBS, and particularly ponds, are still not widely considered to achieve objectives (CHE; GBR; GER; URY). Sometimes, NBS is only embedded in recent policies, and effects on pond and pondscape NBS remain unclear (BEL; ESP; GER; Gölbaşı, TUR). If ponds or pondscapes are intended as NBS, integrating multiple objectives is challenging, such as public well-being or climate change adaptation with biodiversity concerns (La Pletera, ESP; Lystrup, DNK).

Enabling factors appear in specific local contexts. In La Pletera (ESP) and Schöneiche (GER), policymakers strove to harmonize economic output with protecting natural heritage. Also, in the majority of countries studied, yet mostly in pondscapes assessed in-depth, objectives focus on improving the quality of ponds or types of habitats that include

ponds (e.g. amphibian habitats, wetlands). Higher-level policies have only lately incorporated this focus, often concentrating on protected areas (BEL; ESP; GBR; GER).

Pond-specific targets are rare (Pikhakendonk, BEL; Albera, ESP). Denmark is the only country-wide example, as it intends to restore ponds in Natura 2000 areas to achieve a favorable conservation status. Other relevant, more general targets concern the extensification of agricultural practices (DNK; GBR; GER).

4.1.2. Legal standards and regulations

Amongst legal standards and regulations, the legal status (including statutory designations, legal classifications, and zoning[6] of territories, ecosystems, or habitats) of an area and ecosystems contained within it is a meaningful barrier/enabling factor, with the designation of an area particularly impacting NBS implementation (Figure 3).

International designations, such as Natura 2000 or Ramsar, are considered too abstract to have an immediate impact on the ground (CHE; Albera, ESP; GBR; GER; URY); with some exceptions (BEL; La Pletera, ESP). In fact, the status may actually restrict options for pond restoration (GER). However, a designation seems to also correlate with better planning (Pikhakendonk, BEL; Schöneiche, GER), access to financing (BEL; DNK; La Pletera, ESP; GER), better (intended) monitoring (DNK, ESP), stronger institutions (La Pletera, ESP), and stakeholder awareness (GBR). National or local designations support many of the same enabling factors but provide more specific land-use restrictions (e.g. BEL; GER; URY).

A persistent problem is that designations may prevent deterioration but often do not require restoration (CHE; DNK) and that protecting individual ponds does not mitigate land-use pressures (DNK; GBR). Also, designations may hinder cooperation with farmers worried about operational restrictions (CHE; DNK; GBR; TUR). Hence, stakeholders not only hope for the enforcement of land-use restrictions in protected areas (Albera, ESP; GER; TUR; URY) but also improved land-use regulations and monitoring in non-protected areas (BEL; CHE; DNK; ESP; GER; TUR).

Legal classifications categorize ecosystems, determining, inter alia, biophysical quality standards. Occasionally, EU classifications help to attract funding for NBS (e.g. Annex II/IV species of the EU Habitats Directive in Getevallei, BEL; Fyn Islands, DNK; La Pletera, ESP), but can also be superseded by local decisions. In Albera (ESP), for example, temporary ponds (priority habitat as per the EU Habitats Directive), are cataloged for agricultural use, as they are dry most of the year. Also, most classifications setting water quality standards or specifying minimum buffer strip widths along and around water bodies omit ponds (CHE; ESP; GER; TUR; URY). Future country-wide improvements may depend on whether ponds are to be classified as a lake (GER) or wetland (ESP) (entailing land-use restrictions and monitoring).

Zoning is not often a barrier (except for occasionally in CHE, TUR, and Albera, ESP), but rather underutilized for pond protection and conservation (Tommelen, BEL; Albera, ESP; URY). So far, zoning has only been useful where delineating pondscapes as environmental areas has been a "stepping stone" toward inclusion into protected areas or planning documents (Rhône genevois; CHE, La Pletera, ESP; Schöneiche, GER). Stakeholders suggest it could be useful to restrict land use in ecologically sensitive areas (URY) or prescribe ponds as NBS (e.g. as flood/drought prevention) (GER; TUR).

Meanwhile, land tenure is identified as a significant barrier. Often, it is reportedly difficult to work with private landowners (BEL; CHE; GBR) or to obtain financing for

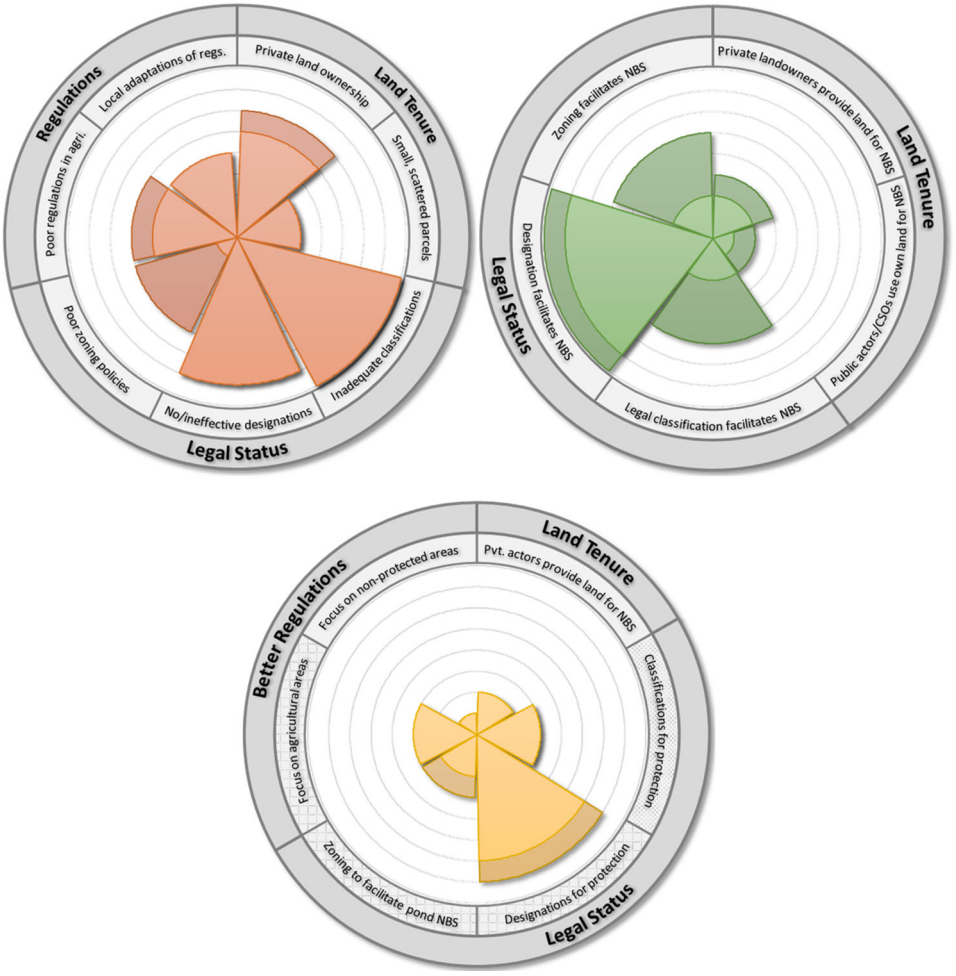

Figure 3. Barriers (red), enabling factors (green), and potentially enabling factors (yellow) linked to "Legal standards and regulations" across case study countries.
Note: The further out an element protrudes, the higher its prevalence across cases (i.e. element touching the ring signifies a prevalence in 8/8 countries). A dark shade means a phenomenon was only found in the pondscape(s) we investigated in-depth in a respective country. Also, subcategories under potentially enabling factors were only mentioned by stakeholders (no pattern), only found in policies (dotted), or both (chequered). Colour online.

projects on private land (Pikhakendonk, BEL; DNK). Elsewhere, fragmented land ownership inhibits NBS at pondscape scale (BEL; DNK; ESP). Conversely, in Geneva (CHE) and Denmark, pondscape NBS are enabled through land ownership by public entities or CSOs. However, if private landowners were to engage, it could actually be advantageous (e.g. due to less bureaucracy) (BEL, CHE, GBR, TUR).

4.1.3. Financing

(Opportunity) costs of pond and pondscape NBS are the most prevalent financing barrier. Project-based financing can help to address upfront costs, but long-term financing is scarce (Figure 4).

Figure 4. Barriers (red), enabling factors (green), and potentially enabling factors (yellow) linked to "Financing" across case study countries.
Note: The further out an element protrudes, the higher its prevalence across cases (i.e. element touching the ring signifies a prevalence in 8/8 countries). A dark shade means a phenomenon was only found in the pondscape(s) we investigated in-depth in a respective country. Also, subcategories under potentially enabling factors were only mentioned by stakeholders (no background pattern) or mentioned by stakeholders and found in policies (chequered background). Colour online.

Management is deemed especially costly (BEL; Bois de Jussy, CHE; DNK; La Pletera, ESP; GBR; URY). Yet even the creation/restoration can be costlier than other NBS (BEL, URY). Also, opportunity costs are considered too high for landowners (foregoing other land uses) in most case study countries (BEL; CHE; DNK; GBR; GER; URY).

Consequently, higher constant support for landowners (especially farmers) is reportedly needed. Currently, financing for measures by private actors is rare and usually linked to ad-hoc stewardship agreements (BEL; CHE; GBR). Public agricultural schemes rather support measures for wetlands and peatlands (DNK: GBR; GER) or

generally biodiversity-rich landscape elements (BEL; DNK; GER). Also, it appears as if some financing schemes do not consider pond benefits in their selection criteria (GBR) or require that measures are aligned with the EU Water Framework Directive (WFD) (GER), which does not automatically cover small water bodies, such as ponds.

If financing is available, funders prioritize creating (individual) ponds. It is difficult to find long-term financing for managing or monitoring ponds and pondscapes (BEL; GBR; Lake Mogan, TUR; URY), except in protected areas (Pikhakendonk and Tommelen, BEL; CHE; Fyn Islands, DNK; La Pletera, ESP; Gölbaşı, TUR). Shifting toward landscape scales (BEL) and long-term financing (La Pletera, ESP; GBR; Schöneiche, GER; URY) could propel pondscape NBS. In fact, a government scheme in Switzerland, along with the Landscape Recovery scheme and Peatland Code in the United Kingdom, will fund large-scale land-use changes on agricultural land over 20–30 years for habitat restoration and climate change mitigation. However, while forests, wetlands, and peatlands are specifically identified for these measures, ponds are not.

The focus on one-time measures also expresses itself in the lack of baseline funding for public institutions, hampering day-to-day management and the implementation of long-term measures (DNK; ESP; GBR; GER; URY). For example, in GER, maintaining small water bodies is optional for water boards, and they carry the financial risk. This risk is particularly high when counties do not have drainage plans, making pond NBS a "shot in the dark" and water boards liable for disturbances to water supply systems.

Meanwhile, corporate social responsibility (BEL; CHE; GBR) and biodiversity offsetting may fuel NBS implementation (GBR; CHE; TUR). In GBR, biodiversity net gain programmes have shown the first results (including for ponds) and municipalities are developing strategies to attract such funds. For other programmes, it is crucial that ponds are recognized as viable NBS. For example, Switzerland obligates fossil fuel importers to offset CO_2 emissions, which will finance NBS as carbon sinks and could consider ponds, if future research confirms indications that ponds sequester carbon.

Finally, sometimes funding would be available, but complex communication and funding application structures hinder access or complicate a good use of the funds (BEL; CHE; Catalonia, ESP; GER). Stakeholders believe that bureaucratic processes first need to be simplified, so public and private actors would seek financing.

4.1.4. Management approaches and tools

This category is broken down into day-to-day management (monitoring as well as permitting and surveillance) and strategic planning processes, describing small-scale management plans and larger scale plans of action. Poor day-to-day management and planning hinder NBS implementation, but in the vast majority of case study countries certain strategies have selectively improved at least monitoring (Figure 5).

First, institutions charged with monitoring have limited resources (BEL; DNK; GBR; Schöneiche, GER; URY), inadequate biophysical indicators (ESP), or simply no interest (Gölbaşı, TUR). Monitoring seems only effective if: (1) CSOs take charge (Bois de Jussy and Rhône genevois, CHE; Lake Mogan; TUR), (2) ponds are clustered (Albera, ESP), (3) monitoring is part of wetland inventories or river basin management plans (RBMPs) (CHE; Catalonia, ESP; GBR), or (4) long-term projects exist (Lystrup, DNK; WFF, GBR). New schemes for ponds in Natura 2000 areas (DNK) or linked to drought management (Brandenburg, GER) may improve monitoring.

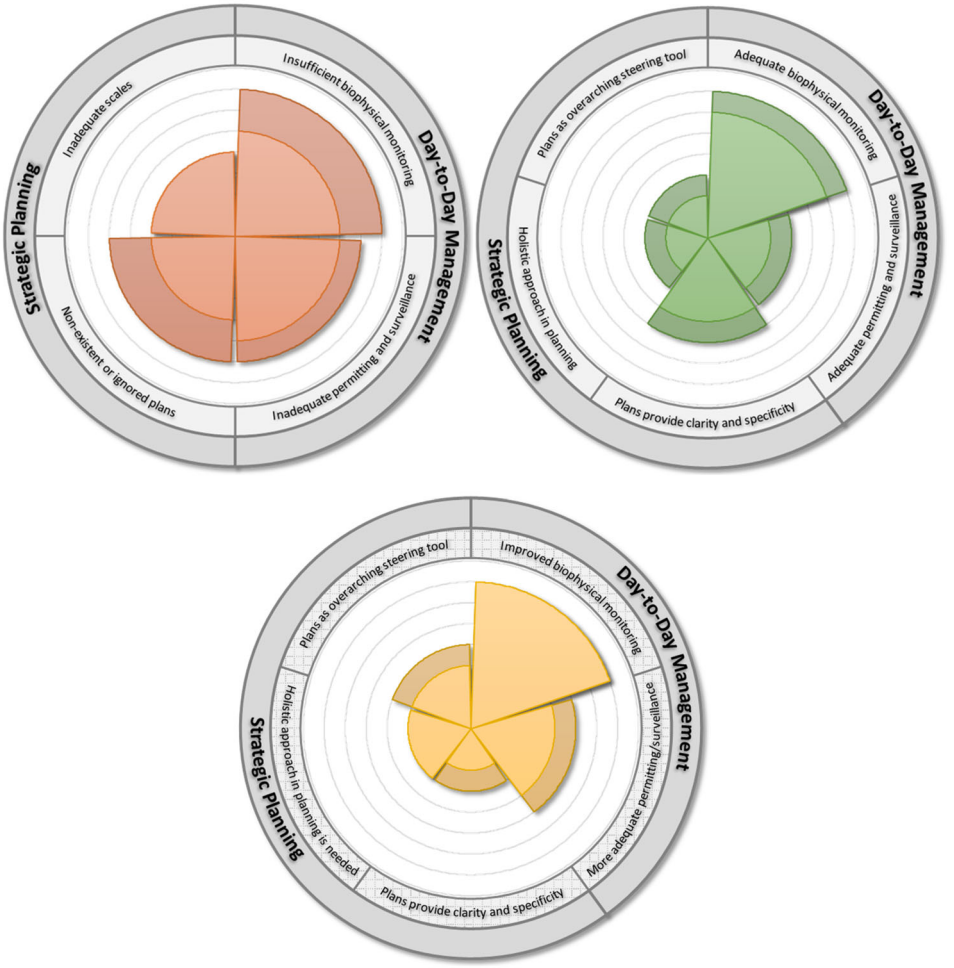

Figure 5. Barriers (red), enabling factors (green), and potentially enabling factors (yellow) linked to "Management Approaches and Tools" across case study countries.
Note: The further out an element protrudes, the higher its prevalence across cases (i.e. element touching the ring signifies a prevalence in 8/8 countries). A dark shade means a phenomenon was only found in the pondscape(s) we investigated in-depth in a respective country. Also, subcategories under potentially enabling factors were mentioned by stakeholders and found in policies (chequered background). Colour online.

Second, land uses harmful to biodiversity are reportedly too easily permitted or not contained (Getevallei, BEL; Catalonia, ESP; Brandenburg, GER; TUR; URY), which is why regulations may only yield positive results with improved surveillance (BEL; GER; TUR; URY). Meanwhile, obtaining a permit for creating or restoring ponds can be laborious (BEL; GBR; GER; Gölbaşı, TUR; URY). Permitting for ponds or regulating surrounding land uses works well when ponds are integrated into zoning plans (DNK; GER), linked to protected areas (URY), or coupled with financing schemes (DNK; GBR).

Third, planning may happen at inadequate spatial scales for pond and pondscape NBS to be considered. Sometimes, even if high-level strategies support NBS, they are

not translated into local action (BEL; GBR; GER; URY). Therefore, it is currently unclear whether, for example, planned eco-friendly measures through the EU's Common Agricultural Policy (CAP) will have an effect (BEL; GER). In contrast, some planning focuses on scales of individual ponds or parts of pondscapes, and thereby neglects essential interactions at or beyond the pondscape scale (BEL; GER).

Pond and pondscape NBS can be integrated into other plans (e.g. for wastewater, protected areas, river basins, tourism) (Lystrup, DNK; Albera and La Pletera, ESP; Gölbaşı and Lake Mogan, TUR), creating a holistic approach and addressing scalar challenges. Current examples are largely limited to pondscapes that we investigated in-depth, but recent RBMPs intend for streams to be reconnected with adjacent waters (including ponds) (Pikhakendonk, BEL; DNK; Catalonia, ESP; GER). Also, Brandenburg (GER) plans to mitigate climate risks through integrated management of lakes, wetlands (including pondscapes), and other Natural Water Retention Measures (NWRMs).

Still, some stakeholders expect that non-binding strategies will not translate into actions as long as binding laws do not support them, otherwise "people do not take it seriously" (BEL; Albera, ESP; Schöneiche, GER; Lake Mogan and Gölbaşı, TUR; URY).

4.1.5. Institutional capacities and cooperation

Overall, the prevalence of barriers and (potentially) enabling factors in this category is lower than for other ones. Structural factors do play a role in the majority of case studies, however. Also, interpersonal factors can be of relevance in individual cases (Figure 6).

On a structural level, first, institutional cooperation is the most common barrier and potentially enabling factor. Between governance levels, conflicts exist as local authorities feel that higher-level ones impose impractical regulations (BEL; ESP; GER; URY). In terms of governance sectors, the integrated management of natural reserves is reportedly hindered by a lack of cooperation (BEL; Schöneiche, GER). Cooperation is only reported for specific pondscapes and exists mostly between local authorities and CSOs (Pikhakendonk, BEL; Geneva, CHE; Albera and La Pletera, ESP; Schöneiche, GER). In response, some stakeholders suggest joint working groups to define management regimes for protected areas (BEL; TUR), translate high-level strategies into local action plans, or simply break down silos (GER).

Second, key institutions reportedly have a small, and often unskilled, workforce. This inhibits management and monitoring as well as support to actors interested in pond and pondscape NBS (BEL; Albera, ESP; GBR; GER; TUR; URY). In addition, planning can burden local institutions, which is seen as one reason why national strategies are not translated into local action (Albera, ESP; GBR; URY). Sufficient institutional capacities have usually arisen from a sustained budget and through historically grown structures (La Pletera, ESP; Pinkhill Meadows, GBR).

Third, a historic focus on rivers and lakes is considered to inhibit pond and pondscape NBS in some countries (Geneva, CHE; GBR; Schöneiche, GER).

On an interpersonal level, the missing rapport of institutional staff with landowners hampers pond and pondscape NBS, fueled by distrust toward authorities (BEL) or non-local "experts" (GER). Relationships with landowners are, instead, upheld by CSOs (BEL; WFF, GBR). This interlinks with a lack of local leaders that spearhead implementing NBS or convince others of their benefits. Champions for pond and pondscape NBS amongst local decision-makers exist only in one of our local pondscapes (La Pletera, ESP).

Figure 6. Barriers (red), enabling factors (green), and potentially enabling factors (yellow) linked to "Management Approaches and Tools" across case study countries.
Note: The further out an element protrudes, the higher its prevalence across cases (i.e. element touching the ring signifies a prevalence in 8/8 countries). A dark shade means a phenomenon was only found in the pondscape(s) we investigated in-depth in a respective country. Also, subcategories under potentially enabling factors were only mentioned by stakeholders (no background pattern). Colour online.

4.1.6. Stakeholder awareness and engagement

In terms of stakeholder awareness, it is the non-interest in ponds or non-awareness of benefits that constitute the most prevalent barriers. In contrast, stakeholder engagement is often identified rather as a (potentially) enabling factor than a barrier. Stakeholders expect that this needs to be supported with awareness-raising and outreach (Figure 7).

The low stakeholder awareness of, or even interest in, pond benefits is especially pronounced with those benefits not primarily focused on economic production (BEL; DNK; Albera, ESP; GBR; GER; TUR; URY). Consequently, pond and pondscape NBS are often reportedly not deemed worth it and there is a neglect of or active resistance against them (Tommelen, BEL; La Pletera, ESP; GER). In particular, farmers often push back on creating ponds, as they fear operational limitations, especially if

Figure 7. Barriers (red), enabling factors (green), and potentially enabling factors (yellow) linked to "Stakeholder Awareness and Engagement" across case study countries.
Note: The further out an element protrudes, the higher its prevalence across cases (i.e. element touching the ring signifies a prevalence in 8/8 countries). A dark shade means a phenomenon was only found in the pondscape(s) we investigated in-depth in a respective country. Also, subcategories under potentially enabling factors were only mentioned by stakeholders (no background pattern) or mentioned by stakeholders and found in policies (chequered background). Colour online.

the site becomes protected (BEL; DNK; GBR). It is ostensibly difficult to motivate farmers to be involved without rapport (BEL; GER; GBR), especially at landscape scale (GBR).

Moving forward, raising stakeholder awareness for pond and pondscape benefits is considered vital by stakeholders (BEL; GBR; GER; URY). Awareness is mostly reported in pondscapes investigated in depth and emanates from first-hand experiences with the benefits of pond and pondscape NBS (Pikhakendonk and Tommelen, BEL; Albera and La Pletera, ESP; WFF, GBR). Moreover, local identification with a pondscape can contribute to awareness, including, due to: (a) ponds being part of a cultural landscape

(BEL; GBR; Schöneiche, GER), (b) a protected status (La Pletera, ESP; Pinkhill Meadows and WFF, GBR), and (c) education or research outreach (BEL; La Pletera, ESP; Geneva, CHE; Pinkhill Meadows, GBR; Schöneiche, GER; S.d.l.C., URY).

CSOs often play a role in advancing pond and pondscape NBS. Either they do advocacy work—raising awareness (TUR) and/or instigating policy changes for pond protection (CHE, ESP)—or even implement NBS themselves. To do so, they enter agreements with landowners (Tommelen, BEL, Schöneiche, GER, and in CHE with local government; Pikhakendonk and Gete Vallei, BEL and WFF, GBR with farmers; Pinkhill Meadows, GBR with a private company). Stakeholders in BEL and GBR actually underlined that it is often easier for CSOs to work with farmers than it is for public actors, as those are perceived as punitive and bureaucratic.

In general, stakeholders expect public engagement to support NBS implementation (especially at larger scales). Detailed reports of successful engagement for pond and pondscape NBS, however, are tied to projects in which stakeholders were involved early and could influence the site's design (Lystrup, DNK; Schöneiche, GER; La Pletera, ESP), management regime (Lystrup, DNK; La Pletera, ESP), and/or integration of the pondscape at landscape scale (La Pletera, ESP; Schöneiche, GER).

4.1.7. Knowledge production and dissemination

Knowledge production and dissemination are not identified as a barrier or enabling factor in the majority of case study countries. Yet, knowledge production through research is often expected to facilitate pond and pondscape NBS (Figure 8).

There is a concern that there is no build-up of baseline data through standardized pond quality indicators (Albera, ESP) or research projects that track the before-and-after of NBS (GBR; ESP; URY). More research into the benefits of pond and pondscape NBS is also needed before their utility will "stick with" policymakers (BEL; CHE; GBR; URY).

So far, research has propelled pond and pondscape NBS in three ways: (1) by providing supportive evidence for policies (Albera and La Pletera, ESP; Lystrup, DNK; Pinkhill Meadows, GBR); (2) by ascertaining pond benefits (Lystrup, DNK; La Pletera, ESP); (3) by increasing public willingness to implement NBS (Albera, ESP; URY). Notably, there is still a lack of research on how to optimize pond and pondscape management (BEL; Albera, ESP; GBR; GER; URY).

Other major challenges are insufficient technical guidelines and support, as well as limited knowledge sharing. Farmers miss high-quality advice on why and how they should create ponds (GBR; URY), so that (non-productive) benefits are generated. Meanwhile, in Brandenburg (GER), the state government has intended to design and disseminate guidelines for NBS for drought risk management, but lower-level authorities pointed out that their distribution has been delayed.

There is evidence of useful advisory services (between local authorities and landowners in DNK and URY) and technical guidelines (for Tommelen, BEL on habitat connectivity at pondscape-scale). However, more dissemination is considered vital. Subsidy schemes coupled with advisory services could incentivize pond creation (GBR; URY). Moreover, updated guidelines on drought risk mitigation through natural water retention measures (NWRMs) (Brandenburg, GER) as well as farm ponds (URY) could prove beneficial.

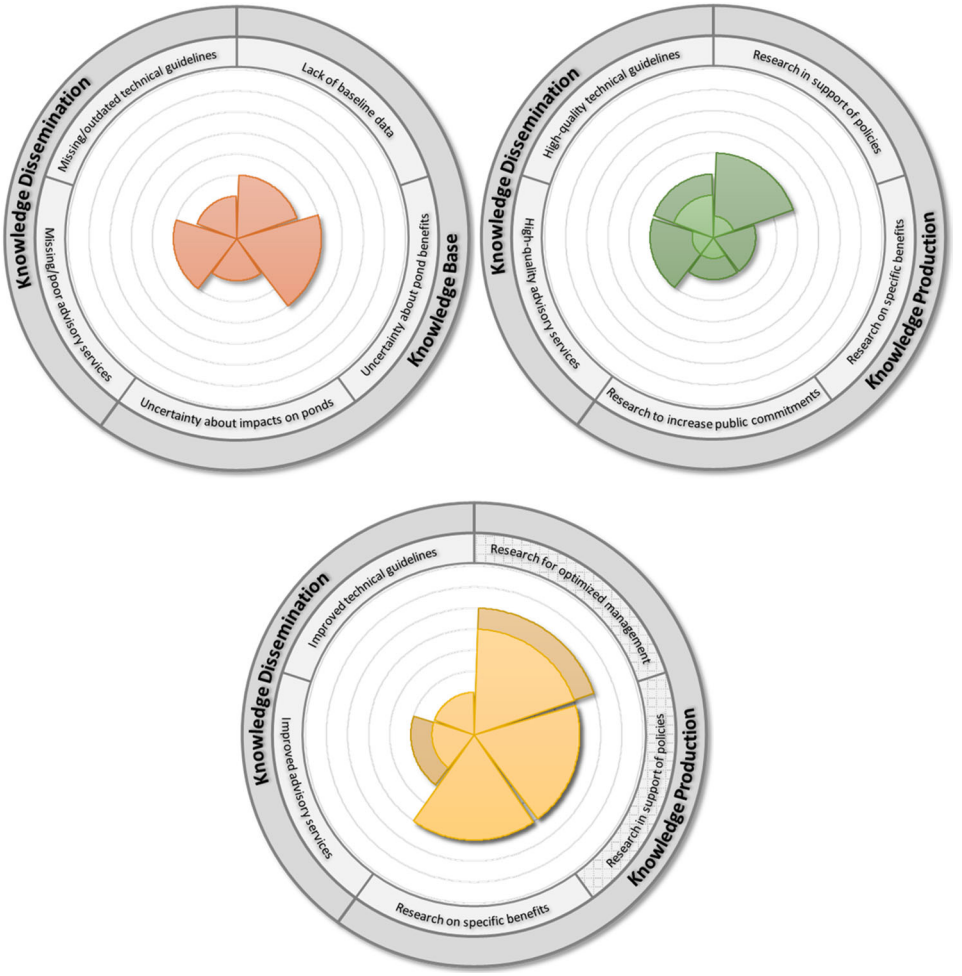

Figure 8. Barriers (red), enabling factors (green), and potentially enabling factors (yellow) linked to "Stakeholder Awareness and Engagement" across case study countries.
Note: The further out an element protrudes, the higher its prevalence across cases (i.e. element touching the ring signifies a prevalence in 8/8 countries). A dark shade means a phenomenon was only found in the pondscape(s) we investigated in-depth in a respective country. Also, subcategories under potentially enabling factors were only mentioned by stakeholders (no background pattern) or mentioned by stakeholders and found in policies (chequered background). Colour online.

4.2. Relationships between categories

Below we present relationships between (sub)categories occurring in more than half of the studied countries, in descending order of prevalence. Many more idiosyncratic relationships exist, but an exhaustive presentation goes beyond the scope of this paper.

4.2.1. Legal status and management approaches and tools

Often the legal status, i.e. the protection of ponds or pondscapes through statutory designations or legal classifications, also affects their management. The status of ponds affects how they are integrated into strategic plans as well as day-to-day management.

First, if a pondscape is (part of) a Natura 2000 site, its development and maintenance are usually taken into consideration in strategic plans—both in site-specific as well as larger scale plans. In Pikhakendonk (BEL), for example, the local management plan lays out a vision for maximizing habitat space and quality for the great crested newt, which includes creating and restoring ponds. In Denmark, restoring ponds in Natura 2000 areas is a national priority, and municipalities with Natura 2000 sites need to plan accordingly. Other designations or legal classifications can, likewise, correlate with an incorporation of pondscapes into planning. This can concern the inclusion in RBMPs (DNK; ESP) or the development of local plans that define permitted land uses and how to improve habitat connectivity (CHE; Schöneiche, GER).

Second, in terms of day-to-day management, legal statuses can be grounds for authorities to define permissible land uses and monitor the adherence of landowners to these standards. In some countries this is already applied to protect ponds (CHE; Schöneiche, GER). Furthermore, monitoring of the biophysical state of ponds is already better in some protected areas (CHE) or, at least, can be a future priority (DNK; ESP).

At the same time, the opposite is often true for ponds and pondscapes without legal status. In Denmark, little is known about the biophysical state of ponds outside Natura 2000 sites. Meanwhile, the EU WFD does not require surface water bodies smaller than fifty hectares to be kept in good status, which is why ponds may not be included in RBMPs or monitored (GER; TUR). Consequently, they are likewise not the focus of key strategies, such as the CAP Strategic Plan which may set land-use restrictions for the protection of ponds and pondscapes on agricultural land (GER).

Also, importantly, legal status alone does not guarantee opportunities for pond and pondscape NBS. In several cases (Schöneiche, GER; Lake Mogan and Gölbaşı, TUR; URY), plans for the development and maintenance of a protected area may exist, but they are insufficiently detailed or simply ignored in practice. Likewise, the surveillance of land uses and continuous monitoring of protected areas can be deficient (GBR; TUR; URY).

4.2.2. Legal status and financing

Statutory designations and other legal classifications can help public institutions and CSOs with accessing funding for pond and pondscape NBS. For example, it appears as if the protection of a pondscape through Natura 2000, or even the mere prospect of it, facilitates access to funding (Pikhakendonk, BEL; Fyn Islands, DNK; La Pletera, ESP). Importantly, in these pondscapes, EU LIFE funding has been renewed multiple times and thereby contributed to institutional cooperation, stakeholder engagement, and monitoring.

Private landowners may also receive support for improved management to guarantee a high-diversity landscape—with often a premium paid for Natura 2000 areas (GER), HNV farmlands (BEL), or other protected sites (CHE; GBR). However, it seems landowners are occasionally hesitant to seek associated funding due to potential restrictions on their operations (BEL; GBR). Positive experiences are reported only from Switzerland, where cantons must enter into stewardship agreements with private individuals if a protected area extends onto private land.

4.2.3. Financing and management approaches and tools

The inclusion of pond and pondscape NBS in strategic plans facilitates access to financing, as many planning processes also have funding schemes associated with them. In Flanders (BEL) and Germany, the maintenance of high-diversity landscape elements will be improved; and some ponds are recognized as such elements, as per the CAP Strategic Plans. Similar support is planned for voluntary buffer strips around ponds in Denmark. At the same time, in England (GBR), the prospect of funding through biodiversity offsetting schemes propelled municipal planning for the use of such funds.

Inversely, if ponds are not considered in key strategic planning processes, this can also affect the financing available for NBS. In Brandenburg (GER), for example, NWRM shall be promoted, but one funding criterion is the alignment with the WFD and associated RBMPs. Since ponds are usually not considered in RBMPs, it is difficult to access financing for associated NBS. The most common risk, however, is the lack of long-term financing to support monitoring and surveillance efforts (especially outside protected areas). Stakeholders report funding shortages (BEL; DNK; ESP; TUR; URY), which complicates assessing the state and benefits of ponds and pondscapes over long periods.

4.2.4. Goals, objectives, and targets and management approaches and tools

Strategic plans define and are defined by goals, objectives, and targets. In EU Member States, CAP Strategic Plans chart rural development containing relevant objectives and targets (e.g. extensification of agriculture, reducing chemicals in wetlands, improving biodiversity in small biotopes, and lowering carbon emissions from wetlands and peatlands) and identifying supporting actions (e.g. conversion of arable land to grassland or wetlands; buffer strips) (BEL; DNK; GER).

National planning policies are also of relevance for setting biodiversity-related policy objectives in general—not only in rural areas. Both Switzerland and Denmark, identify biodiversity in ponds as a priority and put forward measures to ameliorate shortcomings.

Strategic plans can also outline monitoring regimes based on the policy objectives contained in them (BEL; GER). For example, the Low Water Concept of Brandenburg (GER) promotes water retention in natural reservoirs and suggests improvements in hydrologic data to anticipate water needs—including those related to ponds and pondscapes.

In contrast, if biodiversity is not prioritized as an objective, this can negatively affect the standing of ponds in planning processes. In Spain, requirements for environmental impact assessments have been relaxed to expand renewable energy capacities (even in protected areas). Additionally, policy objectives, such as public water supply (BEL, Schöneiche, GER), are focused on a large spatial scale, so that effects on ponds and pondscapes are typically overlooked.

4.2.5. Stakeholder awareness and engagement and knowledge production and dissemination

In La Pletera (ESP) and Lystrup (DNK), past research projects laid the foundation for stakeholder engagement and awareness, so that stakeholders have become keen on implementing pond and pondscape NBS. Furthermore, in most case study countries

(BEL; ESP; GBR; TUR; URY), stakeholders expect research outputs on ponds to be a means to influence public and private stakeholders.

Meanwhile, a need for knowledge dissemination is also evidenced by the combination of a lack of interest in, and knowledge of, pond benefits and management amongst many local actors (BEL, DNK; Albera, ESP; GBR; Schöneiche, GER; TUR; URY).

5. Discussion

Below we first discuss our key findings in the light of existing literature. Initially, we highlight general recommendations for policies and actions, deduced from the barriers, (potentially) enabling factors, and their interlinkages occurring frequently across case studies (Section 5.1). Thereafter, we expand on the complex interrelationships and contextual nature of barriers and (potentially) enabling factors again (Section 5.2).

5.1. Key insights and recommendations

5.1.1. Consider conservation and protection as NBS

NBS has been referred to as an "umbrella concept" encompassing related ideas, such as ecosystem-based adaptation or green infrastructure, whose focus on "solutions" is, though, more palatable to policy and decision-makers (Gómez Martín, Máñez Costa, and Schwerdtner Máñez 2020; Pauleit *et al.* 2017; Seddon *et al.* 2021). Its vagueness, however, has also spurred investigations into which actions are actually promoted under the banner of NBS (Davies *et al.* 2021; Pauleit *et al.* 2017; Seddon *et al.* 2021). Although common definitions of NBS (see Cohen-Shacham *et al.* 2016; Eggermont *et al.* 2015) do also account for actions with a low degree of engineering (for example, ecosystem conservation and protection), including in rural areas, current NBS-related policies and investments predominantly support the creation of new ecosystems in cities (Davies *et al.* 2021; Gómez Martín, Máñez Costa, and Schwerdtner Máñez 2020; Seddon *et al.* 2021).

Disregarding ecosystem conservation and protection through statutory designations and other legal statuses and/or in rural areas as NBS actions could stifle the development of holistic spatial strategies, however. Engineered NBS in cities provide a small set of benefits in high quality, while protection or conservation-focused NBS in rural areas can provide a wider set of benefits simultaneously as well as more significant biodiversity benefits, such as habitat connectivity (Gómez Martín, Máñez Costa, and Schwerdtner Máñez 2020; Krauze and Wagner 2019; Seddon *et al.* 2021). Importantly, protection (and conservation) are not to be implemented for protection's sake, but rather through considering both, the respective strengths of the different types of NBS could be integrated with each other in landscape-level planning processes (Garmendia *et al.* 2016; Krauze and Wagner 2019; Seddon *et al.* 2021). Furthermore, existing, intact ecosystems often already provide the benefits that newly created ones will ultimately yield (Seddon *et al.* 2020).

Unfortunately, seminal literature on barriers to NBS implementation has, likewise, focused to a large extent on ecosystem creation in urban areas (Dorst *et al.* 2022; Tozer *et al.* 2022; van der Jagt *et al.* 2023). Yet, importantly, our analysis shows that if other landscapes and NBS that require little intervention (such as ecosystem protection and conservation) are considered, other barriers and enabling factors come into focus. Specifically, while a statutory designation in itself does not guarantee the

multifunctionality of an ecosystem, and therefore its use as NBS, designations often interlink with other enabling factors, such as possibilities for financing, monitoring, and planning. For example, while other studies did not observe the use of stewardship agreements to enable NBS implementation (van der Jagt *et al.* 2023), we see them employed to great effect in rural, protected areas.

As far as ponds and pondscapes are concerned specifically, we observe that those that have a legal status or are located in otherwise protected areas are more likely to be integrated into strategic plans (such as RBMPs). This may ultimately also help to address scalar challenges that currently still hamper the implementation of pond and pondscape NBS—either plans are too narrow in their focus (e.g. small parts of a pondscape) or too high-level to be relevant for pondscape NBS.

It is upon the respective legislative bodies and public authorities to amend existing policies, so that individual ponds are not only protected in isolation, but also adequate restrictions on the surrounding land use are put in place. Subsequently, it would be helpful for authorities to identify and designate key ponds and pondscapes as protected areas. Of course, since the statutory designation itself, or even the consideration of ponds in strategic plans, do not guarantee good biophysical status, it is also crucial to concurrently improve monitoring, surveillance, and continuous management. In fact, our analysis shows—like previous studies on the performance of protected areas (Watson *et al.* 2014)—that even protected ponds can be affected by, inter alia, ineffective enforcement of regulations and low public acceptance of management measures. A first step could be to raise public awareness and, where applicable, improve relationships with private landowners. Given the positive track record of local civil society organizations in our studied cases, it could be helpful for authorities to collaborate with them for such endeavors.

5.1.2. Expand long-term financing

Our analysis reveals a significant lack of long-term financing and baseline funding for public authorities, particularly affecting ongoing management as well as monitoring of the state and benefits of ponds and pondscapes. This funding gap poses a major barrier to the viability as NBS. As Sowińska-Świerkosz and García (2022) argue, effective NBS must be adaptable over time. Moreover, ecosystems often require time to develop their intended benefits or, at the very least, need to be maintained to provide existing benefits (Krauze and Wagner 2019; Seddon *et al.* 2020, 2021). This is even more applicable to ponds and pondscapes, which often depend on active management for maximum delivery of NCPs (Cuenca-Cambronero *et al.* 2023). Previous studies of NBS funding have, likewise, indicated a problematic preponderance of one-time interventions, rather than dedicated, consistent funding streams and support mechanisms (Garmendia *et al.* 2016; Seddon *et al.* 2021). In the pondscapes, we investigated in depth, positive exceptions were mostly linked to protected areas or the integration of pond monitoring into well-financed, overarching efforts (e.g. wetland inventories).

Yet, more and higher long-term financing should not only target public authorities. When it comes to private landowners, our analysis suggests that it is often a challenge to motivate them to implement NBS on their property. Research into the participation of farmers in voluntary agri-environment schemes suggests that farmers reject long contracts, frequent or invasive monitoring, and inflexibility, but higher compensation will likely increase their cooperation (McGurk, Hynes, and Thorne 2020). Therefore,

to advance the implementation of pond and pondscape NBS specifically, subsidy schemes should more strongly consider ponds and pondscapes, and, where applicable, increase the compensation for landowners. For example, our results show that selection criteria for potential funding sources, such as the Common Agricultural Policy in EU Member States, environmental trusts in GBR, or carbon offsets in Switzerland, so far emphasize the restoration or protection of ecosystems, such as forests, wetlands, and peatlands, but not ponds. It might be reasonable to combine financing programmes with outreach to landowners through trusted organizations and individuals to increase uptake (Dunne, Markey, and Kinsella 2019).

5.1.3. Nurture local leadership

Ultimately, NBS implementation may be decided less by written policies, but rather by the choices of local actors. For example, while EU policies provide relatively much support for NBS, their implementation often depends on the actors on the ground in the Member States (Ryfisch *et al.* 2023). However, as our analysis shows, a lack of interest in pond and pondscape NBS is a significant barrier. It may be municipal staff who doubt the utility of NBS or private landowners who conceive ponds only as infrastructure for food production purposes (as in Uruguay). Other scholars (Raška *et al.* 2022) have noted, in the past, that skepticism about the effectiveness of NBS measures is more pronounced for ponds than other similar ecosystems, such as wetlands, highlighting particular challenges in implementing these undervalued ecosystems.

To boost NBS implementation generally, some authors have suggested that there is a need for "ambassadors" (Kabisch *et al.* 2016) or "champions" (Wamsler *et al.* 2020; Zingraff-Hamed *et al.* 2021). Our analysis only indicates two cases where the absence of local leadership was identified explicitly as a barrier and two cases where this was identified as a (potentially) enabling factor. However, we did observe that land uses detrimental to pond biodiversity are still major policy objectives and some stakeholders expressed the hope that there would be a shift in mindset. Likewise, the non-cooperation of relevant public institutions was considered a major barrier, and its improvement was a potentially enabling factor in many cases. One could argue that both (a change of mindset and better institutional cooperation) would require political leadership (Blicharska and Rönnbäck 2018).

We have observed that CSOs are already doing some advocacy work and building partnerships with landowners, but it is key that public authorities are able and willing to build partnerships amongst each other and rapport with local private actors. The depth and breadth of the support they can offer should be far greater than that of CSOs.

It is important that such outreach and support efforts are initiated right from the project outset, sustained over long timeframes, and targeted at larger groups. Otherwise, it could prove challenging to implement, especially pondscape NBS, because as both our analysis and previous research (Raška *et al.* 2022) show: the main barrier to the effectiveness of pondscape NBS is land tenure and landscape fragmentation. If only a small group would be convinced of the benefits of pond and pondscape NBS, efforts may remain futile as long as the land use of adjacent lots affects well-meaning actors.

5.2. *Addressing contextuality and complexity*

The recommendations introduced above should unlock potential for the implementation of ponds and pondscape NBS in many contexts. However, as Tozer *et al.* (2022) suggest, pathways toward mainstreaming NBS are not linear, but contextual and complex. Which interventions create momentum for NBS will vary from case to case. In fact, they may also vary in how beneficial they would be. For example, while our results indicate that a statutory designation would commonly also lead to heightened access to financing, this effect may be greater in EU Member States, where the status "Natura 2000" is linked to a host of funding mechanisms (Ryfisch *et al.* 2023). Likewise, while the implementation of pond and pondscape NBS would likely benefit everywhere by raising awareness of the biodiversity benefits of ponds, it may be transformational in Uruguay, where landowners primarily value a pond's contribution to agricultural production (Vo *et al.* 2023).

Furthermore, our analysis shows that while there are common relationships between certain (sub)categories of barriers and (potentially) enabling factors, there are many more relationships unique to a particular local context. In addition, due to the number of case study countries and pondscapes investigated in depth, we only recorded pairwise relationships (between two (sub)categories each), while interlinkages are often more intricate (Dorst *et al.* 2022; Raška *et al.* 2022), also adding complexity to the interventions that would be necessary to enable implementation. For example, in Brandenburg (GER), we see a cluster of barriers as county administrations short on human capacity miss drainage management plans, making pond NBS a financially risky undertaking for water boards, who are liable for unanticipated outcomes. These interlocking barriers are unlikely to be found elsewhere, making universally valid action plans near impossible.

6. Conclusion

In this paper, we assessed the barriers and (potentially) enabling factors to the implementation of pond and pondscape NBS. To do so, we examined policies and practices in eight case study countries, investigating seventeen pondscapes across different landscapes and governance regimes in depth. Thereby, we add to a field that has, so far, almost exclusively evaluated the implementation of NBS in urban areas and lacked, in particular, an empirical assessment of the implementation of ponds and pondscapes as NBS—despite mounting anthropogenic pressures on these ecosystems that could provide meaningful benefits as NBS.

Overall, our comparative study revealed that barriers and (potentially) enabling factors, as well as relationships between them, are often idiosyncratic. Nonetheless, we distill three major, overarching insights that bear relevance for ponds and pondscapes specifically, but possibly also NBS implementation generally: First, the presence or absence of legal status for ecosystems and or areas (including through statutory designations and legal classifications of ecosystems) are considerably affecting NBS implementation, especially in rural areas. Importantly, though, when considering ecosystem protection in connection with NBS actions, enabling factors and barriers move into focus that are less prevalent in the literature concerned with NBS implementation in urban areas. Second, expanding financing—first and foremost, long-term financing for public and private actors—is a common need, inhibiting particularly the active management of ponds and pondscapes and therefore long-term delivery of benefits. Third,

a lack of institutional cooperation, low stakeholder interest and awareness, and fragmented land ownership complicate the use of pondscape NBS, especially at large scales. Local leadership should be nurtured in response.

Moving forward, we recommend research that occupies itself with ascertaining the contextual relevance of barriers or potentially enabling factors. Our work, like previous research, has identified whether, for example, a given barrier is present or not. However, this dichotomy is only an approximation, when in fact the extent to which a factor influences NBS implementation varies. If such endeavors would simultaneously identify clusters of barriers, or potentially enabling factors, actors could prioritize their interventions accordingly. This would further advance the insights gained into the relationships between different categories of barriers/(potentially) enabling factors.

Additionally, our analysis highlighted the dissimilar barriers and enabling factors present depending on the landscape in which a given (potential) NBS is or will be, located. This calls for a more conscious focus of future research on non-urban NBS. In this regard, in EU Member States, it could be particularly rewarding to further scrutinize and compare the ramifications of seminal policies, such as the EU's Common Agricultural Policy, for NBS on the ground.

Finally, in an effort to assess the situation on-the-ground, we recorded stakeholder perspectives on actual practices affecting NBS implementation. Moving forward, we would recommend that researchers employ other qualitative methods (e.g. interviews, participant observation, etc.) to further deepen insights into barriers and enabling factors. This can support the design of context-specific interventions for NBS implementation, generally, but also specifically help to ascertain why actors choose to implement some ecosystems as NBS rather than others.

Notes

1. There is no universal definition of a pond, but we follow Richardson *et al.* (2022): "Ponds [have] a maximum surface area of 5 ha, a maximum depth of 5 m, and <30% coverage of emergent vegetation. Ponds […] can be permanent or temporary and natural or human-made" (9). This captures a broad variety of scientific and political conceptualizations, as well as reflecting that water bodies with these parameters have distinct ecosystem structures and functions (Richardson *et al.* 2022). Ponds are part of many types of landscapes and have a multitude of functions, including as retention basins in cities, water sources on farmland and grassland, and natural occurrences in peatlands and wetlands, or fire water reservoirs in woodlands.
2. Generally, biodiversity benefits are more pronounced in pondscapes due to higher habitat diversity, complexity and connectivity (Hill *et al.* 2018; Oertli and Parris 2019). Also, a wide range of benefits can be combined across different ponds in one pondscape (Swartz and Miller 2019).
3. The NBS implementation cycle contains the following stages: (1) identify problem or opportunity; (2) select NBS and related actions; (3) design NBS implementation processes; (4) implement NBS; (5) engage stakeholders and communicate co-benefits; (6) transfer and upscale NBS, and the transversal stage of (7) monitor and evaluate co-benefits (Raymond *et al.* 2017).
4. The selected pondscapes are all under the active or passive stewardship of actors known to or affiliated with partners of the EU Commission H-2020 PONDERFUL project.
5. Researchers familiar with the local pondscapes were asked to apply an extractive qualitative content analysis (Gläser and Laudel 2013). This method requires experience with qualitative research, however. Therefore, if desired, researchers were given an alternative analysis template. We deem this acceptable, as it only served to collect preliminary results, which were later validated.

6. Zoning could have also been coded under "Management Approaches & Tools," as it pertains to strategic planning. However, as zoning assigns regulations governing new development to distinct "zones," we categorized it here.

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Supplemental data

Supplemental data for this article can be accessed online here.

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