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Do Public and Farmer Preferences for Natural Flood Management Align?

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ABSTRACT

The demand for catchment-based flood management to adapt to climate change is growing, with natural flood management (NFM) receiving increasing attention. NFM has implications for the 'providers' of land for measures upstream (the farmers) and the 'beneficiaries' of flood reduction downstream (the public). The misalignment of interests from these stakeholder groups may pose a challenge for flood risk managers during the delivery of NFM at the catchment scale. Considering this, a rapid evidence assessment (REA) of 60 peer-reviewed articles was undertaken. This REA provides an overview of catchment perspectives, compares farmer and public preferences for NFM design, and explores key determinants of scheme acceptance. The public expressed positive perceptions and willingness to pay for NFM, with preferences for measures with large water storage capacity that deliver co-benefits alongside flood management objectives. For farmers, NFM schemes that contributed to on-farm conditions, for example, soil stability, were seen as positive, but overall, their willingness to adopt measures was limited. Nevertheless, knowledge of NFM among both groups strongly determined its acceptance. This suggests that resolving misaligned values will require policymakers and practitioners to work with these stakeholders on NFM design and farmer incentives to secure the delivery of future schemes.

1 | Introduction

Climate change is projected to result in significant changes in precipitation and its seasonality (Intergovernmental Panel on Climate Change (IPCC) 2022; Meresa et al. 2022). Increasing frequency and magnitude of precipitation events are raising concern about future flood risk and its impact on human societies (Alfieri et al. 2017). Global economic damage caused by floods is projected to double for a mean temperature increase of 2°C (Dottori et al. 2018). Until recently, communities and businesses have strived to minimize their exposure to flooding through "hard" river and flood engineering techniques (herein referred to as "grey infrastructure"), such as river and stream straightening, river embankments, and built structures to hold or divert water, including levees and dams (Bubeck et al. 2017).

Calls for grey infrastructure solutions are a typical response to major flood events, which can trigger public demands for immediate action to prevent future damage (Butler and Pidgeon 2011; Newson et al. 2022). However, engineered flood management is costly, with many communities, particularly those with lower population densities (e.g., sub-urban and rural areas), not meeting the cost–benefit analysis criteria for investments in engineered defenses (Ellis et al. 2021). This has increased interest in alternative flood management strategies. Natural flood management (NFM) entails catchment-wide thinking, applying a range of measures which emulate natural hydrological processes to manage the sources and pathways of floodwaters (SEPA 2015). Examples of NFM include slowing the flow of water by installing natural woody dams, planting trees, and enhancing water storage by reinstalling floodplains (Environment Agency 2017). These measures are commonly known as nature-based solutions (NbS) and are becoming increasingly embedded in global policy frameworks due to their ability to work with and enhance nature to restore and protect ecosystems and help society adapt to climate change impacts (European Environment Agency 2021).

Specifically, NFM has been advocated by scholars and policymakers since the early 2000s, with high-profile schemes such as 'Making Space for Water', UK (2004), and 'Room for River', Netherlands (2006). Outputs from these early schemes have contributed to a growing NFM evidence base, informing global projects and NFM guidance (Bridges et al. 2021; SEPA 2015). Changes in UK agricultural policy also underpin new opportunities for NFM. The Basic Payment Scheme under the European Union's Common Agricultural Policy (CAP) is being phased out, while funding streams for Environmental Land Management schemes (ELMs) in England are increasing (Defra 2024). Under ELMs, farmers can be paid for delivering public goods, such as flood regulation, at three different scales: farm, local, and landscape.

The delivery of NFM on a landscape scale entails a shift from localized solutions towards catchment-wide management, which in turn will recruit a wider stakeholding public (Dadson et al. 2017; Potočki et al. 2022), for example, the 'providers' of upstream land for flood control and the 'beneficiaries' of reduced flooding downstream (Paavola and Primmer 2019). Due to the implications of NFM for both land managers who *provide* and the public who *benefit*, a holistic overview of catchment perspectives must be considered during the design and delivery of NFM (Morris and Tippett 2023; Paavola and Primmer 2019). The principal goal of NFM is to reduce flood risk; however, it can also provide multiple potential co-benefits (water quality improvements, habitat creation, carbon sequestration and storage), meaning it is often labeled as a 'win-win' solution (Anderson et al. 2022). For example, public sector bodies and academics have expressed their support for NFM, believing it to be a 'no-brainer' solution because of its perceived social and environmental benefits and cost-effectiveness (Bark et al. 2021). Yet, members of the public hold mixed feelings, with some lacking confidence in its ability to protect homes from flooding (Chin et al. 2008; Morris and Tippett 2023), whilst others believe NFM could boost local economies (Auster et al. 2022; Bwambale and Kervyn 2021) and enhance landscape beauty (Buijs 2009; Deffner and Haase 2018). Another key stakeholder group is landowners, land managers, and farmers (hereafter 'farmer') because large-scale NFM that can retain and detain water within the catchment requires land (Collentine and Futter 2018). Yet, many farmers are concerned about the potential impact NFM could have on their income and reputation and have resisted changes to their agricultural practices (Holstead et al. 2014; Milman et al. 2018; Potočki et al. 2022).

Previous studies tend to explore public and farmer perspectives independently, despite evidence of their interconnectedness. For instance, Holstead et al. (2014) interviewed Scottish farmers to capture their views of NFM. They found that farmers were reluctant to install NFM on their land due to the assumption that the 'unsightly' visual appearance of NFM and the reduction of traditional agricultural activities would mean the public would label them as a 'slipper farmer'. This is a label given to farmers or landowners who neither produce crops nor rear animals but rather receive farming subsidies just for owning land. Supporting this, Wingfield et al. (2021) captured 47 barrier statements around NFM delivery from flood risk management authorities and catchment partnerships. These statements were grouped into seven key themes: politics, policy, and planning; funding; infrastructure; evidence; technical knowledge; and public perception. Among these, flood risk management authorities ranked the barriers associated with public perception as most significant. These results emphasize the compelling nature of public opinion and the perceived impact it can have on proposed NFM solutions and beliefs around farmer uptake. A social consensus on NFM is necessary for its successful design and delivery (Paavola and Primmer 2019; Thaler et al. 2023), and therefore improving our understanding of public and farmer perceptions is pressing.

Since the emergence of NFM, research has stressed that gaps in its evidence base have hindered its implementation (Dadson et al. 2017; Wingfield et al. 2019). This has prompted reviews consolidating evidence to fill these gaps, such as synthesizing NFM modeling approaches (Hill et al. 2023) or summarizing approaches taken to evaluate NFM effectiveness (Connelly et al. 2020). These reviews mostly focus on technical issues relating to NFM delivery and omit issues regarding socio-political barriers, such as land use conflict, social acceptance, or diverse stakeholder interests and values (Bark et al. 2021; Wells et al. 2020). In the broader NbS literature, reviews have been conducted on stakeholder perceptions and engagement with NbS for wider societal challenges (Anderson and Renaud 2021; Ershad Sarabi et al. 2019; Ferreira et al. 2020; Venkataramanan et al. 2020). However, these have focused on interactions between the public and/or purely urban-based NbS measures, with only one specifically assessing NbS in the context of flood risk management (Venkataramanan et al. 2020). Furthermore, studies on attitudes towards NFM measures tend to focus on single examples on a site-by-site basis, such as perceptions of an urban river restoration project (Petts 2007; Tunstall et al. 2000).

Critically, research mostly considers what people think about NFM, rather than actively seeking to understand their preferences for its design and delivery. The exception is D'Souza et al. (2021), who assess public preferences between different NFM options and grey infrastructure. They also explore the role of values that influence preferences, observing that people holding bio-spheric values and self-transcendent values (pursuing social interest over personal interest) demonstrate statistically significant positive preferences toward natural measures (tree planting and wetlands) and negative preferences toward grey infrastructure (dams and weirs).

Values are not the only determining factor of NFM perceptions and preferences. A systematic review of 41 papers identified 10 factors (distance and length of residency; socio-demographics; knowledge; beliefs and values; place attachment; naturalness; risk and safety; care and cleanliness; landscape biophysical characteristics; and design and functional features) affecting public preferences for the rehabilitation of rivers and streams (Garcia et al. 2020). These factors were reviewed in the context of river restoration only, and a synthesis of factors influencing a broad range of NFM measures has yet to be conducted.

To fill the research gaps identified, this paper reviews the evidence regarding public and farmers' preferences for NFM within catchments, including large-scale NFM measures within rural contexts. To do this, a rapid evidence assessment (REA) was conducted. REAs filter research evidence in a focused and time-efficient manner to inform social policy decisions (Burton et al. 2007; Thomas et al. 2013). For this evidence assessment, we ask (i) How is NFM perceived by the public and farmers?; (ii) Where do public and farmer preferences align, and where do they not?; and (iii) What factors determine the acceptance of NFM? By addressing these questions, this review synthesizes perceptions of, and preference for NFM design and delivery. In a wider context, it also aligns with several criteria from the IUCN Global Standard for NbS (IUCN, International Union for Conservation of Nature 2020). These include but are not limited to the acknowledgment of the potential impact NbS may have on stakeholders, interests, and ecosystems beyond the immediate intervention area, inclusive governance, and response to the concerns of stakeholders, particularly between groups where trade-offs exist.

2 | Method

A REA was used to elicit public and farmer values, preferences, and attitudes towards NFM from existing literature. REAs maintain a transparent and reproducible search procedure as they tend to focus on peer-reviewed literature, excluding wider data sources, such as grey literature (Burton et al. 2007). While they follow a more constrained search process than systematic reviews, they remain a vital tool to rapidly synthesize evidence on emerging policy-relevant topics (Dallimer et al. 2020). In the sections below, the search terms, search strategy, and the screening and extracted data management processes are described.

2.1 | Search Focus and Terms

For this REA, the focus was on perspectives from individuals who are affected by the implementation of NFM measure(s); this includes those who will benefit from NFM measures being installed, 'the beneficiaries' (such as the "residents") and those who supply land to install these measures, 'the providers' (such as the "farmers"). This differs from other studies that have considered the views of 'experts' in flood risk management (those from government agencies and environmental organizations) (Bark et al. 2021; Waylen et al. 2018; Wingfield et al. 2021). These groups were excluded from the search process because while they are involved in the funding, design, and delivery of NFM, they are not directly impacted by the schemes. Furthermore, this review specifically focuses on 'operating' landowners/managers who farm or manage the land, rather than 'non-operating' landowners (those who own land but do not farm it themselves). Operating landowners/managers are acknowledged as the most important stakeholders in NFM delivery (Bark et al. 2021) and are more likely to be presented with challenging trade-offs and decisions regarding NFM delivery than non-operating landowners. Therefore, understanding the views of farmers whose livelihoods could be impacted by these measures is key.

To ensure this REA identified the breadth of existing literature on how the public and farmers value NFM, a set of search terms was generated to capture key themes and concepts. A conceptual framework was developed to steer the search process, data collection, and analysis to ensure all three research questions were addressed (Figure 1).

In Step 1, different definitions and types of NFM measures were considered. Across different countries, several definitions have been coined to describe features that work with natural hydrological processes to store, divert, and slow flood waters. For example, in this review, the concept of NFM, which is the preferred term within Scottish flood risk management policy (Wingfield et al. 2019), is primarily used. However, other concepts were considered, such as "Nature-based Solutions Cohen-Shacham et al. (2016)," "Working with Natural Processes" (a favored term of regulatory authorities in England), "Nature-based flood risk management" and the lesser-known concept, "Eco-engineering" (a term that embraces both ecology and engineering disciplines and develops new sustainable ecosystems that hold both human and ecological values; see Mitsch 2012). These collections of terms broadened our search horizon and reduced researcher bias of using only favored or well-known concepts.

Unlike previous reviews, which focus on stakeholder perceptions towards NbS within an urban setting (Ershad Sarabi et al. 2019; Ferreira et al. 2020; Venkataramanan et al. 2020), this review purposefully did not include search terms that capture urban NFM features, such as 'Sustainable Urban Drainage systems' (SUDs) or 'Green-Blue Infrastructure'. Instead, a wider lens was taken to capture types of NFM within large-scale, rural settings, such as "upstream management", "sustainable land management" and "catchment management".

In Step 2, terms were defined for both the 'beneficiaries' and 'providers' of NFM, ranging from broader definitions, such as

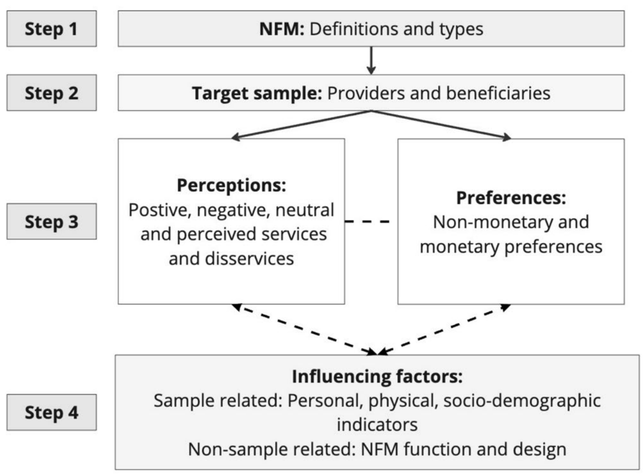

FIGURE 1 | Conceptual diagram outlining the rapid evidence assessment approach.

"public", "communities" and "stakeholders" to more specific terms, such as "resident", "farmer" and "landowner". Finally, Steps 3 and 4 captured the behavioral interactions between the beneficiaries/providers and NFM measure(s), contextualized by terms such as "value" "attitudes", "acceptance", "opposition" and "preferences".

2.2 | Search Strategy, Screening Process and Eligibility

The Scopus database was selected for this REA due to its broad coverage (particularly in natural and social sciences) compared to other academic search engines (Yang and Meho 2007). Between September 2022 and March 2023, a systematic search was completed. The search was limited to peer-reviewed papers. No restrictions were placed on publication date, country, or language. A search string was developed based on Figure 1; see Table 1. It was used to filter the title, abstract, and keywords of peer-reviewed literature. The star function (*) allowed for any documents that used any part of the starred word to be captured in the search; for example, "communit*" could pick up words referring to both "communities" and "community".

This search string returned 926 papers. To determine the relevance of each paper, search criteria were developed and applied to the returned papers, see Figure 2. All papers were subjected to three sequential filters, as proposed by PRISMA guidelines for systematic reviews (Page et al. 2021). First, titles and abstracts were examined, and 615 papers were excluded as they were irrelevant to the research topic. All studies that explicitly mentioned any type of NbS were retained. Second, a brief textual analysis was conducted on the remaining 311 papers, and 193 papers were excluded. Papers were excluded if: the NbS type was not focused on flood management; there was no full access to the paper; or an English version was not available. Although this review was not specifically urban-focused, the search criteria did return several papers looking at urban NFM measures (e.g., SUDs) which were reported under the concept of NbS. These papers were included in the analysis to provide an overview of perceptions within different catchment settings (urban and rural). Lastly, full text analysis was performed, which excluded a further 60 papers. These papers either did not include primary data or had collected data from 'expert' stakeholders only, or assessed technical aspects of NFM (e.g., its effectiveness) without assessing the social aspects of NFM.

Two relevant papers known by the researchers were not identified via the Scopus search string (Glenk and Fischer 2010; Kenyon 2007) and were added later. After examination, these papers did not meet the search criteria due to referring more broadly to water management in the title, abstract, and keywords, for example, under 'climate change adaptation policy' (Glenk and Fischer 2010). While it is possible that these two papers may have been included if more academic databases were consulted (e.g., Web of Science, Google Scholar), this is not common practice when conducting REAs. In contrast to traditional systematic reviews, REAs usually use one database, trading off the inclusion of all types of material on this topic (from peer-reviewed and grey literature sources) for the timely delivery of information that is often required for policy decision-making. Therefore, we can expect that not every paper on this topic will be included in the search return and that an opportunistic inclusion of articles is sometimes necessary. The final selection included 60 peer-reviewed papers for data extraction.

2.3 | Data Extraction and Analysis

Data was extracted from each paper using a pre-determined qualitative coding framework. This framework was developed

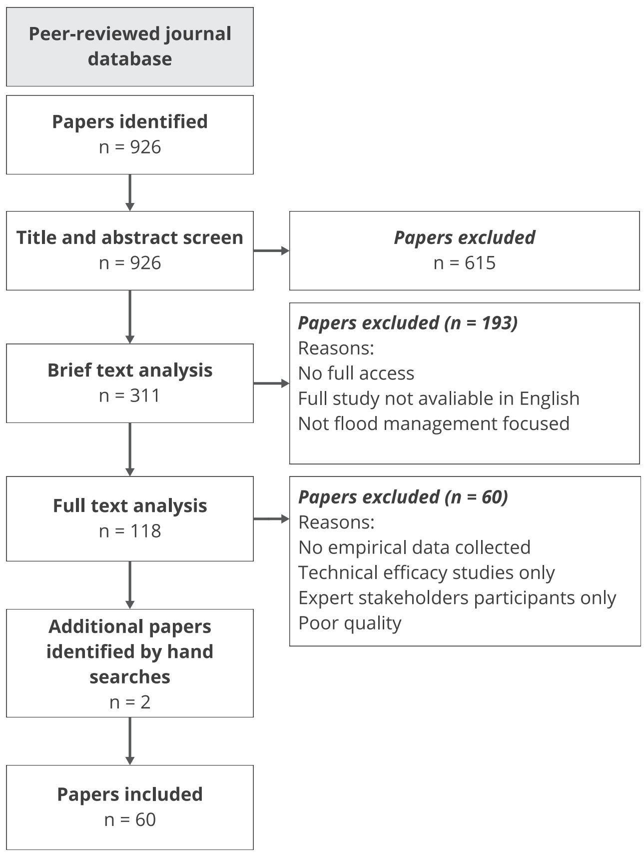

FIGURE 2 | Screening and selection process of papers assessing public values and preferences towards NFM.

TABLE 1 | Scopus search string.

TITLE-ABS-KEY ("nature-based solution" OR "natural flood management" OR "working with natural processes" OR "eco-engineering" OR "nature-based flood risk management" OR "river restoration" OR "floodplain restoration" OR "floodplain storage" OR "bio-engineering" OR "slow the flow" OR "upstream management" OR "sustainable land management" OR "runoff attenuation" OR "catchment management") AND TITLE-ABS-KEY ("stakeholder" OR "public" OR "citizen" OR "resident" OR "communit*" OR "farmer" OR "landowner" OR "land manager") AND TITLE-ABS-KEY ("opposition" OR "perception*" OR "perspective*" OR "attitude*" OR "acceptance" OR "preference*" OR "value*") AND (LIMIT-TO (SRCTYPE, "j")).

from the conceptual diagram outlined in Figure 1 and created in Excel. The framework was structured into five categories: (1) study characteristics; (2) NFM setting and design; (3) perceptions and attitudes towards NFM; (4) preferences for NFM; and (5) factors determining perceptions and preferences.

Categories 1 and 2 contained descriptive characteristics, for which codes were created to provide an overview of the study and NFM settings, for example, study design (setting, methodology, sample number, data source) and NFM types and scale (NFM site: neighbourhood, city, catchment, regional).

For categories 3 and 4, heterogeneity of perceptions and preferences extracted from participants across the 60 papers meant that data were analyzed using narrative synthesis. Whilst narrative synthesis can include the manipulation of statistical data, it mostly adopts a textual approach to the process of synthesis to 'tell a story' of the findings from the retained articles (Popay et al. 2006). In Category 3 (perceptions of NFM), narratives were collected and placed into broad groups such as positive, negative, and neutral feelings or perceived services and disservices. As not all papers revealed individual participant feelings, it was not possible to define the number of participants expressing a certain narrative. Therefore, narratives were grouped by attitudes of the overall majority of participants within the studies (over 50%). For example, if the majority of participants expressed positive feelings towards NFM, this paper would be categorized as 'positive'. The purpose of this REA was to provide a general overview of catchment perspectives, whilst further exploring indicators that influence these perceptions. However, a limitation of a taking an overall approach is the potential omission of perspectives from minority groups. Thus, when considering and interpreting the overall conclusions of these findings, it is important to note that diversity among respondents may have been observable in the original source (all sources are listed in Supporting Information S1).

Papers were also assessed for any potential bias in narratives; for example, only asking views on NFM challenges *or* benefits. This was not found to be the case, and thus we can assume the frequency of positive versus negative narratives was not caused by bias in research focus. A second cycle of analysis assessed similarities and differences between narratives and organized them into sub-groups. The frequencies of these narratives were then tabulated. By applying this two-step approach, a wide range of narratives was explored in depth, rather than immediately being placed into pre-determined codes.

For Category 4, papers were assessed for the presence of 'preferences'. These were either recorded as 'non-monetary preferences', whereby participants expressed preferences for the design and delivery of NFM, or 'monetary preferences' where standard environmental valuation methods had been applied to elicit Willingness to Pay (WTP)[1] or Willingness to Accept (WTA)[2] values for NFM schemes. For non-monetary preferences, data were assessed and categorized into three groups: preferences between NFM and grey infrastructure; preferences between NFM types/features; and preferences for the spatial scale of NFM. For monetary preferences, WTP/WTA values from all papers were extracted and converted to US dollars and were adjusted to present-day (2022) prices to aid analysis.

Lastly, for data in Category 5 (factors determining perceptions and preferences), pre-determined indicators were developed based on previous literature (Anderson and Renaud 2021; Garcia et al. 2020; Venkataramanan et al. 2020) and were categorized by personal, physical, socio-demographic, and design-function indicators. Other indicators that emerged during the review process were also included (Table 2). Indicators found to have a significant influence on perceptions/preferences for NFM (positive or negative) were retained for analysis, and the Chi-Square test of independence was performed to assess associations between different indicators and their significance, for example, knowledge of NFM (personal) and education (socio-demographic).

TABLE 2 | Personal, physical, socio-demographic, and functional indicators identified from the literature and rapid evidence assessment analysis.

Personal	Physical	Socio-demographic	Functional
Knowledge/awareness of environment/flooding	Geographical context	Age	Aesthetic impression
Prior flooding experience	Distance of home from NFM site	Income	Availability of information
Environmental attitudes	Population density	Education	Project design
Recreational usage	Length of residency	Ethnicity	Benefits delivered
Risk perception	Exposure to flooding	Occupation	Scale
Sense of place	Home setting (urban, sub-urban, rural)	Home ownership	Project utility
Values, beliefs, and norms	Exposure to hazard	Household structure	Cost
Trust in implementors	*House design*	Gender	Naturalness
Participation in property flood resilience		Cultural background	*Sustained maintenance*
		Country of residence	*Successful completion*
		Country of origin	*Delivered alongside emergency measures*
		Social network	*Project duration*
			Features that mimic engineered defenses
			Transparency

Note: Indicators emerging during analysis are presented in italics.

3 | Results

The results are presented following the same steps taken during data analysis, starting with a description of study characteristics. Public and farmer perceptions of NFM are outlined, followed by both non-monetary and monetary preferences for NFM schemes. This section concludes by presenting factors that influence these perceptions and preferences for NFM.

3.1 | Study Characteristics

The publication dates of the 60 papers ranged from 1995 to 2023 (Figure 3), with the majority published from 2007 onwards (90%, 54/60 papers). There are peaks in publications, notably from 2006 to 2010 and from 2020 to 2022. Publication peaks could follow the introduction of critical policies, reports, and programmes advocating for a nature-based approach to flood management. For example, the UK's 'Making Space for Water' policy (2004), the Pitt Review (2007), and the Dutch government's 'Room for River' programme (2007). There is some evidence that these government programmes did trigger research in that most papers published prior to 2013 focus specifically on public attitudes towards river and floodplain restoration (68%, 13/19 papers). Just under half of all papers are published from 2020 (45%, 27/60 papers), which coincides with the popularity of the term, 'NbS' and subsequent guidance documents. Prior to 2020, NbS was used infrequently within studies, yet from 2020 onwards, over half of the papers (63%, 17/27 papers) refer to the concept of NbS for addressing flood risk hazards. This reflects the increasing attention for the potential role of NbS in supporting climate change adaptation (Davies et al. 2021; Davies and Lafortezza 2019) and the role of broad-reaching guidance publications (Bridges et al. 2021; IUCN, International Union for Conservation of Nature 2020).

Within the 60 papers, 141 case studies were conducted across 33 countries, collecting data from approximately 22,870 respondents.[3] Most papers were based in Europe ($n=23$), followed by Asia ($n=5$), North America ($n=2$), South America ($n=1$), Africa ($n=1$), and Australasia ($n=1$). This demonstrates a lack of studies within non-European contexts. The search criteria of this REA focused on extracting perspectives and preferences for NFM from two broad groups: 'the public' and 'farmers'. The first group includes both those who would benefit from reduced flood risk when NFM measures are installed upstream (e.g., residents) as well as those who may benefit from the wider services of NFM (such as the general public enjoying recreational opportunities and enhanced wildlife). The second includes those who actively manage the land for agricultural activities who would then have to make changes to provide land for NFM services (e.g., land managers, landowners, tenant farmers).

Most papers returned in this REA focused on the public only (85%, 51/60 papers), whilst five papers investigated farmers and the public together (8%), and four papers (7%) reported the perspectives of farmers only. The imbalance between farmer and public samples reflects a general issue within research where it can be challenging to recruit large and representative samples of farmers (Weigel et al. 2021), with the availability of farmers' time (Prinz et al. 2009) and logistical issues relating to farm remoteness/access (Thomas et al. 2019) noted as key barriers. This issue is reflected in one of the mix-sample papers where researchers approached 16 farmers and only seven were willing to be interviewed (Liski et al. 2019). Successful recruitment has been found to be largely related to pre-existing relationships between researchers and farmers, positive word-of-mouth as well as building trust between academics and participants (Farquhar et al. 2014) which takes time and commitment. Despite the small number of papers researching farmer attitudes ($n=9$), the number of farming participants included in mixed-sample and farmer-only samples is relatively

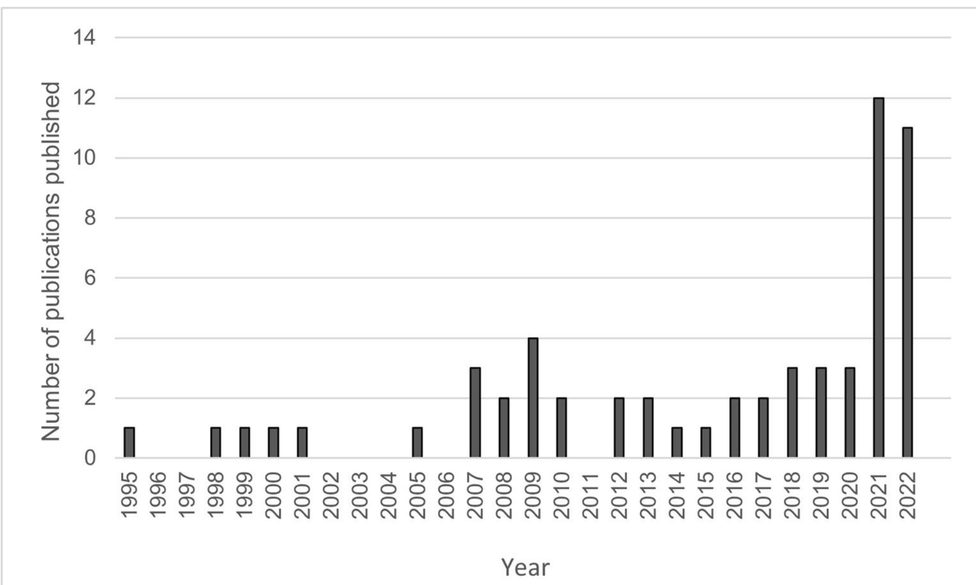

FIGURE 3 | Number of papers published since 1995 to 2023. The search process ended in early 2023. One study from 2023 is included in this review but not in this figure due to obscuring the presentation of data.

large ($n=369$). Therefore, we believe this sample is sufficient to synthesize farmers' views and to make informed conclusions. Of the 9 studies, three focused on livestock farmers (Arsénio et al. 2020; Braconnier et al. 2022; Metcalf et al. 2015), two on arable farmers (Cerdà et al. 2022; Zandersen et al. 2021), one assesses mixed farm types (Holstead et al. 2014) and three did not report on the type of farming activities (Burton et al. 2007; Liski et al. 2019; Nóblega-Carriquiry et al. 2022). Only two studies report whether farmers own or rent the land, with Metcalf et al. (2015) reporting views only from landowners and Holstead et al. (2014) assessing views from both.

Most papers utilized quantitative methods to extract views and preferences towards NFM measures (65%, 39/60 papers). A smaller number used qualitative (22%, 13/60 papers) or a mixed methods approach (13%, 8/60 papers) (Table 3). Most studies (78%, 47/60 papers) contained sufficient information to extract participant preferences for the design and delivery of NFM schemes. The dominant approach used to examine preferences was a questionnaire. For quantitative papers, 32% (15/47 papers) elicited preferences using either a Choice Model Experiment (CME) or Contingent Valuation (CV) to estimate monetary values (WTP for or WTA the NFM scheme). These are standard environmental economics valuation methods used throughout the world by governments, for example, the UK government's Green Book (HM Treasury 2022).

TABLE 3 | Rapid evidence assessment publications ($N=60$): Study design.

Study design	Number of papers (%) (total = 60)
Methodology	
Quantitative	39 (65%)
Qualitative	13 (22%)
Mix-methods	8 (13%)
Preferences examined (monetary/non-monetary)	
Yes	47 (78%)
No	13 (22%)
Preference methods (monetary/non-monetary)	
Questionnaire	34 (57%)
Workshops	7 (12%)
Q-method	3 (5%)
Photo visualizations	9 (15%)
Interviews	3 (5%)
Preferences examined (monetary only)	
Yes	15 (25%)
No	32 (53%)
Preference methods (monetary only)	
Choice model experiment	9 (15%)
Contingent valuation	7 (12%)

Table 4 outlines the NFM type and setting in which perspectives and preferences toward NFM were extracted.

Despite the low number of farmer-only-based studies, the number of studies set within a rural setting was high (32%, 19/60 papers). A similar number of studies were conducted within urban settings (28%, 17/60 papers), while studies situated within a sub-urban environment were uncommon (3%, 2/60 papers). Measures were assessed evenly across a range of scales, from assessments at the individual NFM site (25%, 15/60 papers) to assessments across a regional scale (22%, 13/60 papers). NFM measures located in and around rivers (riparian water storage, riparian vegetation, and instream features) were the most common types explored, usually described under 'river/floodplain restoration.' Perspectives on NFM measures independent from

TABLE 4 | Rapid evidence assessment papers: Natural flood management variables.

NFM variables	Number of papers (%) (total = 60)
Environmental setting	
Urban	17 (28%)
Sub-urban	2 (3%)
Rural	19 (37%)
Mix	21 (35%)
Not specified	1 (2%)
NFM scale	
Individual NFM site	15 (25%)
Neighbourhood, district scale	8 (13%)
City scale	10 (17%)
Catchment scale	14 (23%)
Regional scale	13 (22%)
NFM types	
Instream features	21 (35%)
Riparian water storage	27 (45%)
Riparian vegetation	23 (38%)
Offline tree planting	6 (10%)
SUDs	8 (13%)
Soil management	3 (5%)
Offline storage ponds	4 (7%)
Saltmarsh restoration	1 (2%)
NFM installation	
Prospective/planning/hypothetical	36 (60%)
Mix	12 (20%)
Past	9 (15%)
Current	3 (5%)

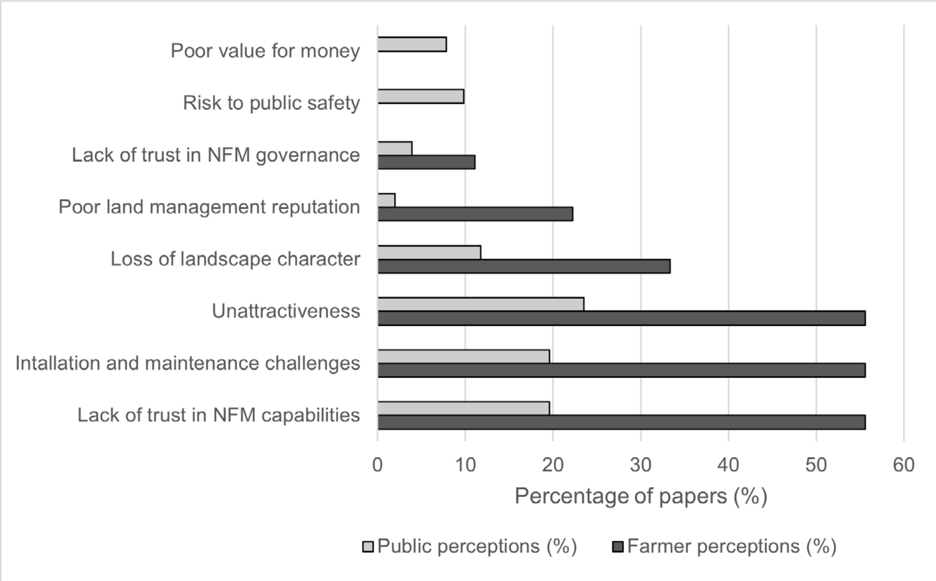

FIGURE 4 | Public and farmer perceptions of natural flood management (negative narratives). Papers that did not demonstrate any negative narratives are not included in the graph.

the riverine environment were explored to a lesser extent, such as soil management (e.g., planting catch crops to reduce erosion, aerating soils to enhance soil infiltration), offline storage ponds, offline tree planting, and saltmarsh restoration. Most papers described realistic (hypothetical) NFM scenarios to survey respondents (60%, 36/60 papers), with the remaining studies presenting existing (5%, 3/60 papers) or past NFM measures (15%, 9/60 papers) to capture respondent perspectives. The higher number of studies based on realistic (hypothetical) NFM scheme scenarios is attributed to authors utilizing standard environmental valuation methods (CV/CMEs) to estimate preferences and WTP/WTA values. Careful survey design (e.g., based on a proposed scheme, expert advice, modeling) and testing reduces biases (including hypothetical bias) when using these methods (Tinch et al. 2019).

3.2 | Public and Farmer Perceptions of NFM Schemes

Negative, neutral, and positive perceptions towards NFM were identified across all 60 papers, with a higher total number of negative comments reported ($n = 72$) than positive comments ($n = 52$). To aid the analysis and interpretation of results, we grouped the farmer and farmer/rural resident papers together ($n = 9$) as previous studies have shown that members of the public living in proximity to farmers hold strong connections to agricultural landscapes, often reflecting similar views to the farming community (Buijs 2009; Iversen et al. 2022). To account for the imbalance between 'farmer' and 'public' papers, the total number of papers in each group citing a negative or positive narrative is converted to a percentage.

Farmers were notably concerned with installation and maintenance challenges, the capability of NFM to deliver flood reduction, and its unkempt appearance. In addition, farmers were also concerned with a loss of landscape character (e.g., agricultural heritage) and the loss of reputation for good (traditional) land management (e.g., being labelled a 'slipper farmer'). The public tended to hold more negative perceptions around the value for money and risk to public safety (e.g., risk of drowning from stored water) (Figure 4).

We further explored whether different perceptions were associated with a specific NFM measure (Figure 5). Again, as there is an uneven number of NFM measures assessed across the papers, percentages of papers per type are used rather than counts. Soil management techniques, such as planting catch crops were notably related to negative reputations, installation challenges and unattractiveness. Whereas perceived ineffectiveness and unattractiveness were associated with instream NFM features.

Neutral feelings towards NFM were identified in only 27% (16/60 papers) of papers, mainly citing inconclusive feelings about the purpose of NFM or its unrealized benefits. Positive feelings towards NFM were found in more than half the papers (53%, 32/60 papers), including five papers with mixed/farmer-only samples. Positive attitudes from the public were associated more with NFM appearance and trust in its capabilities, whereas farmer samples appreciated the enhanced connection to nature (human-landscape interaction) that NFM brings (Figure 6). Both groups perceived the natural elements of NFM to be positive, yet comments about NFM's value for money, perceived safety, impact on community cohesion, and ease of installation were made by public participants only (Figure 6).

Figure 7 demonstrates how perceived attractiveness and naturalness of NFM were mostly associated with riparian vegetation, instream features, and offline tree planting schemes, whilst soil management was found to be positively associated with value for money.

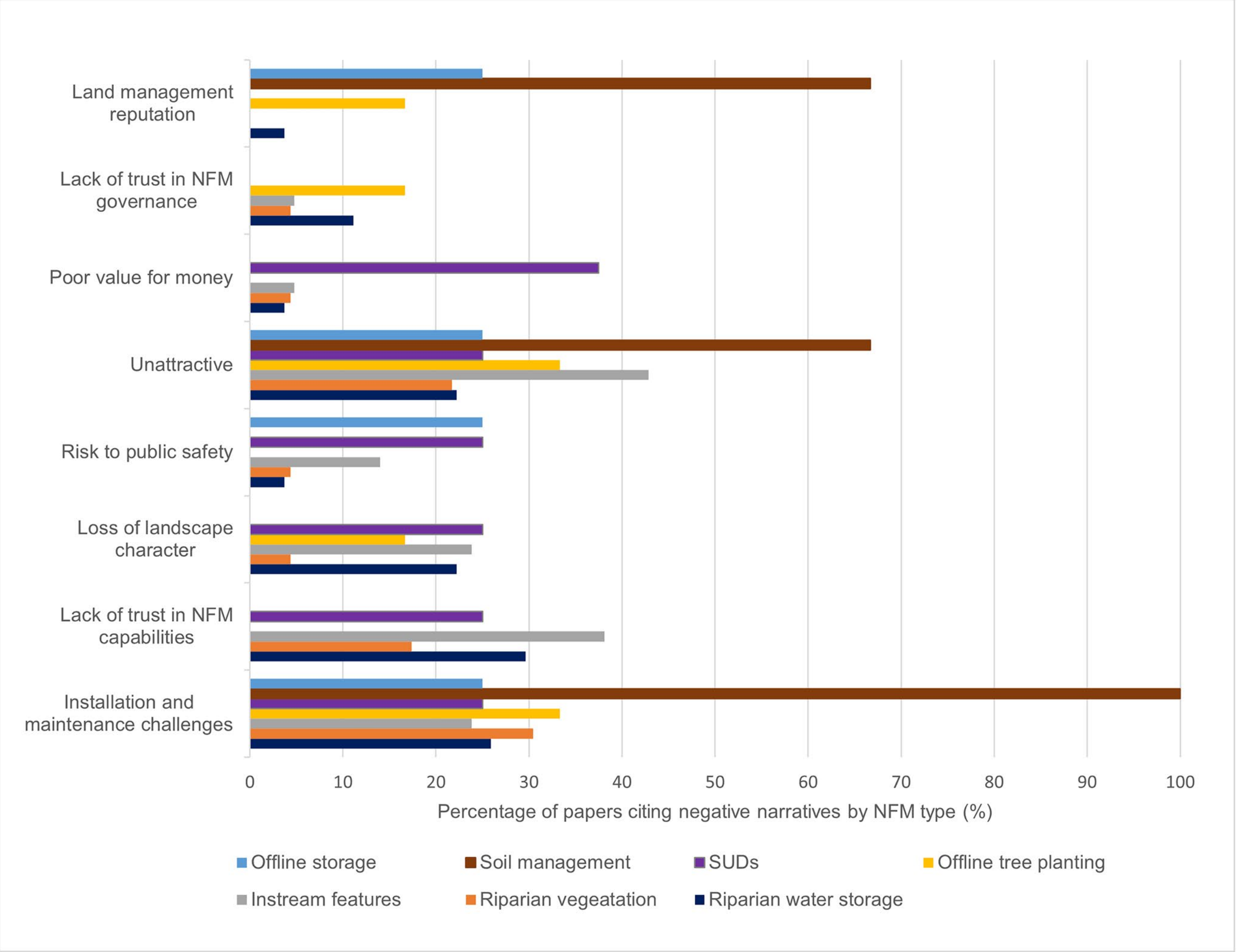

FIGURE 5 | Percentage of papers that identify negatives narratives for each individual natural flood management measure.

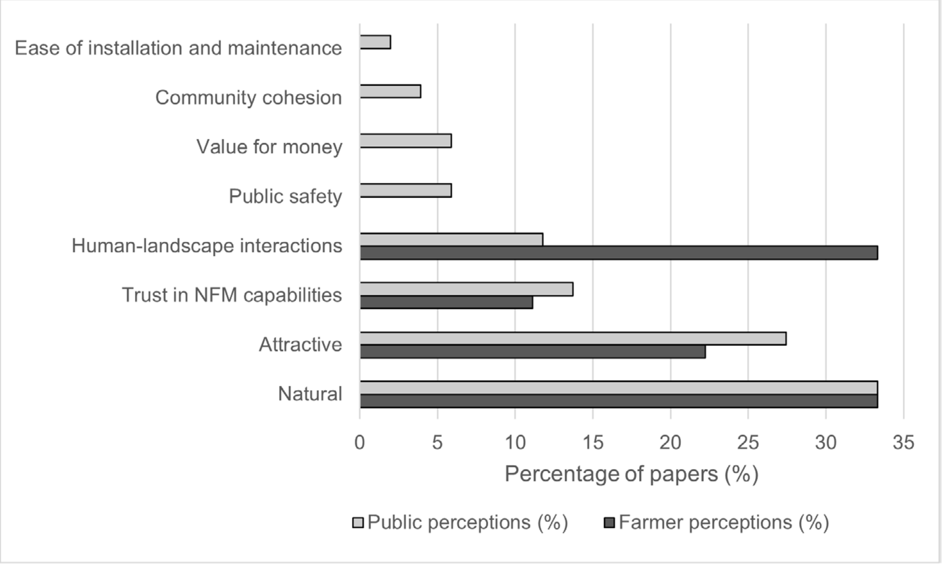

FIGURE 6 | Public and farmer perceptions of natural flood management (positive narratives). Papers that did not demonstrate any positive narratives are not included in the graph.

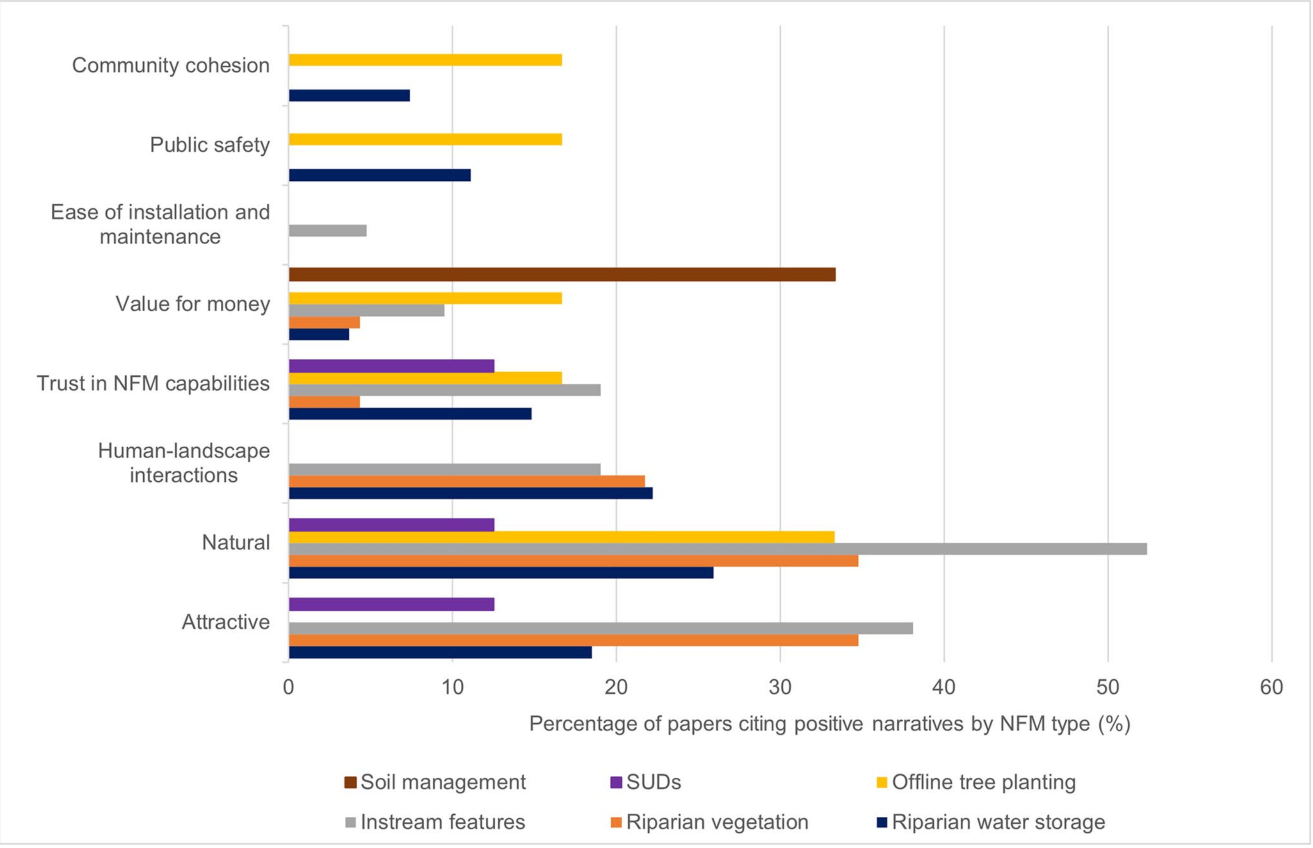

FIGURE 7 | Percentage of papers that identify positive narratives for each individual natural flood management measure.

3.2.1 | NFM Services and Disservices

This REA also assessed the perceived consequences (positive and negative) of introducing NFM measures into the current landscape. These are defined as services and disservices provided by NFM using the four Millennium Ecosystem Assessment (2005) categories (see Table 5). To account for the imbalance between samples, percentages of perceived services/disservices identified across the papers are calculated based on the total number of farmer/public papers that reported at least one ecosystem service/disservice. As most papers asked respondents for their views on realistic but hypothetical NFM schemes (Table 4), respondents' views on the services/disservices of NFM measures are not formed by personal views of an implemented scheme, but rather by their preferences and views of the carefully described scheme. Farmers mostly recognized the regulating services of NFM that support their farming system, such as improved soil stability, water quality, drought, and flood control. They also recognized the potential value of provisioning services, such as increased income through paid NFM contracts. While the public also appreciated these services, more focus was placed on the recreational opportunities NFM brings (cultural) as well as its ecological benefits (supporting).

Fewer perceived disservices of NFM were identified across the papers (Table 6). However, concern over the dedication of land to NFM and what impact this may have on economic productivity, particularly within the agricultural sector, was frequently cited among both public and farmer samples. Farmers were concerned about the cultural impact of NFM on the loss of landscape/farming traditions, whereas the public was concerned about the impact NFM could have on public welfare, such as an increase in antisocial behavior, littering, or an increase in local taxes and property prices. These perceptions were common among studies assessing public perspectives of urban NFM measures, such as river restoration in parks (Diep et al. 2022; Petts 2007) and SUDs installation (Thodesen et al. 2022).

3.3 | Preferences for NFM Schemes

3.3.1 | Non-Monetary Preferences

Preferences for the design and delivery of NFM schemes were reported in 78% of papers (47/60). In this section, we present three types of preferences that are explored: (i) preferences between NFM and grey infrastructure; (ii) preferences between NFM types/features; and lastly (iii) preferences for the spatial scale of NFM.

First, 28% of preference papers (13/47) compare general preferences between grey infrastructure, NFM, and hybrid schemes (a mix of NFM and grey infrastructure). Of these papers, the majority (9 papers) found that respondents preferred NFM options over an engineered or hybrid option, while 3 papers reported preferences for engineered options only (over an NFM option). One paper that assessed views from both the public and farmers (Liski et al. 2019) found that the 'beneficiaries' (the public) preferred NFM schemes, while the majority of potential 'providers'

TABLE 5 | NFM services perceived by the public and farmers.

NFM service	Sub-category	Sample	Percentage of papers (%)
Provisioning	Increased income generating activities	Public	13
		Farmer	40
	Increased water availability for irrigation	Public	3
		Farmer	20
	Enhances public welfare	Public	16
Regulating	Flood control	Public	29
		Farmer	40
	Improves water quality	Public	26
		Farmer	60
	Soil stability	Public	10
		Farmer	20
	Drought control	Public	6
		Farmer	20
	Improves air quality	Public	13
	Thermal regulation	Public	6
	Removal of invasive species	Public	3
Supporting	Enhances wildlife	Public	32
		Farmer	20
	Improves ecological conditions	Public	39
	Increases biodiversity	Public	10
	Supports conservation	Public	10
Cultural	Boosts physical and mental wellbeing	Public	16
		Farmer	20
	High aesthetic value	Public	32
	Access to recreation	Public	55
	Educational opportunities	Public	16
	Provides connection to nature	Public	13
	Boosts community cohesion	Public	6
	Preserves cultural values	Public	3
	Offers intergenerational equity	Public	3

(farmers) preferred more 'static,' engineered options in order to maintain their livelihoods and agricultural heritage.

Secondly, preferences between specific types of NFM measures and their design features were explored in 45% of papers (21/47), with all but one paper investigating public preferences only.[4] Of these papers, 7 directly compare preferences between specific flood management measures. For example, D'Souza et al. (2021) and Ruangpan et al. (2021) asked respondents (public only) to rate different engineered and NFM options, finding that restoration/enlargement of floodplains was preferred the most. Tree planting also scored highly with respect to visual preferences; however, both papers reported that trees were least preferred over floodplain restoration when participants were considering the effectiveness of measures for reducing flood risk. Due to the heterogeneity of NFM types explored among the papers, it was not possible to conclude which NFM option is most preferred. However, it was possible to identify favored design features of NFM options. Design features were mostly associated with water storage and vegetation planting, with a varying degree of preferences for individual features (Figure 8).

A small number of preferences for the design of water storage ponds were identified. Both Li, Nassauer, Webster, Preston, and Mason (2022) and Jakstis et al. (2023) found that over half of participants (public only) preferred permanent storage ponds over temporary storage ponds. Further, Li, Nassauer, and Webster (2022) found that the level of water within a storage pond also influenced preferences, with higher preferences towards typical water levels compared to low levels (perceived as unattractive) or high levels (perceived as unsafe). Preference for the level of connectivity between a river and its floodplain was discussed by five papers, with participants from four of the five studies expressing preferences for full connectivity (e.g., bank removal) to encourage more water storage capacity on the floodplain (Poledniková and Galia 2021; Pradilla et al. 2021; Tapsell 1995; Weber and Stewart 2009). Whereas Saha et al. (2020) found participants (public only) expressed low preferences towards connectivity due to the potential for 'stagnant' pond creation on the floodplain.

Preferences for the design of vegetation features, such as riparian and offline shrubs and trees, were also identified (Figure 8). Generally, an increase in vegetation cover at NFM sites was favored, with preferences for both slight and large increases. Slight vegetation increases were often preferred when participants felt a large abundance of vegetation may lead to the obstruction of views or appear 'overgrown' (Braconnier et al. 2022; Thodesen et al. 2022). In terms of species, a preferred feature was species diversity, and a strong desire for native over non-native species. However, a difference of opinion regarding vegetation management was expressed. The desire for 'controlled' vegetation was found in three urban/suburban-based papers, reflecting a concern that unmanaged/overgrown vegetation could invite anti-social behavior, for example, for 'strangers to lurk' among tall vegetation as well as obstruct views (Jakstis et al. 2023; Petts 2007; Thodesen et al. 2022). These three urban-based papers also reported a preference for design features that benefited humans (benches, litter bins, and play areas). In contrast, a rural-based study found participants (public only) preferred less managed vegetation/disturbance to enhance benefits to nature (Westling et al. 2014).

TABLE 6 | NFM disservices perceived by the public and farmers.

NFM disservice	Sub-category	Sample	Percentage of papers (%)
Provisioning	Loss of land	Public	29
		Farmer	**88**
	Decreased income generating activities	Public	19
		Farmer	**38**
	Higher costs	Public	29
	Anti-social behavior	Public	24
	Pollution	Public	19
	Enhanced risk to public	Public	19
Regulating	Soil erosion	Public	10
		Farmer	**25**
	Reduced water quality	Public	14
	Enhanced flooding	Public	29
Supporting	Attracts pests and diseases	Public	24
		Farmer	**25**
	Ecological damage	Public	10
	Loss of habitats	Public	10
Cultural	Reduced recreation	Public	33
		Farmer	**13**
	Loss of landscape/ farming heritage	Public	10
		Farmer	**25**
	Loss of aesthetic value	Public	19

Lastly, preferences for the spatial scale of NFM implementation were explored in 45% of papers (21/47). In 14 papers, the scale of NFM was measured from a status quo baseline (do-nothing), followed by subsequent levels of NFM delivery. Nearly all papers found that participants tended to choose the NFM scheme over do-nothing. The exceptions are Zandersen et al. (2021) and Cerdà et al. (2022), who elicit farmer preferences and found that the majority preferred the 'do-nothing' option. For those preferring the NFM scheme, three papers found a preference for small-scale (partial) NFM installation (Arfaoui and Gnonlonfin 2020; Braconnier et al. 2022; Deacon and Schläpfer 2010), whilst eight papers reported a preference for large scale (full) installation of NFM features (Brouwer et al. 2016; Chen et al. 2018; Derkzen et al. 2017; Hérivaux and Le Coent 2021; Junker and Buchecker 2008; Poledniková and Galia 2021; Sanon et al. 2012; Tapsell 1995). One paper found that large-scale NFM strategies were only preferred if combined with large-scale engineering strategies; otherwise, implementation of NFM on a small scale was preferred (Arfaoui and Gnonlonfin 2020).

3.3.2 | Monetary Preferences

From an economic point of view, individuals' preferences for a good can be measured either via their WTP for that good (as a beneficiary) or WTA payment for that good (as a provider) (Tinch et al. 2019; Verlynde et al. 2019). WTP values were elicited from 28% of preference papers (13/47) and WTA values from 4% of papers (2/47). Of these, eight applied CMEs, six applied CVs, and one paper applied both (Weber and Stewart 2009). Few valuation studies took place at a catchment scale (4 papers), with most focused on a specific NFM measure in a local setting (11 papers). The values presented below are estimates that have been rendered commensurable by converting them to 2022 US dollars.[5] These values are followed by the WTP/WTA as a percentage of the average per capita income (PCI) of the country where the valuation took place.[6]

WTP values elicited from CMEs and CVs varied by type of NFM measure and study area. The lowest values are reported for an urban river restoration scheme, where Chen et al. (2018) extract public WTP values using a CME with both Guangzhou (China) and Brussels (Belgium) residents. The Brussels case study revealed a lower WTP value ($11.21 US dollars/household/year, 0.02% PCI) than the Guangzhou case study ($32.38 US dollars/household/year, 0.25% PCI) despite Belgium citizens having a much higher living wage. The authors suggest this could be attributed to the poor water quality levels of Guangzhou's watercourses, which would have been improved by the river restoration scheme (Chen et al. 2018). Similarly, when conducting spatial comparisons across three European countries, Brouwer et al. (2016) reveal a range of WTP values for riparian water storage: Hungary = $30.40, Austria = $109.75, and Romania = $43.23 (US dollars/household/year, 0.17%; 0.21%; 0.27% PCI, respectively). Again, the country with the lowest average household income (Romania) has the highest WTP/PCI.

Two studies elicited WTA, that is, compensation values from farmers who are asked to implement NFM measures on their land. Zandersen et al. (2021) conducted a CME to assess farmers' WTA for a contract that would allow a local Danish Municipality to periodically flood farmland to reduce urban flood risks, and Cerdà et al. (2022) used a CV to elicit WTA values from Spanish farmers to compensate them for changing their soil and land management practices (by planting cover crops). Both papers found that most farmers preferred the status quo option (e.g., no contract in place). However, for those farmers who did accept the proposed changes to land management practices, Spanish farmers shifting to catch crops were WTA $141.27 US dollars/ha, 0.48% PCI (Cerdà et al. 2022). Whereas Danish farmers permitting periodic flooding of farmland expected an average compensation of $510.20 US dollars/ha, 0.75% PCI, but with higher values if the farmers had prior experience of farmland flooding (WTA = $624.53 US dollars/ha) and lower values where they had no experience (WTA = $394.03) (Zandersen et al. 2021).

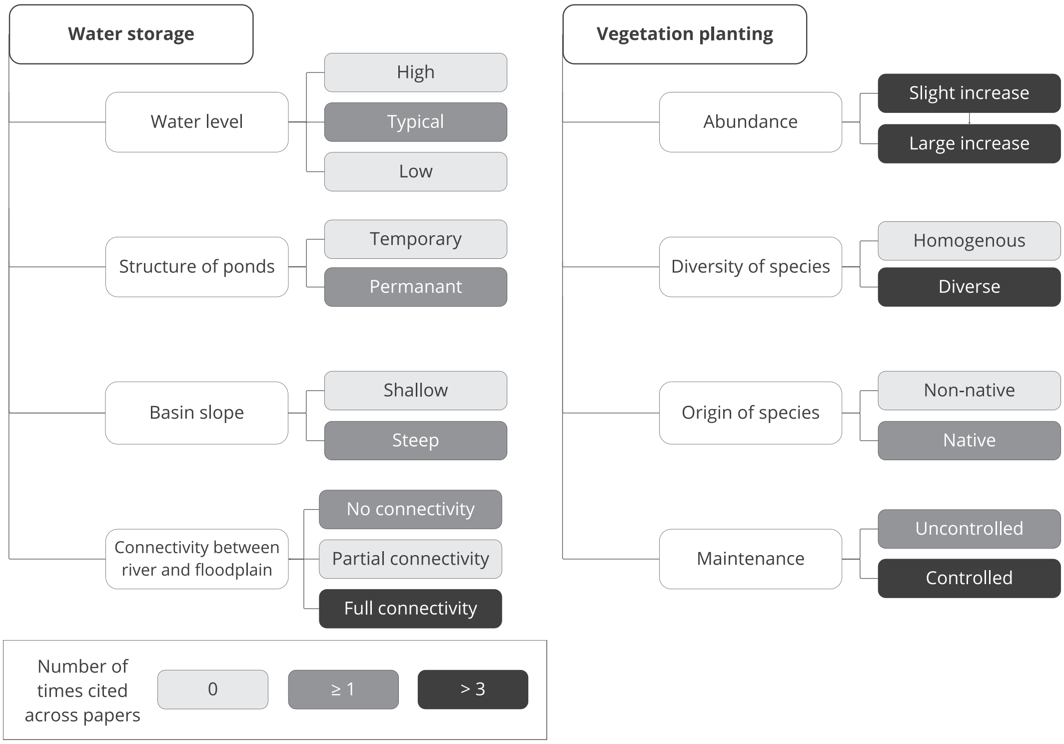

FIGURE 8 | Preferences for design features for water storage and vegetation planting. The shade of boxes shows the number of papers that most participants expressed their preferences for that specific design feature.

On average, CV studies revealed lower WTP values per household per year ($31.12) compared to CME estimates ($90.50). Disparities in CV and CME estimates are not uncommon (e.g., Hanley et al. 1998; Stevens et al. 2000; Weber and Stewart 2009). For example, Weber and Stewart (2009) estimated higher CME values than CV values for river and floodplain restoration. The authors recommend using the higher WTP values generated from the CME, as the model was richer in predicting variables, had tighter standard deviations around the mean, and a much larger sample size due to CMEs requesting multiple observations per person.

Such disparities between CV and CME values do not mean that one method is better than the other. For example, Hynes et al. (2011) argue that deciding the type of stated preference technique is context-dependent, with CVs having the advantage of assessing WTP for a scenario as a whole (e.g., installing NFM interventions vs. status quo), whilst CMEs measure the marginal value of change in individual attributes (e.g., WTP for low, medium, or high levels of floodplain reconnection) and provide information on how respondents trade off different attributes. It is important that policymakers use WTP values appropriate for their environmental context and where there is a range of values, these can provide bounds to guide public/farmer payments.

3.4 | Factors That Influence Perceptions and Preferences

Factors affecting perceptions and preferences were investigated in 83% of papers (50/60). Most papers applied quantitative methods to assess whether factors influenced perceptions and preferences (67%, 40/60 papers), and thus, results are observed with the assumption that significance testing has occurred. A mix of pre-determined sample characteristics (personal, physical, and demographic) outlined in Table 2 were selected for testing. Papers either reported significant/insignificant results or no results at all. For the latter, we have assumed that absent results are due to their insignificance. While a pre-determined framework outlined sample characteristics, the open code approach during analysis did highlight several non-sample-related characteristics (Table 2), such as the design features and functions of NFM. Both are presented below.

3.4.1 | Sample Characteristics

This sub-section presents sample characteristics that were explored as influencing indicators in seven papers or more. Most papers included an assessment of indicators (83%, 50/60 papers), of which a full summary can be found in Supporting Information S2.

Personal and socio-demographic characteristics were the most tested indicators, whilst physical characteristics were explored to a lesser extent. Figure 9 shows that 'Knowledge' of flooding and NFM features was the most tested indicator (found in 14/50 papers). A significant, positive relationship between knowledge and NFM acceptance was identified in all papers (farmer and public samples) demonstrating that the more knowledge someone has, the more accepting they are of NFM. Other personal indicators, such as environmental attitudes, values, recreational use, prior flood experience,

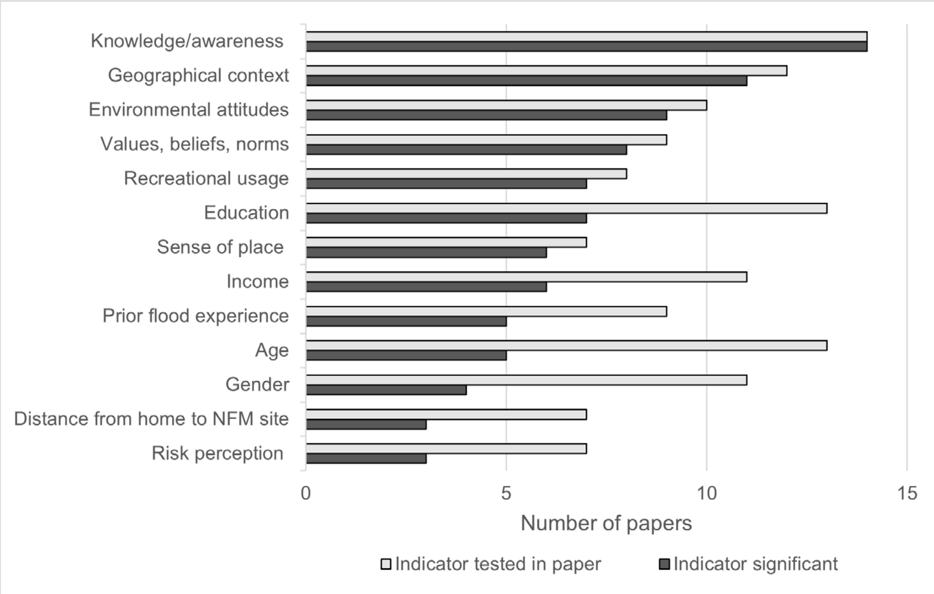

FIGURE 9 | Personal, physical, and socio-demographic indicators that were tested in papers (light grey) and indicators that were found to be significant (dark grey). Sample characteristics that were not tested in 7 papers or more were excluded from analysis.

and sense of place were explored to a lesser extent but were found to significantly influence NFM perceptions and/or preferences. The exception is risk perception, which was explored in 7/50 papers, but only 3/7 identified a significant relationship. Age, gender, education, and income (socio-demographic) were commonly tested, yet only income and education were found to be significant in over half of the papers that tested (Figure 9). Higher education levels were found to have a positive, significant relationship with NFM perceptions.

Further analysis using the Chi-square test of independence indicated that papers exploring knowledge were also likely to explore education: $X^2(1, N = 50) = 4.67$, $p = 0.031$. Furthermore, these associated indicators were also found to have an influential effect on perceptions and preferences, yet at a lower level of statistical significance: $X^2(1, N = 50) = 3.43$, $p = 0.064$. These findings suggest that participants with a higher education (e.g., a university degree) and those more knowledgeable about flooding and NFM measures are more accepting of these measures.

'Geographical context' (physical), which is described by the regional location of NFM and/or location attributes, was frequently tested (12/50 papers). Of these 12 papers, all but one identified geographical context as a significantly influential factor. Distance from home to the NFM site, tested in 7/50 of the papers, was a significant and positive factor in three papers (e.g., the closer someone lived to a NFM site, the more accepting they were of NFM). Further analysis found a significant association between the distance that people live from a NFM site (e.g., the river) and their engagement in recreational activities: $X^2(1, N = 50) = 13.02$, $p = 0.001$. When tested together, both factors were found to have a significant influential effect: $X^2(1, N = 50) = 7.35$, $p = 0.007$. This suggests that those living close to NFM sites, and those who engage with recreational services provided by the NFM site, are more likely to have positive perceptions/preferences of NFM.

3.4.2 | NFM Features and Design

Indicators relating to NFM design were not necessarily associated with a specific NFM measure but rather could be considered in the planning of various NFM strategies, such as: improving information availability; outlining and delivering project co-benefits; presenting transparent project costs and ensuring sustained maintenance. The most important feature of NFM design was 'aesthetic impression', which was found to have a significant, positive effect on perceptions and preferences in eight papers (e.g., the more attractive the NFM feature, the more value is attached to it). Thus, aesthetic impression is an important factor to consider when designing NFM strategies, combined with informing stakeholders about the project. Other NFM design indicators, such as project duration, whether other emergency measures are delivered alongside NFM, or the extent to which NFM mimics engineered defenses may also be influential yet remain underexplored across the literature (see Supporting Information S2).

4 | Discussion

This REA analyzed 60 papers on public and farmer perceptions/preferences towards NFM measures. We found that the perceptions and preferences of both stakeholder groups are not aligned. Here, we address our three research questions and outline implications for the uptake of NFM in flood risk management and environmental policy.

4.1 | How Is NFM Perceived by the Public and Farmers?

A review of perceptions found that farmers believed NFM to be ineffective and unattractive (Figure 4). Farmer-based papers also cited that NFM leads to a 'bad reputation', which reinforces findings by Holstead et al. (2014), who report farmers' reluctance to install NFM measures due to their 'unkempt' appearance and potential impact on their land management reputation. However, these views are based on a small number of farmer studies and therefore may not necessarily represent the wider farming community. Yet, the synthesis of negative views from the 369 farmers within the sample of these studies, especially towards measures that require permanent land use change/large expanses of land, demonstrates the need for future policy to ensure NFM options are flexible and cover the costs of lost output, maintenance costs, and opportunity costs. Contrary to farmers' views, the public mostly finds NFM to be attractive (Figure 6), particularly measures which involve instream features, riparian vegetation, and riparian water storage (Figure 7). These measures were also associated with being highly 'natural,' which arguably generates more aesthetically pleasing landscapes (de Groot and de Groot 2009; Hu et al. 2019; Junker and Buchecker 2008).

As the success of NFM is dependent on the availability of land to install measures, it is unsurprising that farmers were concerned about the installation and maintenance of NFM. Uncertainty around installation and maintenance has been cited as a key barrier to NFM delivery, particularly regarding the availability of long-term funding (Environment Agency 2019) and confusion over who takes responsibility for the long-term management and maintenance of NFM (Wingfield et al. 2021). Installation challenges were associated mostly with soil management measures, such as planting cover crops or blocking drains to re-wet the land. This requires farmers to adjust their agricultural practices, which have been deeply embedded for generations. For instance, post-war agricultural policy in the UK paid farmers to drain their land to maximize food production (O'Connell et al. 2007; Werritty 2006). These embedded practices may lead to 'path dependency', a concept where present-day thinking is influenced and controlled by past decisions, presenting a significant barrier to NbS uptake (Davies and Lafortezza 2019; Waylen et al. 2015). Both public and farmer concerns regarding NFM and landscape change support this argument.

Potential landscape changes associated with NFM were mostly reported with riparian water storage, offline tree planting, and SUDs (Figure 5). Whilst measures involved with soil management, riparian vegetation, and instream features do not tend to compete with other land uses, tree planting and water storage entail the conversion of land to accommodate these measures. Many papers found that loss of land and productivity is one of the most perceived disservices of NFM (Table 6), indicating that the potential impact of NFM on farm businesses is a concern for farmers and the public. Nevertheless, numerous services of NFM were recognized, including increased flood control, water quality improvements, biodiversity enhancement, and recreational opportunities (Table 5). These trade-offs suggest that interests concerning land use and resource management are not always aligned, leading to potential land conflict as demands to address multiple environmental and societal challenges increase (Stosch et al. 2022; von der Dunk et al. 2011).

Although most perceptions towards NFM discussed in this paper are based on carefully designed and tested realistic scenarios, they provide essential information to consider when designing and delivering NFM. Catchment planners/managers will need to address any concerns with effective communication and information provision. Likewise, expectations of project-related benefits need to be managed to avoid unnecessary disappointment.

4.2 | Where Do Farmer and Public Preferences for NFM Align, and Where Do They Not?

Findings from this REA demonstrate a misalignment of public and farmer NFM preferences. Public preferences tended to favor NFM measures, even when compared to grey infrastructure options. Whereas farmers demonstrated less acceptance, preferring grey infrastructure over NFM (Liski et al. 2019) or no intervention (Cerdà et al. 2022; Zandersen et al. 2021). Although only a few studies elicited preferences between different types of NFM measures, D'Souza et al. (2021) and Ruangpan et al. (2021) find that floodplain enlargement/restoration and tree planting were favored by the public. Figure 7 shows that instream features, riparian water storage, and riparian vegetation were associated most with attractiveness and effectiveness, which could explain why preferences for NFM features inclined towards water storage and vegetation-based measures. This evidence is supported by previous studies assessing public preferences for landscape attributes within the USA (Nakarmi et al. 2023) and Austrian (Arnberger et al. 2021) national parks, revealing that the public favored forested/high-vegetated landscapes the most, followed by those with water bodies.

Figure 8 emphasizes that not only do the public express preferences for types of NFM measures, but also specific features within NFM types, for instance, permanent water storage over temporary, native over non-native vegetation, and diverse over homogeneous vegetation. These preferences could be influenced by the awareness of environmental co-benefits, such as biodiversity enhancement and habitat creation which NFM can provide (Table 5). Despite this, the extent to which NFM features deliver ecological benefits appears to be capped when the landscape appears 'unsafe' or 'unmanageable'. For example, preferences inclined towards managed vegetation, which is known to offer lower ecological value than natural, untamed vegetation (Hu et al. 2019). Vegetated landscapes with low maintenance input have received negative responses from the public in the past, particularly within urban landscapes (Hofmann et al. 2012; Hu et al. 2019), while unmanaged, natural vegetation is more accepted in rural contexts (Hu et al. 2019; Kenwick et al. 2009; Westling et al. 2014). Thus, those installing NFM features and schemes must be conscious of striking the balance between seeking high levels of ecological value and aesthetic impression, particularly within an urban setting.

Findings suggest that the public holds spatial preferences for NFM delivery, with the majority valuing large scale over small scale installation of schemes (Section 3.3.1), which would require larger expanses of land if installed. To subsidize the temporary or permanent loss of land, farmers require compensation (Morris et al. 2016). Payment for Ecosystem Services (PES) has gained increasing influence in international and national environmental policies, whereby financial incentives (e.g., via public or private funds) are used to encourage management practices that deliver ecosystem services, such as flood regulation or biodiversity enhancement (Merlet et al. 2018; Schomers and Matzdorf 2013). This REA finds that in the 13 papers that elicit WTP values from the public, most respondents in each study preferred to pay for an NFM scheme (e.g., via annual council tax) rather than not pay for it and have nothing. This suggests the public is supportive of policies that use public funds to enhance flood resilience via natural measures. Nevertheless, NFM requires a catchment-wide perspective, yet most studies elicit WTP values from residents living close to the NFM site (in situ). Whereas economic preferences of residents living downstream (ex situ) from an NFM scheme are underrepresented. Furthermore, the concern over loss of land expressed by farmers, and public preferences towards large-scale NFM schemes, present a concerning misalignment between both stakeholder groups.

Public and farmer participants did hold aligned attitudes towards the environmental benefits of NFM (Figure 6); for farmers, regulating services can improve their business and livelihoods through improvements to soil health and higher yields or increased resilience to climate change through drought control (Table 5). While this service may not be a priority for the public, they still strongly value the supporting services of NFM, which can enhance wildlife through habitat creation and improvement to ecological conditions. In some cases, stakeholders may hold more interest in the delivery of NFM co-benefits rather than for the primary flood control objectives. For example, in a comparative case study assessing urban river restoration preferences from Brussels (Belgium) and Guangzhou (China) residents, Chen et al. (2018) found that despite having a lower living wage, Chinese residents were WTP more for the proposed scheme as it would also improve Guangzhou's water quality, which was known to be very poor. NFM co-benefits likely improve scheme acceptance among the public and farmers and boost WTP values for NFM schemes. Thus, in some cases, it may be more beneficial to promote and deliver NFM measures under established policies and funding mechanisms, such as England's Biodiversity Net Gain (Defra 2023a) or Nutrient Neutrality (Defra 2023b), as well as learning from international schemes that deliver environmental services from agricultural land (Bark 2021).

Despite evidence of public WTP for environmental services, more consensus on compensation values for delivering public goods on farmers' land is required. In England's policy context, this challenge is being addressed under ELMs, through a programme of Test and Trials (Defra 2021). Initial findings highlight that compensation must go beyond the cost of implementation plus foregone income to ensure ongoing maintenance costs are also covered (Defra 2021; Holt and Morris 2022; Potočki et al. 2022). At the time of the literature search, only two papers elicited WTA values for installing NFM on farmland, suggesting more research is required (including in non-European contexts) to support programmes like the ELMs Test and Trials to determine fair and equitable compensation for farmers and land managers.

4.3 | What Factors Determine the Acceptance of NFM?

This REA includes a variety of papers with different contextual factors (such as culture, NFM setting, geographical context), yet we can identify common indicators across papers that provide explanations of why NFM may be accepted or not accepted by communities. Papers mostly explored influential characteristics relating to the sample (personal, physical, and socio-demographic), whilst the impact of indicators relating to the design and functional features of NFM was explored to a lesser extent. We note that the indicators provided in Figure 9 and Supporting Information S2 are not an exhaustive list, and many more socio-economic and cultural variables specific to each NFM location likely significantly determine acceptance/opposition. Therefore, preferences will vary between places, and heterogeneity in stakeholder attitudes will not always be well captured in research. Furthermore, this REA presents a very euro-centric synthesis, lacking representation from Global South studies, a common problem in the literature (Woroniecki et al. 2023). Fortunately, new research is now emerging around NbS implementation for addressing natural disasters, including flooding in the Global South (Mukherjee et al. 2022; Rauf et al. 2024). Whilst we are unable to capture the full spectrum of heterogeneity, we discuss indicators of interest below. These are likely to be applicable regardless of the cultural or socio-economic context. NFM practitioners and catchment managers can use this information, alongside an in-depth assessment of local contextual factors, to facilitate NFM acceptance in different communities.

Access to recreation was the most perceived service of NFM, followed by flood regulation (Table 5). Therefore, it is unsurprising that recreational use was an influential factor in NFM acceptance in most papers. This could also be explained by most papers exploring NFM types that were associated with river restoration (instream features, riparian water storage, and riparian vegetation). River restoration interventions often seek to integrate recreational features in their design, for example, river pathways for biking and walking (Deffner and Haase 2018; Tunstall et al. 2000; Westling et al. 2014). However, in other cases, NFM may be installed upstream on private land (Morris et al. 2016) and may not be accessible to the public. Considering these findings, it is important for flood managers to consider the potential recreational value of NFM sites and, where possible, take the opportunity to enhance recreational access not only for locals but for wider catchment visitors too.

Previous literature has argued that residents who express a strong sense of place with their local, rural environment have been found to feel compassion for farmers and their businesses as well as associate the farming landscape with 'beauty' and 'charm', leading to resistance to projects which threaten this, such as large-scale delivery of NFM (Buijs 2009; Iversen et al. 2022). In this REA, 6/7 papers that assessed sense of place found it to be a significant indicator of both NFM acceptance (Anderson and Renaud 2021; Dai, Han, et al. 2021) and opposition (Born et al. 1998; Braconnier et al. 2022; Buijs 2009; Holstead et al. 2014). Although sense of place determined more opposition than acceptance of NFM, one paper found that these feelings are malleable (Braconnier et al. 2022). The authors assessed both public and farmer attitudes and found that a strong sense of place was highly associated with the need to protect agricultural traditions. However, following increased understanding and respect of the river, respondents became more accepting of new management strategies to ensure natural ecosystems were sustained.

In line with these findings, knowledge and understanding of NFM and flood risk management were the most influential factors of acceptance (Figure 9). Learning has been identified as a significant mechanism for addressing complex challenges and uncertainty in environmental management (Pahl-Wostl 2002; Suškevičs et al. 2018). Previous literature has argued the value of learning and knowledge exchange for aligning stakeholder values and instigating change towards new management practices, such as NFM (Benson et al. 2016; King et al. 2023; Mills et al. 2011; Ngai et al. 2020; Pahl-Wostl 2009). Results from this REA not only support the argument that knowledge exchange and understanding are critical for NFM acceptance but also demonstrate the need for social learning networks to align public and farmer values as well as to help society to adjust to new landscapes that accommodate large-scale NFM.

5 | Conclusions

The demand for NFM at the landscape scale entails a shift from localized solutions towards catchment-wide management, recruiting a wider stakeholding public, such as land managers who *provide* NFM and the public who *benefit* from NFM. Therefore, a holistic overview of catchment perspectives must be considered to support policymakers and catchment managers to install NFM schemes that meet the needs of both stakeholders, removing a potential barrier to its uptake in flood risk management policy. This REA synthesized evidence from 60 peer-reviewed papers regarding public and farmers' perspectives of, and preferences for NFM across different catchment settings, highlighting areas of potential trade-offs and misalignments between stakeholder groups when designing and installing NFM. This knowledge combined with an in-depth understanding of the socio-cultural characteristics of the NFM site and surrounding area can support catchment managers/policymakers in designing and installing NFM schemes that are sensitive to the needs of both the public and farmers.

Overall, public and farmer persectives and preferences regarding NFM were misaligned, yet opportunities for synergies were observed. The public expressed strong support for NFM, favouring measures which can hold large volumes of water (e.g., floodplain storage), generate recreational opportunities while also enhancing aesthetically pleasing landscapes (e.g., with native and diverse tree planting and vegetation). Farmers, meanwhile, tended to prioritise the functional and on-farm benefits of NFM, valuing measures that improve soil stability and water quality/avaliability, but remained cautious of NFM measures that interfere with agricultural activities or reduce productive land. Importantly, the public recognised that NFM entails implementation costs and demonstrated a WTP for schemes that enhance flood resilience and deliver wider environmental and social benefits. These findings suggest that emphasizing the benefits of NFM measures in ways that align with different community interests and priorities may help strengthen the acceptance of schemes from both stakeholder groups.

Whilst increasing NFM acceptance among the public is observed, the unwillingness of farmers to engage in NFM contracts is a concern. Although the number of papers exploring farmer perspectives and preferences is limited, trends in farmer behavior are observed, with preferences expressed towards a 'do-nothing' approach over paid NFM contracts. The IPCC Sixth Assessment Report has stressed the important role that the agricultural sector plays in adapting to water-related risks, with many adaptation responses occurring on farmland, including water storage, agroforestry, and soil moisture conservation (Intergovernmental Panel on Climate Change (IPCC) 2022). Therefore, engaging farmers with agri-environmental schemes is essential for enhancing resilience to future climate-related risks. Considering this, we recommend further investigation into the barriers and enablers of farmer engagement in schemes, such as PES, as well as a better understanding of fair and equitable compensation values for the temporary or permanent loss of farmland.

Lastly, it is essential that we do not underestimate the power of knowledge exchange and effective communication to facilitate the acceptance and uptake of NFM measures. Knowledge exchange is not only vital between farmers to encourage cross-farm NFM schemes, but also between farmers and residents to align perspectives and demonstrate the support and appreciation the public holds towards NFM and those installing it. This will ensure damaging assumptions such as farmers fearing negative reputations for land management are removed. Therefore, we recommend that practitioners and catchment managers are aware of the potential influence the public can have on farmer behavior and attempt to align values by facilitating knowledge exchange and learning opportunities throughout the design and delivery phase of NFM schemes.

Data Availability Statement

The data that supports the findings of this study is available in the Supporting Information.

Endnotes

[1] Commonly applied in environmental and cultural economics, WTP is defined as the maximum amount an individual is willing to pay to obtain a good or avoid a negative outcome Plott and Zeiler (2005).

[2] Used in a similar context to WTP, rather it focuses on compensation. It is the minimum amount an individual is willing to accept a negative outcome or to forego a positive one Plott and Zeiler (2005).

[3] This number is approximate as some studies do not state the number of participants, as well as the repeated use of participants within papers that conducted both questionnaires and interviews. The known number of participants included in each paper is presented in Supporting Information S1.

[4] Some studies include additional stakeholder groups (e.g., beyond public and farmer participants), but this analysis focuses exclusively on preferences identified from these two groups.

[5] WTP values from all papers have been converted to US dollars and are adjusted to present-day (2022) values using a US Consumer Price Index calculator.

Source: https://www.usinflationcalculator.com/. See Supporting Information S3 for conversions and calculations.

[6]WTP/WTA as a percentage of average income is estimated from GDP per capita (2022) for each country (in US dollars). Data cited from World Bank.

Source: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD. See Supporting Information S3 for full calculations.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Data S1:** Summary of papers and study characteristics. **Data S2:** Full table of indicators investigated across the papers. **Data S3:** WTP values converted to present day US dollars and WTP as a percentage of income calculated using GDP per Capita data (2022) for each country.