Received: 28 November 2017 | Revised: 6 August 2019 | Accepted: 10 August 2019

DOI: 10.1111/jfr3.12561

ORIGINAL ARTICLE

CIWEM Chartered Institution of Water and Environmental Management | Journal of Flood Risk Management | WILEY

Barriers to the uptake and implementation of natural flood management: A social-ecological analysis

Josh Wells | **Jillian C. Labadz** | **Amanda Smith** | **Md. Mofakkarul Islam**

Animal, Rural and Environmental Sciences, Nottingham Trent University, Nottingham, UK

Correspondence
Josh Wells, Animal, Rural and Environmental Sciences, Nottingham Trent University, Nottingham, UK.
Email: josh.wells@ntu.ac.uk

Funding information
Nottingham Trent University; NTSU Green Leaders; Trent Regional Flood and Coastal Committee

Abstract

Natural flood management (NFM) is increasingly promoted as a sustainable flood risk management (FRM) option, but significant barriers remain to its implementation. We assess the barriers to uptake and implementation of NFM using an approach in which we conceptualise a catchment as a social-ecological system. We investigate the barriers relating to multiple stakeholders, biophysical, and social components and the interactions between these different system elements. Semi-structured interviews were undertaken with land managers and practitioners of FRM in the United Kingdom. Data were analysed using qualitative methods, including thematic coding and categorisation. Key barriers of 25 identified were: economic constraints for land managers, the current lack of scientific evidence to support NFM and current lack of governance over long-term responsibility for NFM, which hinders future monitoring and maintenance. Practitioners within some sectors were less likely to recognise barriers noted by land managers, including cultural challenges, catchment planning concerns, and lack of perceived control. For successful wider implementation of NFM, it is crucial that practitioners recognise the barriers that land managers experience, and that projects should build monitoring programmes into their funding bids, to assess impacts on flood risk and maintenance needs and to build the evidence base to guide future NFM implementation.

KEYWORDS

barriers, flood risk management, governance, natural flood management, social-ecological system

1 | INTRODUCTION

Flooding is the most frequent and most experienced form of natural disaster globally; nearly half of the people affected by natural disasters within the last century were affected by floods (Guha-Sapir, Hoyois, & Below, 2013; UNISDR, 2015). With the increasing threat of climate change, which could double to quadruple river flood probabilities by 2080 in comparison to 2000, effective flood risk management (FRM) is essential (Thorne, 2014).

Due to the widely identified limitations of conventional engineering based solutions (Iacob, Brown, & Rowan, 2017), new sustainable approaches to FRM are currently being sought (Daigneault, Brown, & Gawith, 2016; Huq & Stubbings, 2015). Within this remit, natural flood management (NFM) has emerged as a term used to describe FRM measures which work with natural hydrological processes to retain and slow water within the upper catchment, while creating wider benefits beyond FRM such as habitat creation, diffuse pollution reduction, and sediment capture (Barlow, Moore, & Burgess-Gamble,

2014; SEPA, 2016). Such measures may not be strictly natural, as they are constructed interventions and are set within a catchment which is likely to have been impacted by unnatural process such as floodplain development or channel straightening. For the purposes of this article, NFM is the term applied, as it is that currently used within the industry.

NFM is becoming increasingly favoured due to its lower costs, when compared to structural FRM measures such as flood walls and embankments, combined with a desire from the public to enhance ecological and other benefits whilst reducing flood risk (Nicholson, Wilkinson, O'Donnell, & Quinn, 2012; SEPA, 2016; Morris, Beedle & Hess, 2014; Environment Agency, 2017). The UK Environment Agency's (EA) "Working With Natural Processes" evidence directory (Burgess-Gamble et al., 2017), in which this research underpins Case Study 25, collated current knowledge to improve scientific understanding of NFM. That document, combined with £15 m of UK government (DEFRA) funding announced in July 2017, has encouraged wider implementation of NFM in the United Kingdom. Although the use of NFM is becoming increasingly common in the United Kingdom (Dadson et al., 2017), significant barriers still exist to its implementation.

At present there is limited literature on the role that stakeholders play in the uptake of NFM (Lavers & Charlesworth, 2016). Furthermore, few studies have been conducted on the barriers to the uptake of NFM practices as perceived by stakeholders such as farmers or FRM practitioners (Holstead, Colley, & Waylen, 2015; Rouillard, Ball, Heal, & Reeves, 2015; Waylen, Holstead, Coley, & Hopkins, 2017). There is a growing realisation that the barriers to NFM uptake need to be identified using a broader, system wide approach (Thorne, Lawson, Ozawa, Hamlin, & Smith, 2015). Accordingly, in this article we aim to apply a social-ecological systems (SES) approach (Ostrom, 2009) to identify the barriers to the uptake of NFM practices in the United Kingdom. This study provides an opportunity to contribute to the existing literature by assessing the barriers from the viewpoints of both land managers and FRM practitioners.

2 | ANALYTICAL FRAMEWORK

For this analysis we conceptualise a catchment facing FRM challenges as a SES in which biophysical factors interact with social variables, leading to desirable or undesirable outcomes. The SES framework is adapted from a framework proposed by Ostrom (2009) (Figure 1). The framework comprises six components: the governance system, actors, the resource system, resource units, interactions, and outcomes. Each individual element is discussed in more detail below.

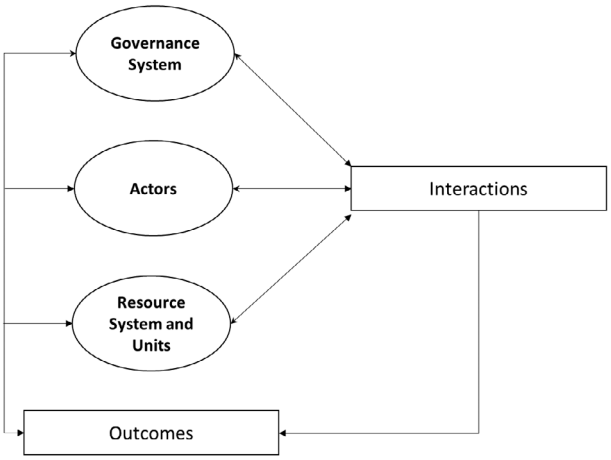

FIGURE 1 The social-ecological systems framework (SES) used to structure data analysis in this study (source: adapted from Ostrom, 2009)

2.1 | The governance system

The term "governance system" refers to both formal and informal institutions which guide activities to manage flood risk (Kaufmann, 2017). This includes laws and regulations, debates, negotiations, public consultation, protest, and further decision making actions (Lebel et al., 2006; Mahon, Crute, Simmons, & Islam, 2017; Ostrom, 2009; Nagendra, & Ostrom, 2014). Governance does not have to derive only or primarily through the state, but can include many other actors, both governmental and non-governmental, which have influence over varying scales of NFM implementation (Lebel et al., 2006).

Polycentric governance is the governance over an issue from multiple centres which range in scale (Ostrom, 2012). This is applicable to NFM in the United Kingdom, as decisions for implementation of NFM are influenced by multiple scales of governance. At the largest scale, EU legislation [such as the Water Framework Directive (WFD; European Union, 2000) and the European Union (2007)] has influenced greater working with natural processes and required that multiple benefits such as ecological gains are sought. At a national scale, the need for new scientific evidence of NFM as an effective FRM method is driving projects for the EA and funding such as the £15 million announced by DEFRA for allocation in 2017 (Leadsom, 2016). At a regional scale, the Lead Local Flood Authority (LLFA) or Internal Drainage Board (IDB) has governance over and responsibility for smaller channels termed "Ordinary Watercourses." An IDB is a public body with a mix of elected and appointed members, and amongst other roles it is concerned with managing water levels in lowland areas, including reducing risk from flooding. NFM is often most suitable within the upper catchment, so is most likely to be installed through LLFA decision making. At a smaller scale, decisions for NFM implementation can also be promoted and implemented through community action (Bracken et al., 2016). Local flood action groups who would prefer NFM within their

catchment can influence uptake though active cooperation with land managers, the LLFA, non-governmental organisations (NGOs) and the EA (Green & Penning-Rowsell, 2010).

2.2 | Actors

Actors are individuals who interact and create outcomes as part of the system (Ostrom, 2009). The term "actors" has been chosen because there may be individuals involved who are not necessarily users of the resource system, but who have an influence over the outcomes (Mcginnis & Ostrom, 2014). This may include practitioners of FRM, NGO employees, members of the public, land managers, and owners. All are part of the system and co-produce outcomes, yet some of these actors (such as NGOs or practitioners) may not be "users" of the biophysical or hydrological catchment in the same sense as land managers and the local community.

As actors, practitioners face barriers which exist within an institutional setting. A study by Waylen et al. (2017) interviewed 18 practitioners within FRM institutions in Scotland, to discuss the barriers to implementation of NFM. They identified three key themes surrounding barriers to NFM from within institutions: challenges in using evidence and handling uncertainty, difficulties in allocation of resources, and complexities of coordination and communication.

A significant actor barrier to the implementation of NFM is lack of land owner uptake of interventions (Posthumus, Hewett, Morris, & Quinn, 2008). Landowners and managers are key decision makers in whether they wish to implement NFM. Not all landowners are farmers, and not all land managers are owners, so they may have different barriers to uptake, but ultimately the decision to implement NFM falls with the owner of the land. It is therefore important to identify and assess such barriers to these groups of actors in detail and to assess if current practice considers such barriers.

A study by Holstead et al. (2015) used semi-structured interviews with 15 farmers in Scotland to discuss the potential barriers to NFM uptake from their viewpoints. Discussion suggested that there are six criteria which affect uptake: economics, availability of advice and support, public perception, joined up policy, catchment planning, and traditions. It was found that 53% of farmers who had not installed NFM said their land was too valuable and 38% stated that there was insufficient funding. Similarly, Rouillard et al. (2015) found that landowners in Scotland and England were not willing to give up productive land for FRM. The study found that farm economics was a significant barrier to catchment wide FRM, as a loss of agricultural land may incur losses of agricultural subsidies which require land to be in productive agricultural practices. This highlights that, without sufficient financial support, land owner uptake will be low.

Historic agricultural policy has led to the creation of cultural barriers to uptake. Post-war agricultural policy in the United Kingdom paid famers to drain land with ditches and land drains, in order to maximise food production (Iacob, Rowan, Brown, & Ellis, 2014; Wheater & Evans, 2009). Thus, the reversal of this practice would undermine the legacy left by ancestors of the farm and move a farmer away from their traditional role as a food producer (Holstead et al., 2015).

A report by the House of Commons Environmental Audit Committee (2016) stated that the National Farmers Union acknowledged the importance of NFM but argued that lack of maintenance interventions could cause prolonged flooding unnecessarily. This demonstrates that NFM barriers can be complex and cross multiple stakeholders and jurisdictions. Without the correct policy, resources and funding in place, practitioners are unable to offer future maintenance options which could hinder landowner/manager uptake.

Holstead et al. (2015) found that the biggest individual barrier for farmers in Scotland (64% of respondents agreed) was the lack of support and information provided to install NFM. They recommended that clearer information should be provided, with land owners needing a personal advisor who is trusted. Likewise, an appointed advisor could help with paperwork generated by multiple policies and consents required before implementing NFM.

2.3 | Resource system and units

The "resource system" is defined as the biophysical parts of a SES, such as the geology, topography, and soil types (Mahon et al., 2017; Ostrom, 2009). In the context of this research, it also includes the hydrological processes, which are traditionally analysed and modelled using a systems approach (Shaw, Bevan, Chappel, & Lamb, 2011). "Resource units" refers to the resources within a catchment (Ostrom, 2009). Within the NFM context, this could include individual NFM interventions such as bunds, leaky barriers, or woodland. However, it could also refer to economic resource units such as crops or livestock (Mahon et al., 2017). NFM currently has biophysical barriers restricting its implementation, which may reduce overall uptake of interventions. Installing an appropriate NFM intervention depends on the characteristics of a watercourse and, just as importantly, its surrounding catchment (Avery, 2012). For example, the watercourse gradient, catchment soil type, elevation, and land use are examples of catchment parameters that must be assessed before NFM implementation. If the watercourse gradient is too steep, interventions such as leaky barriers may not be appropriate as scour may be exacerbated within the streambed (Thomas & Nisbet, 2012). Additionally, if the land use surrounding the watercourse is residential or supports high value crops, NFM will be faced with barriers due to a significant loss of resource units.

2.4 | Interactions

"Interactions" within the system can be positive or negative (Ostrom, 2009). A negative interaction between farmers and legislation can be conceptualised as between actors and the governance system. Interactions can also be between actors and the resource system, such as a land manager planting woodland in an effort to reduce runoff and soil erosion.

Internationally, stakeholder engagement in the decision making process is recognised as a vital aspect of FRM (Begg, Callsen, Kuhlicke, & Kelman, 2017). There is a need for greater stakeholder engagement as an interaction within the system, with specific emphasis on interactions between practitioners and land managers if barriers to the uptake of NFM are to be overcome (Cornell, 2005; O'Donnell, Lamond, & Thorne, 2017). Stakeholder engagement raises awareness of FRM issues and can be used to overcome cultural barriers through education and to create greater project success, as stakeholders have a sense of ownership over schemes (DEFRA, 2013; Thaler & Levin-Keitel, 2016).

It has been acknowledged that a lack of communication, both within institutions and between organisations, causes barriers to NFM uptake (Waylen et al., 2017). Without knowledge sharing and communication between organisations and institutions, NFM uptake will be hindered. This is especially important within cross-boundary catchments. These may cross the borders of a local authority or, at a larger scale, national borders. It can be difficult to determine where one jurisdiction ends and another begins, especially in the case of ordinary watercourse and main river responsibilities (Bracken et al., 2016). Therefore, due to the lack of communication between responsible organisations from both sides of the boundary, a barrier to NFM implementation is presented.

3 | METHOD

In this study, 23 interviews were undertaken—17 with practitioners within UK FRM, and 6 with land managers within a catchment above Southwell, Nottinghamshire, United Kingdom. This study site was chosen because NFM has been implemented recently by the authors as part of a wider research within the local catchment. Interviews were used because the qualitative data gathered would offer an in-depth and rich picture of the complex barriers to NFM faced by interviewees.

One of the land managers did not actively farm their land and one was a tenant, so the term "land manager" was selected to reflect this. With regards to the land managers, the study has a small geographical reach as the interviews focus on land managers within Southwell only. For the practitioners, the associated FRM sectors were: statutory body (7), NGO (5), academic (2), local government (1), and consultancy (2). However, the practitioners had a wider geographical reach across the United Kingdom.

Practitioners were recruited through networking with further respondents selected by snowballing. They were selected for their knowledge of NFM, but also their wider knowledge of FRM governance. All but one of the significant land managers in Southwell were interviewed, with recruitment based on the land holding within the catchment. Land managers were interviewed in May/June 2016, with practitioners being interviewed between October 2016 and February 2017.

Interviews were conducted by the first author either face to face or by telephone and were semi-structured to give the respondents opportunity to elaborate on their perspective of emerging themes surrounding the barriers to NFM. The interviews were steered by a topic list, informed by current literature on the barriers to uptake of NFM. For land managers, it included questions on what they think NFM is, whether they already have NFM features on their land and what they perceive to the barriers to uptake to be on their landholding. Practitioner questions focused on what they perceive are barriers to land managers, but also on current constraints on implementation as a result of funding, policy, and governance.

Interviews were recorded and transcribed by the interviewer. Transcripts were imported into NViVo qualitative research software and were coded into the categories within the analytical framework. Sub-codes where then created to show emerging themes, identified by the interviewer. A matrix query was used within NVIVO, to identify which of the barriers cited by land managers were also discussed by practitioners.

4 | RESULTS AND DISCUSSION

Table 1 shows the themes and corresponding source counts identified from the interview transcripts, concerning various barriers to NFM. Some niche barriers were identified, but were only mentioned rarely and briefly. For the purpose of this article, such barriers have not been discussed in detail but are listed. Ecological factors, which are part of the SES framework, were not widely identified by interviewees as barriers. Although the article applies the SES framework on a conceptual level, the responses focused more on the social aspects of the SES framework.

4.1 | Governance system barriers

Only one land manager stated that they would require greater scientific evidence to uptake NFM measures, suggesting that social-economic factors are more significant to them. However, within the practitioner remit, the current lack of evidence has wide implications. Current UK FRM policy requires a cost–benefit ratio to be calculated, as well as the number of properties that will have a lower flood risk as a result of FRM:

TABLE 1 Barriers to natural flood management identified during interviews, with source counts by sector

Category	Theme	NGO	Statutory	Academic	Consultancy	Local government	Land managers	Total source citation count
Governance system	Lack of scientific evidence	5	7	2	2	1	1	18
	Lack of governance	5	7	1	2	1	2	18
	Lack of funding	5	6	2	2	1	0	16
	Policy challenges	4	7	2	1	1	0	15
	Transboundary catchment challenges	3	4	1	1	0	0	9
	Challenges over responsibility for NFM implementation	0	3	1	0	0	0	4
	Governance implications for land managers	1	0	0	0	0	0	1
Actors	Financial constraints for land managers	4	3	2	2	0	5	16
	Perceptions of NFM	4	5	2	2	1	2	16
	Actor lack of knowledge	2	3	2	1	0	4	12
	Land manager cultural challenges	1	2	1	1	0	5	10
	Intangible benefits of NFM	2	3	1	0	1	0	7
	Catchment planning concerns	0	0	0	0	0	5	5
	Land managers want evidence that NFM works	1	1	1	0	0	1	4
	Impacts of previous floods	1	0	0	0	0	2	3
	Land manager does not have time	0	1	0	0	0	0	1
	Land manager given negative advice on NFM	0	0	1	0	0	0	1
	Practitioner flood fatigue	0	0	1	0	0	0	1
Resource system and units	Site restrictions for NFM opportunities	0	0	0	0	0	3	3
	Number of land managers in catchment causes challenges	0	0	0	1	0	0	1
	NFM demonstration sites not applicable	1	0	0	0	0	0	1
Interactions	Interactions with land managers	3	3	1	1	1	5	14
	Interactions between practitioners	3	5	1	1	1	1	12
	Interactions with the public	1	2	1	0	1	0	5
	Negative media representation of NFM	1	2	1	0	0	0	4

Note: Green indicates low source count, red indicates high source count. The number of citations is graded by colour from Red to Green.

> …if you can tap in and find that evidence to show that natural flood management could work and to realise these benefits then the funding is available, but it's that chicken and egg, you've got to find the evidence first…—Practitioner 1.

Without evidence that NFM has a beneficial impact, schemes are not currently being implemented due to the inability to calculate the cost–benefit ratio. Thus, opportunities to produce evidence are missed; consequently, a feedback loop is created (Figure 2).

Practitioners highlighted that the limited evidence for effectiveness of NFM has resulted in a lack of funding for capital works but, just as pressing, is the lack of funding for monitoring and maintenance of current projects. This has been discussed within previous literature (Lane, 2017; Barlow et al., 2014; Dadson et al., 2017; JBA Consulting, 2015; Dixon et al., 2016) and links to another barrier identified within the governance system—FRM policy challenges. Practitioners stated that NFM benefits such as flood risk reduction and ecosystem services are complex to calculate and are often not tangible, therefore NFM is less likely to receive funding when compared to structural measures which allow for flood risk reduction to be calculated through standard hydrological and hydraulic modelling approaches (DEFRA, 2013).

The lack of funding for maintenance was cited by land managers as an issue. During a recent site visit by local land managers to an experimental NFM site within Southwell, this barrier was discussed as a significant barrier to them. This was also noted as a barrier by several practitioners, with acknowledgement that present NFM measures are not within the EA asset register, meaning that the structures cannot be included within maintenance plans.

> …at the moment those leaky dams do not find their way onto our [EA] asset register, and if they are not on our asset register, then there is no way we can plan for maintenance as part of our five year maintenance programme…—Practitioner 5.

It has been argued within the literature that NFM is not represented within current English legislation (Howarth, 2017). This was raised by practitioners, suggesting that a lack of policy creates barriers to implementation though lack of consequent funding. However, it was argued by other practitioners that policies such as the WFD (European Union, 2000), the Flood and Water Management Act (2010), and the Flood Risk Management Act (2009) in Scotland do already support NFM implementation and a wider catchment based approach.

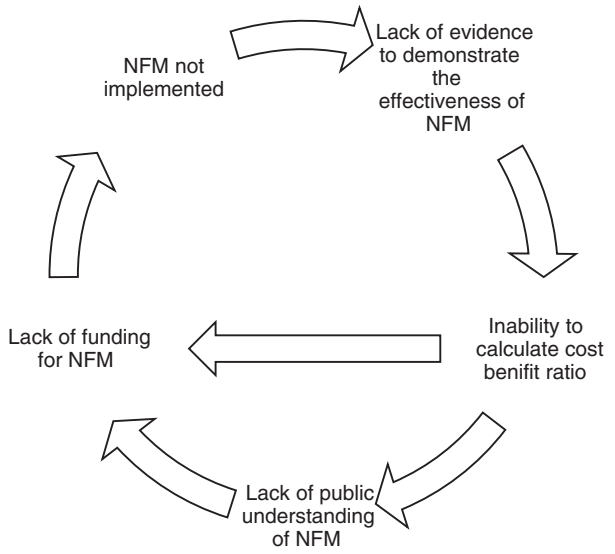

FIGURE 2 The positive feedback loop created by a lack of evidence and funding for natural flood management (source: authors' own construction based on interview data)

With the United Kingdom currently preparing to leave the European Union (*Brexit*), practitioners were both concerned and encouraged about the future of such legislation. On one hand, there was a concern that *Brexit* could lead to a change in funding for NFM interventions and the abolishment of legislation policed by the EU such as the WFD. On the other hand, it was argued that *Brexit* could allow for new funding such as agri-environment payments to land managers who install NFM measures.

Transboundary catchment challenges, between national or administrative boundaries, were mentioned as a potential barrier. The barriers within this theme were solely mentioned by practitioners, as no land manager interviewees had experience of working transboundary land. Challenges cited included data sharing across national boundaries, but also a lack of communication across administrative boundaries. As hydrological catchments do not adhere to national or administrative boundaries, communication needs to occur between stakeholders involved within the catchment rather than the political boundary:

> …recommendations of the Pitt review was to give the local flood authority a greater role in surface water management… but we were a little hesitant around it because our concern was that the political boundaries of county councils say, created effectively artificial barriers within that catchment system…—Practitioner 9.

Challenges over the responsibility for NFM implementation were mentioned by practitioners as a further barrier to uptake. One practitioner from the statutory sector suggested that the EA is not the correct organisation to implement NFM, as projects require local ownership over longer periods of time. The interviewee mentioned that, as the EA is also a regulatory body, negative interactions with land managers may have occurred previously. This can create tension during the negotiation process and therefore links to barriers discussed within the interactions category.

Three practitioners stated that LLFAs should be implementing NFM, as they have local governance and responsibility over ordinary water courses, which are often located in the upper catchment where NFM opportunities may have the greatest potential. One practitioner suggested that NGOs should be more involved during NFM implementation, as they have more flexibility with their objectives and can bring in external financial support.

4.2 | Actor barriers

Lack of knowledge of NFM was mentioned as a barrier within several interviews. Four of the six land managers interviewed had not previously heard of the term natural flood management and failed to understand the stated aims of such interventions. Similarly, Holstead, Kenyon, Rouillard, and Galan-Diaz (2014) found that 59% of farmers within their study knew nothing of NFM, which demonstrates the urgent need for dissemination of knowledge to the local level. Knowledge gaps vary between actors, such as the public or land managers not knowing what NFM is or how it aims to affect the hydrological regime of a watercourse (Holstead et al., 2014; SNIFFER, 2011).

The lack of knowledge of practitioners was more complex, as these interviewees were selected for their understanding of what NFM was and what it aimed to achieve. FRM institutions in the United Kingdom contain a large proportion of employees from engineering backgrounds (Waylen et al., 2017). Therefore, due to unfamiliarity with new approaches, there was a reluctance to change towards softer engineered approaches, especially for employees who have a lack of experience of NFM methods. This demonstrates that a cultural shift is required by practitioners, to include NFM within FRM.

> We have never actually engaged in natural flood management in the form that you are looking at it now… retaining water in the upper parts of the catchment for short periods to reduce the flows downstream"—Practitioner 4.

A lack of knowledge of farming practices by FRM practitioners was mentioned by interviewees within the NGO sector. This creates challenges during stakeholder engagement activities, which can hinder NFM projects at an early stage (RPA, 2015). Therefore, this barrier is strongly linked to the interaction category within the SES framework, as a lack of knowledge of farming practices by practitioners may cause negative interactions to occur. For example, a negative interaction may be suggesting NFM be implemented in areas of the farm which are not suitable, or not understanding that losses of agricultural subsidies may ensue if productive land is altered. This suggests that, when approaching land managers to discuss potential NFM interventions, a representative who understands farming practices should be used.

Perceptions of NFM by various actors can also be a barrier to its uptake. Practitioners generally believed that the public perception of NFM was positive. However, nine of the practitioners interviewed highlighted that the public perception of NFM may be too positive and creates reliance upon it as a FRM measure.

> …the other extreme is where you get communities who perhaps have got a natural flood management scheme and have got too much faith in it and believe it will protect them from flooding and stop flooding…"—Practitioner 11.

For this reason, expectation management is required when communicating the aims of NFM projects to the public. If expectations are not managed, communities may feel that NFM will protect them from flooding, which will lower overall resilience. This has also been cited within relevant literature (Collentine & Futter, 2016; Holstead et al., 2015; Nisbet, Marrington, Thomas, Broadmeadow, & Vatalin, 2011).

The intangible benefits of NFM were also suggested as a possible barrier to uptake, because the flood risk benefits of NFM schemes are not immediately seen within downstream settlements. This causes a spatial disconnect between upper catchment management and the downstream community.

Financial constraints for land managers were cited as a barrier by both groups of respondents. It was suggested that there is a lack of compensation available to land managers for installing NFM on their land. Related to this, land loss and a loss of income as a result of NFM implementation were also cited by land managers and practitioners as barriers to uptake.

> The financial side of it is a big issue and it's that you have to grapple with you know- government especially…—Land manager 3.

As NFM can cause loss of productive land and consequently a loss of income to the farm business, land managers expressed opinions that such compensation was necessary if NFM was to be a viable intervention within their land. It is therefore essential for the success of NFM projects that payments are made accordingly for any financial costs which occur as a result of the intervention.

Cultural challenges, such as a resistance to change as a result of ancestral influence on land managers, were cited as a barrier. The "drainage culture" created as a result of historic incentives to maximise agricultural outputs through land drainage was also found to reinforce this.

> …a lot of our land had been low lying, my grandfather spent a lot of money on trying to drain his land to keep it in good condition…—Land manager 2.

In the interviews, land managers expressed a similar reluctance to rewet land and were keen to keep drainage free flowing. Practitioners generally did not cite this barrier,

highlighting instead the need for greater stakeholder engagement between land managers and practitioners.

Catchment planning concerns, such as increased development on floodplains or covering gardens with impermeable surfaces, were identified as an actor-based barrier. This was cited by five of the land managers, but not by practitioners. It was felt that, if NFM was to be used, better planning should take place within the downstream settlement to prevent development in at-risk areas. This may be due to land managers having specific opinions surrounding operation of the planning system within the local catchment where they farm. At present there is controversy regarding FRM and housing development within the town of Southwell, which may influence the attitudes of local land managers. If FRM is to be more sustainable nationally, such issues need to be addressed as part of wider, holistic catchment plans.

Finally, the impact of previous floods was mentioned as a barrier to land manager uptake. A specific barrier identified by one land manager was a lack of perceived control as a result of a previous flood event. Perceived control is defined as the belief that individuals can influence the environment and achieve desired outcomes (Wallston, Wallston, Smith, & Dobbins, 1987). The flooding event that Southwell experienced in 2013 was a high magnitude, low frequency extreme event which caused large scale runoff due to high intensity rainfall over a short duration of time (Suri & Page, 2014). Due to that extreme event, the land manager felt that NFM would be ineffective in reducing flood risk downstream. As a result NFM measures were not being considered as a viable FRM option. This barrier links the actor and governance categories, with a greater evidence base required to demonstrate the benefits of NFM is required to overcome this.

4.3 | Barriers within the resource system

Few barriers cited by interviewees fell within the "resource system and units" category. One land manager mentioned that catchment biophysical factors such as topography or the location of footpaths could create barriers to uptake, as they limit the spatial opportunities for interventions:

> on our property there is a footpath right next to the natural flood defence so that will impact on it as well—Land manager 6.

Interestingly, such barriers were only cited by land managers, not by practitioners, which may be due to the more specific knowledge that land managers have of their land and catchment. This highlights the need for practitioners to draw upon local knowledge as a positive interaction to locate opportunities for NFM interventions.

4.4 | Interactions

Practitioners suggested that negative interactions between different organisations posed a barrier to NFM uptake. This was mentioned by all sampled sectors of FRM. There is currently a structure for FRM within the United Kingdom which delegates responsibilities to multiple organisations including the EA, LLFA, water companies, and IDB.

It was suggested by the interviewees that organisations involved within a NFM scheme may have opposing views or different agendas for what they aim to achieve. It was also stated that the timescales for organisations may not align and this must be taken into consideration during partnership working. Thus, the governance system is creating barriers which apply to the "interaction" category within the SES framework. Specifically, it was mentioned by interviewees that conflicts could occur between other FRM authorities and the IDB, as a result of such governance structures. Other FRM authorities seeking to implement NFM may wish to hold water on the land or to block existing ditches, thus creating a potential conflict of interests between organisations. Some of the land managers interviewed here were familiar with decisions of an IDB and they suggested that, since the IDB has a greater contact with land managers, it would be the best organisation to oversee FRM issues in relevant areas. This demonstrates trust from the land managers towards the IDB and so it is imperative that the objectives of the IDB and other FRM organisations are aligned, if NFM is to be successfully implemented by collaborative working.

The barrier of negative interactions also applies within organisations where different responsibilities exist. It was suggested that the lack of communication within organisations is causing a barrier to NFM implementation:

> …you have the flood risk people for whatever reason might not talk to their consenting and biodiversity people and one may have a very strong opinion but may not actually choose to explore it with colleagues to see whether things can be resolved…—Practitioner 16.

Such institutional barriers could be due to the lack of resources to communicate internally or the lack of willingness to change (Waylen et al., 2017). However, positive interactions can benefit NFM intervention if carried out within the early stages of the project and so should be encouraged within FRM institutions.

Respondents discussed negative interactions with land managers as a current barrier to uptake. Three of the land managers interviewed expressed views that a current lack of advisory support is a barrier to NFM uptake. Three practitioners also cited this barrier. Interestingly, practitioners who mentioned this barrier were all from NGOs and may reflect the fact that this sector recognises the support needed for land managers. Therefore, relevant NGOs may be better placed to advise and support land managers. Additionally, it was suggested that the EA may not be the ideal organisation to approach land managers, as they are also a regulatory organisation and so relationships may be harder to form:

> …we are still a regulatory organisation, so with some landowners, there may have been issues with us on- you know, environmental issues or they've had or visits from environmental officers or that kind of thing… you wouldn't want any potential scheme damaged because they've already got a prejudice against the Environment Agency…—Practitioner 1.

Two practitioners stated that there is a current lack of stakeholder engagement with land managers. Land managers also said that they had experienced negative interactions, linked to the governance system, which would be a barrier to them undertaking NFM. It is crucial for future projects that positive engagement is used as an interaction to support land managers who wish to install NFM. This also applies to practitioner interaction with the public. Barriers cited include negative experiences of authorities in the past, public hostility towards the EA and a lack of community engagement overall. One stated example of a negative experience for communities was expressed as being let down by the governance system in the past, such as when a FRM scheme was not being implemented locally. One practitioner highlighted that, following the winter 2015 floods, public hostility towards the EA rose due to the severity of flooding and the perceptions that the public held. Stakeholder engagement should be core to NFM projects and needs to include the local community at the earliest possible instance, if such conflict and hostility is to be overcome.

Finally, media representation of NFM was discussed by four practitioners as a potential barrier to NFM projects. This has not been reported previously within the literature. Media representation of organisations involved within FRM and NFM can cause hostility between them and the public. However, it was also suggested that media outputs can report NFM outcomes as overly positive, so that expectations of what NFM can achieve are not being managed in a suitable way.

5 | CONCLUSIONS

This study has applied a SES approach to identify and analyse the barriers relating to the uptake and implementation of NFM in the United Kingdom. Unlike previous studies of NFM, which have focused on a single group or limited aspect of the barriers, the SES framework has allowed for the barriers to be identified in a more holistic manner, rather than in isolation.

The findings here suggest that the barriers to NFM uptake and implementation are complex and diverse. They include not only the biophysical characteristics of catchments, but also factors such as a lack scientific evidence of NFM effectiveness, a lack of governance over the maintenance of NFM projects, land managers' past experiences and cultural beliefs, negative media representation of NFM, and problematic interactions between stakeholders.

Several individual barriers have also been identified by other recent studies. Examples include the lack of scientific evidence to show the effectiveness of NFM (Dadson et al., 2017; Milman, Warner, Chapman, & Short Gianotti, 2017; Wingfield, Macdonald, Peters, Spees, & Potter, 2019), the absence of an effective NFM governance (Holstead et al., 2015), lack of perceived control over flooding (Waylen et al., 2017), and cultural influences on land mangers (Holstead et al., 2014). More importantly, however, the application of the SES framework has demonstrated that such barriers may exist at multiple levels and are interrelated. For example, the lack of empirical evidence regarding the effectiveness of NFM leads to difficulties in gaining access to funding for NFM which, in turn, limits the opportunities to gather evidence. It is therefore recommended that NFM projects should build monitoring programmes into their funding bids, to assess the impacts on flood risk and maintenance needs, and to build the evidence base to guide future NFM implementation.

The application of the SES framework also shows that the barriers to NFM uptake go beyond a single stakeholder. For instance, in the United Kingdom, the responsibility for FRM lies with multiple organisations, and therefore, it is important for these stakeholders to interact effectively for successful implementation of NFM projects. However, as this study finds, the barriers identified by one stakeholder group (e.g., land managers) may not be recognised by another group (e.g., practitioners), which may act as a barrier to productive interactions between them. Practitioners, for instance, highlighted barriers mostly within the "Governance System" and "Interactions" categories, whereas land managers mostly mentioned barriers within the "Actors" category. Moreover, some barriers discussed by land managers were not mentioned by practitioners. This suggests that a "shared understanding" of NFM barriers probably does not

exist in the United Kingdom. It is important that such bottlenecks to effective stakeholder interactions are identified and this is where a systems- and multi-stakeholder-oriented framework, such as the SES framework used in this study, can be useful. If the current research had focused on the barriers to land managers in isolation, this crucial barrier to productive stakeholder interactions would not have been found.

Notwithstanding these valuable insights, this study is limited in its identification of the barriers to NFM uptake relating to the attributes of "resource systems and units," that is, the "ecological" aspects of SES. The few barriers identified in this regard were: site restrictions, the number of land managers within a catchment (leading to difficulty in catchment-wide application), and demonstration sites not being perceived as widely applicable. Some respondents did mention biophysical aspects, but questioning stakeholders explicitly on the "naturalness" of NFM would give further insight into the ecological aspects of NFM and could identify the interactions between the social and ecological systems. Such research may give insight into further barriers to uptake and allow for new approaches to NFM implementation to emerge.

ACKNOWLEDGEMENTS

Josh Wells is supported by a Nottingham Trent University PhD Scholarship. The authors would like to thank Andrew Disney (Environment Agency) and Professor Colin Thorne (University of Nottingham) for their advice and assistance with the research. We would also like to thank Nottingham Trent University, the Environment Agency, Trent RFCC (local levy), the Southwell Flood Forum, and NTSU Green Leaders and for their contributions towards funding of the wider research project on Natural Flood Management.

Data Availability Statement

Data cannot be submitted in order to protect the anonymity of participants. The research complied with relevant ethical review (Nottingham Trent University). Data were used and stored in accordance with the GDPR.

ORCID

Josh Wells https://orcid.org/0000-0001-7729-5589

REFERENCES

Avery, L. M. (2012). *Rural sustainable drainage systems (RSuDS) [Online]*. Environment Agency. Retrieved from www.evironment-agency.gov.uk

Barlow, J., Moore, F., & Burgess-Gamble, L. (2014). *Working with natural processes to reduce flood risk [Online]*. Environment Agency. Retrieved from www.environment-agency.gov.uk

Begg, C., Callsen, I., Kuhlicke, C., & Kelman, I. (2017). The role of local stakeholder participation in flood defence decisions in the United Kingdom and Germany. *Journal of Flood Risk Management*, *11*, 180–190. https://doi.org/10.1111/jfr3.12305

Bracken, L. J., Oughton, E. A., Donaldson, A., Cook, B., Forrester, J., Spray, C., … Bissett, N. (2016). Flood risk management, an approach to managing crossborder hazards. *Natural Hazards*, *82*, 217–240. https://doi.org/10.1007/s11069-016-2284-2

Burgess-Gamble, L., Ngai, R., Wilkinson, M., Nisbet, T., Pontee, N., Harvey, R., … Quinn, P. (2017). *Working with natural processes-evidence directory*. Bristol, England: Environment Agency.

Collentine, D., & Futter, M. N. (2016). Realising the potential of natural water retention measures in catchment flood management: Trade-offs and matching interests. *Journal of Flood Risk Management*, *11*, 76–84. https://doi.org/10.1111/jfr3.12269

Cornell, S. (2005). *Improving stakeholder engagement in flood risk management decision making and delivery [Online]*. Bristol: Environment Agency Retrieved from www.environment-agency.gov.uk

Dadson, S. J., Hall, J. W., Murgatroyd, A., Acreman, M., Bates, P., BEVAN, K., … WILBY, R. (2017). A restatement of the natural science evidence concerning catchment-based 'natural' flood management in the UK. *Proceedings. Mathematical, Physical, and Engineering Sciences*, *473*, 20160706. https://doi.org/10.1098/rspa.2016.0706

Daigneault, A., Brown, P., & Gawith, D. (2016). Dredging versus hedging: Comparing hard infrastructure to ecosystem-based adaptation to flooding. *Ecological Economics*, *122*, 25–35.

DEFRA. (2013). *Economics of climate resilience natural environment theme: Natural flood management*. London, England: DEFRA Retrieved from www.defra.gov.uk

Dixon, S. J., Sear, D. A., Odoni, N. A., Sykes, T., & Lane, S. N. (2016). The effects of river restoration on catchment scale flood risk and flood hydrology. *Earth Surface Processes and Landforms*, *41*, 997–1008. https://doi.org/10.1002/esp.3919

Environment Agency. (2017). *Natural flood management tool box* [online]. Environment Agency. Retrieved from www.environment-agency.gov.uk

European Union. (2000). Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. *Offcial Journal of the European Communities*, *327*, 1–72.

European Union. (2007). Directive 2007/60/EC of the European Parliament and of the council of 23 October 2007 on the assessment and the management of flood risks, *Official Journal L288*.

Guha-Sapir, D., Hoyois, P., & Below, R. (2013). *Annual disaster statistical review 2012, Centre for Research on the Epidemiology of Disasters (CRED)*. Louvain, Belgium: Université Catholique de Louvain 50 pp.

Green, C., & Penning-Rowsell, E. C. (2010). Stakeholder engagement in flood risk management. In G. Pender & H. Faulkner (Eds.), *Flood risk science and management* (pp. 372–385). West Sussex: Wiley-Blackwell.

Holstead, K. L., Colley, C., & Waylen, K. (2015). *Tackling the barriers to implementing natural flood management: Summary Report [online]*. Aberdeen: James Hutton Institute Retrieved from http://www.hutton.ac.uk/

Holstead, K. L., Kenyon, W., Rouillard, J. J., & Galan-Diaz, C. (2014). Natural flood management from the farmers perspective: Criteria that affect uptake. *Journal of Flood Risk Management*, 69–75. https://doi.org/10.1111/jfr3.12129

House of Commons Environmental Audit Comitee. (2016). *Flooding: Cooperation across government* [online], House of Commons. Retrieved from www.parliment.co.uk

Howarth, W. (2017). Integrated water resources management and reform of flood risk management in England. *Journal of Environmental Law*, *29*(2), 255.

Huq, N., & Stubbings, A. (2015). How is the role of ecosystem services considered in local level flood management policies: Case study in Cumbria, England. *Journal of Environmental Assessment Policy and Management*, *17*(4), 1550032. https://doi.org/10.1142/s1464333215500325

Iacob, O., Brown, I., & ROWAN, J. (2017). Natural flood management, land use and climate change trade-offs: The case of Tarland catchment, Scotland. *Hydrological Sciences Journal*, *62*(12), 1931–1948.

Iacob, O., Rowan, J. S., Brown, I., & Ellis, C. (2014). Evaluating wider benefits of natural flood management strategies: An ecosystem-based adaptation perspective. *Hydrology Research*, *45*(6), 774–787.

JBA CONSULTING. (2015). *Woodland and natural flood management- Lessons Learned [online]*. Surrey, England: Forestry Commission Retrieved from http://www.forestry.gov.uk

Kaufmann, M., & Wiering, M. (2017). Discursive junctions in flood risk governance – A comparative understanding in six European countries. *Journal of Environmental Management*, *196*, 376–386.

Lane, S. N. (2017). Natural flood management. *Wiley Interdisciplinary Reviews: Water*, *4*(3), E1211. https://doi.org/10.1002/wat2.1211

Lavers, T., & Charlesworth, S. M. (2016). *Sustainable surface water management: A handbook for SUDS*. Oxford: Wiley.

Leadsom, A. (2016). *Speech: A government that supports rural business* [online]. DEFRA. Retrieved from https://www.gov.uk/government/speeches/a-government-that-supports-rural-business.

Lebel, L., Anderies, J. M., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T. P., & Wilson, J. (2006). Governance and the capacity to manage resilience in regional social-ecological systems. *Ecology and Society*, *11*(1), 19.

Mahon, N., Crute, I., Simmons, E., & Islam, M. M. (2017). Sustainable intensification – "Oxymoron" or "third-way"? A systematic review. *Ecological Indicators*, *74*, 73–97.

Mcginnis, M. D., & Ostrom, E. (2014). Social-ecological system framework: Initial changes and continuing challenges. *Ecology and Society*, *19*(2), 30.

Milman, A., Warner, B. P., Chapman, D. A., & Short Gianotti, A. G. (2017). Identifying and quantifying landowner perspectives on integrated flood risk management. *Journal of Flood Risk Management*, 34–47. https://doi.org/10.1111/jfr3.12291

Morris, J., Beedell, J., & Hess, T. M. (2014). Mobilising flood risk management services from rural land: Principles and practice. *Journal of Flood Risk Management*, *9*, 50–68. https://doi.org/10.1111/jfr3.12110

Nagendra, H., & Ostrom, E. (2014). Applying the social-ecological system framework to the diagnosis of urban lake commons in Bangalore, India. *Ecology and Society*, *19*(2), 67.

Nicholson, A. R., Wilkinson, M. E., O'Donnell, G. M., & Quinn, P. F. (2012). Runoff attenuation features: A sustainable flood mitigation strategy in the Belford catchment, UK. *Royal Geographical Society*, *44*(4), 463–469.

Nisbet, T. R., Marrington, S., Thomas, H., Broadmeadow, S., & Vatalin, G. (2011). *Slowing the flow at Pickering*. London: DEFRA.

O'Donnell, E. C., Lamond, J. E., & Thorne, C. R. (2017). Recognising barriers to implementation of blue-Green infrastructure: A Newcastle case study. *Urban Water Journal*, 1–11.

Ostrom, E. (2012). Polycentric systems: Multilevel governance involving a diversity of organizations. In E. BROUSSEAU, T. DEDEURWAERDERE, P.-A. JOUVET, & M. WILLINGER (Eds.), *Global Environmental Commons : Analytical and political challenges in building governance mechanisms*. Oxford: Oxford University Press. https://doi.org/10.1093/ACPROF:OSO/9780199656202.003.0005

Ostrom, E. (2009). A general framework for analysing sustainability of social-ecological systems. *Science*, *325*(5939), 419–422.

Posthumus, H., Hewett, C. J. M., Morris, J., & Quinn, P. F. (2008). Agricultural land use and flood risk management: Engaging with stakeholders in North Yorkshire. *Agricultural Water Management*, *95*(7), 787–798.

Rouillard, J. J., Ball, T., Heal, K. V., & Reeves, A. D. (2015). Policy implementation of catchment-scale flood risk management: Learning from Scotland and England. *Environmental Science and Policy*, *50*, 155–165.

RPA, RHDHV and Allathan Associates. (2015). *Project RPA/001/14: Assessing the mechanisms for Compensating Land Managers*, report for the Scottish Government, August 2015, Loddon, Norfolk, UK.

Scottish Environmental Protection Agency. (2016). *Natural flood management handbook*. Stirling: SEPA Retrieved from www.sepa.org.uk

Shaw, E. M., Bevan, K. J., Chappel, N. A., & Lamb, R. (2011). *Hydrology in practice* (4th ed.). London: Spon Press.

SNIFFER. (2011). *Understanding the opportunities and constraints for implementation of natural flood management by farmers*. Sniffer [Online]. Retrieved from www.sniffer.org.uk.

Suri, D., & Page, A. (2014). Exceptional rainfall and thunderstorms over Nottinghamshire on July 23, 2013. *Weather*, *69*(11), 314–322.

Thaler, T., & Levin-Keitel, M. (2016). Multi-level stakeholder engagement in flood risk management-a question of roles and power: Lessons from England. *Environmental Science and Policy*, *55*, 292–301.

Thomas, H., & Nisbet, T. (2012). Modelling the hydraulic impact of reintroducing large woody debris into watercourses. *Journal of Flood Risk Management*, *5*(2), 164–174.

Thorne, C. R., Lawson, E. C., Ozawa, C., Hamlin, S. L., & Smith, L. A. (2015). Overcoming uncertainty and barriers to adoption of blue-Green infrastructure for urban flood risk management. *Journal of Flood Risk Management*, *11*, S960–S972. https://doi.org/10.1111/jfr3.12218

Thorne, C. (2014). Geographies of UK flooding in 2013/4. *Geographical Journal*, *180*(4), 297–309.

United Nations International Strategy for Disaster Reduction (UNISDR). (2015). *Disaster statistics*, UNISDR. Retrieved from http://www.unisdr.org/we/inform/ disaster-statistics

Wallston, K. A., Wallston, B. S., Smith, S., & Dobbins, C. A. (1987). Perceived control and health. *Current Psychology*, *6*, 5. https://doi.org/10.1007/BF02686633

Waylen, K. A., Holstead, K. L., Coley, K., & Hopkins, J. (2017). Challenges in enabling and implementing natural flood management in

Scotland. *Journal of Flood Risk Management*, *11*, S1078–S1089. https://doi.org/10.1111/jfr3.12301

Wingfield, T., Macdonald, N., Peters, K., Spees, J., & Potter, K. (2019). Natural flood management: Beyond the evidence debate. *Area*, 1–9. https://doi.org/10.1111/area.12535

Wheater, H., & Evans, E. (2009). Land use, water management and future flood risk. *Land Use Policy*, *26*(Suppl. 1), S251–S264.

How to cite this article: Wells J, Labadz JC, Smith A, Islam MM. Barriers to the uptake and implementation of natural flood management: A social-ecological analysis. *J Flood Risk Management*. 2019;e12561. https://doi.org/10.1111/jfr3.12561