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Willing to have, willing to help, or ready to own—Determinants of variants of stewardship social practices around Blue-Green Infrastructure in dense urban communities

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Introduction: There is increasing acceptance of the desirability of involving communities in stewardship activities around urban blue-green infrastructure (BGI) to generate acceptance, reduce vandalism and decrease the maintenance burden on authorities. However, little is yet known about the willingness of communities to engage in such stewardship, or the drivers to participate in activities.

Methods: This research adopted a practice lens and firstly defined three variants of BGI stewardship associated with passive acceptance, active care for and ownership of BGI. Secondly, the research conceptualized these practices within a complex of pro-environmental practices communities could perform. Through a face-to-face household survey in a dense UK urban area, the research sought to identify the prevalence of these variants of practice, their associations with other pro-environmental practices and the meanings, resources and competencies that drive a household's willingness to engage.

Results: The research found different willingness for the three variants with passive most popular and ownership least. Meanings associated with BGI stewardship practice appeared to differ in crucial respects from other pro-environmental practices and were most associated with water-management rather than climate concern, however some place-based motivations were also involved. Practical resource and competency considerations also affected willingness to perform active stewardship and ownership variants.

Discussion: The research concluded that promoting the water-management aspects of BGI for all variants, along with facilitation of engagement with more active variants, could increase interest in BGI stewardship participation.

KEYWORDS

Blue-Green Infrastructure (BGI), stewardship, flooding, Social Practice Theory (SPT), raingardens, permeable paving, rainwater barrel

1. Introduction

Blue-Green Infrastructure (BGI) is increasingly advocated for in the UK and internationally by governments, academics and NGOs, as a strategy for sustainable urban water and flood risk management (FRM) (HM Government., 2016; EEA., 2017; Li et al., 2017; EPA., 2022), and is growing in the numbers of schemes worldwide due to greater understanding and popularity of the concepts (for example rain-gardens, permeable paving, and rainwater barrels, Deely and Hynes, 2020). However, little research has yet considered longer-term infrastructural operation, maintenance and stewardship within the plurality of urban systems in which BGI may be embedded. Sustainable adaptation of urban areas using BGI has been argued to rely on the

attitudes and behaviours of local communities (Shandas, 2015; Buijs et al., 2016; Everett et al., 2019); schemes will require tolerance and respect to reduce deliberate or careless mistreatment that could detract from their multiple designed benefits. In some contexts, such as the austerity-driven UK economy since 2010, where one of the core questions became "but who's going to pay for it?" (Mell, 2021, p. 628), it may also be very advantageous for communities to take a more active role in lay maintenance or even ownership. In this paper, we capture some of the attitudes and activities embodied in the practice of stewardship.

Previous research has drawn on a range of theoretical stances to explore stewardship behaviour (Matheveta et al., 2018). This research takes a practice theory lens (Schatzki, 2001), allowing us to examine detailed repeat activities within a complex of pro-environmental practices including three modes of stewardship relevant for BGI. As noted by Corsini et al. (2019), practice theory is increasingly being applied to the field of sustainable consumption. It has also been applied in the explanation of water usage, urban stewardship and BGI (Pullinger et al., 2013; Krasny et al., 2015; Lamond and Everett, 2019). Using this lens, we propose therefore to examine the suggested practice(s) of BGI stewardship to create insights around how such practices may evolve from, or interact with, existing pro-environmental practices. These three modes are: Passive stewardship, characterised by acceptance and respect for BGI and its purpose. but no active engagement; Active stewardship, including willingness to engage in monitoring and maintenance, and Ownership, where there is some shared responsibility (sited on property owned or leased by private individuals or organisations).

Passive stewardship can be helpful in reducing maintenance requirements for urban BGI (e.g., littering and deliberate/unintentional harm, Choe et al., 2020). Further, it has been demonstrated that active stewardship can improve the maintenance and vitality of urban vegetation (Locke et al., 2014), but also that participating in stewardship can benefit individuals' and communities' wellbeing and resilience (Svendsen, 2009; Buijs et al., 2016). Encouraging both active and passive stewardship can therefore potentially benefit longer-term BGI goals, and more widely. Stewardship *via* residents' associations, stewards groups, service-days and community events is seen by some as an important element in longer-term maintenance, as well as in helping realise proposed multiple benefits (often a goal of such programs), such as reducing anti-social behaviour and improving community cohesion (Lindt, 2015; Willems et al., 2020). The third mode of practice, ownership or hosting BGI on privately-owned land, can also be critical to ensuring connectivity in neighbourhood or citywide schemes to optimise the benefits, or provide the quantum of BGI necessary to reduce flood risk (Ghofrani et al., 2017). Although many studies show generally positive attitudes to BGI (Bastien et al., 2012; Dobbie, 2016; Everett et al., 2019; Deely and Hynes, 2020), it would not be sensible to assume that this pro-BGI feeling automatically translates into all such practices, or indeed more widely. Venkataramanan et al. (2020, p. 8)'s systematic review of GI knowledge, attitudes, intentions, and behaviour found that "across nine studies that asked about maintenance responsibility, most residents wanted the city or municipality to take care of GI." They do also, however, note from Everett et al. (2016)'s paper that in Portland, Oregon, some residents were frustrated at not being allowed to take care of local bioswales; desired practices were there, as potential, but held back by the city. This serves to demonstrate that sentiments will vary region by region, city by city, and so highlights the importance of conducting more localised research in the area.

A variety of BGI options exist to help mitigate flooding, requiring different levels of engagement and types of stewardship. Some are attached to buildings and in private hands, others are public realm. In this paper, we consider a common group of adaptations considered suitable for dense urban residential areas, namely rainwater barrels, permeable paving, and raingardens (both private and public ownership). These adaptations have been increasingly applied in the US (Lindt, 2015), where lessons learned include the importance of multi-agency partnerships and community participation.

As Matsler (2019, p. 161) has demonstrated, green infrastructure struggles to fit properly and be accounted for within traditional financial asset management systems due to occupying a variety of different spaces along a green-to-grey "ecological-technological spectrum" and so not sitting well within accounting standards' norms, protocols, and practices. One result of this is that whilst capital will be found within the UK and more widely to install BGI due to legislative FRM requirements, costs associated with longer-term management can remain problematic and contested (Mell, 2021). Further, although we could argue that BGI is a *critical* infrastructure for FRM, the UK has seen a gradual shift of much of its critical infrastructure from publicly to privately-owned since the 1970s (Kitagawa et al., 2017) and a legitimate fear could be that full private ownership of nominally municipal BGI might produce gated communities, restricting access and so provision of multiple benefits to the wider public. Similarly, Cousins and Hill (2021) note that in the US, pressures to financialize GI through the use of municipal debt markets could create a debt burden with inevitably inequitable results. For this reason, it is beginning to become more widely acknowledged that lay community engagement and participation could potentially be very important to encouraging wider resident acceptance and creating best value (Hoang and Fenner, 2014; Everett et al., 2018; Donaldson and João, 2019).

To the same extent, it is fully acknowledged that social equity issues can prevail within volunteering (Riedman, 2021) that can lead to an unfair weight of expectations for free resilience-promoting labour being placed upon less empowered minority groups, and women particularly (Meerow and Newell, 2019). The authors would not wish to detract from arguments for the adequate compensation of given labour, where such compensation is desired and possible, however, it is strongly felt that within the context of austerity UK (and very possibly elsewhere), local authorities will not have such capacity for a good number of years, whilst BGI is urgently needed. Zuniga-Teran and Gerlak (2019) have also written about a range of important social and environmental issues that can arise around GI and BGI, leaving groups or communities disenfranchised, under-served or excluded; the topic is beyond the remit of this paper, however these are both important issues to be aware of when conducting social research around BGI.

Beyond matters of recompense, the question of factors affecting stewardship and, by extension, ways that longer-term stewardship might be encouraged, is less well-researched. In particular, the difference between willingness-to-have, willingness-to-help and willingness-to-own has not been extensively studied. Furthermore, whilst in Syracuse, New York, Baptiste et al. (2015) concluded that willingness to implement BGI was related to desires to improve

aesthetics and the urban environment, there is a dearth of studies considering notions of BGI stewardship within dense UK urban and low-income neighbourhoods.

2. Literature review

2.1. Blue-Green Infrastructure (BGI) stewardship and engagement

Stewardship has been discussed by Barrow (2019) in a wider sense of preserving natural and cultural heritage for future generations, implying a deep meaning of holding the environment in trust and conserving existing sense of place. However, with specific respect to BGI, a narrower focus can be found. Brears (2018) acknowledges community stewardship as a goal of public awareness and education campaigns around BGI. Equally, Young et al. (2014) recognise that stewardship is an essential component of BGI in New York. Shandas (2015), who considered the Portland stormwater management initiative, maintains that stewardship may be engendered through improved understanding of BGI's use as a replacement for grey infrastructure. Cerra (2017) extends the notion of stewardship to ownership of private BGI-type assets within urban areas. Motivation to undertake stewardship activities have a range of explanations, from the spiritual (Barrow, 2019) to the incentivized (Cerra, 2017). Authorities will benefit from understanding the motivations of communities with respect to stewardship and could thereby better target engagement to foster such voluntary engagement with BGI. Environmental stewardship groups can play a large role in the sustainability of BGI, and can provide a significant resource for their management. For example, in the NY CITY STEWMAP survey over 800 groups responded, representing 540,000 members and staff (Landau et al., 2019). Apart from authorities' obligations to consult with local communities, Lamond et al. (2020) have pointed out the need for long-term engagement, to promote continued deeper levels of understanding.

Active stewardship can be an individual or group activity; in this sense, it is linked to and yet distinct from volunteering as described in Jerome's typology (Jerome et al., 2017) as an organised group activity, either formal or informal, is only one mode in which individuals can contribute to stewardship. Volunteering has been found to be affected by length of residence, life-stage, including presence of children in the family, income and tenure (Troy et al., 2007; Ghimire and Skinner, 2019). Enqvist et al. (2019) proposed that whilst place-attachment is important, meaning of place will also affect attitudes, as individuals will be attached to differing aspects of the urban landscape. Sense of stewardship may also be linked to sense of place and place-attachment.

Individual stewardship practices become, arguably, more important when BGI is located on private property; here, the line between stewardship, self-interest and routine maintenance is more blurred. While de Guzman et al. (2018) found no difference between homeowners and renters in their attitudes to tree-care, owning rainwater barrels has been seen to be related to tenure (Doron et al., 2011; Pullinger et al., 2013), linked to both lack of outdoor space and perceived lack of control over installing devices. It is also important to go beyond group volunteering, considering and creating BGI stewardship practice variations allowing for the diversity of neighbouring communities that react differently to materialities, have variable competencies and attach their own subtle meanings to nature (Bell et al., 2018). Furthermore, passive stewardship practices are principally cognitive ones unrelated to volunteering.

Krasny et al. (2015) considered urban environmental stewardship or civic ecology practices to have broad meaning; for example, litter-picking has teamwork connotations as well as cleaning nature, whereas the *friends of the gorge* project recognised the stress-relieving benefits of nature. However, green self-identity could also bias individuals and households towards pro-environmental practices; self-identity has, for example, been shown to increase willingness to adopt and purchase environmentally-friendly plastics (Russo et al., 2019).

When considering stewardship of BGI it is important to recognise that, while the primary motivation for schemes in the UK is most often surban water management, BGI provides multiple benefits that may be of more relevance to communities than flood risk reduction. This is particularly the case where flood risk benefits are predominantly realised downstream. Local communities then interact with a blue-green space and attach meaning to it that may include flood risk reduction (if they are aware of the primary function) but may emphasise other BGI attributes such as amenity, aesthetic value, habitat and biodiversity, cooling, or carbon sequestration, and be responsive to schemes targeting improvements in these aspects. So BGI stewardship has the potential to overlap with other more prevalent stewardship concerns than flood and water management. It follows that individuals may be motivated from a general environmental stewardship or local improvement perspective, rational expectation of financial or other recompense and/or specific interest in aspects of GI, for example gardening. Therefore, it is important to situate BGI stewardship within a wider network of practices that urban households may perform.

2.2. Pro-environmental social practices

We propose here employing Social Practice Theory (SPT) as a lens by which to seek to understand local communities' needs, capacities and motivations for engaging with BGI in a variety of different fashions. SPT developed from a close variety of theories (Giddens, Bourdieu, Foucault and others) reflecting upon *why* and *how* people engage with different practices (habits, conventions, ways of doing or not doing things such as cooking meals, doing the laundry, etc.), looking to get beyond the reductive binaries of agency/structure, individualism/holism through analysing complexes (or series) of practices of *groups* of people.

Reckwitz (2002, p. 249) defines a "social practice" as "a routinised type of behaviour which consists of several elements, interconnected to one another"; practices are norms, conventions, shared behavioural routines, they do not deny individual autonomy but do provide an interesting unit for social analysis aside from the individual or the social. We see SPT as a useful lens linking habitual behaviours to values and capabilities. It serves as a helpful framing in the context of reflecting the ongoing nature of stewardship activities that fit within the complex of practices that urban communities may or may not enact.

We here define a complex of domestic pro-environmental practices (see Figure 1) which overlap and can be grouped together. This complex is not comprehensive but represents some common

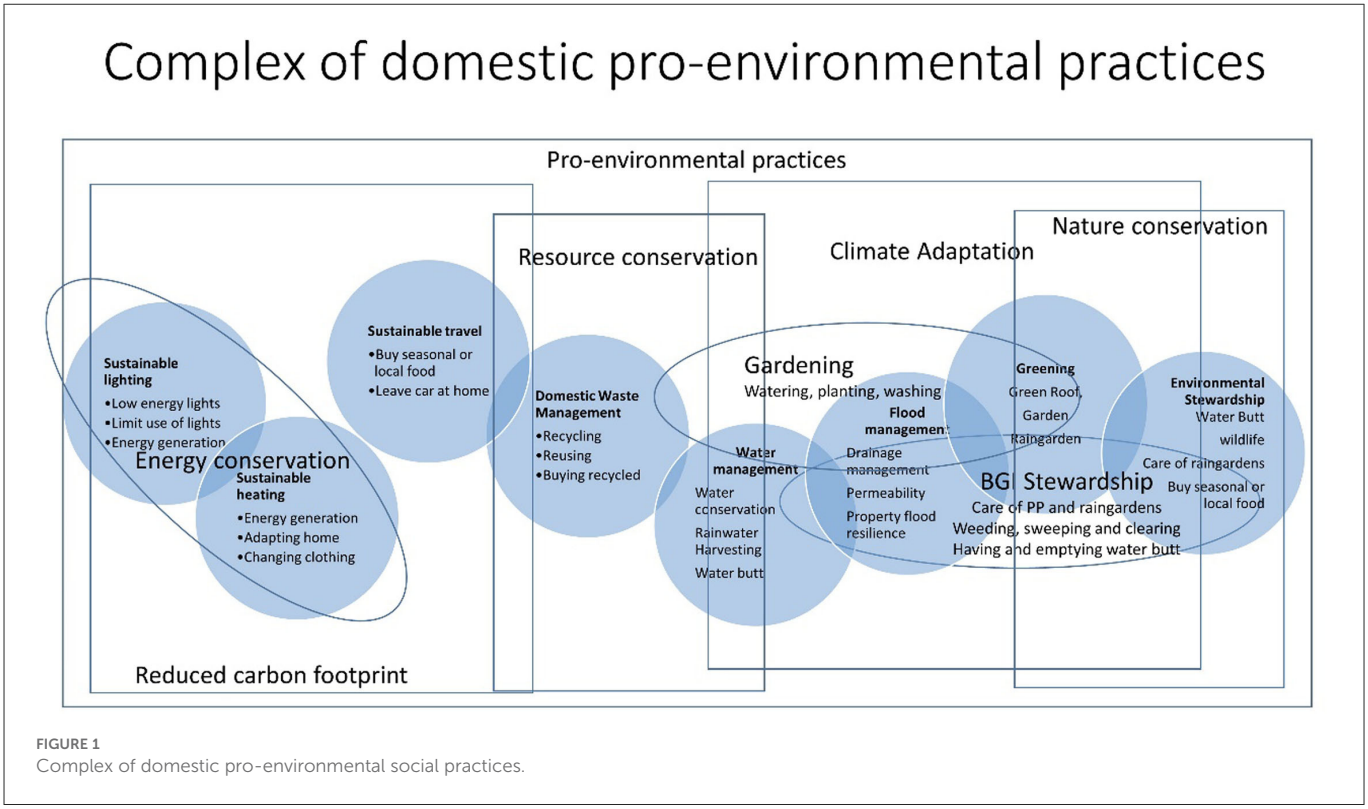

FIGURE 1
Complex of domestic pro-environmental social practices.

practices adjacent to our proposed BGI stewardship practices. Furthermore, it is not a unique characterisation of practices, as some, such as energy generation, can be seen in more than one sustainable practice group and could be seen as part of a much broader economic or environmental practice in its own right. We also recognise in this paper that an individual or household identity may shape the practices they engage in, but that practices may fit within different lifestyle identities and experiences (Bell et al., 2018), so for example energy conservation practices such as low-energy lighting may be adopted by cost-conscious households or green-energy conscious households. The different meanings inherent in these identities may create variations of the practice, for example, the choice of low energy bulb varies based on cost vs. energy-saving priorities. Other variations of the practice include maintaining lower levels of lighting, directional lighting, etc. Switching off lights and buying low-energy lightbulbs are routinized practices, whereas careful placing of lighting or buying solar panels are more conscious decisions (Shove, 2010; Axsen et al., 2012). that includes current pro-environmental practices and expressed willingness to engage in new practices around installing and maintaining BGI on both public realm and private property.

Such ambiguity is common to discussion of practices and our choice of framing is based on the thread of practice-meanings. Previous research suggested that stewardship attitudes and behaviours are strongly linked to environmental and spiritual significance (Cerra, 2017), and BGI is strongly linked to sustainable and environmental meanings (Deely and Hynes, 2020). For the purposes of understanding the role of the proposed BGI stewardship practices, we have chosen to frame them as pro-environmental rather than economic because they will have low financial implications for carriers, but rather higher social and environmental meanings. This allows us to link practices within a common framework to design our survey, but also implies that we must examine the potential for households to attach different meanings to their own practices in their responses to our questions.

The study sought to answer the following questions: How prevalent are pro-environmental practices in our survey population? How aware are they of flood risk and what are their attitudes towards BGI? How willing are they to engage in different modes of BGI stewardship? What meanings are associated with pro-environmental practices and expressed willingness to engage in practices that we group under BGI stewardship? What associations exist between pro-environmental practices generally and BGI stewardship practices around rainwater barrels, permeable paving, and raingardens? What characteristics affecting competency to actively participate, affect levels of active stewardship practice, rainwater barrel ownership, and pro-environmental practices? Are socio-demographic characteristics important in the type of pro-environmental or stewardship practices performed?

3. Methods

The study employed a door-to-door survey of residents in Wingrove, a dense urban area in Newcastle-upon-Tyne. The selection of location was based on a purposive design seeking to include: features of BGI rarely interrogated in the UK but important in retrofitting dense urban areas; mixed socio-demographics rarely included in UK BGI surveys; an area with low-to-medium direct risk of flooding, the main risk being pluvial flooding that could be significantly reduced by BGI; a low level of existing BGI; a dense urban area with low natural permeability, and some existing awareness of flood risk, to increase salience of the survey and encourage responses.

We asked about potential adaptation of the area through rainwater barrels, permeable paving, and raingardens. Adaptations such as green roofs were not included due to the steep roof-pitch common across the area, and larger-scale swales were not considered suitable due to the predominantly narrow width of streets and pavements.

The population considered was all households living in the area and the target sample was 500, not aiming to be representative of the local population but rather to get a broad range of different respondents engaging in a variety of practices. A face-to-face approach was chosen to try to improve response-rate (Hox and De Leeuw, 1994) as well as to help overcome any potential issues stemming from respondents being users of English as a second, third or further language, and to accommodate people with a potentially low reading-age; the least burdensome method of delivery for a longer questionnaire (Bowling, 2005).

A Computer-Aided Personal Interview (CAPI) approach was employed, questions read out and shown to respondents, to help with clarification and allow use of pictures for illustrative purposes, with responses digitally recorded. Clear images of the BGI devices were shown for reference with the relevant questions.

Five-point Likert-scale questions (48) were asked about: Perceptions of flood risk in and downhill of Wingrove; perceptions of 3 types of BGI devices (rainwater barrels, permeable paving and raingardens), such as whether people would like to have them, would use them and help to maintain them, would not be inclined or might struggle to do so; fears about climate change and its impact upon flood risk; feelings about flood risk more generally, and environmental attitudes and practices. Open-ended questions were kept to a minimum (2), to minimise survey-length. Ten further closed questions were asked about demographics. The data was provided in Excel format, whereupon it was recoded into SPSS and underwent statistical analysis.

In the initial phase of analysis, scale variables were created to represent three potential meanings (climate concern, flood concern, belief in measures) and four actual or proposed practices (active BGI stewardship, passive BGI stewardship, BGI ownership and other pro-environmental practices). These scales were tested for dimensionality using factor analysis (principal components), and reliability using Cronbach Alpha. Household characteristics were explored individually, although income was not used as a distinguishing characteristic due to the lack of responses.

Descriptive analysis was used to answer the questions as given in Table 1.

TABLE 1 Analytical approach to research questions.

How prevalent are the different practices in our survey population, how aware are they of flood risk and BGI? How willing are they to engage in different modes of BGI stewardship?	Descriptive statistics means and proportions of respondents
What meanings are associated with pro-environmental practices and expressed willingness to engage in 'BGI stewardship practices'?	Bivariate correlation of attitudes and practices using individual practices followed by Spearman's rank correlation of Likert scale variables
What associations exist between pro-environmental practices generally and 'BGI stewardship practices' around water butts, permeable paving, and raingardens?	Bivariate correlation amongst different practices followed by Spearman's rank correlation of Likert scale variables.
What practical aspects affect levels of active stewardship practice, rainwater barrel ownership, and pro-environmental practice?	Kruskall Wallis/Mann Whitney analysis of tenure, length of residence, and other household characteristics, with Likert scale variables of stewardship practice
Are other socio-demographic characteristics important in the type of pro-environmental or stewardship practices performed?	Correlation of other socio-demographic variables with scale variables of stewardship practice

4. Results

The target total of 500 questionnaires was achieved, however, the completion rate of individual questions varied. In general, attitudinal questions were answered, but there were some missing demographics responses that were generally below 25 (5%). Those variables with missing responses above 5% [namely education (14%), occupation (47%) and income (80%)] have been described but were excluded from associations analysis. Face-to-face completion of this survey may have contributed to residents' reluctance to disclose income (Bowling, 2005).

4.1. Sample characteristics

Wingrove was purposely selected to have mixed socio-demographics at the lower-income end, as representative of dense urban areas outside of London, and this was reflected in the gathered data. Respondents had lived in Wingrove for a median average of 8 years in households, with a median 2 adults and 1 child per household, 88% had lived there <20 years. A slight majority (57%) owned their own property, with 32% being private tenants and 10% social housing tenants. The median age was 35–44, 48% identified as female, just over half (52%) identified their ethnicity as "White," 29% as "Asian/Asian British," 6% as "Black/Black British," 6% as "Multiple/Mixed" and 8% as "Other." Ten percent identified as disabled. The most common educational attainment was no qualifications (44%), 28% had GCSEs (or equivalent) only, 16% A-level (or equivalent), leaving only 13% with a degree or higher qualification. Most respondents (80%) chose not to reveal their income. Of those disclosing their income, the median bracket was £0–15,000 per year and 22% were on unemployment or other benefits. Common occupations (responses in open text) included cleaners, taxi-drivers, retired, building-trade and shop-workers. There was also a significant student population; this is a known area with many houses of multiple occupation suitable for student accommodation. Therefore, we can characterise the sample as mixed tenure, low income, and low educational attainment.

4.2. Perceptions of flood risk and attitudes to BGI

General awareness of flooding was strong: 69% agreed or strongly agreed that Wingrove flooded in heavy rain and 71% that heavy rain in Wingrove could cause flooding downhill; flooding concerned 52%. However, only 3% had experienced flooding in their homes, 16% around their home and 44% in the streets around their home. This

was expected, given the design of the study and selection of an area at low risk, with mainly pluvial on-street flooding.

Concern about flooding was fairly low; only 33% agreed or strongly agreed it was increasing, most were uncertain (46%) or disagreed, the same proportion were worried about flooding. However, just over half agreed or strongly agreed that climate change could increase flooding in Newcastle, demonstrating an understanding of the link between climate change and flooding. A large minority (44%) thought they would cope well with flooding, whereas only 13% thought they would not cope well; similarly, 43% thought flood risk could be removed with enough work, only 8% thought it could not be removed. Common suggestions for improving flood risk (an open-text question) included sweeping leaves and other litter, clearing drains and dredging rivers. A handful of other suggestions related to flood barriers and permeability. Adapting property to reduce flooding was seen as a waste of money by 24%, and 62% were willing to adapt their area to reduce flood risk to areas downhill.

Generally positive attitudes were expressed about increasing provision of two of the three BGI facilities: 61% agreed or strongly agreed they would like permeable paving and 68% that it would improve the area's look; 79% thought raingardens would green the area and 70% that they would make it prettier. Conversely, only 38% thought more houses should have a rainwater barrel and only 33% either already had or would like one.

4.3. Tolerating and respecting (passive stewardship)

As mentioned, the majority of respondents would like permeable paving (61%) and thought both paving (68%) and raingardens (70%) would improve the area's aesthetics. It follows that these respondents should tolerate such installations. A similar proportion would refrain from mistreating them: 65% agreed or strongly agreed they would not damage paving and 66% agreed or strongly agreed they would not litter raingardens. Those that did not agree were generally uncertain (33% for paving and 30% for raingardens), perhaps because they were not entirely sure what actions might damage installations, and perhaps even felt they would be influenced by general upkeep with respect to their behaviours. A very small minority disagreed (2% paving and 4% raingardens). There is a positive and significant (at 1%) association between liking the thought of installations and intention to treat them with respect.

However, there was some concern about long-term treatment by others. About one-third thought permeable paving might be mistreated (34% agreed or strongly agreed). A higher proportion (55%) agreed or strongly agreed that raingardens might suffer from anti-social behaviour. Finally, concerns about maintenance were expressed by 60%, who agreed or strongly agreed that "I fear that the paving would involve lots of work."

These figures point to a real concern by some that these installations would suffer from poor treatment by others and even by themselves, leading to long-term deterioration. Fear of poor treatment was associated with less confidence that permeable paving would work to reduce flooding, though not raingardens. However, neither the fear of other peoples' poor treatment nor the need for maintenance was associated with not liking the installations, suggesting concerns about treatment was not enough to discourage acceptance.

4.4. Clearing and weeding (active stewardship)

Willingness to become actively involved with BGI maintenance was lower than willingness to avoid damaging it. However, there was an encouraging 41% of people who agreed or strongly agreed that they would clear or sweep paving, with only 26% disagreeing or strongly disagreeing.

Weeding was less popular than clearing and sweeping, but still a sizeable minority expressed willingness. For raingardens and paving, 29 and 30%, respectively, agreed or strongly agreed, whereas 38 and 30%, respectively, disagreed or strongly disagreed.

A large proportion of respondents (over one third) were uncertain about participating in these proposed activities. These could potentially be households that might be moved to participate through engagement activities. Although we did not ask why respondents expressed willingness, we speculate that lower willingness to weed may be associated with perceptions a more arduous, time consuming or dirty activity, or one may be seen to require competencies or equipment that households lacked. Willingness to weed was associated with having or wanting a rainwater barrel, so positively associated with gardening practices or outdoor activity that could benefit from using rainwater.

4.5. Active rainwater barrel ownership

Only 60 respondents reported owning a rainwater barrel, just over 12%. A further 20% said they would like one. In all, 37% agreed or strongly agreed that they liked having or would like to have a rainwater barrel. The 5% difference may be attributable to those that would like one at some point but not in their present accommodation. Only 2 people who had a rainwater barrel said they did not like having it.

Almost all people (97%) with rainwater barrels said they would use some of the water collected but were less certain about using it all (37% would struggle to do so). However, 67% were committed to emptying the rainwater barrel before heavy rainfall (whether or not the water was of use).

Across all respondents, 47% agreed or strongly agreed that emptying their rainwater barrel would be difficult. This may be linked to many households' being limited in ability to instal and use them, outside space being limited to a yard, or possibly having no private outside space at all (residing in "Tyneside Flats," a form of terraced maisonette). Difficulty in emptying the rainwater barrel was also associated with identifying as social tenants (61% agreed or strongly agreed), single-adult households (56% agreed or strongly agreed) and being disabled (64% agreed or strongly agreed). Only two social housing tenants had rainwater barrels, and these were the two respondents not happy having them.

Despite this, 38% agreed or strongly agreed they would empty the rainwater barrel before rainfall, including some that thought it would be difficult to do, 41% were uncertain and 21% disagreed. Willingness was, in turn, associated with a belief that rainwater barrels have a role

TABLE 2 Correlation between wanting to limit impact on climate change and pro-environmental practices.

Spearman's rank correlation Correlation with wanting to limit their impact on climate change	Correlation	Sig	Percent adopting practice
Installed solar	0.01	0.79	5
Better insulation	0.24**	0.00	39
Use low energy bulbs	0.34**	0.00	64
Avoid using car	0.33**	0.00	39
Turn off lights in empty rooms	0.13**	0.00	77
Keep heating low wear more clothes	0.10*	0.03	59
Reuse things	0.11*	0.02	56
Buy seasonal or local produced food	0.10*	0.02	72
Recycle	0.17**	0.00	77
Use recycled	0.08	0.07	63

The * and ** symbol indicates the significant values at 95% and 99% confidence respectively.

in flood risk reduction (Spearman's rank correlation 0.53 significant at 1%).

4.6. Environmental attitudes and social practices

Over two-thirds (69%) felt it was important to limit climate change, as opposed to only 12 (2%) who disagreed or strongly disagreed, the rest (28%) being uncertain. Fewer people (57%) agreed or strongly agreed that they wanted to reduce their impact on climate change. Almost all (93%) agreed or strongly agreed that they knew how to do so.

The practices and choices made by those who wanted to reduce their climate impact were somewhat consistent with their attitude, as reflected in the correlation between attitude and reported practices (Table 2). However, many of those who did not express the desire to limit impact also reported pro-environmental practices. This suggests that many of these practices, framed as "pro-environmental," have other motivational drivers such as cost-saving (e.g., turning off lights), or that some have become the dominant social practice, expected of everybody, and enabled through curbside waste collections, government insulation programs and prevalence of low-energy lightbulbs. Energy-saving practices were overall straightforward low or no-cost practices. However, installing solar (an expensive and complex adaptation) was pursued by a very small minority (5%). Being uncertain in opinions about climate change was related to the lowest engagement with pro-environmental behaviours.

Wanting to limit one's climate change impact was also positively correlated with positive statements about permeable paving and raingardens and negatively correlated with negative views. However, correlation with statements about rainwater barrels were lower; although some people believed in the positive effects of rainwater barrels in general, they did not want them themselves. The positive aspiration is possibly mediated by practical considerations around using rainwater barrels in their property.

Significantly positive correlations were observable between practices within each practice category. Positive correlations existed between water resource management and BGI stewardship practices. For example, having a rainwater barrel was strongly correlated with being able to use the water and with being willing to take an active role in weeding, clearing, and tidying permeable pavements and raingardens (half with rainwater barrels would volunteer as opposed to a quarter of the rest), although those with rainwater barrels were ambivalent about the installation of such features in their area. Negative correlations were exhibited between practices related to water resource management and both waste management and energy conservation. BGI stewardship practices were also negatively correlated with energy conservation and waste management. Positive correlations existed between waste management and energy conservation. The practice of reuse, however, had only positive significant correlations across all categories.

4.7. Validity of scales

Seven scale variables were created, based on responses to a total of 37 questions that used Likert scales, except for the environmental practices; these were created based on standardised average scales. To test the validity and reliability of the scale factor analysis and reliability analysis were carried out as described in methodology, with results shown in Table 3. Pro-environmental practices other than BGI stewardship were grouped into one scale for convenience.

Means and standard deviations of the constructed scales are also shown in Table 3. This shows that on average, environmental practices are the least coherent group (represented by eigenvalues), as might be expected given that there are several clusters of practice contained with this scale. Rainwater barrel ownership practices have the most negative score, representing low ownership and willingness to own. Interesting to note is that the environmental practices scale has the most positive score, representing high prevalence of such actions among respondents, even more positive than passive stewardship and climate concern.

4.8. Associations between practices and meanings

Using Spearman's rank correlation to explore the correlations between practices and meanings showed multiple significant associations (Table 4); only statistically significant correlations are discussed below. Climate concern and flood concern were significantly correlated, but at a low level. Both climate concern and flood concern were positively associated with belief in measures at a moderate level. In turn, belief in measures was strongly linked to passive stewardship and moderately linked to active stewardship and rainwater barrel ownership, but not to environmental practices. Climate concern was moderately associated with passive and active stewardship and less associated with environmental practices and rainwater barrel ownership (low level). Conversely flood concern was moderately correlated to rainwater barrel ownership and active stewardship and less associated with passive stewardship. There was a negative association between flood concern and other environmental practices.

TABLE 3 Validity of scale variables.

	No variables	1st eigenvalue	Cronbach's alpha	Mean, 1 = strong positive; 5 = strong negative	Standard deviation
Climate concern	5	61%	0.843	2.37	0.61
Flood concern	5	64%	0.857	2.63	0.73
Belief in BGI	5	49%	0.729	2.55	0.59
Pro-environmental practices	10	36%	0.773	1.93	0.41
Passive stewardship	4	54%	0.706	2.30	0.60
Active stewardship	3	80%	0.869	3.03	0.91
Rainwater barrel ownership	5	55%	0.780	3.11	0.74

TABLE 4 Correlation (Spearman's Rho) between practices and meanings relating to BGI stewardship and other pro-environmental practices.

	Climate concern	Flood concern	Belief in measures	Passive stewardship	Active stewardship	Rainwater barrel ownership	Pro-environmental practices
Climate concern	1.000	0.153**	0.401**	0.444**	0.374**	0.166**	0.202**
Flood concern		1.000	0.433**	0.159**	0.348**	0.395**	−0.180**
Belief in measures			1.000	0.625**	0.472**	0.440**	0.030
Passive stewardship				1.000	0.326**	0.379**	0.300**
Active stewardship					1.000	0.420**	−0.081
Rainwater barrel ownership						1.000	−0.054
Pro-environmental practices							1.000

The ** symbol indicates the significant values at 95% confidence.

TABLE 5 Kruskall–Wallis/Mann–Whitney measures of association between household characteristics, practices and meanings relating to BGI stewardship and other pro-environmental practices.

Test statistic	Tenure, KW	Flood experience, KW	Ethnicity, KW	Disability, MW	No. children, KW	No. adults, KW	Age, KW	Gender, MW	Length residence
Climate concern	1.6	−0.4	6.9	−1.1	9.4*	16.0*	4.5	0.2	8.6*
Flood concern	33.2**	10.0**	5.0	−0.0	0.2	8.2	15.9**	1.0	22.3**
Belief in measures	44.6**	4.3**	2.4	−1.5	0.4	7.8	8.8	1.2	32.5**
Passive stewardship	24.2**	1.4	8.9*	−1.4	0.9	14.9*	6.9	0.8	28.6**
Active stewardship	34.0**	2.7**	5.6	−3.4**	2.8	10.3	11.5*	−0.6	18.7**
Rainwater barrel ownership	59.2**	4.5**	4.5	−4.6**	0.6	30.6**	17.9**	1.4	24.2**
Pro-environmental practices	8.3*	0.6	7.0	3.4**	7.8*	9.3	33.7**	−1.0	34.5**

The * and ** symbol indicates the significant values at 95% and 99% confidence respectively.

Passive stewardship was moderately associated with all other practices (active stewardship, rainwater barrel ownership, and other environmental practices). Active stewardship and rainwater barrel ownership were also moderately related. Therefore, links between practices related to BGI stewardship and other pro-environmental practices were seen as weak overall, whereas there were stronger links between water-specific meanings and practices, and climate meanings and stewardship practices.

4.9. Association of household characteristics with meanings and practices

Associations between household characteristics, meanings and practices were explored *via* Kruskall–Wallis (Table 5). Household characteristics had very few statistically significant correlations with meanings, except for tenure and flood experience. Climate concern was slightly associated with household size (number of children and

number of adults at the 5% level). Flood concern was positively associated with age. Tenure was related to flood concern and belief in measures, but not climate concern. As might be expected, flood experience was associated with flood concern and with belief in measures.

Performing or being willing to perform practices was also associated with different characteristics (Table 5). Differences in tenure were associated strongly with differences in passive and active stewardship, as well as active rainwater barrel ownership. Homeowners were more likely to be positive towards these practices than tenants, and private tenants more than social. There were also weak associations of household tenure with environmental practices, with social tenants slightly more positive towards these practices than the other tenure types. Flood experience was strongly associated with active stewardship and rainwater barrel ownership. Differences in ethnicity were not strongly associated with any differences in active practices, but there was a slight tendency for those of Asian ethnicity to be less positive towards passive stewardship compared with other groups. Having a disability was negatively associated with more active practices, but not with passive stewardship. Households with one adult were less likely to be active rainwater barrel users whereas very large households (above 5 adults) were more positive towards them. Age was a significant factor in all practices, but there was a non-monotonic age-practices relationship; young people (under 24) were less likely to engage in any practices, older people (over 65) less likely to active stewards or rainwater barrel owners, but more likely to pursue pro-environmental behaviours. The middle-aged (35–64) were most positive towards practices, on average. Respondent gender had no impact on any attitudes or practices.

Finally, length of residence was associated with many factors including tenure, flood experience, ethnicity, disability, number of children and age, but particularly tenure, age, and ethnicity. Length of residence was also strongly associated with meanings and practices. Households in residence <5 years scored less positively towards all practices than those over 5 years. Those living in the area 10–15 years were most positive towards rainwater barrels.

5. Discussion

The results suggest that, in this dense urban area with relatively low income and mixed tenure, a high level of climate and flood awareness exists, pro-environmental practices are prevalent, and the majority of respondents were willing to see changes in their area to reduce flooding, even though they might not be the biggest beneficiaries. Similarly positive public perceptions were observed in different, more suburban and urban contexts in Gazzard and Booth (2020), as well as Anderson (2022)'s recently submitted thesis, also tying in well with the bulk of findings from Jarvie et al. (2017) in Scotland comparing man-made ponds with those of natural origins and research conducted in Northeast England and Northern Ireland (Lamond et al., 2020). Not all results are consistently positive, of course, as indicated by Venkataramanan, Lopez, McCuskey, Kiefus, McDonald, Miller (2020)'s systematic review; a variety of positive and negative elements encouraging or discouraging acceptance and appreciation are noted by the authors, negatives including pests, litter, untidiness, crime, felt safety and maintenance costs. Recurring themes throughout much of the social BGI literature indicate that participatory development, awareness-raising and good management of maintenance issues are core to encouraging acceptance and appreciation, and so sustainable functioning BGI. Lay stewardship is not suggested as an outright *replacement* for professional FRM monitoring and maintenance, although in an era of austerity and neoliberal budget-cutting, it is felt that lay engagement might function to reduce certain costs whilst also offering opportunities to enhance awareness, appreciation, BGI engagement and social inclusion; thus, it could hopefully act as an *enabler* of more widespread BGI rollout, with potentially multiple benefits.

We saw a general lack of correlation between practices we defined as general pro-environmental and BGI stewardship. This implies that these "other" pro-environmental practices may be driven by different meanings and competencies than the stewardship variables. Although the pro-environmental practice scale scored well in terms of reliability, the multi-dimensional nature of this scale (represented by the spread of eigenvectors) suggests this interpretation may have some basis. The scale is nonetheless correlated also with climate concern, suggesting there is more than one variant of the practice complex, some driven by climate concerns and others by cost considerations.

The financial meanings associated with low-cost energy conservation and waste management practices were not explored directly in the survey. However, some linkage is indicated by the tendency for higher levels of pro-environmental practices to be observed within older households, single-adult households and social housing tenants that may be expected to have lower average disposable incomes. This suggestion is also in line with the segmentations discovered by Golob and Kronegger (2019), that saw some 50% of Europeans as "side-line environmentalists," pursuing low-cost practices related to consumption reduction but not undertaking practices that represented a cost to them.

The meaning of the pro-environmental practices can also be explored with reference to climate awareness. Waste management practices were not associated with the desire to limit climate change. This finding supports previous research on recycling in Portugal that demonstrates social expectations and ease of recycling are key drivers of recycling behaviour, rather than general environmental attitudes (Valle et al., 2005), thereby attaching meanings of good citizenship to the practice. Some energy conservation practices (insulation, low-energy lightbulbs and avoiding car-usage) were associated with wanting to limit climate impact.

We saw more similarity among responses related to BGI, with water management and BGI stewardship practices holding similar meanings. The three BGI stewardship scales are more closely related and more unidimensional than the pro-environmental practice scale. They appear to be measuring three different levels of willingness to participate in BGI stewardship in a consistent manner.

Passive stewardship is built mostly on meanings and experiences (including flood experience), whereas active stewardship and rainwater barrel ownership are also affected by more practical considerations. Some water-resource management and BGI stewardship were also positively correlated with desire to limit climate change. Worry about flooding and positive attitudes to

adaptation against flooding were positively correlated with water resource management practices and BGI.

Tenure affects the ability of households to make changes to their property and therefore willingness to instal and manage a rainwater barrel. Tenants had on average lived there for a shorter time, especially, in this case, the student population, and might have been less motivated to instal and manage a rainwater barrel through lack of investment in the property and the local area. This finding is relevant to the goals of local authorities that might wish to encourage ownership of BGI in dense urban environments for reasons of lack of public space or because of connectivity requirements. Landlords may be influential in installing systems, but tenants also need to be involved in maintenance and management.

In the specific case of rainwater barrel ownership and management, our results around low prevalence of and difficulties in emptying them are consistent with previous work by Pullinger et al. (2013) on water use and specifically the practice of gardening. They observe that 56% of households with outside space undertake no watering activity. They categorised gardeners into "Casual Gardening" using watering cans or jugs, "high-tech gardening" using mains-water and hosepipes, sprinklers, and automated irrigation, "amateur enthusiastic gardening (5%) using a mix of mains and rainwater barrel and "green fingered gardening" (6%) using only rainwater barrel. Therefore, 11% had a water butt, which concurs with our sample where 60/500 or 12% of respondents reported owning one. Widespread anticipated difficulty in emptying rainwater barrels can be expected in a population where more than half of gardens are not actively watered.

Engagement in active stewardship and rainwater barrel ownership was also reduced by characteristics that might increase physical limitations of household members, such as disability and being older than 65; these did not affect passive stewardship. Equally, time and resource constraints may have affected willingness of single-adult households to engage with active stewardship.

Although the patterns observed do demonstrate associations between attitudes and practices and between practices and household characteristics, there is still a large amount of variability in willingness to engage that was not related to these factors. A large proportion expressed a great deal of uncertainty in their responses to questions about engaging with stewardship. This may imply they are not clear what is involved in stewardship or that they feel they lack skills; there may therefore be room to move opinions *via* targeted engagement and consultation. They may also experience practical difficulties in engaging due to lack of time, physical ability, or outside space.

Our data suggests people with belief in measures and pro-environmental views could be encouraged to become more actively engaged through mitigation of these practical constraints. More households could use rainwater barrels, even if they do not need to use the water themselves if they were easily able to discharge them to a communal space or to a specific identified neighbour. Low- or no-cost rainwater barrels could be offered to tenants by the Council or social landlords. Provision of communal equipment and training could encourage those lacking skills and resources to engage in active sweeping and weeding. Volunteer sessions could be arranged at different times and/or include communal support for caring responsibilities.

Associations seen within our responses regarding tolerance and respect for installations suggest that keeping them well-maintained may engender liking and associated good practices. Increased active stewardship is therefore likely to increase passive stewardship practice through increased liking of well-maintained schemes. Clear communication of the required installation treatment would also be helpful. This is especially important in Wingrove and similar urban areas with a large proportion of transient residents and renters; continual renewal of positive communication is required.

6. Conclusion

We observe from the literature that both active and passive stewardship could be important in enhancing the sustainability of BGI installed in public spaces, in places where BGI is not recognised and treated as a critical infrastructure. Our data shows highest levels of willingness to engage in passive stewardship, followed by active stewardship, with ownership lower again.

The data shows that willingness to engage in all kinds of BGI stewardship practice is associated with security of tenure, understanding of BGI, belief in BGI, flood experience and pro-environmental attitudes, but not with other pro-environmental practices. Water-management meanings associated with BGI appear to be an important driver of stewardship practices.

In addition, active stewardship and ownership are more common when a more complex set of enabling and motivational factors are in place, such as physical capabilities, appropriate skill sets and place attachment (as represented by tenure and length of residence). Ownership practices are most enabled by homeownership, as opposed to renting, and ability to manage BGI, i.e., empty rainwater barrels.

Other pro-environmental practices appear less driven by environmental attitudes. Some, such as recycling, may be performed as the dominant practice and others, such as energy-conservation, motivated by economic considerations as much as by attitudes to climate change.

This analysis suggests that increased BGI stewardship will be encouraged by: Drawing on the meanings associated with water resource management; providing skills-building opportunities to enable active engagement; building a culture of stewardship that promotes passive stewardship as a dominant practice, and engaging with time- and resource-poor households in ways that recognise active stewardship as part of "daily life activities" and fitting in with "daily schedules."

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Faculty of Environment and Technology Research

Ethics Committee, University of the West of England. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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