Values influence public perceptions of flood management schemes

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Abstract

Natural Flood Management (NFM) is now well established as a paradigm for reducing flood risk. It is characterised by adopting a catchment-wide hydrological perspective and applying NFM such as wetlands, riparian vegetation and river channel rehabilitation. However, despite substantial attention in the river science literature and growing appreciation for NFM among environmental managers, little research has been conducted on how the public perceives NFM. This study explores preferences for a variety of flood risk management schemes through an online survey of the UK public, and assessed how different characteristics of these schemes contribute to preferences via Q-method utilising an array of photographs. Relationships between survey respondents' underlying transcendental values and their preferences for NFM schemes were also studied. Results revealed that while NFM approaches were appreciated for their appearance and wildlife benefits, traditional grey engineering – particularly dams – was seen as more effective in ameliorating flood risk. Q-sorts of photographs revealed three factors that characterise participants' preferences: (i) "Engineered - Natural", (ii) "Messy - Neat" and (iii) "Grey - Green". Finally, transcendental values were significantly related to flood scheme preferences, with 'Self-Transcendence' values positively correlated with preference for tree planting and wetlands and negatively with dams and weirs. 'Conservatism' values were positively correlated with preferences for

dredging and weirs and negatively with wetlands. These findings emphasise the plurality of public perceptions related to NFM and the diverse value orientations within which they are grounded. River and catchment managers seeking to promote NFM solutions should focus on addressing public concerns about the efficacy of NFM for mitigating flood risk, and consider how to communicate solutions in ways that resonate with a diverse set of public values.

Keywords:

Natural flood management; public preferences; transcendental values; flooding; Q-method

1. INTRODUCTION

Flooding is the most deadly and costly natural hazard globally (Hendry *et al*., 2018; Stevens *et al*., 2016; Llasat *et al.* 2009). Despite a long history of management, flooding remains prevalent and the number of reported floods has increased noticeably since the 1960s (Jha *et al*., 2012; Stevens *et al*., 2016). As such, past management has not successfully mitigated these risks (Johnson *et al*. 2019) and trust in previous management techniques and strategies has been tested and questioned (e.g. Bubeck *et al.*, 2017). The increased risk of flooding despite vast investment in traditional, predominately grey flood infrastructure has resulted in the relatively recent adoption of new methods, and particularly a shift to more integrated approaches to flood risk management (Bubeck *et al.*, 2017). Integrated approaches consider the whole catchment with the aim of achieving long-term sustainability by understanding and aligning with natural bio-geophysical processes. As part of this shift in focus, flood risk mitigation increasingly involves 'Natural Flood Management' (NFM). NFM utilises the hydrological benefits of green infrastructure, and is promoted as a form of sustainable flood risk management (Lane, 2017; Wells *et al*., 2020), with documented success in reducing peak flows and increasing lag times (e.g. LUPG, 2004; Thomas and Nisbet (2007); Wilkinson et

al. 2019). NFM also offers multiple ancillary benefits (Iacob *et al.*, 2014) including reducing costs incurred by flood damages, amenity values and ecological improvements (Lane, 2017).

The paradigm of NFM reflects changing environmental management scholarship, but has largely developed in isolation from the views of relevant stakeholders and the wider public. Several European countries have encouraged the integration of rural land use with flood risk management (Holstead *et al.*, 2017). However, a key issue that has inhibited the implementation of this type of flood risk management is the permission and acceptance of landowners (Howgate and Kenyon, 2009; Bark et al. 2021). Indeed, successful environmental management depends in large part on social acceptability of environmental actions, and an understanding of public perceptions (Bennett, 2016).

There has been substantial research into public engagement with, and perceptions of flood risk management schemes (e.g. Myatt *et al*., 2003; Reed, 2008; Morrison et al. 2019). For example, scholars have identified a link between beliefs about nature and support for river restoration (Connelly *et al*., 2002; Groot and De Groot, 2009). Buijs (2009) investigated public perceptions of the 'ideal' river environment using questionnaires and open interviews. The results indicated that scenic beauty was preferred, and that floodplains should be well-maintained, such as through mowing of grass. Furthermore, White *et al*. (2010) highlighted the benefits of involving the public within flood risk management, including improving understanding of decision-making processes, increasing personal responsibility, and enhancing the quality of information about specific areas of flood risk.

However, increasing public engagement is a difficult process especially with newer concepts or where there may be a lack of knowledge, as is the case with NFM. To date, there has been

a general lack of acceptance by the general public of NFM's efficacy in reducing flood risk (Huq, 2017; Wells, 2019). Yet opinions are complex, with less favourable views of NFM associated with individuals who have previously been flooded (Wells, 2019), a lack of knowledge about the benefits of NFM (Huq, 2017; Wells, 2019), and land-owners and farmers who question responsibility, ownership and costs associated with NFM (Beck et al. 2021). There is therefore a need for further research into the plurality of public perspectives on NFM and the factors that influence them.

Values are receiving increasing conceptual and empirical attention in environmental and sustainability research because they enable exploration of the underlying psychological constructs that determine environmental attitudes, and have been explored from diverse disciplinary perspectives (Dietz *et al*. 2005; Ives and Kendal 2014; Kenter *et al*. 2019). Given the diversity of ways that the concept of value is used in environmental management (Ives & Kendal, 2014), we adopt the term "transcendental values" to describe those abstract, universal values assessed in this study. Drawing on Schwartz and Bilsky, (1987), transcendental values are defined by Kenter et al. (2015: 88) as "conceptions about desirable end states or behaviours that transcend specific situations and guide selection or evaluation of behaviour and events". Empirical evidence has linked transcendental values with environmental attitudes and behaviours (Stern *et al*., 1995; Stern *et al*., 1998), and as such they have been identified as important to consider in managing ecosystem services (Raymond & Kenter, 2016).

There is currently scant literature on the relationship between values and perceptions of river management. One important exception is Morris-Oswald and Sinclair (2005) who investigated values with regard to flood risk management in two Canadian communities.

They found that some values act as a constraint on management, especially where proposals focus on the implementation of sustainable floodplain management practices. However, there is currently no literature on the relationship between underlying transcendental values and people's preferences for different river management schemes. This knowledge is essential to ensure the burgeoning movement of NFM has a 'social licence'. Insights could inform how flood risk management measures could be designed and communicated for both public acceptability and environmental benefits. Therefore, this study aimed to:

1. Investigate individuals' preference for various flood risk management schemes.
2. Identify attributes of flood risk management schemes that influence preferences by the public.
3. Explore the relationship between individuals' transcendental values and their preferences towards flood risk management schemes.

This over-arching intention is to provide insights for those involved in the planning and design of flood risk management strategies and to inform how management strategies are conveyed to stakeholders. The work focuses on the UK which could potentially face significant changes to environmental policy as a result of Brexit, and suffers significant national flood risk annually.

2. METHODS

2.1. Questionnaire design and dissemination

An online survey was developed to collect information on respondents' preferences for different flood risk management schemes, perceptions of the schemes according to relevant criteria (appearance, benefits to wildlife and effectiveness), and their underlying values. It was distributed via social media, including Facebook and Twitter, and on the website for a funded research project on flood resilience (University of Nottingham, 2019). Although the

125 survey was open to any member of the wider UK public, our aim was not to obtain a
126 demographically representative sample but rather to ensure a sufficiently diverse set of views.
127 Ethics approval was obtained from the School of Geography, University of Nottingham prior
128 to data collection (approval granted 27th March 2019).
129
130 The questionnaire comprised three sections. The first collected socio-demographic data
131 including age, occupation, the highest level of education, gender and postcode. Only the first
132 half of postcodes was recorded and was used to split respondents into rural and urban based
133 on the 2011 Rural Urban Classification (DEFRA 2014) and the Scottish Government Urban
134 Rural Classification (Scottish Government, 2016). A binary question was also asked to
135 establish whether the individual had experienced flooding in the past, or within their current
136 property. Analysis was carried out to determine whether these data played a role in affecting
137 peoples' values and perceptions of flood risk management and, where this was the case, is
138 presented herein.
139
140 **2.2. Assessing transcendental values and preferences**
141 The second section of the questionnaire assessed individuals' transcendental values. Values
142 were assessed following Stern's et al. (1998) interpretation of Schwartz (1992) values scale,
143 which indicates a universal structure of values that includes Self-Transcendence, Self-
144 Enhancement, Openness to Change and Conservation (or traditional) values. Stern et al.'s
145 sub-scales were used to distinguish between altruistic and biospheric value orientations
146 within the broader category of Self-Transcendence values. Stern et al.'s (1998) shortened
147 version of Schwartz's values has been widely used and found to have good reliability and
148 predictive success (e.g. Corner et al., 2014). A 7-point Likert scale was used to measure the
149 importance of each of the 15 items as a 'guiding principle' in respondents' lives.

The final section assessed the preferences of the individuals regarding flood risk management schemes. Six photographs were shown, representing both NFM (tree planting, wetland creation and wooden dams) and traditional flood risk management (dams, dredging and weirs). For each of the images the individual provided a subjective rating for: (i) effectiveness for managing flooding, (ii) appearance and, (iii) benefits for nature and wildlife on a 5-point Likert scale. Following this, each individual was asked to rank the images from 1 to 6 (1 being the best and 6 the worst) based on their overall preferred management scheme for flood control. Finally, they were asked to give a short justification for their overall preference ranking.

2.3. Statistical analysis of questionnaire data

Associations between respondents' socio-demographics and their overall ranking of flood risk management schemes were analysed via Kruskal-Wallis H tests. Comparison of preference ratings for flood risk management schemes according to different criteria (effectiveness, appearance, wildlife benefits and overall rating) was also achieved via Kruskal-Wallis H tests with Mann-Whitney U post-hoc comparisons. To examine the structure of underlying value items from the questionnaire data, an exploratory factor analysis was carried out with Varimax with Kaiser Factor Rotation (Brace *et al*., 2012). A principal component extraction method was used, with items considered to be part of a cohesive group if their factor loadings were >0.4 (Samuels, 2016). Two, three and four-factor solutions were calculated. The number of factors was confirmed by first analysing the scree plot to identify components with eigenvalues >1. In order to establish the categories and best fit of the factors, Schwartz's circumplex model was used to determine logical item groupings, in accordance with other studies (e.g. Hinz *et al.*, 2005; Perrinjaquet *et al*., 2007). To establish

which value orientations most strongly relate to overall flood risk management perceptions, a Spearman's Rank Correlation was used to compare the factor scores for participants with the overall rankings for flood control of the management schemes. All statistical analyses were completed in SPSS v25 (IBM Corp. 2017).

2.4. Q-method

To complement the survey methodology, Q-method using images of flood risk management schemes was applied face to face with a smaller group of people to inductively identify attributes of flood mitigation options that relate to preferences. The Q-method was devised and developed in the 1930s by William Stephenson (McKeown and Thomas, 1988). It is an inductive method that allows participants to demonstrate their viewpoints in response to a sample set of stimuli, which can be statements or images (Herrington and Coogan, 2011). One of the strengths of the methodology is that it enables quantitative structural analysis of participant responses without the need for pre-determined, a-priori categories of phenomena. Q-method is commonly used with statements; however, photographs can also be used and can assist with engaging people from a range of ages, education levels and backgrounds (Milcu et al., 2014). Within landscape perception, the use of photographs remains one of the most common approaches and, by using the Q-method, a large number of situations can be presented (Fairweather and Swaffield, 2001). This methodology also allows the combination of both quantitative and qualitative techniques to gain an understanding of an individual's point of view (Webler and Tuler, 2006; Herrington and Coogan, 2011), permitting a more interpretative and exploratory analysis.

The Q-method was employed to explore interactively how people perceive visual representations of flood risk management schemes. Individuals were approached and

interviewed at the Nottingham Lakeside Arts Centre and in the School of Geography, University of Nottingham on an open day. Thirty-six images depicting twelve different management options were used, with three different images for each option, selected based on the clarity of the photography and requiring the management option to be the focus of the photograph. For each of the management options, at least one image depicted a 'natural' approach (e.g. wetland creation, large wood, tree planting, detention basins, flow deflectors and leaky dams), while at least one other image depicted a grey engineering approach (e.g. dam, weir, dredging, flood wall, channelisation, and levees). Each participant was firstly given the chance look through all 36 images with the name of the management option on the back. They were also supplied with a list of definitions and were able to ask for further clarification throughout the recorded interview. The participant was then asked to place the images into three piles, representing the best, neutral, and the worst options overall for flood risk management, participants were asked to consider each scheme overall thinking about their appearance, benefits to wildlife and effectiveness as a flood risk management scheme. The scale was relative, not absolute. Therefore, even if a participant regarded all the images as having merit, a decision had to be made concerning the relative level of merit, making the participant choose between the best and the worst options (Webler and Tuler, 2006). Once the photographs had been assigned to the piles, participants were asked to order the images on a grid, working through each of the piles, creating a Q-sort. A Q-sort is the completion of this grid (see Supplementary Material for an empty Q-sort template). As they did so, they were asked to explain why they had made their decisions. Distribution of the images was not taken as final until the participant was content with all their choices. The participant was then asked to give reasons for their choices for the best and worst option. A photographic record was made of each individual's preferences, and this was translated into excel using the definition

224 names, each photograph was then given a number to represent each definition name, to allow
225 for later analysis.
226
227 To investigate the preference for management options in the Q-sorts, a factor analysis was
228 performed on photograph scores. The results were uploaded to the Ken-Q Analysis software
229 package, as used by Ladan *et al*., (2018) and Porter *et al*., (2017). Eight factors were
230 extracted using Principle Component Analysis and three factors were selected for rotation,
231 with a Varimax rotation applied (Watts and Stenner, 2005). The factors were produced using
232 the image names, however, in order to see the factors visually, the image names were
233 converted back to their images in order to display results visually. For each respondent, a
234 loading score was calculated for each factor, in essence rating the degree to which that
235 individual Q-sort is related to each factor (Webler and Tuler, 2006). The analysis can isolate
236 one prevalent factor or produce several factors. From the output of the Q-sort, each image
237 was ranked, and thus image scores were derived for each factor. Additionally, for each
238 respondent socio-demographic information was recorded to enable comparison with resulting
239 factors.
240
241 **3. RESULTS**
242
243 **3.1. Respondent profile**
244 In total, 170 individuals participated in the online survey, of which 151 completed all sections
245 of the questionnaire. Only complete responses were considered for analysis. Similar numbers
246 of responses were received from females and males (n = 78 females and n = 73 males), with a
247 wide range of ages completing the survey (16 to 65+ years old). The majority of individuals
248 had a first degree (40%) or higher degree (30%), indicating that respondents were generally

highly educated. The most common occupation was in 'life, physical, and social science occupations' (23%), with students comprising a further 21% of respondents. Geographically, respondents were spread through England and Scotland, but with a more living in urban environments (80%) than in rural environments (20%). Kruskal Wallis H Tests revealed that the only significant relationship between overall ranking of the management options and socio-demographics found was between education levels for the overall ranking of dredging and wetlands (Supplementary Material). Those with higher qualifications ranked dredging significantly lower (i.e. less preferred) and wetlands significantly higher (i.e. more preferred) than people with lower qualification levels.

For the Q-method a total of 18 individuals participated, of which 11 were male and 7 were female, aged between 16 and 65+ years old. The majority of individuals were either students (44%) or retired (22%), and 56% had a University degree or higher qualification. Given the low sample size, the role of socio-demographics on responses in the Q-method was not analysed further.

3.2 Management Preferences

Average scores for appearance, effectiveness and benefits to wildlife of each management option were calculated from 5-point Likert scale survey responses (Figure 1), and significant preference differences were found between flood risk management schemes for each category of assessment. Full statistical details of pairwise tests between scheme types for each preference category can be found in supplementary material (Supplementary Material).

In terms of flood risk management effectiveness, Kruskal-Wallis tests again revealed differences between scheme types ($H(5) = 119$; $p<0.001$). Dams (mean = 3.81, SD = 0.93)

and wetlands (mean = 3.77, SD = 1.07) were considered more effective than all other options, and there was no statistical difference between them. The remaining four schemes rated lowest for effectiveness (with no discernible difference between), namely dredging (mean = 2.87, SD = 1.15), tree planting (mean = 3.07, SD = 1.12), weirs (mean = 3.05; SD = 0.91), and wooden dams (mean = 3.13, SD = 0.85).

Flood risk management schemes were rated differently for appearance preference ($H(5) = 366$; $p<0.001$). Tree planting (mean = 4.52, SD = 0.78) and wetlands (mean = 4.40, SD = 0.86) scored the highest for appearance, and did not statistically differ from one another. Dams and dredging were the lowest scoring management approaches for appearance (means of 2.81 [SD = 1.12] and 2.49 [SD = 1.18], respectively) and did not statistically differ either.

Differences in ratings for benefits to wildlife were evident between flood risk management schemes ($H(5) = 455$; $p<0.001$). Wetlands and tree planting scored the highest for benefits to wildlife (mean = 4.62, SD = 0.74; and mean = 4.51, SD = 0.73 respectively), with no statistical difference between the two. Both these schemes were found to have higher ratings for wildlife benefits than all other forms of flood risk management approaches. This reflected an overall trend of more natural options scoring higher than grey engineering when considering wildlife benefits. The scheme with the lowest rating was dredging (mean = 2.16, SD = 1.13) with post-hoc tests demonstrating that respondents considered this to be of less benefit to wildlife than all other categories.

<Figure 1 here>

298 In terms of differences in overall preference (Figure 2), management schemes varied
299 significantly ($H(5) = 455$; $p>0.001$) as follows: wetlands were the most preferred
300 management option, followed by dams and tree planting (no statistical difference), wooden
301 dams and weirs (no statistical difference), with dredging the least preferred management
302 option. This order closely resembled that of effectiveness ratings, with dams being ranked
303 second overall despite receiving low ratings on attractiveness and benefits to wildlife. This
304 suggests that schemes' ability to reduce frequency and magnitude of flooding strongly
305 influences overall public preference.
306
307 <Figure 2 here>
308
309 **3.3. Attributes associated with management scheme preferences.**
310 The Q-method results built upon the survey reports of preferences for flood risk management
311 schemes by revealing how people categorise different management approaches and implicitly
312 prefer particular attributes. Three Q-sort factors were identified and labelled according to the
313 gradients observed in the array of photographs, namely (i) Engineered – Natural, (ii) Messy -
314 Neat and (iii) Grey - Green. These are shown in Figures 3-5.
315
316 The general gradient of the Q-sort for Factor 1 went from traditional, engineered/concrete
317 flood risk management at the lower (less preferred) end of the scale to more natural
318 management options at the higher (more preferred) end (Figure 3). Images on the less
319 preferred end of Factor 1 depicted concrete and grey engineering features, including weirs,
320 flood walls, channelisation, and dams. The middle range included detention basins, levees,
321 flow deflectors and dredging. Images at the more preferred end of the continuum were

associated with the more woody structures, such as flow deflectors, leaky dams, tree planting, and large wood.

<Figure 3 here>

For Factor 2, the general trend of the Q-sort was a preference towards the management options that looked well-maintained and appearing to be neat, characterised by mown grass (Figure 4). Dredging was positioned at the lowest end of the factor (least preferred), which aligned with the results of the online survey. Tree planting was positioned at the preferred end of the spectrum, aligning with results of the survey. However, in contrast to the other Q-sort factors, the images within this array appeared to be organised according to visual order or neatness, rather than scheme type or environmental performance.

<Figure 4 here>

Factor 3 showed a continuum from grey to green (Figure 5). The higher scoring end was comprised of detention basins, wetlands and tree planting. Towards the lower end of the Q-sort were the traditional flood risk management options of dams, floodwalls, and channelisation, representing grey options. The middle of the array included images of large wood, leaky dams and dredging.

<Figure 5 here>

3.4 Structure of personal values

To explore the association between personal values and preferences for flood risk management schemes, the structure of Stern's (1998) universal value scale was explored. Items with factor loadings over ±0.4 were grouped into value orientations in accordance with Samuels (2016). Some items did not load on factors as expected according to Stern or Schwartz's value typologies. As such, three of the items were removed including item 2: A world at peace, free of war and conflict, item 6: Equality, equal justice for all, and item 12: Self-discipline, self-restraint, resistance to temptation. Through assessment of eigenvalues and item loadings, a four-factor solution based on the circumplex and previous papers (Stern et al., 1998) was selected as the best fit statistically, and in accordance with the theoretical scale structure in Stern et al. (1998), namely Self-Transcendence, Openness to Change, Self-Enhancement and Conservatism (Table 1.).

Factor 1, Self-Transcendence, comprised both Altruistic / Self-Transcendence values and Biospheric / Self-Transcendence values. Items loading most strongly on this factor related to the preservation of nature and the environment. Factor 2, Openness to Change, was associated with the acceptance of new ideas or trying different opportunities. Factor 3, Self-Enhancement, indicated values related to personal benefits. Finally, Factor 4, Conservatism values, are also known as traditional values and relate to a general opposition to novelty and change. The item wealth, material possessions, money loaded similarly on factor 3 (n = 0.608) and factor 4 (n = 0.521) but was grouped in factor 3 to maintain consistency with its interpretation in other studies.

<Table 1 here>

3.5 Relationships between values and management preferences

371 The results from the Spearman's Rank Correlation illustrated significant, albeit weak,
372 relationships between the factor scores for participants with the overall rankings for flood
373 control of the management schemes (Table 2). For Self-Transcendence (i.e. Biospheric-
374 Altruistic values) there was a statistically significant positive correlation with preference for
375 tree planting ($p = 0.007$) and wetlands ($p = 0.030$). Negative correlations between the value
376 orientation Self-Transcendence and both dams and weirs were statistically significant,
377 although correlation coefficient values were low ($r_s < 0.3$ in all cases). The second factor,
378 Openness to Change, was only found to have a statistically significant correlation with
379 preference for wooden dams ($p = 0.011$) and there were no statistically significant
380 correlations between the factor Self-Enhancement and any of the flood risk management
381 options. Dredging ($p = 0.031$) and weirs ($p = 0.018$) both had significant, positive
382 correlations with the Conservatism factor whereas wetlands had a statistically significant
383 negative correlation with Conservatism ($p = 0.009$).
384
385 <Table 2 here>
386
387 **4. DISCUSSION**
388
389 4.1. Flood mitigation preferences
390 Across all the methods used, there was an overall preference for NFM options. For example,
391 wetland creation was given the highest overall rating in the questionnaire and was rated
392 highly across all three of the key characteristics: appearance, effectiveness, and benefits to
393 wildlife. This finding is consistent with others who have found that society places high value
394 on wetlands (Davidson *et al*., 2019) and, as scientific understanding of their ecological value
395 has increased, public appreciation has also increased (Heimlich *et al*., 1998). This positivity

towards wetlands has been associated with their mutual benefits for recreation and educational opportunities, in addition to flood mitigation opportunities (Knight *et al*., 2001; Jose et al., 2014). Tunstall *et al.* (2000) documented how residents in East Peckham, UK, who could see detention basins from their windows felt they had a positive impact on the appearance of the area. Those respondents with higher education qualifications expressed stronger preferences for wetlands, indicating that prior knowledge of the potential importance of wetlands is important to their value. This accords with Wells (2019) who found NFM was more valued by those who had prior understood of the associated benefits. The overarching preference for NFM approaches observed in the survey data is supported by the array of images produced in the first factor of the Q-method results. This factor represented a gradient from grey engineering to natural approaches and had 9 respondents loading onto it.

Dams were considered the most effective option and came second in the overall preference ranking despite scoring low on appearance and benefits to wildlife. This firstly demonstrates that while people associate NFM with aesthetic and wildlife benefits, dams continue to be perceived as an effective strategy for managing flooding (Lebel *et al.* 2009). Second, it suggests that perceived effectiveness is critical in establishing public support for management – perhaps more than a scheme's appearance or biodiversity. Similar findings were documented in the Swiss Alps, where individuals who had suffered flooding expressed a preference for more traditional measures such as dams, which they believed to be more effective (Buchecker *et al.*, 2016). This type of grey engineering is especially preferred when it is within or close to an urban area (Mosley, 1989). Despite this perception of grey engineering as effective for managing flooding, wetlands were ranked second for effectiveness. Wetlands are a key management scheme as they store water for short periods, delaying flood peaks (Potter, 1994). Results from the present research suggest that this

benefit may be well-recognised by the broader public in the UK. In contrast, dredging was perceived as the least effective option, and significantly more negatively by those with higher qualifications. This may be associated with an ongoing, high profile debate in the UK media with regard to dredging for flood mitigation, illustrated through the floods of winter 2013-14 in the Somerset Levels of South West England (Thorne, 2014). The media coverage it received could have educated the public on issues surrounding the effectiveness and sustainability of dredging, particularly those with University education interests in the environment.

Despite the apparent perception of grey engineering as effective for managing flooding, the appearance of schemes also influenced their final overall ranking. Overall, the 'green' options were considered more aesthetically pleasing than grey engineering, with wetlands and woodland also rated highly for overall preference. This result was reflected in the third Q-sort factor depicting a spectrum of preference from grey to green. For example, the two photographs of levees that were 'green' rather than the one where the grass was more 'brown' tended to be scored higher. Lara *et al*. (2010) found similar results with local managers having a preference for 'greener' types of flood risk management. Likewise, dry wetlands were preferred if the vegetation had colour as this implied health (Dobbie and Green, 2013). This is consistent with work on river restoration, where for example, Junker and Buchecker (2008) found that the public in Switzerland viewed restoration outcomes based on their aesthetics, with naturalness improving appearance. Similarly, Everett *et al*., (2018) found that the public in the USA preferred 'blue-green' infrastructure for flood management, which looked more natural when compared to grey infrastructure. Indeed, there is a large literature documenting people's visual preference for green or natural features (e.g. Ulrich, 1993; Kaltenborn and Bjerke, 2002; Silva *et al*., 2013; Chiang and Jane, 2017; Zhao

et al., 2017). Conversely, grey engineering schemes were given the lowest rating when it came to appearance and were often referred to as being an ‘eye-sore’ in conversation with Q-sort participants. In particular, respondents identified the degree to which flood risk management structures fitted into their surroundings as a key factor for acceptance.

Management options that appeared ‘messy’ were also scored relatively low for appearance, particularly woody structures. This result from the online survey was also consistent with the Q-sort results, with Factor 2 representing a gradient from schemes that were deemed messy to those that were neat. Research has found that areas are seen to be less appealing if they appear dry or contain dead vegetation, whilst areas that are open and have regular maintenance are preferred (Williams and Cary, 2002). This may relate to an idea of order and intent to ‘control’, which can be associated with mowing and removing of unfamiliar plants that has been linked with flood control and safety improvements (McCormick *et al*., 2015). The messy-neat and grey-green factors represented different gradients, which align with Nassauer’s (1993) well-established principles on ecological aesthetics, namely that landscape attractiveness is associated with visual cues of neatness, order and care. Indeed, in the context of flood risk management, previous research has shown conspicuous large wood was not popular with the public, even where it had formed naturally (Gregory and Davis, 1993; Chin *et al*., 2008; Ruiz-Villanueva *et al*., 2018).

In general, respondents associated grey engineering with negative impacts on wildlife and more natural approaches to flood risk management with positive impacts. Wetlands were perceived to be very important for wildlife, and this function may have contributed to their high overall preference by survey respondents. Wetlands support multiple ecological functions (Dobbie and Green, 2013) and are vital in supporting diverse plant communities

(Lishawa *et al*., 2019) and providing habitat for fish (Heimlich et al., 1998). Survey respondents did not associate dams with wildlife benefits, perhaps indicating greater public knowledge of the negative impacts of dams (e.g. fragmentation of habitat and impeding nutrient and sediment transport) relative to other flood risk management schemes.

4.2 Values as a predictor of overall preference

Transcendental values were significantly related to preferences for management options, highlighting both the heterogeneity of 'public' preferences and the deep psychological origins of attitudes towards environmental management options. Our findings revealed that Self-Transcendence values (including values for other people and the environment) were positively associated with preferences for tree planting and wetlands, and negatively associated with preferences for dams and weirs. Conversely, Conservatism values were positively associated with dredging and weirs, and negatively with wetlands. These findings help to explain why both grey engineering (dams) and natural flood risk management (wetlands) approaches were rated highly overall in public preferences. It appears that the environmental benefits of natural flood management are more salient for those with biospheric value orientations (incorporated within Self-Transcendence values), while conservative values underpin more 'traditional', 'well-proven' approaches. These findings align well with existing research on values and environmental attitudes. For example, Schultz *et al*. (2005) carried out research across six countries and found that values were important in how people understood environmental issues, in particular that Self-Transcendence was positively related to environmental concern whereas Self-Enhancement had a negative association.

Somewhat counterintuitively, preference for wooden dams (a form of NFM) was not statistically related to Self-Transcendence values, possibly because the appearance of this management option is perceived as messy. However, there was a positive relationship between wooden dams and Openness to Change values, perhaps because this is one of the newer, more novel techniques. As expected, both dredging and weirs had a positive relationship with Conservatism values and wetlands had a negative relationship. Conservatism is positioned as the opposite of Openness to Change (Schwartz, 1992), and here inverse relationships were found. To better understand how personal values relate to preferences for river management, future research should look to combine measures of transcendental values with context-specific values. For example, Morris-Oswald and Sinclair (2005) identified seven community values related to floodplain management in Canada, including identity, civic engagement, and personal rights and liberties. Similarly, Mould et al. (2020) revealed the importance of 'relational values' between people and riverine environments for motivating participation in river management. These examples, along with the present study, demonstrate the importance of moving beyond technical understandings of catchment dynamics and superficial notions of stakeholder support or opposition, to comprehend the deeper value structures and dynamics that underpin public engagement with rivers.

4.4 Management Implications

Overall, NFM approaches were preferred over traditional, grey engineering, suggesting that there is substantial potential for ongoing promotion of NFM among environmental managers (Vávra *et al*, 2017). However, more consistent positive responses to NFM were associated with benefits for attractiveness and wildlife, rather than for effectiveness in tackling flooding. The results therefore suggest that focussing on aesthetic and wildlife benefits of schemes may

increase public support for more natural options. River managers could improve public acceptance of NFM by highlighting the attractiveness and wildlife benefits in public communications such as press releases, media engagement and signage at relevant sites.

However, our findings issue a word of caution against treating the 'public' as a homogenous group. Even though sociodemographic analyses indicated few significant differences in preference of mitigation scheme, different individuals possessed different value orientations (Stern *et al.*, 1993), and these transcendental values were related to preferences for flood risk mitigation schemes. For example, wetlands were significantly preferred by people with strong Self-Transcendent (biospheric) values as might be expected, but were significantly not preferred by those holding Conservative values. In addition, the more strongly people identified with Self-Transcendent values, the more strongly they preferred NFM approaches over traditional, grey engineering. Therefore, a sensible strategy to improve social acceptability of NFM among those with a strong orientation towards conservative values would be to focus more on highlighting the safety and effectiveness of NFM for mitigating flood risk, rather than the ecological benefits. This is supported by Straka et al. (2016) who identified that when information about wetland environments was provided to the public in a way that aligned with their value orientations, then those environments were given a higher preference by the public. Finally, there were no statistical relationships between flood risk management schemes and Self-Enhancement values. Therefore, there may be potential for river managers to highlight the benefits of NFM schemes for individuals, which are currently under-emphasised. Examples may include the personal health and wellbeing benefits of green infrastructure.

The Q-method supports an overall preference for green, more natural approaches to flood risk management. The three Q-sort factors indicate that some people prefer green areas, others neat and others natural. Whilst there is a superficial similarity between these three concepts, a potential contradiction exists between providing areas that are both neat and natural. This has been documented for river management in the context of the provision of large wood in rivers, with the general public typically regarding large wood in rivers – a natural and important habitat feature – as 'messy' and therefore undesirable (Chin *et al.*, 2008; Kondolf and Yang, 2008; McCormick *et al*., 2015). River managers will have to accommodate this diversity of views. Further work is needed to consider how the design of NFM approaches can accommodate both amenity requirements and ecological function (Corney, *et al.* 2015).

Q-method has great potential as a tool for engaging members of the general public; within this research it provided useful additional data, adding more insight than a traditional questionnaire could. This is highlighted as the Q-method allows for more of a comparison between flood risk management approaches. However, a limitation of the Q-method is its small sample size due to the need for this method to be conducted in person. Adapting the Q-method to be completed online may increase the response rate and strengthen the results. However, it was invaluable to conduct this method in person as the interviewer was able to provide the participant with support throughout the process.

5. CONCLUSION

This study has revealed that the public generally hold favourable attitudes towards NFM over grey engineering, driven largely by people associating NFM with attractiveness and benefits to wildlife. However, there remains a persistent perception that grey engineering schemes, particularly dams, represent more effective solutions for mitigating flooding. However, this

research has highlighted the importance of heterogeneity among the public's values and attitudes. Different groups of people orient preferences for schemes around their degree of 'naturalness', 'neatness' or 'greenness'. This has revealed a potential challenge for NFM schemes to be perceived simultaneously as natural and tidy. Further, individuals' preferences for NFM schemes are rooted in deeply held transcendental values, with these expressed in often diverging attitudes towards natural and hard-engineered solutions. This study has therefore highlighted the importance of taking into account public values and attitudes in the design, implementation and management of NFM. Further research is now needed to validate these insights in the context of real-world flood risk management schemes. Additionally, it would be worthwhile for environmental management scholars to consider in more detail the efficacy and ethics of shaping public values, and to explore longitudinal change in people's preferences towards river management approaches.

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Tables

Table 1. Factor loadings from the factor analysis of values, where bold text illustrates which value grouping each statement is most strongly orientated towards.

Statement	Self-Transcendence	Openness to Change	Self-Enhancement	Conservatism
"Protecting the environment, preserving nature"	**0.863**	0.311	0.058	0.124
"Respecting the earth, harmony with other species"	**0.855**	0.308	0.017	0.162
"Unity with nature, fitting into nature"	**0.825**	0.157	0.098	0.061
"Social justice, correcting injustice, care for the weak"	**0.769**	0.076	0.038	0.171
“A varied life, filled with challenge, novelty, and change"	0.156	**0.804**	0.083	0.167
"An exciting life, stimulating experiences"	0.193	**0.752**	0.197	0.369
"Curious, interested in everything, exploring"	0.372	**0.717**	0.179	-0.066
"Authority, the right to lead or command"	-0.024	0.226	**0.829**	0.033
"Influential, having an impact on people and events"	0.334	0.115	**0.729**	-0.007
"Wealth, material possessions, money"	-0.255	-0.024	**0.608**	0.521
"Honouring parents and elders, showing respect"	0.374	0.237	0.095	**0.738**
"Family security, safety for loved ones"	0.552	0.302	-0.045	**0.596**

Table 2. Spearman's Rank Correlations between transcendental value orientations and overall ranking of each management option. Significant correlations at $\alpha = 0.05$ are indicated in **bold**.

	Self-Transcendence			**Openness to Change**			**Self-Enhancement**			**Conservatism**		
	r_s	n	p	r_s	n	p	r_s	n	p	r_s	n	p
Dam	-0.234	151	**0.004**	-0.087	151	0.287	0.109	151	0.184	0.100	151	0.221
Dredging	-0.008	151	0.924	-0.088	151	0.282	-0.076	151	0.345	0.176	151	**0.031**
Tree Planting	0.217	151	**0.007**	-0.023	151	0.775	0.043	151	0.598	-0.094	151	0.252
Weir	-0.195	151	**0.016**	0.001	151	0.991	0.058	151	0.478	0.192	151	**0.018**
Wooden Dam	0.017	151	0.836	0.206	151	**0.011**	-0.067	151	0.413	-0.139	151	0.088
Wetlands	0.177	151	**0.030**	0.120	151	0.142	-0.087	151	0.290	-0.213	151	**0.009**

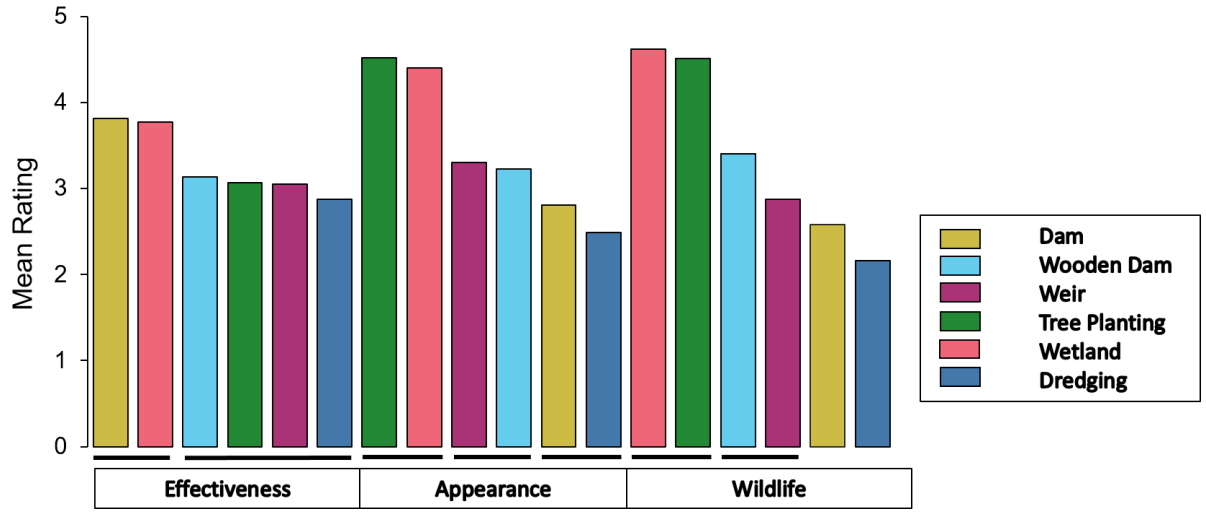

Figure 1 Mean score for appearance, effectiveness and benefits to wildlife for each of the management options in the survey. Management options that were not significantly different in ratings are denoted by a solid black line underneath the bars for each rating category. The absence of a connecting line indicates the schemes were found to be significantly different. Details of these tests can be found in the Supplementary Material.

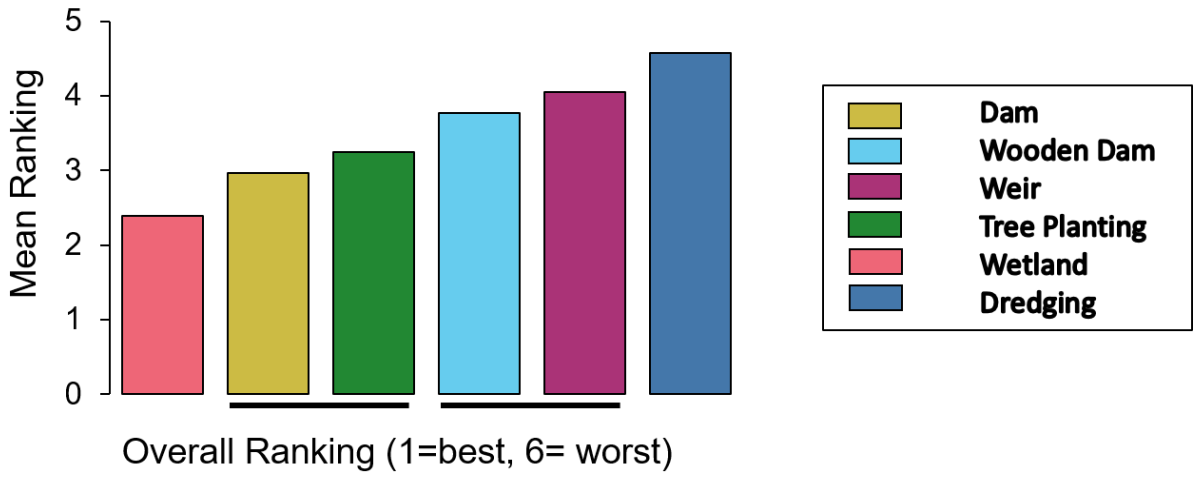

Figure 2 Mean ranking overall for the management options (1 = best and 6 = worst). Management options that were not significantly different in ranking are denoted by a solid black line. The absence of a connecting line indicates the schemes were significantly different. Details of these tests can be found in the Supplementary Material.

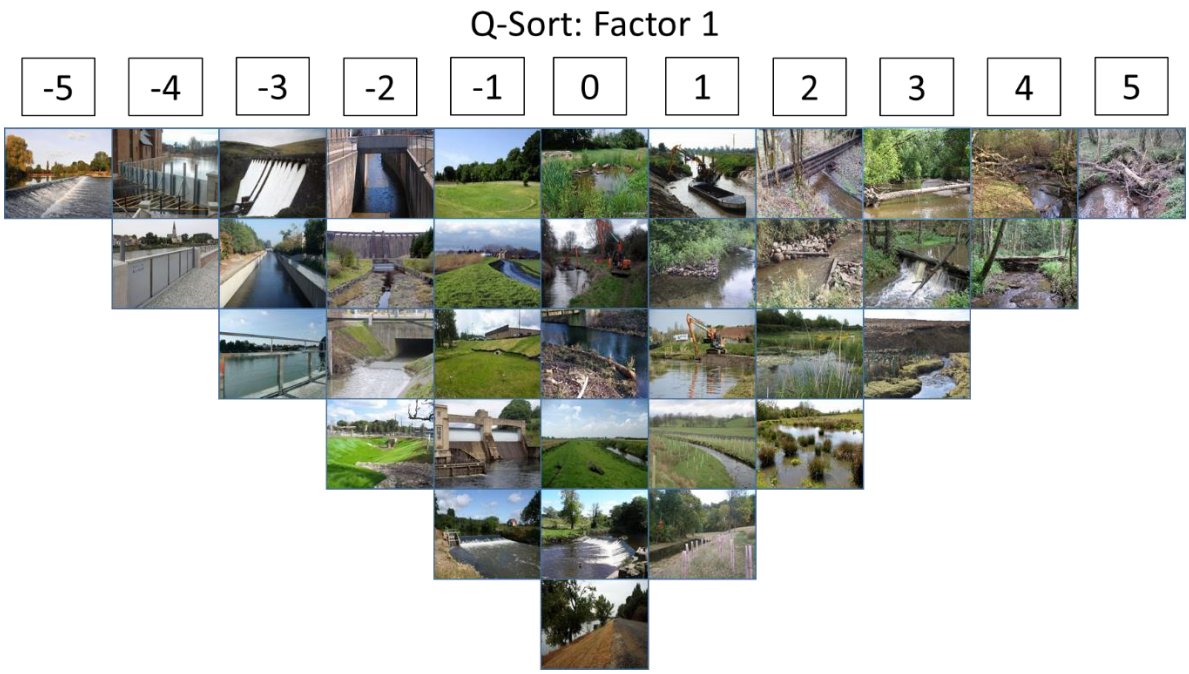

Figure 3. The Q-sort is produced by the participant sorting the photographs from worst (left) to best (right) Factor 1 Q-sort depicting a spectrum of preferences from “engineered” (left) to “natural” (right).

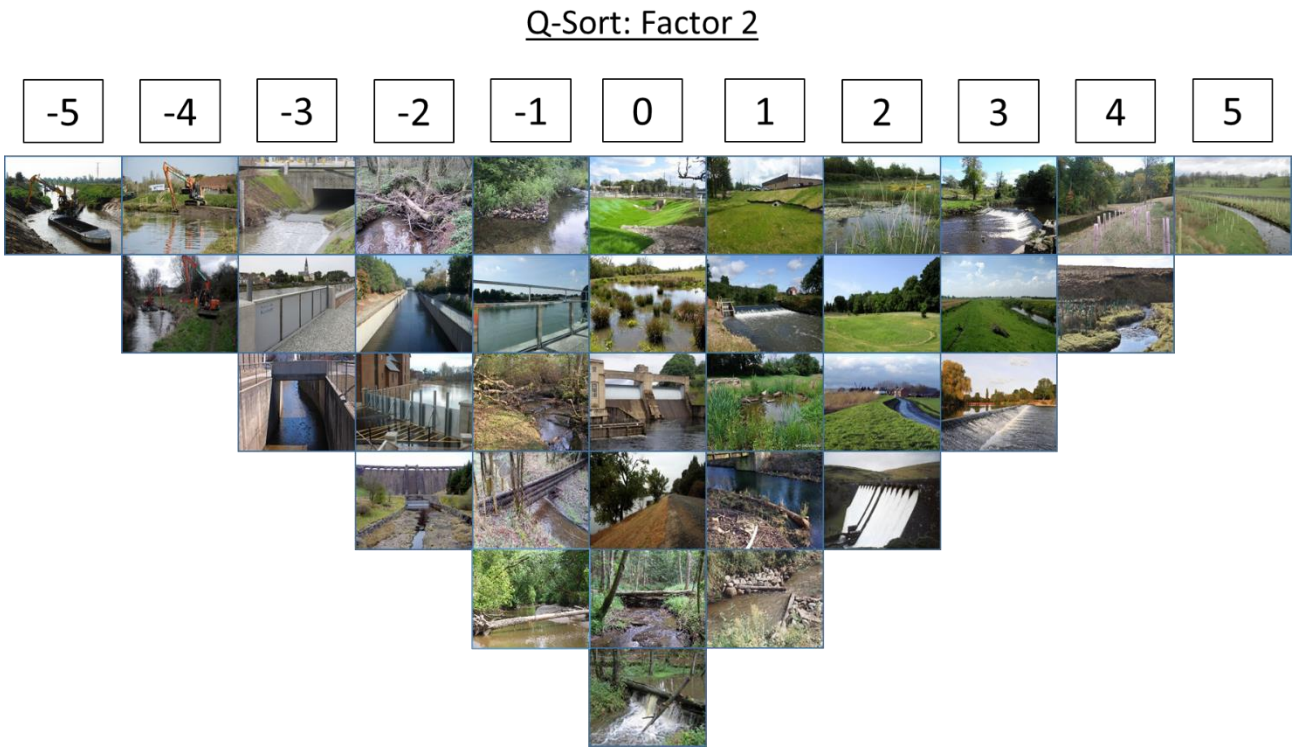

Figure 4. The Q-sort is produced by the participant sorting the photographs from worst (left) to best (right). Factor 2 Q-sort depicting a spectrum of preferences from “messy” (left) to “neat” (right).

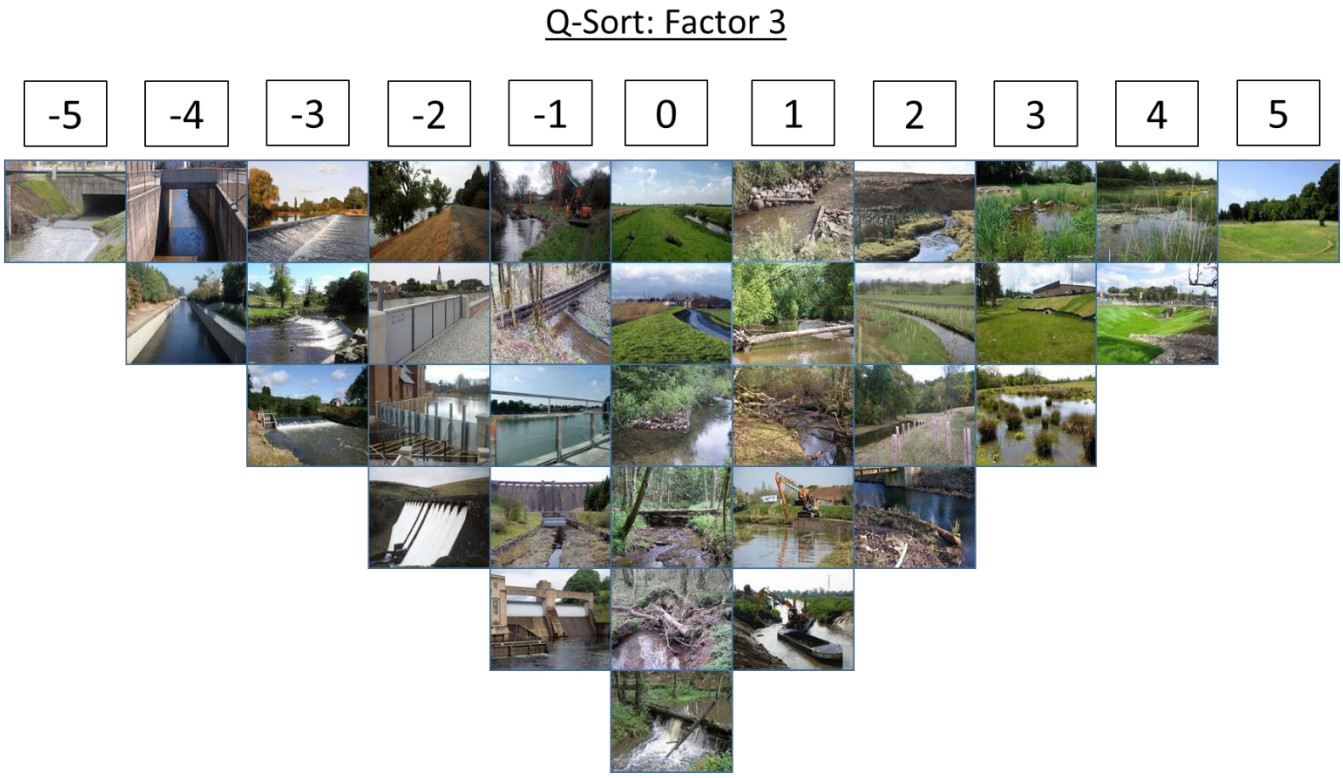

Figure 5. The Q-sort is produced by the participant sorting the photographs from worst (left) to best (right). Factor 3 Q-sort depicting a spectrum of preferences from “grey” (left) to “green” (right).