

Public Perceptions of Flood Management Schemes in the UK

By

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This thesis presents results of original research undertaken by the author. The work has been conducted in accordance with the University of Nottingham's Code of Research Conduct and Research Ethics and in accordance with the School of Geography's risk assessment procedures

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Abstract

This research investigated the public's perceptions of flood management schemes within the UK. Generally, the research considered whether there was an overall preference for natural flood management schemes or hard-engineering ('grey-infrastructure') schemes. The research explored individuals' perceptions with regard to three main characteristics; the appearance, the effectiveness and the benefits to wildlife and how these impacted on their view of water management systems. Additionally, individuals' underlying values (tied to the guiding principles in their lives) were established and compared with the individuals' perception of flood management options. This is a novel idea, as there has been little research associated with gaining an understanding and utilising the individuals' values specifically to assess rivers and flood management. Following this, the research considered whether there are other variables such as socio-demographics which would contribute to, and impact on, public perceptions. The methodology employed during this research included a questionnaire administered online, the Q-methodology and interviews conducted using the Projected Augmented Reality Model (PARM) as an external stimulus. The interviews conducted for both the PARM and the Q-method were used as supplementary, qualitative data to support the quantitative statistical analysis. The overall findings highlighted a preference for natural flood management with regard to appearance, effectiveness and benefits to wildlife. Furthermore, "Self-Transcendence", "Openness to Change" and "Conservatism" value orientations were significantly associated with flood management preferences. In contrast, "Self-Enhancement" values were found to have no relationship with the flood management schemes. Finally, individuals' preferences for flood management systems increased with higher levels of education, indicating that increasing public knowledge in this area would be likely to lead to greater support for management scheme usage.

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Content Table

Chapter 1 Introduction	01
1.1 Aims and Objectives	02
Chapter 2 Literature Review	04
2.1 River and Flood Management	04
2.2 Stakeholder and public engagement with river management schemes	05
2.3 Research into public perceptions of river management	07
2.4 Values	09
2.4.1 Understanding people's values	09
2.4.2 Values and environmental management	11
2.4.3 Values and food management	12
2.5 Q-Methodology	13
Chapter 3 Methodology	15
3.1 Methodological Overview	15
3.2 Data collection and Processing	15
3.2.1 Questionnaire	15
3.2.2 Projected Augmented Reality Model (PARM)	19
3.3 Q-Methodology	21
3.4 Qualitative Information	22
3.5 Quantitative data analysis	23

Chapter 4 Results	26
4.1 Questionnaire	26
4.1.1 Socio-Demographics	26
4.1.2 Value composition	29
4.1.3 Management preferences	33
4.1.4 Comparisons of variables to overall management ranking	35
4.2 Q-Sort	39
4.2.1 Q-sort factors	39
4.2.2 Factor 1: 'Grey-Infrastructure' – Natural	39
4.2.3 Factor 2: Messy – Neat/Organised	42
4.2.4 Factor 3: Grey – Green	44
4.3 Qualitative Response	46
4.3.1 Wetlands	46
4.3.2 'Grey-Infrastructure – Natural' Factor	47
4.3.3 'Messy-Neat/Organised' Factor	50
4.3.4 'Grey-Green'	51
4.3.5 Natural Management	51
Chapter 5 Discussion	53
5.1 Participant preferences for management approaches	53
5.1.1 Overall preference	53
5.1.2 Appearance	55
5.1.3 Effectiveness	57
5.1.4 Benefits to wildlife	60
5.1.5 Socio-Demographics	61
5.2 Values as a predictor of overall preference	63
5.3 Perception of flood management options using Q-Methodology	66

Mikaela D'souza	4342897
5.4 Management Implications	69
5.5 Limitations	71
Chapter 6 Conclusion	73
Chapter 7 References	77
Chapter 8 Appendix	98

Figures

Figure 3.1 Flowchart illustrating if respondent was from a rural or urban areas

Figure 3.2 Images showing the PARM

Figure 3.3 Images of a completed Q-Sort

Figure 3.4 Schwartz value circle

Figure 4.1 A map showing respondents location highlighting if it is a rural or urban area

Figure 4.2 Factor 1 Q-Sort as produced through the Ken-Q Analysis software

Figure 4.3 Factor 2 Q-Sort as produced through the Ken-Q Analysis software

Figure 4.4 Factor 3 Q-Sort as produced through the Ken-Q Analysis software

Figure 8.1 Boxplot comparing ratings given on the Likert scale in the questionnaire for effectiveness, appearance and benefits to wildlife and flood management type

Figure 8.2 Boxplot comparing ratings given on the Likert scale in the questionnaire for effectiveness, appearance and benefits to wildlife and flood *the response category (appearance, benefits to wildlife and effectiveness)*

Figure 8.3 Q-Sort for Factor 1 splitting the management schemes into natural management (green) and hard-engineering (grey)

Figure 8.4 Q-Sort for Factor 2 splitting the management schemes into natural management (green) and hard-engineering (grey)

Figure 8.5 Q-Sort for Factor 3 splitting the management schemes into natural management (green) and hard-engineering (grey)

Tables

Table 4.1 Socio-demographics for completed questionnaires

Table 4.2 Table showing the factor loadings from the factor analysis of the values

Table 4.3 Table showing the factor grouping of the values

Table 4.4 Table showing the value factor loading of respondents who have been flooded

Table 4.5 Average score for appearance, effectiveness and benefits to wildlife for each of the management options in the survey

Table 4.6 Average ranking overall for the management options

Table 4.7 The output from the Kruskal-Wallis H Test comparing the overall ranking of the management options and age

Table 4.8 The output from the Kruskal-Wallis H Test comparing the overall ranking of the management options and gender

Table 4.9 The output from the Kruskal-Wallis H Test comparing the overall ranking of the management options and urban/rural classification

Table 4.10 The output from the Kruskal-Wallis H Test comparing the overall ranking of the management options and occupation

Table 4.11 The output from the Kruskal-Wallis H Test comparing the overall ranking of the management options and education level

Table 4.12 Table showing spearman's rank results for values and overall management preference

Table 4.14 Socio-Demographics of the participants that align with Factor 1

Table 4.15 Socio-Demographics of the participants that align with Factor 2

Table 4.16 Socio-Demographics of the participants that align with Factor 3

Table 8.1 Factor loadings for each Q-Sort compared to the factors

Table 8.2 Ranking of each image or each factor with the highest rank in bold

1. INTRODUCTION

Flooding is a topic at the forefront of future climate change issues, illustrated through flood projections (Benson et al., 2016). Flooding remains one of the most common global natural disasters (Llasat et al., 2009) and in England alone there are around 2.4 million properties at risk of flooding (Fitton et al., 2016). Within water management, public participation has been prevalent since the 1970s mainly via consultation and public meetings (Russell, 2009) and a European Union Directive has highlighted the importance of public participation when considering and designing policies for floods (Lara et al., 2010).

There has been a shift in river management paradigms towards the implementation of more natural options of flood management (Howgate and Kenyon, 2009; Dadson et al., 2017). However, there has been little research on how the public views these new forms of management. Similarly, there is only limited work on people's views of traditional flood management Brown and Damery (2002). Therefore, there needs to be more work examining public perceptions of newer flood management schemes, as well as those that have been around for decades.

There has been a variety of research that has investigated the public's perceptions of rivers (House and Fordham 1997; Junker and Bucheker, 2008; Zhao et al., 2017); however, the present research will focus specifically on flood management methods. It is essential to understand the public's preferences to inform success criteria for flood management schemes. If a scheme is supported by the public, they typically feel safer Buijs (2009). Over the last 30 years there has been an increase in stakeholder engagement in river management, and an increase in the level at which the public is involved in water related issues (Orr et al., 2007). This has been at least partially due to the integration of stakeholder engagement into legislation such as "The European Water Framework

Directive” which is an initiative to manage rivers within the context of the whole catchment and in a more integrated way (European Commission, 2019). By understanding what the public wants and acting on it, there is a greater likelihood of gaining their support for implementation and future management of the scheme.

1.1 Aims and Objectives

This research project will investigate whether there is a difference in the public's preferences between natural flood management and hard-engineering (also referred to as 'grey-infrastructure'). There will be a particular focus on individuals' values to see whether these values influence their preference regarding the choice of different forms of flood management. To ascertain individuals' values, Stern et al.'s (1998) interpretation of Schwartz's (1992) theory of basic values will be used. There has been substantial research exploring individuals' values (Stern et al., 1998; Dietz et al., 2002; Dietz et al., 2005); however, none of these studies considered if an individual's underlying values influence their perceptions of rivers or flood management. In addition to values, preferences will be investigated with an emphasis on the appearance, benefits to wildlife and effectiveness of various flood management schemes. This research does not aim to identify whether one characteristic is more important than another, but instead investigates what drives individuals' overall perception of flood management schemes.

Specifically, this project aims to investigate perceptions of flood management schemes in the UK. It will achieve this by achieving the following objectives:

1. To identify whether individuals' perceptions of flood management vary according to scheme characteristics including appearance, benefits to wildlife and effectiveness.

2. To assess whether perceptions of flood management schemes are influenced by an individual's values.
3. To explore the possibility that other variables, such as age, education level and career type, may also influence people's perceptions with regard to flood management.
4. To briefly explore the implications for river management associated with the findings of this research.

2. LITERATURE REVIEW

2.1 River and Flood Management

As a result of climate change and sea-level rise, flooding is an increasing threat and remains one of the deadliest hazards in the UK (Brown and Damery, 2002) and globally (Hoekstra, 2006 and Kundzewicz et al., 2014). Therefore, it is necessary to bring flooding to the forefront of government and general public awareness, and to use that awareness to create sustainable and successful management actions. Throughout history, human activity has modified rivers and streams, resulting in contemporary rivers having substantially different forms, processes and dynamics than pre-disturbance equivalent states (Vought and Lacoursiere, 2010). The legacy of human interference has decreased resilience to flooding, which has historically been managed predominately through hard engineering methods. However, the sustainability of this approach in the context of future climate change has been questioned (e.g. Johnson et al. 2019). In response to the flaws of hard engineering approaches, there has been a move towards more natural interventions for river and flood management over the past three decades (Howgate and Kenyon, 2009).

Over-engineering of rivers in the past has led to their degradation through time. In these cases, it is desirable to restore them back towards a more natural state, which can support more biodiverse and resilient ecological communities (Penning-Rowsell and Burgees, 1997; Tunstall et al., 2000). According to the Environment Agency (2010), green infrastructure schemes are increasingly acknowledged as more acceptable than grey infrastructure solutions, in both the academic and public domain. As a result of past degradation and increased public and political concern for conservation, water management is becoming more environmentally focussed than previously (Fordham et al., 1991) and now focuses holistically, on the entire catchment (Werrity, 2006). One result of this is a shift in perspective from “flood defence” to “flood risk management”

(Howgate and Kenyon, 2009; McEwen et al., 2017). For example, there is a drive to providing rivers with more space to store floodwaters on floodplains and, there is now an expectation, sometimes by law, to combine flood protection measures with ecological rehabilitation of river corridors (Junker and Buchecker, 2008).

2.2. Stakeholder and public engagement with river management schemes

Water quality awareness and a sense of personal responsibility have increased over the past three decades, in parallel to the move from grey to green infrastructure in river management (Gao et al., 2018). For example, de Groot (2012) documents a policy shift in Western Europe from dike reinforcement to a more sustainable approach where the river was provided with more marginal space to move and flood. In the work of de Groot (2012) public respondents were asked if each management scheme was good or bad, safe or unsafe and, natural or unnatural. The results showed that 65.7% of individuals preferred the 'Room for River' style in comparison to dike reinforcement (de Groot, 2012). In addition, the public felt the 'Room for River' strategy was safer and more natural than dike reinforcement (de Groot, 2012).

Other examples of rural land management include implementing measures such as wetland restoration, afforestation, and less intensive agricultural practices, which help to reduce flooding by slowing water run-off and increasing storage capacity (Rouillard et al., 2014). Rouillard et al. (2014) found that using rural land to reduce flood risk is being proposed by many governments but, this methodology is often opposed by landowners. Therefore, cooperation between landowners and communities for successful natural flood management is crucial (Howgate and Kenyon, 2009).

Although there has been a shift towards more natural management approaches, grey infrastructure is still highly valued and is often still the most appropriate course of action. In the 1960s and 70s, there was a concern from river engineers that the public may deem 'softer' engineering as being ineffective for flood protection relative to hard engineering (Tunstall et al., 2000). The extent to which this is still the case, and the complexities of public perceptions are not well understood. For example, a flood event in the Kander Valley, Switzerland was blamed on ecological enhancement measures by residents, resulting in a loss of confidence in these management schemes (Buchecker, 2016). Therefore, it is necessary to understand what influences individual preferences towards management schemes, particularly in communities proximate to green infrastructure initiatives and where there is a lack of direct funding from governments (Howgate and Kenyon, 2009).

Stakeholder engagement is key to successful and sustainable flood management. Over the years, stakeholder engagement has become more recognised and important to gaining funding (White et al., 2010; Maynard, 2013; Thaler and Levin-Keital, 2016; Megdal et al., 2017). It can also improve the efficiency of water management (Megdal et al., 2017). Stakeholder engagement is used to address issues and develop solutions together (*ibid*). In recent years, flood management has taken a socio-technical turn, moving from a focus on only technical aspects of planning towards the incorporation of more social aspects of flood management (Nye et al., 2011). By understanding what is needed from individuals local to where schemes are to be implemented, river managers can gain an understanding of the river at a deeper level, enabling flood management schemes to provide multiple benefits. The success of any flood management scheme is dependent on the awareness of local stakeholders including both local citizens and local administrative units (Thaler and Levin-Keital, 2015; Megdal et al., 2017). Indeed, allowing for more engagement with the public increases the transfer of knowledge and

understanding of the catchment (Maynard, 2013). However, engaging stakeholders and publics with decisions around flooding has challenges. In particular, flood events are not frequent occurrences and individuals who have been impacted by flooding in the past can become complacent or forget the severity of impacts, and thus the importance of the implementation of flood management (Tseng and Penning-Roswell, 2012).

2.3. Research into public perceptions of river management

Public perceptions are a key criterion when assessing flood mitigation techniques as public opinion can influence policy and the implementation of schemes. Having knowledge of public perceptions of flood management is therefore considered key to their success and acceptance by many researchers (Miller and Hobbs, 2007; Howgate and Kenyon, 2009; Mehring et al., 2018; Ruiz-Villanueva et al., 2018). There is an ongoing debate as to how investments should be spent on flood defences and the extent that they should reflect the preference of local residents (Benson et al., 2016). It has been noted that it is important to consider public viewpoints throughout all stages of flood mitigation and the management of rivers, including the planning, design, implementation and the ongoing maintenance of schemes (House and Sangster 1991).

Junker and Buchecker (2008) suggest that project planners and landscape planning experts should consider reducing flood risk and ecological rehabilitation as their primary goals. However, it is necessary to understand whether these goals are in line with public wishes as, if not, it could cause delay in, or failure of the implementation of flood management options (Ledox, et al., 2005). In order to implement ecosystem restoration programmes (Alam, 2011) and flood risk management (Everett et al., 2018) it is critical to have an understanding of public perceptions, particularly those of local residents and landowners (Rouillard et al., 2014). In addition, interacting and communicating with the public at an early stage

can result in enhanced community support, which in turn can reduce the chance of potential conflicts between stakeholders (Le Lay et al., 2013).

Penning-Rowsell and Burgees (1997) found that riverine environments have different meanings to different groups and that these are deeply embedded within the individual's culture. People's perceptions of flood management also differ according to whether they have been previously flooded or not, associated with an increased fear of flooding (Groot, 2012). Other areas that influence perception are the level of knowledge and understanding with regards to water management schemes and thus, bridging the gap between scientific and public knowledge is important (Benson et al. 2016).

Much research has been carried out on general perceptions of rivers. For example, management can be judged on different criteria, including recreational use, wildlife benefits (Tunstall et al., 2000; Westling et al., 2014), scenic beauty, flora and fauna, naturalness and cleanliness (Westling et al., 2014). Research has also found a link between beliefs about nature and support for river restoration (Connelly et al., 2002; Groot and De Groot, 2009). Fordham et al. (1991) carried out interviews with 193 residents living along the River Thames, examining people's preference concerning proposed flood alleviation schemes that were likely to impact the environment. The outcome was that people valued bridges, maintaining right of way, and that appearance was high on the list of individuals' preferences. Buijs (2009) investigated what the public perceived as the ideal river environment using questionnaires and open interviews. The results indicated that scenic beauty was preferred, and the floodplain should be well-kept.

Le Lay et al. (2013) noted that it is important to understand how local stakeholders perceive a river channel in order to better evaluate whether they will support proposed braided channel restoration projects. They looked into how braided rivers are perceived by different social groups in

the area. 127 people were surveyed using a photo-questionnaire with 10 photographs depicting different riverscapes. Participants were asked to score each photograph in terms of aesthetic value, beneficial use and river management needs. The results found that perception differed in accordance with the individual's interests but that gravel bars were consistently perceived as less aesthetically pleasing.

Perceptions of riverine environments differ across age groups as demonstrated by Yamashita (2002). This research explored adults' and children's perception and evaluation of water in the Japanese landscape. They asked residents to take pictures of their environment and record their description, finding that adults highlighted more mid- to long-distance elements and dynamic aspects of water. In contrast, pre-pubertal children indicated that planners should focus more on short-distance elements including water, and especially on its quality. This was hypothesised to be because children are shorter, so they are closer to the water, or that children may have stepped closer to the water as this may have been considered to be more fun.

2.4. Values

2.4.1. Understanding people's values

Values and attitudes have recently gained attention as a key component of ecological management and conservation (Ives and Kendal, 2014).

People's values broadly state what they view as being either more or less desirable (Schwartz et al., 2000). There are two main types of values: underlying values and assigned values. Underlying values are transitional goals that serve as a guiding principles in people's lives help shape peoples' judgments of the world, whereas assigned values are those that give an estimated worth to a place or entity (Ives and Kendal, 2014).

Values may be important for understanding how people develop a

relationship with the environment (Dietz et al., 2005); however, environmental management decisions do not typically account for values; rather, the predominant focus is given to the technical aspect of environmental management (Ives and Kendal, 2014).

Values are important as they help us to make decisions and choices (Dietz et al., 2005). Attitudes differ from values as they encompass the likes and dislikes of individuals and, consequently, tend to be focused on evaluations of a specific object or situation (Ives and Kendal, 2014). Values are unlikely to change even when presented with new information whereas attitudes are more readily influenced by situational factors and external inputs (Stern et al., 1995). Values can influence beliefs about consequences and can impact attitudes and behaviour (Stern and Dietz, 1994). They are shaped and embedded via pre-adult socialisation and are key to a person's identity (Gatersleben et al., 2014). Values are not mutually exclusive; an individual may hold several orientations to a certain degree; however, they do differ between individuals, social structure and cultures (Stern and Dietz, 1994). Differences can also emerge within values as a result of different environmental conditions and evolutionary processes (Heine and Norenzayan, 2006). In order to influence values, efforts need to be made to implement long-term education programmes (Martin and Czellar, 2017).

Stern's et al. (1998) interpretation of Schwartz (1992) values scale indicates that major clusters of values include Self-Transcendence, Self-Enhancement, Openness to Change and Conservation (or traditional) values. Sub-scales are used within Self-Transcendence to distinguish between altruistic and biospheric value sets. Corner et al. (2014) and Stern et al. (1998) suggested that the Altruistic and Biospheric values are closely linked with Schwartz's Self-Transcendence whilst Egoistic values are linked to the Self-Enhancement cluster. In the context of environmental applications, Egoistic values might be expressed via individuals wanting to protect areas of the environment which have a direct impact on

themselves, or not wanting to protect the environment if it is at an expense to that individual (Stern and Dietz, 1994). Altruistic and Biospheric values are more closely related and can be expressed in environmentally friendly actions for the good of other people or the environment itself.

2.4.2. Values and environmental management

Stakeholder engagement is key to current river management, but current decision-making frameworks are dated, which has limited its success (Blackstock and Richards, 2007). Using a new approach that incorporates 'values' would be novel and could lead to greater success through aligning messages with a plurality of value orientations. Despite the potential benefits of a values-based approach to increase engagement with stakeholders, it would be challenging in practice as people often hold conflicting values (Ives and Kendal, 2014).

Research on how values can shape engagement with environmental issues is well established (Corner et al., 2014). Individuals' willingness to undertake pro-environmental action is a function of values (Stern et al., 1995; Stern et al., 1998). It has been found that environmental concern can be associated with three classes of value objects: other people, non-human objects and the self (Stern and Dietz, 1994). Values are often discussed with a focus on how they can develop a more sustainable relationship with the environment. Many theories have made links between values and pro-environmental behaviour. The values-belief-norms (VBN) is a theory of environmental concern and behaviour, it puts an emphasis on the links between values and decisions about the environment (Dietz et al., 2005). Additionally, the Theory of Planned Behaviour suggests when people have a positive attitude towards the environment, it is more likely to encourage pro-environmental behaviour (Steg and Vlek, 2009).

A significant amount of research has been carried out on the roles of values in environmental management. Ford et al. (2009) illustrated how values can be good predictors when it comes to people's judgment on management decisions, which was particularly the case with work on clear-felling in native forests. Furthermore, there has been a growing interest regarding how values shape public engagement with issues such as the risks of climate change. Kaltenborn and Bjerke (2002) looked at the association between environmental values and landscape perceptions. It was found that ecocentrics (those who value nature for what it is [Thompson and Barton, 1994]) have a preference for wildlands with water and cultural landscapes. Furthermore, people with anthropocentric values (individuals who value nature due to its physical or material benefits for people) (Thompson and Barton, 1994) preferred farm environments.

2.4.3. Values and flood management

The significance of people's values in flood management has not been widely researched; however, there are some studies that have explored values and perceptions of river management. Morris-Oswald and Sinclair (2005) investigated values with regard to flood risk management in two Canadian communities. They noted that some values act as a constraint on management, especially where proposals focus on the implementation of sustainable floodplain management practices. Furthermore, Myatt et al. (2003) investigated the drivers for public acceptance to a managed coastal realignment scheme. It was found that there were two main barriers to acceptance of this scheme. The first was a lack of public confidence in the Environment Agency, and the second was a lack of understanding of coastal defences and managed realignment issues. In order to address these issues, the research highlighted that local community engagement activities can be useful in addressing these inhibitors.

2.5 Q-Methodology

A useful method for exploring and illustrating people's viewpoints is the Q-methodology, devised and developed in the 1930s by William Stephenson (McKeown and Thomas, 1988). It allows participants to illustrate their viewpoints in a response to a sample set of stimuli, which can be statements or images (Herrington and Coogan, 2011). Within landscape perception, the use of photographs remains one of the most common methodologies and Q-Methodology gives the opportunity to present a large number of situations (Fairweather and Swaffield, 2001). Q-methodology is commonly used with statements; however photographs are regarded as a better stimuli to reach out to as many people as possible, including those of any age and education level (Milcu et al., 2014).

This methodology 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), allowing a more interpretative and exploratory analysis. The process helps draw out the underlying attitudes and values behind the subject choices. The aim of this method is to compare the viewpoints of individuals, not to establish the viewpoints of the whole population, instead helping to identify clusters in relation to a topic (Milcu et al., 2014). The groupings of individuals occur through the ranking of the images, which gives a visual representation of an individual's viewpoint, allowing identification of individuals that share a similar viewpoint (Dewar et al., 2007). This approach considers the whole pattern of responses, the aim being not to look at patterns amongst people but instead being to compare different individual viewpoints in relation to a reference point (Herrington and Coogan, 2011).

The Q-methodology has been used for exploring perceptions of riverine environments only infrequently; however, it has been used for other environmental research and, in particular, landscape perception and cultural service. Fairweather and Swaffield (2002; 2003) carried out two

research projects in New Zealand focused on tourist experiences. First, they looked at local and visitor experience in a town, investigating the importance of different landscapes using 30 photographs on a scale going from -4 to +4 (Fairweather and Swafford, 2002). Second, they expanded on this work with three case studies investigating visitor experience in natural and modified landscapes. Photographs illustrated a landscape setting, or a visitor activity and Q-sorts were completed by local people, residents from overseas, and individuals who were just visiting New Zealand (Fairweather and Swafford, 2003). Finally, Gauger and Wyckoff (1973) implemented a Q-methodology in relation to water resources using 44 photographs depicting water development projects. It was noted that projects dominated by nature were preferred by respondents and that there was a negative association for water projects that were incomplete or appeared polluted. It was hypothesised that both naturalness and stages of development were seen to implicate the aesthetic value of projects.

3. METHODOLOGY

3.1. Methodological overview

The methodology was broadly split into two sections: 1. data collection and processing, and 2. data analysis. Three methods were used to investigate preferences for flood management options with regard to their appearance, benefits to wildlife and effectiveness. These methods were a questionnaire, a Projected Augmented Reality Model (PARM), and the Q-Methodology. Additionally, the Q-methodology was used to understand the individuals' general perceptions of management schemes and which variables were considered when deciding the best and worst flood management options. All three methods were used to establish whether natural flood management or 'grey infrastructure' was preferred. The information from all three methods provided quantitative data, which was statistically analysed, and qualitative information, which was used to aid interpretation of the quantitative results.

3.2. Data collection and Processing

3.2.1 Questionnaire

To address objectives 1, 2 and 3, data on individuals' preferences for flood management schemes and their underlying values were gathered via an online questionnaire (Appendix 1). The questionnaire comprised three sections. The first collected general information about the person who filled in the questionnaire, including: age, occupation, the highest level of education, gender and postcode. A binary question was also asked to establish whether the individual had experienced flooding in the past, or within their current property. This information is potentially important to understanding the potential reasoning associated with individual choices.

The second section of the questionnaire assessed the individuals' values. This was carried out using the interpretation of Schwartz's values by Stern et al. (1998). Schwartz's original scale contained 56 items, which would be too time-consuming and effort intensive for this questionnaire. Instead, Stern et al.'s (1998) shorter version was used, which has been found to still have good reliability and predictive success (e.g. Corner et al., 2014). A 7-point Likert scale was used to measure the importance of each value as a 'guiding principle' in respondents' lives.

The final section assessed the beliefs and preferences of the individuals regarding flood management schemes. Six images were shown, representing a spectrum between 'natural' management (tree planting, wetlands, and wooden dams) and hard-engineering (dams, dredging, and weirs), to better understand each individual's preference. For each of the images the individual rated: (i) effectiveness for managing flooding, (ii) appearance and, (iii) benefits for ecology/nature/ 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) overall, as a management scheme for flood control. Finally, they were asked to give a short justification for their overall ranking.

The survey was produced online using the survey platform Qualtrics. It was distributed via social media, such as Facebook and Twitter, including on the JBA Trust twitter page. It was also posted on the project website for 'Achieving Urban Flood Resilience in an Uncertain Future' project (University of Nottingham, 2019).

Respondents' postcodes were used to assess whether they were from an urban or rural environment. Figure 3.1 demonstrates the process for the classification of the respondent's location, which involved converting postcodes to XY coordinates and adding the points to ArcMap. GIS shapefiles for Local Enterprise Partnerships (LEPs) showing the 2011 Rural Urban Classification were then downloaded (DEFRA, 2014) and

imported into ArcMap. The two data sets were then collated and the attribute table was converted into an excel spreadsheet, with each postcode being classified as either rural or urban, so that the results were ready for statistical analysis in SPSS.

The classification only covered England, but completed surveys were also received from people residing in Scotland. For these respondents, the Scottish Government Urban Rural Classification (Scottish Government, 2016) was used to define their rural or urban status. The two-fold classification was used from the document to identify whether individuals lived in urban or rural environments.

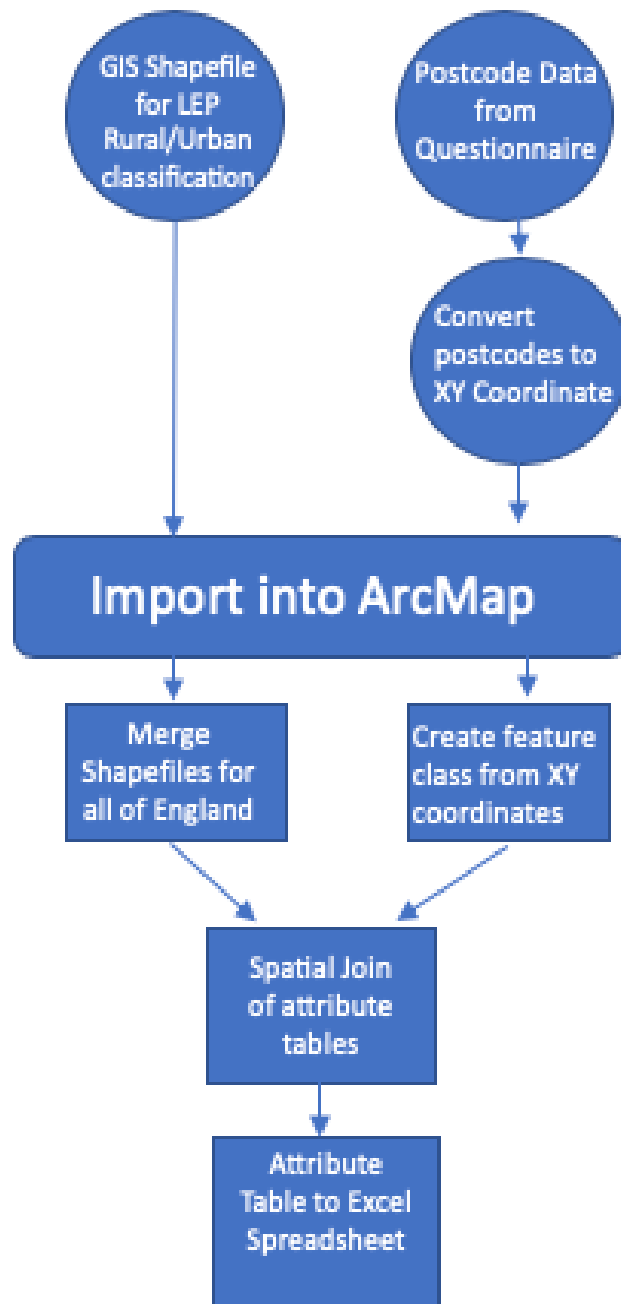


Figure 3.1 Flowchart to establish whether each respondent was from a rural or urban neighborhood

3.2.2 Projected Augmented Reality Model (PARM)

For this investigation, semi-structured interviews were conducted, with individuals being asked questions while using the PARM as a visual aid (Preistnall et al., 2012; Figure 3.2). This method was employed using a novel 3D model tool which had the functionality of gaining the attention of individuals, making them more willing to participate in the research. It is also a method that is increasingly being employed to gain a better understanding of the public's viewpoint and to increase their engagement on different issues (Priestnall et al., 2012). The model was useful for people who have not experienced the event first hand because it visualised just how devastating flood events can be. The PARM allows a story to be told and, as it is highly interactive, this means that individuals are more engaged with the topic, which encourages them to provide more thorough responses (Tlhoale et al., 2014).

Image A



Image B

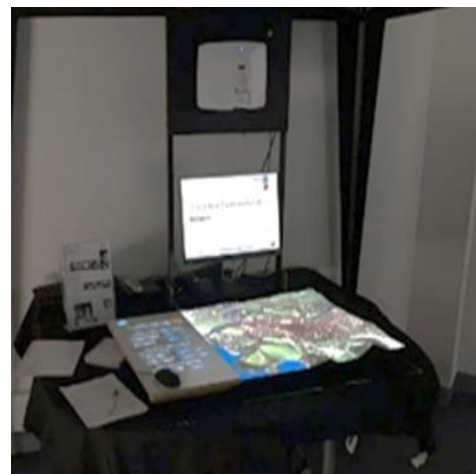


Figure 3.2 Images of the Projected Augmented Reality Model (PARM).

Image A is an example of a participant being interviewed using the model. Image B is the model itself.

The PARM was placed in the Nottingham Lakeside Art Gallery and individuals were approached and asked if they would like to participate in the study. Nottingham Lakeside Arts is adjacent to a public park and near to public transport links. The gallery is also open to the public and has a café. The PARM was set up in a meeting room at the front of the building to facilitate the approach to people passing by. It was chosen as a site because of its visibility and potential to attract a breadth of respondents. Furthermore, individuals were interviewed at the School of Geography (University of Nottingham) at a prospective student event. The individuals were A-Level students (aged between 16-18) from a Nottingham school.

The PARM was based on the Keswick area, using topographic data and aerial imagery. However, the flood interventions and scenarios projected on the PARM were theoretical and are not specific to Keswick. During the interview, each participant was shown the history of Keswick (land changes), followed by data from a flooding event, highlighting the areas flooded on the map.

The questions respondents were asked were associated with the characteristics that they selected with regard to preference to flood management options (appearance, effectiveness and benefits to wildlife). As such, interviews progressed differently depending on the respondent's interaction with the PARM, though interviews particularly focused on drawing out some key information from each respondent. Initially, questions were asked regarding whether the individual's property had ever been flooded and whether they had ever been to the Keswick area, as these experiences could influence their answers. Following this, water management options were shown, including wetland creation, dams, a detention basin, a weir, tree planting, levees and woody deflectors. An image of each type of scheme was shown and the respondent was asked whether they recognised that type of management asset. If not, they were provided with a definition of that asset type. A discussion was started,

initially to understand what they generally considered to be best practice and which characteristics they were drawn toward.

Following this, for each of the options, questions were asked to gain insight into the individual's perception about the appearance (aesthetics), the potential benefit to ecology, and how effective they thought each option was, if they did not refer to these issues in the general discussion.

Qualitative responses provided further nuance and insight into themes explored in the Q-Sort and online surveys.

3.3.3 Q-Methodology

The Q-method was employed to explore interactively how people perceive visual representations of flood management schemes (Figure 3.3). The sampling technique used for the PARM interviews was also used for this study, with individuals approached at Nottingham Lakeside Arts and in the School of Geography, University of Nottingham. Thirty-six images showing twelve different management options were used, with three different images for each option. For each of the management options, at least one image depicted a 'natural' approach (e.g. wetland creation, large woody debris, tree planting, detention basins, flow deflectors and leaking dams), while at least one other image depicted a hard engineering approach (e.g. dam, weir, dredging, flood wall, channelisation, and levees) (Appendix 2). The 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 first placed the images into three piles, representing the best, neutral, and the worst overall options for flood management. The scale was relative, not absolute. Therefore, even if the 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 photographs had been assigned to the piles, participants were asked to order the images on a grid. 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 happy with all their choices.

Finally, participants were asked to give reasons for their choices for the best and worst option. The interviews were then transcribed for use as supplementary, qualitative information, adding context to quantitative analysis of data. A photographic record was made of each individual's preferences, and this was translated into excel using the definition names, to allow for later analysis.



Figure 3.3 An image of a completed Q-Sort as collected at Lakeside Arts

3.4. Qualitative information

Substantial quantities of qualitative information were derived from interviews carried out during the Q-Methodology and PARM investigations. These interviews followed a semi-structured format. The interview was conversation led but steered towards the general questions outlined in Appendix 7. There was the potential to qualitatively analyse this

information but, given logistical and time constraints, this was not possible. Instead, this information was transcribed and stored for potential future coding and qualitative analysis. Here, this qualitative information has been used to support the quantitative data analysis, adding insights and providing greater depth to the interpretation of results. To achieve this, transcripts of interviews and open questions on the questionnaire were sorted based on the respondents' overall view of river management. Quotes from transcripts were then selected from grouped responses to support quantitative analysis, with the aim of offering potential explanations for the statistical findings.

3.5. Quantitative data analysis

To examine the structure of underlying value items from the questionnaire data, a factor analysis was carried out *as per* Stern et al. (1998). In order to group the values together, the factor loading had to be over ± 0.4 , which is often used and generally reliable 'rule of thumb' when using factor analysis (Samuels, 2016). The factor analysis employed a principle component extraction method, with Varimax with Kaiser Factor Rotation (Brace et al., 2012). The number of factors was confirmed by first analysing the scree plot to identify components with eigenvalues of more than one. In order to establish the categories and best fit of the factors, Schwartz circle was used as an aid (Figure 3.4). The Schwartz circumplex model demonstrates how the different values are related to one another and has been used in numerous studies (e.g. Hinz et al., 2005; Perrinjaquet et al., 2007). The circle is arranged into different sectors, which highlights broad values. Stern et al. (1998) based the typology of values on Schwartz's model. Factor loadings from the analysis did not align with Stern or Schwartz's typologies. As such, three of the items were removed including item 2: "A world at peace, free of war and conflict" and 6: "Equality, equal justice for all", which were both altruistic values, and item 12: "Self-discipline, self-restraint, resistance to temptation" a Conservatism value. In SPSS two,

three and four-factor solutions were again calculated. 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).

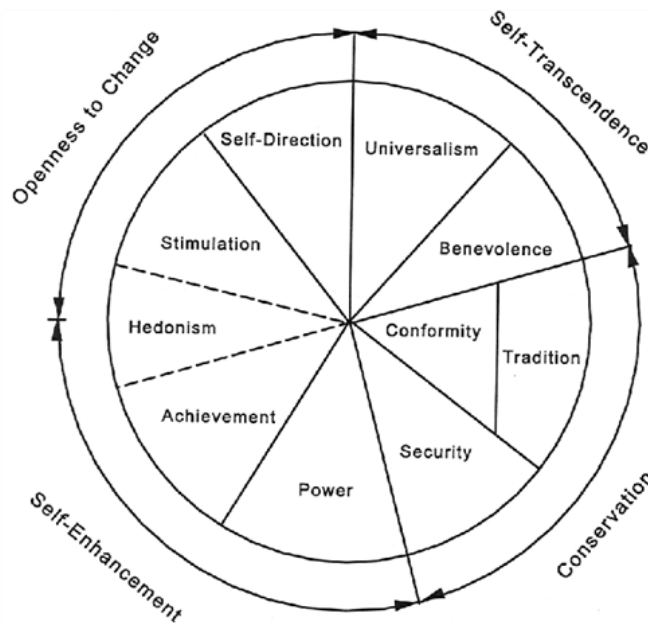


Figure 3.4 The Schwartz Value Circle

To establish which value orientations most strongly related to overall flood 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. A Spearman's Rank Correlation was determined to be most appropriate for this given the non-parametric nature of the data.

The Kruskal-Wallis test was chosen as the most appropriate statistical test to apply when comparing ordinal Likert-scale response data across different categories (Hinton et al., 2014). The first Kruskal-Wallis test was performed to compare the ratings scores given on the Likert scale, to the

response category (effectiveness, appearance and benefits to wildlife). The second test was performed to compare the ratings given by respondents to the type of management scheme.

Finally, from the survey data, a Kruskal-Wallis H Test was performed comparing the socio-demographic data and the overall rankings of the management schemes. The socio-demographics included age, education level, occupation, gender and following the classification of postcodes; urban or rural were inputted into SPSS and a Kruskal-Wallis H Test was performed.

To investigate the preference for management options in the Q-Sorts, a factor analysis was performed on photograph scores. The results were uploaded to the Ken-Q Analysis software package, as used by Laden et al. (2018) and Porter et al. (2017). Eight factors were extracted using Principle Component Analysis and three factors were selected for rotation, with a Varimax rotation applied (Watts and Stenner, 2005). The factors produced using the image names were converted back to images using PowerPoint. These results were also compared to the survey data results to identify whether the appearance, benefits to wildlife or effectiveness averages could account for any of the patterns that had emerged.

A secondary version of each factor produced from the analysis was created that highlighted the placement of images depending on whether they were natural or hard-engineered. Furthermore, for each respondent, a loading score was calculated for each factor, in essence rating the degree to which that individual type is like that factor (Webler and Tuler, 2006). The analysis can pull out one prevalent factor or produces several factors. From the output of the Q-sort, each image was ranked, and thus information was gained regarding which factor the image had scored the highest on. Additionally, for each respondent the socio-demographics information was recorded to see if that explained why individuals related to each factor.

4. RESULTS

4.1 Questionnaire

4.1.1 Socio-Demographics

In total, 170 individuals participated in the survey, of which 151 completed all sections of the questionnaire (Table 4.1). Only the fully completed responses were considered for analysis. Similar numbers of responses were received from females and males ($n = 78$ females and $n = 73$ males), with a wide range of ages completing the survey (16 to 65+ years old). The majority of individuals had a first degree (39.7%) or higher degree (29.8%), indicating that respondents generally had high levels of education. The most common occupation was in 'life, physical, and social science occupations' (23.2%), with a further 20.5% of respondents considering themselves to be students. Geographically, respondents were spread through England and Scotland, but with a more living in urban environments (80.1%) than in rural environments (19.9%).

Table 4.1 Socio-demographics including occupation, education level, age and gender for the completed surveys

Socio-Demographics		Count of Responses
Occupation	Student	31
	Computer and Mathematical Occupations	4
	Sales and Related Occupation	4
	Installation, Maintenance, and Repair Occupation	1
	Educational Instruction and Library Occupations	7
	Transportation and Material Moving Occupations	2
	Building and Grounds Cleaning and Maintenance Occupations	1
	Retired	8
	Office and Administrative Support Occupations	2
	Life, Physical, and Social Science Occupations	35
	Business and Financial Operations Occupation	10
	Healthcare Support Occupations	2
	Management Occupations	5
	Food Preparation and Serving Related Occupations	2
	Personal Care and Service Occupations	2
	Unemployed	4
	Arts, Design, Entertainment, Sports, and Media Occupations	14
	Architecture and Engineering Occupations	10
	Healthcare Practitioners and Technical Occupations	3
	Construction and Extraction Occupations	1
	Community and Social Service Occupations	1
	Production Occupations	2
Education Level	A-Levels or vocational equivalent	17
	First Degree (BA/BSc)	60
	GCSE/O-Levels/BTEC or equivalent	14
	Higher Degree (MA/MSc/PhD etc.)	45
	None	1
	Other	8
	Prefer not to say	1
Age	Vocational Qualification	5
	16-24	47
	25-34	31
	35-44	23
	45-54	25
	55-64	19
Gender	65+	6
	Female	78
	Male	73

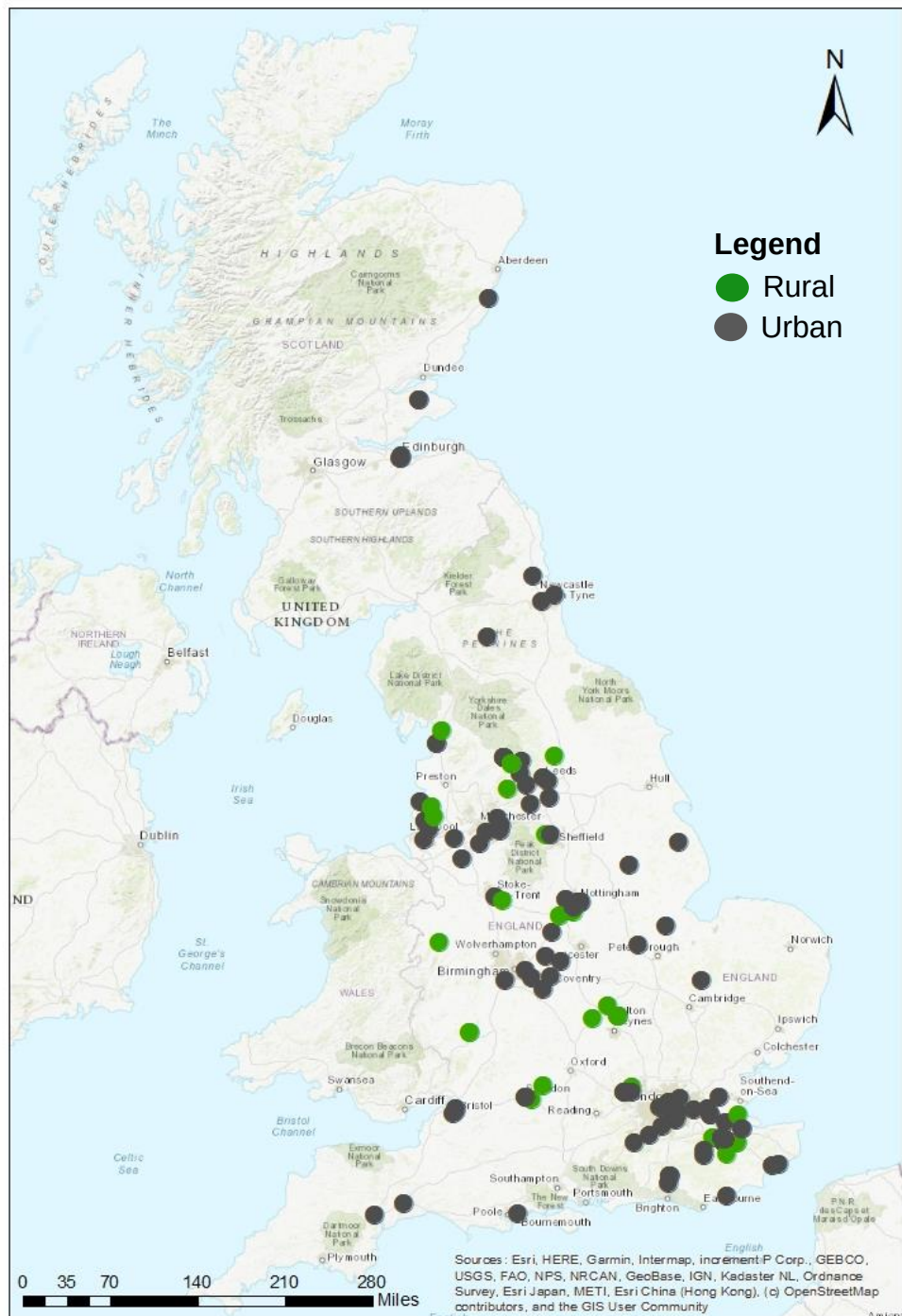


Figure 4.1 A map showing respondents place of residence, with marker colour distinguishing between rural or urban areas

4.1.2 Value composition

Individuals' values were analysed using a factor analysis to establish the factor groupings. In order to group together the values, the factor loading had to be over ± 0.4 , which is considered to be a reliable 'rule of thumb' when using factor analysis (Samuels, 2016). The calculated factor loading scores can be found in Table 4.2. The final factors were "Self-Transcendence", "Openness to Change", "Self-Enhancement" and "Conservatism" (Table 4.3).

Factor 1 'Self-Transcendence' comprised both Altruistic / Self-Transcendence values and Biospheric / Self-Transcendence values. This value orientation was strongly linked to the preservation of nature and the environment. Secondly, 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.

It was difficult to decide where to group the statement "wealth, material possessions, money" because the factor loadings were similar for factor 3 ($n = 0.608$) and factor 4 ($n = 0.521$) (Table 4.3). However, it was grouped in factor 3 as this had the stronger loading factor and the statement better matched the theory behind factor 3.

Finally, a comparison was made between individuals who stated that they had previously been flooded and the value groupings. Table 4.4 illustrates the factor loadings for each individual that had been flooded. The number highlighted in bold illustrates the value grouping each individual is orientated most towards.

Table 4.2 Table showing the factor loadings from the factor analysis of the values

Statement	Factor 1	Factor 2	Factor 3	Factor 4
"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 4.3 Table showing the factor grouping of the values

Factor	Value grouping	Statement
Factor 1: Self-Transcendence	Altruistic/Self-transcendence	"Social justice, correcting injustice, care for the weak"
	Biospheric/Self-transcendence	"Unity with nature, fitting into nature"
	Biospheric/Self-transcendence	"Respecting the earth, harmony with other species"
	Biospheric/Self-transcendence	"Protecting the environment, preserving nature"
Factor 2: Openness to Change	Openness to change	"Curious, interested in everything, exploring"
	Openness to change	"An exciting life, stimulating experiences"
	Openness to change	"A varied life, filled with challenge, novelty, and change"
Factor 3: Self-Enhancement	Self-enhancement	"Authority, the right to lead or command"
	Self-enhancement	"Influential, having an impact on people and events"
	Self-Enhancement	"Wealth, material possessions, money"
Factor 4: Conservatism	Conservation	"Honouring parents and elders, showing respect"
	Conservation	"Family security, safety for loved ones"
Items excluded	Altruistic/Self-transcendence	"A world at peace, free of war and conflict"
	Altruistic/Self-transcendence	"Equality, equal justice for all"
	Conservatism	"Self-discipline, self-restraint, resistance to temptation"

Table 4.4 Table showing the value factor loading of respondents who have been flooded

Respondent	Self-Transcendence	Openness to Change	Self-Enhancement	Conservatism
7	0.63332	-1.20677	-0.31572	-0.37772
34	0.17226	1.63304	-0.35664	-0.71003
41	0.21384	-0.91728	-1.54986	-0.16554
42	-0.68785	0.27475	-1.5136	-0.19709
55	-0.80741	0.23003	-1.48185	-0.60581
57	0.06388	-0.20742	-0.72721	-0.78997
62	-1.24213	1.37329	1.97982	-0.92592
63	1.30594	-1.61613	1.09366	0.01866
74	-1.44185	0.34395	0.14563	0.33233
79	-0.23561	-0.31439	-0.03707	-0.78999
90	-0.51346	-0.12621	0.55059	-0.07289
97	0.49295	1.3569	-0.20192	0.68676
98	0.89414	0.26593	-1.46148	-0.38195
100	-0.24987	-0.04513	-1.27154	-0.45915
103	-0.90744	1.78662	-1.26202	-1.30853
145	0.13972	-0.94702	2.39402	-0.02298
147	-0.81403	-0.00023	-1.45608	-0.66854

4.1.3 Management preferences

The management options analysis was carried out based on the variables “appearance”, “effectiveness” and “benefits to wildlife”. Initially, the average score for each of these management options was calculated (Table 4.5). A Likert scale was used to score the variables on a scale of 1 to 5, with 5 being the best and 1 the worst. For appearance, the results indicated that tree planting scored the highest out of the three categories, with an average of 4.52. This was followed by wetlands (4.40), another natural form of flood management, and then weirs (3.30) (Table 4.5). These findings illustrated that natural forms of flood management were preferred, with the exception of wooden dams. Dams and dredging were the lowest scoring variables.

Dams were considered the most effective option for flood management (3.81), closely followed by the wetlands (3.77) and then wooden dams (3.13). As with appearance, dredging scored the worst (2.87) for effectiveness, with tree planting and weirs scoring 3.07 and 3.05, respectively.

Wetlands scored the highest for benefits to wildlife (4.62), followed by tree planting and wooden dams (4.51 and 3.40, respectively). This ranking was similar to that for appearance, except that all 3 natural forms of management were at the top. The natural management options were ranked higher than the hard engineering schemes, with weirs having an average of 2.87 and dams 2.58. Once again, dredging had the lowest average score (2.16). A Kruskal-Wallis was performed on these data. This test was deemed the most appropriate for assessing differences in ordinal rating scores for categories of response type and management scheme (see Hinton et al., 2014). Both the differences between response category (i.e. effectiveness, appearance and benefits to wildlife) and differences between management types were significant ($p = 0.002$, $p < 0.0001$, respectively) (Appendix 3). The Kruskal-Wallis identified significant

differences in ratings among management types ($H = 680.0$, d.f. = 5, $p < 0.000$). Furthermore, the Kruskal-Wallis identified significant differences in ratings among the response categories ($H = 12.60$, d.f. = 2, $p < 0.000$).

Table 4.5 Average score for appearance, effectiveness and benefits to wildlife for each of the management options in the survey

	Dam	Dredging	Tree Planting	Weir	Wooden Dam	Wetlands
Appearance	2.81	2.49	4.52	3.30	3.23	4.40
Effectiveness	3.81	2.87	3.07	3.05	3.13	3.77
Wildlife Benefits	2.58	2.16	4.51	2.87	3.40	4.62

When considering the overall rankings (Table 4.6), wetlands were the most preferred management option, followed by dams. Tree planting and wooden dams were the next highest preferences. The perception of the respondents was that weirs and dredging were the worst management options. The overall rankings suggest that effectiveness is a highly important variable, as demonstrated by dams being ranked second overall. Dams scored the highest average with regards to effectiveness but scored much lower in the other categories. Wetlands were scored the best overall because it was second for both appearance and effectiveness, and top for benefits to wildlife. Tree planting came third in the overall rating because it scored low in effectiveness but, high in the other characteristics. Finally, and unsurprisingly, dredging scored the lowest in the overall ranking as it had the worst average for all the other variables.

Table 4.6 Average ranking overall for the management options

Management scheme	Ranking
Dam	2.96
Dredging	4.57
Tree Planting	3.25
Weir	4.05
Wooden Dam	3.77
Wetlands	2.39

4.1.4 Comparisons of variables to overall management ranking

A Kruskal-Wallis H test was used to compare the overall ranking to socio-demographic information of participants (see results in tables below). The overall ranking of the management options differed statistically according to age (Table 4.7), gender (Table 4.8), and urban/rural land use (Table 4.9). Although there was no statistical difference between occupation and the overall ranking, wetlands were marginally significant (Table 4.10) and wooden dams (table 4.10). Finally, for education level there was a statistical difference between dredging (table 4.11) and wetlands (Table 4.11).

Table 4.7 The output from the Kruskal-Wallis H Test comparing the overall ranking of the management options and age

	Dam	Dredging	Tree Planting	Weir	Wooden Dam	Wetlands
X ²	5.602	9.144	3.575	4.855	6.462	1.212
Df	5	5	5	5	5	5
p	0.347	0.103	0.612	0.434	0.264	0.944

Table 4.8 The output from the Kruskal-Wallis H Test comparing the overall ranking of the management options and gender

	Dam	Dredging	Tree Planting	Weir	Wooden Dam	Wetlands
X ²	0.072	0.954	0.098	2.220	0.370	0.134
Df	1	1	1	1	1	1
p	0.789	0.329	0.755	0.136	0.543	0.714

Table 4.9 The output from the Kruskal-Wallis H Test comparing the overall ranking of the management options and urban/rural classification

	Dam	Dredging	Tree Planting	Weir	Wooden Dams	Wetlands
X ²	0.304	0.588	0.807	0.769	0.057	0.241
Df	1	1	1	1	1	1
p	0.581	0.443	0.369	0.381	0.812	0.624

Table 4.10 The output from the Kruskal-Wallis H Test comparing the overall ranking of the management options and occupation

	Dam	Dredging	Tree Planting	Weir	Wooden Dam	Wetlands
X ²	17.895	25.360	22.720	20.928	30.913	31.375
df	21	21	21	21	21	21
p	0.656	0.232	0.359	0.463	0.075	0.068

Table 4.11 The output from the Kruskal-Wallis H Test comparing the overall ranking of the management options and education level

	Dam	Dredging	Tree Planting	Weir	Wooden Dam	Wetlands
X ²	7.129	20.080	10.498	10.272	10.088	20.588
Df	7	7	7	7	7	7
p	0.416	0.005	0.162	0.174	0.184	0.004

The results from the Spearman's Rank illustrate a relationship between value orientation and flood management preference. For "Self-Transcendence" there was a statistically significant positive correlation with dams ($p=0.004$), weirs ($p=0.016$), tree planting ($p=0.007$) and wetlands ($p=0.030$). Correlations with wooden dams and dredging were not statistically significant ($p = 0.836$ and $p = 0.924$, respectively) (Table 4.12).

Negative correlations between the value orientation "Self-Transcendence" and both dams and weirs were statistically significant. The fact that wooden dams, a form of natural flood management, were not statistically significant with 'Self-Transcendence' is surprising as one might expect them to be associated to 'Self-Transcendence', which is dominated by environmentally friendly actions. On the other hand, dredging was expected to be statistically insignificant with 'Self-Transcendence', as it does not align with the biospheric/self-transcendence values.

The second factor, 'Openness to Change', was only found to have a statistically significant correlation with wooden dams ($p=0.011$). Spearman's rank correlations with wetlands, dams, weirs, tree planting, and dredging were not statistically significant (Table 4.12).

There was no statistically significant correlation between the factor "Self-Enhancement" factor and any of the flood management options.

Finally, dredging ($p = 0.031$) and weirs ($p = 0.018$) both had significant, positive correlations with the "Conservatism" factor. On the other hand, wetlands had a statistically significant negative correlation with Conservatism ($p=0.009$), while tree planting and wooden dams did not have a statistically significant correlation with "Conservatism".

Table 4.12 Spearman's Rank Correlation Coefficient using Stern's Values scales that were factor analysed into 4 factors using the Varimax rotation method and principle component analysis extraction method compared to the overall ranking of each management option.

	Altruistic/Biospheric			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

4.2 Q-Sort

4.2.1. Q-sort factors

All 3 Q-sort Factors; “Grey-infrastructure - Natural”, “Messy - Neat/Organised” and “Green - Grey” were checked to identify whether any patterns had emerged. When a comparison was made between natural management and hard engineering options, there was a clear trend showing a preference for natural management (Appendix 4). When looking at the weighting of a respondents individual Q-sort to a particular Q-sort factor, respondents that have a positive correlation with the Q-sorts means that their sort was most like the q-sort being discussed. On the other hand, respondents with a negative correlation means that their Q-sort was directly opposite to the factor being discussed.

4.2.2. Factor 1: ‘Grey-Infrastructure’ – Natural

The general trend of the Q-sort for Factor 1 went from engineered/concrete at the lower end of the scale to more natural management options higher up the scale (Figure 4.2). The lowest scores for Factor 1 “Grey-Infrastructure - Natural” were associated with concrete and hard-engineering, including weirs, flood walls, channelisation, and dams. The middle range was the more ‘greener looking’ management options, which included detention basins, levees and flow deflectors. Dredging was also in the middle range. Finally, the highest scores were associated with the more “woody” structures, such as flow deflectors, leaky dams, tree planting, and large woody debris.

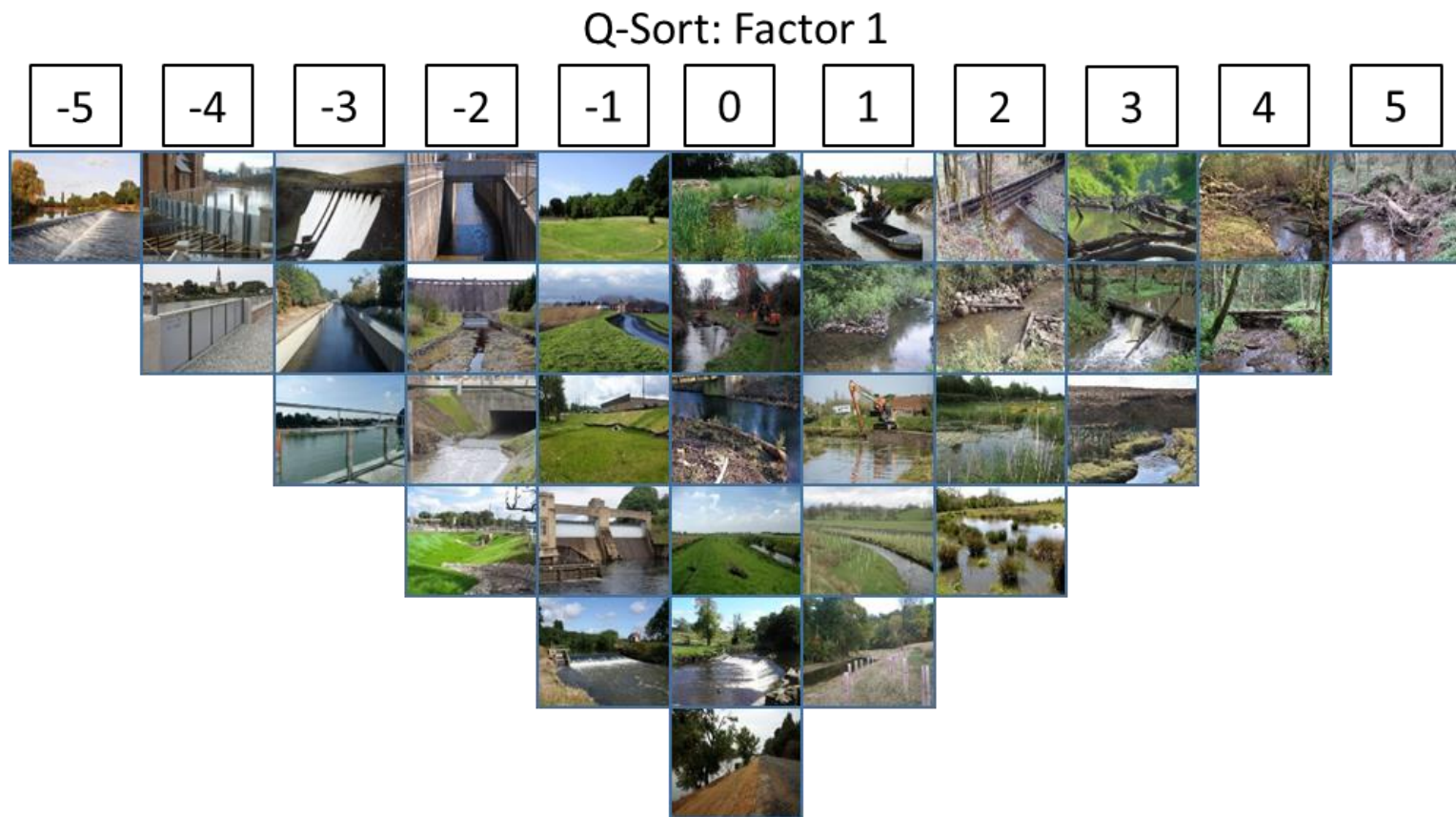


Figure 4.2 Factor 1 Q-Sort as produced through the Ken-Q Analysis software

Every participant was aligned to one of the three factors, in accordance with the factor to which their Q-sort was most similar. With respect to the individual factor loadings, six participants had their weightings closest to the “Grey- Infrastructure - Natural” factor (Appendices 5). Three participants (participants, 9, 11 and 12) had negative correlations with this factor, suggesting that these individuals ranked natural management schemes as the worst and showed a preference for engineered and concrete structures. Looking at the socio-demographics of the participants that aligned with this “Grey-Infrastructure - Natural” factor, there was a range of ages, occupations and educations levels (Table 4.14). The Grey-Infrastructure - Natural factor was male dominated, with four males and only two females.

Furthermore, every image had a ranking related to each factor (Appendix 6). Overall, it was found that Large Woody Debris, Dredging, Channelisation, Leaky Dams and Flow Deflectors had their highest rankings on the ‘Grey-Infrastructure – Natural’ factor. This was not surprising as Large Woody Debris, Leaky Dams and Flow Deflectors are all natural management schemes (Appendix 6).

Table 4.14 Socio-Demographics of the participants that align with Factor 1

Respondent	Factor Weight	Age	Occupation	Education Level	Gender
17	5.70722	55-64	Driver	GCSE/O-Levels/BTEC or equivalent	Male
6	3.78073	65+	Retired	CIPS	Male
16	2.96158	55-64	Scientist	Higher Degree (MA, MSc/PhD etc.)	Female
9	-3.84413	16-24	Student	First Degree (BA/BSc)	Male
12	-9.5036	65+	Retired	NNEB	Female
11	-10	25-34	Water Officer	Higher Degree (MA, MSc/PhD etc.)	Male

4.2.3 Factor 2: Messy – Neat/Organised

For Factor 2, the general trend of the Q-sort was a preference towards the management options that looked neat or organised (Figure 4.3). Dredging was classed as being the worst management option, which aligned with the results of the questionnaire. Tree planting was classed as the best, again matching the results of the questionnaire, as this management option ranked highly against most of the variables. For this Q-sort, there was not necessarily a straight split between natural management and hard engineering. At the lower end came floodwalls, channelisation, and large woody debris, whilst the middle section was represented by leaky dams, detention basins, and flow deflectors. Finally, wetlands, weirs and levees were placed towards the higher end of the Q-Sort, leaving tree planting as the highest ranked management scheme.

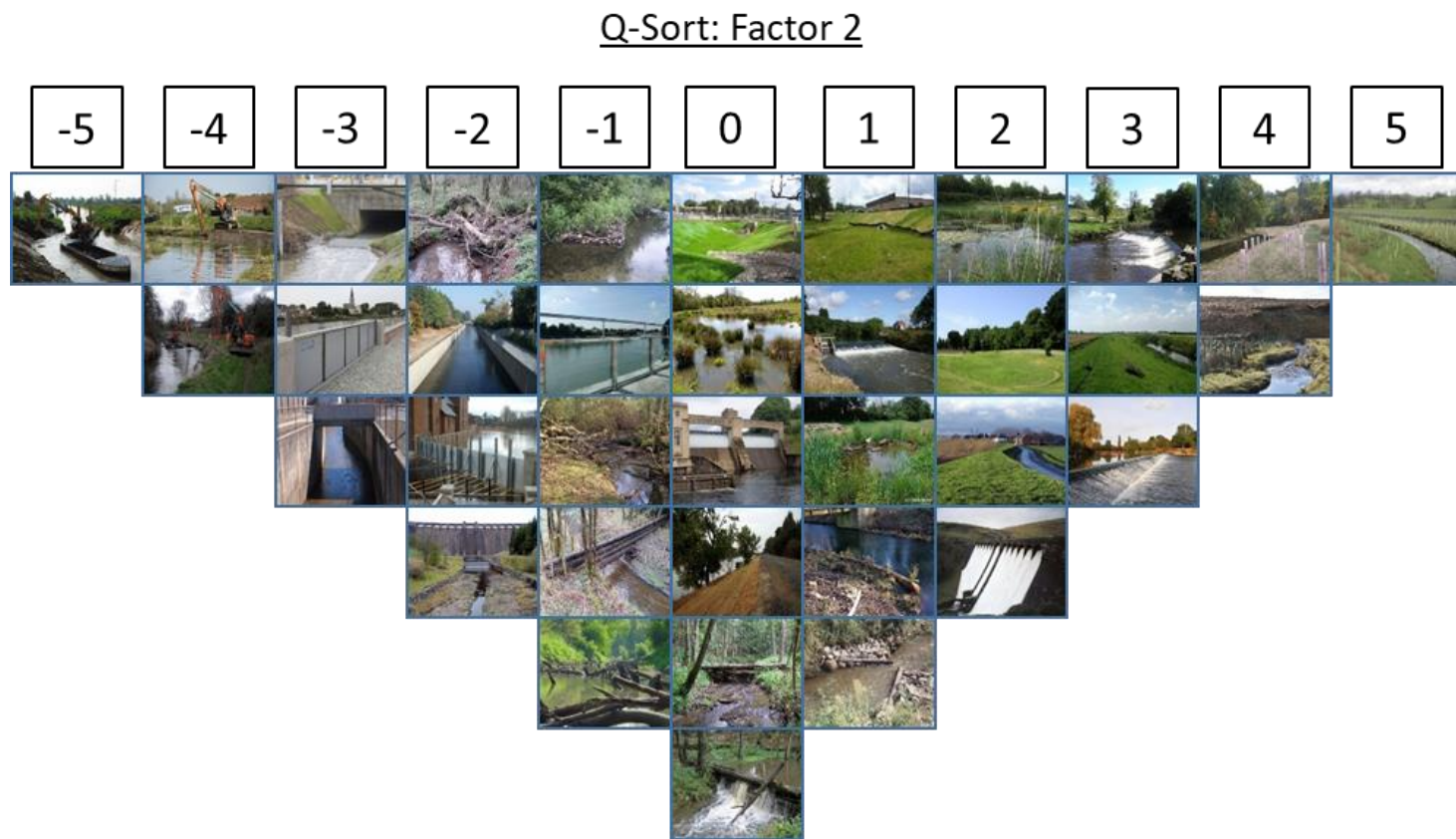


Figure 4.3 Factor 2 Q-Sort as produced through the Ken-Q Analysis software

Furthermore, the ‘Messy – Neat/Organised’ Factor sorting showed the most similar results between participants, with a lot of the resulting sorts showing similar ordering of management options. There were nine participants matching this factor (Table 4.15 and Appendix 5) and all the participants had a positive correlation. No patterns seem to emerge for this factor when compared with the socio-demographic data.

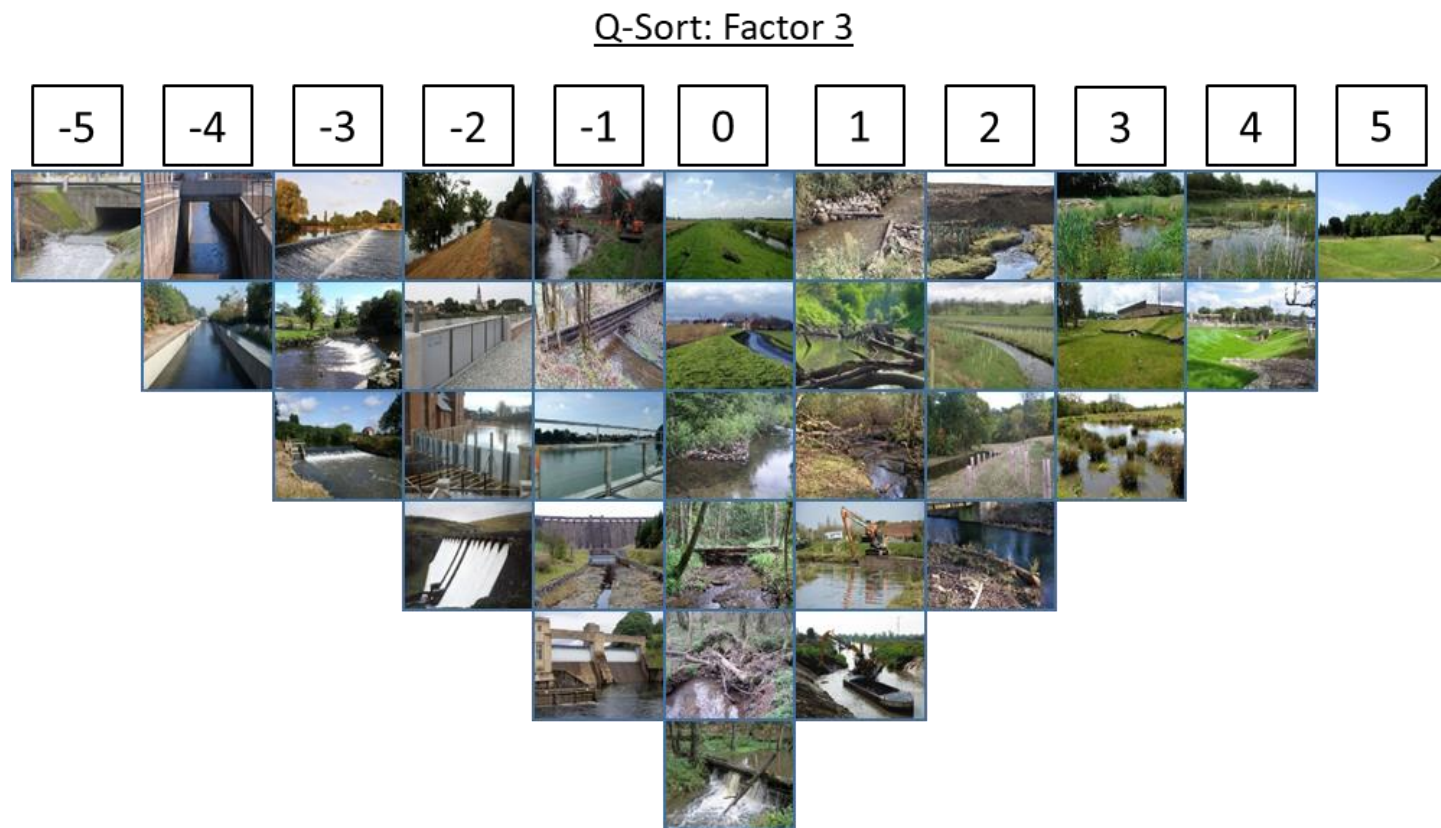
Finally, looking at the image rankings, four of the images had their highest ranking on the ‘Messy – Neat/Organised’ factor, including; dams, weirs, tree planting, levees and flood walls (Appendix 6). This is to be expected as all these management options are often referred to as being neat/organised.

Table 4.15 Socio-Demographics of the participants that align with Factor 2

Respondent	Factor Weight	Age	Occupation	Education Level	Gender
14	10	55-64	Retired	FCCA	Male
8	9.25277	16-24	Student	First Degree (BA/BSc)	Male
4	8.96606	16-24	Student	First Degree (BA/BSc)	Female
13	8.68943	55-64	Retired	Higher Degree (MA/MSc/PhD etc.)	Male
2	7.02104	16-24	Student	A-Levels or vocational equivalent	Male
10	6.58615	16-24	Student	First Degree (BA/BSc)	Male
15	5.55879	55-64	Housewife	A-Levels or vocational equivalent	Female
18	5.42237	45-54	Reatil	GCSE/O-Levels/BTEC or equivalent	Female
1	4.97787	16-24	Student	GCSE/O-Levels/BTEC or equivalent	Female

4.2.4 Factor 3: Grey – Green

Finally, Factor 3 accounted for a continuum from grey to green (Figure 4.4). The better end is comprised of detention basins, wetlands and tree planting. These were then followed by predominantly ‘brown’ natural management schemes, including the large woody debris and leaky dams. The dredging also fell in the middle section. Towards the lower end of the Q-sorts were the hard engineered dams, floodwalls, and channelisation.



There were only three participants that aligned with factor 3 (Table 4.16 and Appendix 5), all being positively correlated with it. With regard to socio-demographics, all three had their highest level of education as “First Degree (BA/BSc)’.

With regard to the ranking of the images, wetlands and detention basins had their highest ranking relating to this factor (Appendix 6). Both of these are green forms of natural management, so this result is unsurprising.

Table 4.16 Socio-Demographics of the participants that align with Factor 3

Respondent	Factor Weight	Age	Occupation	Education Level	Gender
3	9.03043	55-64	Surveyor	First Degree (BA/BSc)	Male
7	6.89371	16-24	Student	First Degree (BA/BSc)	Male
5	5.80531	16-24	Student	First Degree (BA/BSc)	Female

4.3. Qualitative Response

This section brings together all the qualitative responses, including the answers from the survey linked to why their first choice for the overall rankings was made, and quotes selected from the PARM and Q-Method interviews.

4.3.1 Wetlands

Wetlands were the most preferred management option in the questionnaire. This finding is reinforced by the supporting statements from the survey respondents, which encompassed a range of reasons for preferring it. These included the effectiveness of wetlands i.e. *“It has good ecological benefits, a good appearance and it is effective as a management system”* (respondent 011), and respondent 123 suggesting *“A wetland is very effective at storing the water and also has multiple other environmental benefits in addition to the flood management”*, and respondent 142 indicating their belief that *“Wetlands can be effective at storing flood water; they are also highly beneficial for nature”* (respondent

142). Other respondents mentioned wetland benefits of creating habitat for wildlife; i.e. wetland *“creates a habitat for wildlife, minimal resources needed to produce it, minimal maintenance, good for the environment”* (respondent 002). There was also a preference for wetlands as they were a natural form of flood management i.e. *“wetlands are a natural phenomenon providing catchment areas for water and natural habitat for wildlife”* (respondent 084) and respondent 020 *“Natural, looks more attractive, creates habitats for nature”*. Finally, some respondents suggested that their preference for wetlands was linked to their appearance i.e. *“Wetlands look nice and natural, they offer heterogeneous habitats for many different species and if implemented effectively and in the right place they can be extremely successful in reducing flooding, holding back water and slowing down flow and runoff”* (respondent 005).

4.3.2 ‘Grey-infrastructure – Natural’ Factor

Results from interviews support the sorting of the images in the Q-sort (‘grey-infrastructure to natural’), with many individuals referring to the engineered structures as being an ‘eyesore’ i.e. *“A dam that is probably quite effective but is a bit of an eyesore”* (participant 02), and another participant also saying that *“a dam would be a bit of an eyesore maybe”* (participant 27). Dams, in particular, were often referred to as being ugly i.e. *“the dams I think it can be very effective but this one is quite ugly so it is going to go quite low down”* (participant 10) or *“they [dam] are pretty ugly”* (participant 25). On the other hand, participants suggested that many of the more natural management options would not be an ‘eyesore’. These included detention basins: *“Yes I would be happy to have that [detention basin] near my house, not really an eyesore at all”* (participant 19), tree planting *“I would put tree planting quite high as it is not an eyesore and it is probably quite effective at interception”* (participant 02) and leaky dams *“Leaky dam, probably put that around here as it is not an eyesore”* (participant 02). It was suggested that there was a preference for more natural-looking schemes, with participant 01 stating *“as long as they look*

natural, which they do normally, they fit in with the scenery and everything. They are not an eyesore for anyone”.

One participant suggested that they rated channelisation as lower, as its production resulted in the increased emission of CO₂ *“This [channelisation] one involves a lot of CO₂, and concrete”* (participant 03)” with another saying *“I really don’t like the channelisation...it is just a lot of concrete* (participant 04)”. Many participants suggested that they disliked management options which looked industrial *“this [dam] looks very industrial”* (participant 07)”, *“They [weirs] look industrial”* (participant 26)” and participant 08 said similar *“The left has quite a lot of the industrial, looks quite out of place in the river, that’s the dredging, channelisation and flood walls”*. There were also references to disliking options that involved heavy machinery *“Things that involve this kind of heavy machinery... I think [dredging] that ruins the enjoyment of being in the area, so put them more to the left”* (participant 08). Throughout the interviews, individuals suggested that they did not like options that were ‘man-made’ or ‘man-built’: *“I don’t really like flood walls in general, just because they are quite man-made”* (participant 04), *“I don’t like the concrete ones as much... because I think, err, I don’t know, I just think all these concrete big dams, they just don’t look [good]”* (participant 05), *“I feel that anything that is man-built is open to error and can break down in time”* (participant 18) and *“I can imagine that is pretty effective, but then it [dams] is very man-made, probably takes a lot of work and isn’t as attractive”* (participant 24).

From the Q-Sort, one of the reasons that dams, which were ranked highly overall in the survey, were not ranked higher could be due to their impact on the environment *“I am going to put some of the dams...they are good in terms of flood management but the reason they are not going higher is because they have really detrimental impacts on the ecology of the stream”* (participant 07). Also, some individuals stated the fact that dams can create political issues when asked as to whether dams would be effective:

“No, especially if you are a neighbouring country. Not good for them, if you have shared rivers with other countries then absolutely no” (participant 22).

Some individuals had a negative correlation to the Q-sort, suggesting they had a preference for engineered/concrete management schemes.

Generally, this was due to the effectiveness of the management scheme outweighing any other variable. This was supported in the survey results as well, with dams (an engineered scheme) rated the highest: *“Although ugly and terrible for the environment, dams are excellent at controlling water. So, for flood control, they are probably the best. However, I do not think they are sustainable”* (respondent 004) with another individual simply stating *“Just think Dams are the most effective.”* (Respondent 028).

Furthermore, one individual suggested that they would put dams as the best option for flood control but understand that a variety of options are required, *“Purely from a flood control point of view, dams I believe to be most effective as you can regulate the release/storage of water to cope with oncoming storm events and they provide a very high level of protection as well as being able to generate hydroelectric power. However, their effect on the environment, both upstream and downstream is very detrimental. Being in the environmental sector, I know a mixture of both hard and soft engineering is required to provide an adequate level of flood control whilst also being sustainable and future proof. Reducing the amount of water reaching the watercourse in the first place (planting trees etc.) is a very sustainable way of flood control, but it's not immediate”* (respondent 143). Other individuals preferred hard engineering and in particular dams, as they offered other benefits such as hydroelectric power, *“Implementing a Dam can help control the discharge of the river which is important during heavy rainfall periods. Also has economic benefits such as hydroelectric power”* (respondent 032). On the other hand, some made their choice because it was the management option that they know the most about: *“Probably because of the Hoover Dam in Las Vegas”* (respondent 053) and *“To be honest I do not know much about*

them all but have seen a dam and the work. So, going with what I know" (respondent 059) and similarly with participant 12 *"R: As your best one you have the weirs and the floodwalls, why is that your decisions? P: They are probably the ones that I know most about R: Okay P: And...the most effective probably."*

4.3.3 'Messy – Neat/Organised' Factor

When making decisions on Factor 2 Q-sort, there was often reference to the levels of neatness: *"But it [leaky dam] looks neat so it is not as bad"* (participant 04) and participant 04 stated, *"I mean that [channelisation] looks neat but again not very natural"*. One participant suggested that they preferred detention basins because *"I do not think you would know what that was if you saw it (participant 04)"*. On the other hand, some options were disliked for not being neat *"So this one [large woody debris], I think it looks quite natural, but it is not as neat"* (participant 04) or *"With the woody bits, I don't think they look very neat. They are natural, but they do not look as good"* (participant 04). Throughout the interviews there was often dislike expressed about large woody debris, as it was considered to be messy: *"They [large woody debris] can look a bit messy can't they"* (participant 01) and similarly with the flow deflectors: *"I think they [woody deflectors] look a bit messy and like they could have just been there by accident"* (participant 24). Along with the messy look, some participants suggested that they would not observe that the 'woody bits' were in place as flood control schemes *"I wasn't a fan of the large woody debris or the wetlands... I just think they just look like there has been bad weather there and it has been blown over rather than an actual like prevention thing"* (participant 09), *"Erm, don't know, they just kind of look like a storm has just blown over a tree [woody deflectors]"* (participant 19) and participant 26 *"I think it [woody deflectors] looks a bit untidy but its nature trees fall down but I don't see what that would do to prevent flooding if it slows the water then the water will back up won't it"*. One participant even referred to

being scared by the large woody debris *“Large woody debris it does not look natural, it looks a bit scary to be honest”* (participant 04).

4.3.4 ‘Grey-Green’

Finally, for Factor 3 ‘Grey-Green’, the reasons provided could be due to people having a preference for areas of green open space. *“Because they [detention basins] look natural, they are green open spaces that you can walk your dog in, like use”* (participant 07) and how green open space can be good for mental health (participant 07) *“And like green open space is good for mental health as well”*.

4.3.5 Natural Management

In conclusion, looking at all 3 of the Q-sorts, there was an overall preference for natural management options. This was supported by the interviews performed during both the PARM and the Q-method:

“Afforestation is obviously soft engineering, so I like it because it is very natural and good for other things as well” (participant 01), with another saying *“I have gone from basically more natural to more less natural”*

(participant 5) This was backed up further with another participant suggesting *“People want what looks the most natural and looks the nicest”* (participant 6), and similarly with the opinion of participant 16 who argued that *“the best thing is the more natural-looking elements, so I have gone for the wetland creation then the flow deflectors and large woody debris”*.

Others prefer the natural elements because in their eyes it does not look like there is any management actually taking place, illustrated by participant 20 who said *“It looks quite natural, it just looks like a tree has fallen in there”* or participant 22 suggesting that *“It looks kind of natural, like something just fell, tree trunk just fell and stayed there”* and participant 14 saying *“All these [detention basins] look very natural, I wouldn’t think there was anything going on”*. Throughout the interviews there was also a preference for the more natural management options, as they had less impact on the environment *“It [detention basin] looks very natural which I*

guess is a good thing because you don't want it disturbing the nature, so in that sense it is good" (participant 29). Also, individuals referred to use of environmental resources to assist with flood control *"I think it [tree planting] looks really natural, so it is a good way of using environmental resources to stop flooding"* (participant 24) and the idea of working with nature and not against it (McHarg, 1969) *"Because I think if you let nature do its thing, and don't disturb it, the next time around it will sort itself out, that's what I think"* (participant 17). However, there was an understanding that some of the natural management options were not suitable for all instances *"Natural looking ones are probably good for small things but then I understand that is probably not ideal for you know big rivers"* (participant 5).

5. DISCUSSION

This discussion is divided into five main sections. In the first section, participants' overall preferences for approaches to river management are considered. This consideration will draw on the questionnaire results and qualitative responses gathered using all three research methods (questionnaire, Q-methodology and PARM). This section will also consider perceptions of different elements, including appearance, effectiveness and benefits to wildlife, as well as the influences of socio-demographics.

The second section focuses on values as predictors of overall preference. The third section deals with the grounded perceptions of river management, drawing on the data from the Q-Sorts. The fourth section synthesises the previously discussed results and considers their implications for river management and river restoration. In the fifth and final section, limitations faced whilst conducting this research are considered.

5.1 Participant preferences for management approaches

5.1.1 Overall Preference

Across all the methods used, there was an overall preference for natural flood management options. For example, wetland creation was given the best overall ranking in the questionnaire as it positively encompasses all three of the key characteristics: appearance, effectiveness, and benefits to wildlife. Society places high value on wetlands (Davidson et al., 2019) and as scientific understanding of their ecological value has increased, so has their public appreciation (Heimlich et al., 1998). Wetlands are not only good for flood management; they also provide added recreation and educational opportunities (Knight et al., 2001). Management is increasingly taking a holistic approach, switching from hard engineering to softer engineering (nature-based methods) and utilising geomorphological approaches (Chin and Gregory, 2005; Brown et al., 2018). Soft engineering techniques are being designed to emulate nature, and

research has shown that management designed to work with the river and not against it can yield improved outcomes (de Vriend et al., 2014; Keesstra et al., 2018). For example, research in East Peckham found that residents initially doubted the new natural management schemes that were implemented, as they feared the structures could not withstand the high winter flows exhibited by the river; however, subsequent experience reassured them (Tunstall et al., 2000). Natural flood management, in particular detention basins, can be seen to provide multiple co-benefits including benefits to wildlife and flood management. Furthermore, residents who could see the basins from their windows said they had a positive impact on the appearance of the area. Other advantages can include educational and recreational opportunities (Jose et al., 2014). Within flood risk management there are opportunities to create natural environments that enable the establishment of natural and diverse environments (Penning-Rowsell and Burgees, 1997). A specific example is a wetland created in North America, where people expressed a preference for storm water management when it mimicked the natural ecosystems, preferring the more natural wetland environments (Kaplowitz and Lupi, 2012).

A recurring point made by respondents was that they found it difficult to choose just one option as the best for flood control. Instead, they suggested that a combination of management schemes is the ideal solution for flood management, as illustrated by their qualitative responses. For example, the qualitative responses demonstrated that wetlands were preferred in the upper catchment but suggested that they may not be suitable for 'big rivers'. Hence, a variety of schemes is ideal for successful flood management. This finding has been identified elsewhere in the published literature. Lara et al. (2010) found that both residents and the local government preferred a combination of structural (grey-infrastructure) and non-structural (natural) management options. Tree planting is another good example of a type of management that needs to be incorporated with

other forms of management. As suggested by respondents in the qualitative responses, tree planting on its own could not stop a large flood event, however, it can play a part in reducing the probability of a large flood occurring. There is a range of benefits from tree planting, including canopy interception and increased infiltration due to tree roots (Bartens et al., 2008). However, tree planting is mainly implemented upstream, where there tends to be more land available (*ibid*).

For all three methods, it was consistently acknowledged that management should be implemented at the catchment scale rather than just focusing on the river channel (Penning-Roswell and Burgees, 1997; English Nature et al., 2003; Gilvear et al., 2012). When management considers the whole catchment it can be referred to as taking a 'holistic approach' (Wharton and Gilvear, 2007; Collentine and Futter, 2018) and this is found to be the best way to tackle the socio-ecological issues of flooding (Lawson et al., 2014). This is not only good for the environment, as there will be ecological benefits from the incorporation of natural management options, but also good for local people and society, because natural flood management can provide green space that has been shown to improve mental health (Peacock, 2005). However, some of the public who could play a vital role in this sustainable management have little knowledge about the success of this type of management (Collentine and Futter, 2018).

5.1.2. Appearance

Based on their research in Switzerland, Junker and Buchecker (2008) suggested that the public views a restoration outcome based on its aesthetics. They carried out a survey investigating natural river corridors and how these satisfy the public's needs. Their conclusion conforms with the results of this research, with perceived naturalness found to improve the aesthetics of flood management options. Within the questionnaire tree planting and wetlands had the highest average ranking and both are natural forms of flood management.

One likely reason for this high preference overall is the respondents' preferences concerning the appearance of the different flood management options. There is a large literature that has documented people's visual preference for green or natural features and landscapes (Ulrich, 1993; Kaltenborn and Bjerke, 2002; Junker and Buchecker, 2008; Silva et al., 2013; Chiang and Jane, 2017; Zhao et al., 2017). The finding that individuals tend to prefer more natural looking environments could be associated with the perception that they are environments which offer more health benefits. According to Hull et al. (2001) naturalness is an indirect measure of health and follows the assumption that 'nature knows best'.

Similarly, Everett et al. (2018) found that the public prefer 'blue-green' infrastructure for flood risk management, which looks more natural when compared to grey infrastructure. Thus, there seems to be a particular focus on the aesthetics when looking at the perceptions of bioswales in the USA. Blue-green infrastructure is a version of natural flood management and is a significant component of flood risk management (Thorne et al., 2018). Blue-Green infrastructure leverages biophysical processes to reduce flood risk, including runoff detention, storage and infiltration.

Conversely, the hard-engineering schemes were given the lowest rating when it came to appearance and were often referred to as being an 'eye-sore' and not fitting in with their surroundings. Furthermore, individuals did not like water management techniques that involved a lot of concrete, or heavy machinery as it looked too industrial. However, Strumse (1994) suggested that concrete structures were considered to be better if they were made to look like, or fit into, more natural looking, old structures or stone walls. The degree to which flood management structures were seen to fit into their surroundings was also identified as a key factor for acceptance of hard engineering approaches. In this context, contrasts in the appearances of dams and wooden dams were often mentioned by respondents in their qualitative responses. If the flood management option

was within a wooded area it was suggested that wooden dams were preferred; however, within some towns there was more of a preference for dams (concrete) in the interview discussions. This suggests that some individuals' concern is not what the management scheme actually does but whether it looks like it should be there.

On the other hand, when looking at appearance, any management that looked messy received a low preference score overall. This was particularly the case with woody structures, which were judged to look unsightly. A messy appearance was preferred by some people as the flood management structure and area still looked natural; however, some individuals wanted a management scheme where they could actually see progress and change being made. It was found that areas that contained woody debris were not as popular as areas free from woody debris, even if they had been formed naturally (Gregory and Davis, 1993; Chin et al., 2008; Ruiz-Villanueva et al., 2018). Some respondents said that they felt environments with woody debris were unsafe (Ruiz-Villanueva et al., 2018). Appleton (1975) stated that this was rooted in evolutionary theories, which result in them being less attractive and looking more chaotic, especially where there were decaying or dead trees were present (Zhao et al., 2017). If the wood is removed then this is preferred by people; however, it would likely also decrease the ecological value. Gobster et al. (2007) referred to this dilemma as the "aesthetic-ecological conflict": the conflict faced when an area provides ecological benefits, however, it is not thought to be aesthetically pleasing.

5.1.3. Effectiveness

When considering the average ranking of the effectiveness in questionnaires, the averages were much lower than those for appearance or benefits to wildlife. This could be linked with levels of knowledge regarding flood management options. Another suggestion could be that the public may not deem the schemes to be effective as they have lost faith in

the country's ability to handle floods in light of the recent or projected future flooding.

Dams were considered to be the most effective option, and they came second in the overall ranking. This was surprising as they ranked lower on appearance and benefits to wildlife. This demonstrates that people understandably rank the effectiveness of flood management scheme highly, relative to aesthetics and benefits to wildlife. It is well known that dams are important when it comes to controlling and managing water resources (Lehner et al., 2011). Dams can provide vital flood reduction and have been proven to have the ability to protect agricultural lands and urban areas around the world (Graf, 2001). As previously mentioned, some individuals have said that they want to see a noticeable change when it comes to flood management and this can be demonstrated through forms of hard engineering, such as dams. Support for this comes from research in the Swiss Alps where individuals who had suffered a flood event expressed a preference in more traditional measures such as dams, as they believe them to be more effective (Buchecker, 2016). This type of hard-engineering was especially preferred when it is within or close to an urban area (Mosley, 1989), and again this could be linked to flood management options 'fitting into their surroundings' - as discussed with regard to the appearance.

The effectiveness of dams can also be highlighted as they are not only good as a method of flood control, but they also provide alternative benefits. The social and economic benefits of dams can be enormous, although those benefits are seldom distributed equitably across the population (Graf, 2001). These benefits include navigation which can provide economic growth (*ibid*), improved security of water supplies, and the generation of hydropower (Lehner et al., 2011). Dams have been used for hydropower for many years and in over 150 countries, and in the late 20th century hydropower produced provided 19% of the world's electricity

supply (WCD, 2000). However, a negative that was discussed by a respondent were the political issues brought about by dams through border issues on trans-national rivers. Although not specific to this research, rivers often form or cross state boundaries making policy and decision making difficult (*ibid*).

Wetlands were ranked as second for effectiveness. Recent commentary has suggested that grey infrastructure alone is inadequate to face the issues of the future that will be brought about due to climate change (Collentine and Futter, 2018). Wetlands are some of the most bio-productive environments in the world, providing a vast amount of socio-economic and ecological services that are vital to human survival (Halls, 1997; Chen and Shih, 2019). Wetlands are a key management scheme when preventing flooding as they are natural flood conveyors (Heimlich et al., 1998). They store water for short periods, which delays flood peaks, and in the long-term they are also beneficial in reducing floods (Potter, 1994). Wetlands also provide other benefits including improving water quality as they filter sediments and nutrients from the surface and ground waters (Williams, 1996). They also retain and process low concentration contaminants such as pharmaceuticals, personal care products (Rousseau et al., 2008) and reduce aquatic concentrations loads of solids and metals (Martin, 1988). Wetlands are key to ecological functions, and they provide natural wildlife nurseries and habitats, which increase biodiversity (Birol and Cox, 2007 and Chen and Shih, 2019). Results from the present research therefore suggests that these scientifically-documented functions of wetlands may be well-recognised by the broader population of the UK, as their effectiveness is evidently appreciated.

In contrast, dredging was perceived as the least effective water management system and other research has supported the negative perception of this flood management option. The negative perception towards dredging in large rivers may stem from in part the use of a

dredging vessel, which results in the creation of ballast water. Ballast water could provide a negative connotation associated with possible contamination as ballast water contains products such as oil and hydrocarbons, which negatively impact water quality (Mostafa, 2012). Also, Tsangaris et al. (2014) advised that dredging is not the best method of reducing flood risk. There is an ongoing debate in the UK with regard to dredging, which can be illustrated through the floods of winter 2013-14 in the Somerset Levels of South West England. On the one hand, the local residents and farmers stated the floods were a result of the lack of dredging, however it was argued by the EA that dredging could not have prevented the flooding (Bell, 2014). A positive of this event is the media coverage it received, which would have educated the public on how dredging would be unsustainable or unsuitable in most flooding situations.

Regarding other management options explored in this study, tree planting scored highly on both appearance and benefits to wildlife but was only third in the overall ranking because of its relative low ranking for perceived effectiveness.

5.1.4. Benefits to wildlife

Zhao et al. (2017) suggested that humans prefer a landscape if it has high ecological integrity. Dobbie (2013) states that wetlands are an important landscape element and can be beneficial for wildlife. Wetlands were perceived by the public to be very important for wildlife, and this function may have contributed to their high overall preference by survey respondents. As noted above, wetlands support multiple ecological functions. They are also vital in supporting diverse plant communities (Halls, 1997) and they provide a key habitat for fish and wildlife (Heimlich et al., 1998).

Alternatively, it was noted in the questionnaire results and qualitative responses that hard-engineering had negative impacts on the wildlife and the environment, explaining why they were ranked lower. Individuals had a particular focus on the adverse effects of dams, which could be explained by respondents having greater knowledge of dams relative to other flood management schemes. In the qualitative responses it was discussed how they can impact habitats. This is backed up within the literature, with Ligon et al. (1995) suggesting that due to the construction of a dam, habitat can be drastically or subtly changed, resulting in the significant alteration of the ecology. Dams can be detrimental to aquatic and riparian ecosystems (Graf, 2001). They fragment habitats (Jansson et al. 2000) and impede the delivery of nutrients and sediments downstream (Lehner et al., 2011). Such disturbances were picked up with respondents, with numerous mentioning specifically how they alter the flow of sediment downstream. This, along with an interruption to the flow of water, reduces the delivery of habitat-forming substrate which is needed for fish refuge and nesting (*ibid*). When the flow is interrupted this not only impacts habitat but by storing the sediment it results in the river being sediment starved downstream (Graf, 2001), interrupting the ecological processes that would otherwise take place (Ligon et al., 1995). Safety was also a concern of respondents illustrated in the qualitative responses. A further negative environmental impacts could result from the lack of maintenance of dams, as due to the erosion this could result in the reintroduction of sediment into the channel (Castillo et al., 2007), this is also a concern of safety as dams begin to age (US Army Corps of Engineers, 1996).

5.1.5. Socio-Demographics

The socio-demographics were compared to the overall rankings in the questionnaire. A significant association between education and preferences for management schemes was identified. First, there was a

link between education level and two flood management options including wetlands and dredging. Van der Wal et al. (2014) suggests that when information is presented regarding management options, with a particular focus on the ecological benefits or impacts, then a higher preference is given in comparison to areas where information is not presented. The link with education level and wetlands could also come about due to the familiarity of the flood option, leading to a better feeling towards the management option (Gobster et al., 2007). Not only does it influence an individual's perceptions; other research has found that knowledge can create support for new river restoration projects when being implemented (Connelly et al., 2002). When looking at river restoration and knowledge there is a particular focus on wood in rivers as it has been established that an increase in knowledge leads to more support. Wyżga et al. (2009) found that individual's perceptions of wood in advanced geography students was positively improved. They found a reduction in those considering wood to be dangerous in rivers and an increase in individuals suggesting there should be habitat improvement in rivers without wood. This can suggest that increasing education with regards to different flood management options can increase the support for them.

Furthermore, current A-Level students had more negative relationship with dams and positive relationships with tree planting and wetlands compared with those of other education levels. A possible explanation for this could be that it results from what is being taught in schools, with the push being towards more natural flood management options and highlighting the detrimental environmental impacts of dams. Also, young people today are increasingly concerned with environmental issues, generally (Liere and Dunlap, 1980; Baldassare and Katz, 1992).

5.2 Values as a predictor of overall preference

This section focuses on the values section of the questionnaire and how values can be used as a predictor of the overall preference of flood management options. For each of the value groupings, reasons behind preference for management options are discussed. Following this, other literature exploring values and environmental attitudes is explored.

For the Self-Transcendence value grouping, Altruistic and Biospheric values were combined in this category. Although there are differences between altruistic and biospheric values they are often grouped together (e.g. Schultz, 2001). Altruistic and biospheric values are noted by Schultz (2001) to have a negative correlation with Self-Enhancement values and a positive relationship with Self-Transcendence values. Self-Transcendence values are often associated with pro-environmental behaviour. Stern (2000: 408) gives a definition for pro-environmental behaviours as, “the availability of materials or energy from the environment” and/or by the extent to which the behaviours positively, “alter the structure and dynamics of ecosystems or the biosphere”. Preferences for tree planting and wetlands were positively related to this value orientation. This is to be expected as they are both natural forms of flood management.

Furthermore, De Groot and Steg (2010) suggested that individuals who were altruistically and biospherically orientated are more likely to be self-determined and act in a more pro-environmental manner. Weirs and dams also had an association with the Self-Transcendence value grouping; however, this was a negative relationship implying those aligning most with this value orientation did not like weirs and dams. This is likely due to the adverse environmental impacts of weirs and dams (Poulet, 2007).

Unsurprisingly, dredging did not have an association with Self-Transcendence values due to the environmental harm typically caused by dredging. Somewhat counterintuitively, wooden dams were not statistically related to Self-Transcendence values considering they are a form of

natural management. However, this could be due to the perceived negative appearance of this management option with any woody structure being seen as messy.

With reference to the Openness to Change values, there was a relationship found with wooden dams. In comparison to the other flood management options considered, this is one of the newer techniques. This would align with the values in this category as it is suggested that individuals who are open to change would therefore be interested in these newer techniques being brought about within natural flood management. Since these values tend to affirm more creative or new opportunities and ideas, there is a logical rationale for the positive relationship between Openness to Change values and preferences for wooden dams.

The third factor relating to Self-Enhancement was not related significantly to preference for any management scheme. This value orientation, sometimes framed as egoistic values, is typically associated with less pro-environmental behaviour (Schultz and Zelezny, 1998 and de Groot and Steg, 2010) and more with choices and actions that result in personal gains (*ibid*). A reason for this could be that individuals with strong Self-Enhancement values may not have any care towards environmental issues. Further, they may be opposed to their personal finances (in the form of taxes), being directed towards flood management when it does not have a direct impact on themselves. However, had those individuals been subject to a flood event themselves, then one would expect their concern and awareness to increase with regards to flood management (Schultz et al., 2005). However, as highlighted in the results it was found that individuals who had previously been flooded aligned most with Self-Transcendence and Openness to Change values. However, there was only a small group of individuals that had been flooded making it difficult to come to a conclusive answer. The suggestion could be made that the

experience of flooding mediates the effect of Self-Enhancement on attitudes.

It is unsurprising that preferences for both dredging and weirs had a positive relationship with Conservatism values. Wetlands were also associated with Conservatism but this was a negative relationship. Conservatism is often referred to as being the opposite of Openness to Change: individuals that hold these values prefer to stick to the status quo (Schwartz, 1992) and do not want things to change. Conservatism is defined by values of tradition, conformity and security (Schultz et al., 2005). Preference for wetlands having a negative relationship with conservative values is not surprising, as to the general public there is sometimes a lack of knowledge of wetland creation being used as a form of flood management (Adams et al., 1994; Haberl et al., 2003) thus individuals holding these values may be less susceptible to having a preference towards them. Dredging and weirs being associated with this factor could be brought about because dredging in particular is a traditional form of flood management that has been carried out for centuries. It is known globally and has had lots of media coverage so people could go with the idea of 'stick to what you know' (BBC News, 2014).

Results from the present study align well with existing research on environmental values and environmental attitudes. Ojea and Loureiro (2007) looked into how values affect people's willingness to pay for environmental goods. It was found that altruistic values are associated with consideration of ethical aspects in decision-making, and this plays a role in the formation of pro-environmental attitudes and greater willingness to pay for environmental goods. Furthermore, Schultz and Zelezny (2003) carried out research on creating value-based messages for Americans. It was found that Americans tend to be more aligned with Self-Enhancement values, the environmental issues are known and people believe that something should be done but they are not willing to deal with the problem

if it results in personal inconvenience or discomfort. Literature has said that environmental messages tend to appeal more to those with Altruistic values. However, in order for messages to appeal to those with Self-Enhancement values, environmental messages need to illustrate how they will benefit the people reading the message. Kaplan (2000) suggests aligning the messages to other motivations such as bringing need, making a difference and forging a better life. Schultz et al. (2005) carried out research across six countries including Brazil, Czech Republic, Germany, India, New Zealand and Russia looking into the relationship between values and environmental attitudes. It was found that values are important in understanding environmental issues. As previously found, it was noted that Self-Transcendence had a positive relationship with environmental concern, whereas egoistic values had a negative association. Consequently, it was found that Self-Transcendence values were linked with environmental behaviour, but Self-Enhancement was not, supporting previous research. Finally, Straka et al. (2016) carried out research on urban wetlands and looked at how wildlife value orientations may influence perceptions. The results in this research found that when information was provided that aligned with value orientations, then those landscapes were given a higher preference.

5.3 Perceptions of flood management options using Q-Methodology

This section will discuss each of the three factors generated from the factor analysis of the Q-Sorts. The general trend of the 'sort' will be explained, and this will then be linked back to elements previously discussed with regards to the overall preference of flood management options. Firstly, in factor 1 ('grey-infrastructure' – natural) there was a general trend for natural management options which was supported through previous findings in the questionnaire. For the second factor (messy – neat) levels

of neatness or organisation seem to be the determining patterns for this Q-sort. For the third factor (grey – green), this went from flood management options that were grey in colour to green in colour.

With regards to the 'grey-infrastructure – natural' factor, this factor is influenced most by what the participants deemed as being the most appropriate forms of flood management with regards to its functions and benefits. Looking at the socio-demographics of this factor it was surprising that the individual with the 'Water Officer' position had a negative relationship with this factor. The reason this is surprising is because you would expect those that work in the environmental sector today to be in support of more natural options. Throughout the interview for this individual, there was reference to the effectiveness of hard-engineering schemes and these options being structurally sound. The individual did like natural flood management options but, in terms of a worst case scenario for flooding the hard-engineering was deemed more suitable.

Factor 2 'messy-neat' was heavily associated with appearance. This factor had the 'messy' flood management options and the lower end of the scale and those considered to be neat or organised at the top. This idea of order could relate to the intent to 'control' which can be associated with standard 'yard care' such as mowing and removing of unfamiliar plants which can be developed alongside flood control and safety improvements (McCormick et al., 2015). Research has found that areas are seen to be less appealing if they are dry or dead-looking, whilst areas that are open and have regular maintenance are preferred (William and Cary, 2002). It can be noted that there is a greater sense of neighbourliness and higher cultural value if an area is neat and has mown lawn (Nassauer, 1993). Like the questionnaire with reference to the ranking of appearance, tree planting was considered to be the best and dredging was the worst. This is supported by House and Fordham (1997) where river engineers regard a scene to have more value if it is ordered and controlled.

When it comes to these perceptions for the 'messy-neat' factor there was not necessarily an even split between natural and hard-engineering as both tree planting and channelisation were mentioned positively. Nassauer (1993) concluded that a landscape is more likely to be attractive if it is neat and well cared for, regardless of naturalness, as a sense of order is considered to be of great importance (Kaplan and Talbot, 1988). Furthermore, throughout the qualitative responses flood management options 'fitting into their surroundings' was often referred to. Detention basins were picked out as being neat and some suggested that they could not tell any management was taking place. Although the general trend of the sort was levels of neatness, it is surprising that floodwall and channelisation were in the lower end of the sort considering these were often referenced as being neat. A suggestion for this could be down to them not being natural which was found to be the overall preference for all three factors. Therefore, although they could be considered to be neat because they are not a natural management option, overall, there is a lower preference for them. Similarly, as found in the questionnaire the 'woody structures' were considered to be messy (Kondolf and Yang, 2008; McCormick et al., 2015). Looking at the participants who aligned most with this factor, they all had a positive relationship with the factor. This meant they all supported the idea of a preference towards neat and organised flood management. There were no patterns that emerged from the individuals who align with this factor.

Finally, the third factor 'grey – green' was also heavily linked to appearance as this was dominated through the colour of the flood management options. A preference was found for 'green' management i.e. green in colour. This involved any management which was greener in colour but was also associated with the area being looked after and cared for. Lara et al. (2010) found similar results with local managers having a preference for 'greener' types of flood management. Likewise, dry wetlands were preferred if the vegetation had colour as this implied health

(Dobbie, 2013). Within the Q-sort, the two levees that were 'green' rather than the one that was 'brown' tended to score higher. River environments supply recreational opportunities including areas of active passage, open spaces and aesthetic pleasure (Cengiz, 2013). Detention basins are a prime example of areas that only act as a management scheme during high flow when they are inundated and are otherwise utilised as a space for recreational activities (Ashley, n.d.). Green space and recreational use of river environments has also been linked to improved mental health (Peacock et al., 2005).

5.4 Management Implications

This section will discuss how results from this research might inform river management and river restoration. The fact that natural flood management was preferred overall offers encouragement to river managers in the context of increased use of these options.

Different value groupings were seen to influence perceptions of flood management. De Groot and Steg (2010) highlighted that biospheric values can be enhanced and egoistic values can be weakened (De Groot and Steg, 2009). This would be useful for flood management with the fact that natural flood management was preferred and the Self-Transcendence value grouping in this research was heavily linked to natural flood management. In the literature it was suggested that although it is difficult to physically change values (Schwartz, 1992), it is possible to stimulate people to act upon biospheric values more. Another option would be to frame messages with regards to the implementation of flood management options to suit certain value orientations. For example, if these biospheric values could be enhanced then more support for natural flood management, such as planting trees and wetlands, could be found. A further practical implication of understanding an individual's values is that it

was found that those who had a Self-Transcendence values were more willing to accept policy measures positively with regard to climate change (Corner et al., 2014). As such, it is necessary to try and influence an individual's values in order to support and suit the type of management scheme that is trying to be implemented. There's a divide between some who call for values to be changed, and others who argue we should work within existing value frames. Within the context of rivers, evidence found in this research suggests that some schemes will conflict with certain value orientations but be supported by others. The first thing managers need to realise is that there is a plurality of perspectives and that some messaging needs to be altered. For example, rather than further highlighting the ecological benefits of tree planting or wetlands, it needs to be highlighted that they are well-justified and safe. In short, improving the public's knowledge of the whole management scheme is crucial.

As previously suggested, knowledge can improve support for flood management schemes. Improving education will increase knowledge and therefore, will result in support for sensible management options. Research to support this includes that by Ruiz-Villanueva et al. (2018) with regards to wood in rivers. Wood in rivers can be seen to be a natural hazard due to a lack of knowledge. In most parts of the world negative views of wood were expressed as being less aesthetically pleasing. There were exceptions to these views mainly in Germany, Sweden and Oregon, USA, where a lot of research was conducted in areas containing a large amount of woody debris, where the ecological importance was better understood (Chin et al., 2008). Understanding the positive benefits has an impact on the acceptance of the aesthetics, this was also understood by Ruiz-Villanueva et al. (2018). Here scientists (who had a better understanding of the benefits) expressed riverscapes containing wood as more aesthetically pleasant, less dangerous and needing less improvements than those respondents with less knowledge from "The General Public". Thus, improving the education of the benefits of wood within rivers is required

(Gregory and Davis, 1993). If the benefits are not understood and accepted, the negative perceptions that currently exist within a large proportion of the general public could have negative implications when it comes to any future implementation of restoration schemes (Ruiz-Villanueva et al., 2018). This can influence management as information points near to the scheme can be implemented to inform the public of what is being done and the benefits the scheme will provide.

5.5 Limitations

Throughout the research a range of limitations were faced especially when it came to the interviews. Firstly, it is difficult to generalise to a broader population using the results from the Q-Methodology and the PARM because of the relatively small sample size. Similarly, the semi-structured interviews were valuable in adding depth to analysis but, again, the comments by individuals cannot necessarily be extrapolated to wider populations. Thematic coding of qualitative data would help bolster quantitative analysis, and this is recommended in further research. An additional limitation is that all interviews took place in Nottingham. Analysis across broader areas of Nottingham would likely reveal a greater diversity of perspectives. However, the benefit of the interviews taking place next to a university campus (University of Nottingham), meant that many interviewees did not grow up in the local area and were dispersed across the UK. Similarly to this, it would have been ideal to do a postal survey for the questionnaire but, this was not possible due to financial constraints. Furthermore, interviews could progress differently, although this was limited by following a step-by-step guide to aid the conversation (Appendix 7). Additionally, with regards to the images selected for the Q-Methodology, further preliminary research could have revealed any intrinsic biases related to specific images. Finally, it would have been preferable to have each respondent participate in the Q-Methodology,

PARM and complete a survey in order for individual comparisons to be made across all three methods. Further research should therefore involve every participant partaking in all methods involved in the research, enabling direct comparisons to be made.

6. CONCLUSION

This research has found that generally the public has a preference towards natural forms of flood management rather than 'grey infrastructure'. In pursuing the first objective, associations were identified with an overall preference towards natural flood management specifically associated with appearance. Primarily it was found that natural flood management was considered to be the most aesthetically pleasing. This was especially the case if the flood management was "green" in colour. On the other hand, hard-engineering strategies were classed as being 'eye-sores'. However, while there was a preference for natural management, it was noted that if a flood management scheme fitted well into its surroundings then it was deemed as appropriate. Additionally, with reference to appearance, 'messy-looking' options such as large woody debris were considered unsightly and dangerous and were therefore disliked. Furthermore, there was a strong preference towards options that were neat and organised and appeared as if they were being cared for. Individuals also preferred flood management schemes that looked like they were doing something and was there for a reason.

Dams were perceived as being the most effective. Dams came second in the overall ranking of the survey, illustrating just how important effectiveness is perceived, as dams had low scores for both appearance and benefits to wildlife. When looking at the perception of benefits to wildlife, it was unsurprising that natural flood management was preferred. It was noted throughout this research that the reason that wetlands had the best overall ranking in the survey was because they encompassed the following elements; appearance, effectiveness and benefits to wildlife. On the other hand, dredging scored lowly throughout. This type of flood management was classed as being unsustainable and unsuccessful as a form of flood management.

With regard to the second objective, the research illustrated that an individual's values influenced their preference of flood management options and is an important factor to consider during decision-making. Altruistic and Biospheric (Self-Transcendence) individuals preferred natural management options and did not like some hard-engineered schemes including dams, linked with the adverse environmental impacts. Individuals who aligned with the "Openness to Change" values preferred wooden dams. In comparison to many of the other management options wooden dams in the eyes of the public are classed as one of the newer forms of management so it is unsurprising that this group liked this form of flood management. The "Self-Enhancement" category did not have a significant statistical relationship with any of the management schemes. Perhaps this is because these individuals are not concerned with issues such as flood management as it does not have a direct impact on themselves. Finally, those with "Conservatism" values preferred dredging and weirs, which are both options well known to the public. This group like to stick to what they know so having this type of management is what they would prefer. These findings demonstrate that values do influence perceptions with regards to flood management.

Although appearance, effectiveness and benefits to wildlife were the main topics of concern other topics were also highlighted during this research answering the third objective. A critical area was associated with familiarity, understanding and knowledge of the impacts and benefits of flood management schemes, which had a very strong influence on individual's perceptions and choices. Additionally, it was noted that many respondents struggled in choosing just one management option. Instead, they stated that for the most successful flood management, a combination of management schemes was required, and decision-making should focus on the whole catchment rather than on just one specific reach. Finally, it was noted that there is also a preference for flood management options that provide alternative benefits including recreational use and taking into

consideration other useful elements including security of water supply and hydroelectric power.

As an output of this research, there are areas that have been highlighted that require further work. Firstly, with regards to values it is not only necessary to know which values align with different management options but also how values might be cultivated to align more easily with flood management schemes that are being implemented in different areas. As natural flood management is preferred, it is important for future research to consider how to cultivate Biospheric and Altruistic values which could be the key to the success of natural flood management. More research is required with regards to the "Openness to Change". It would be interesting to know whether all forms of newer flood management are preferred by these individuals. It could be advantageous to carry out more research into individuals who align with "Self-Enhancement", which could focus on how and whether the direct impacts that floods could have on these individuals will change their preferences differ.

Finally, it is critical that education on the impacts and benefits of the different types of flood management schemes is rolled out to the wider "public" as this can have a huge impact on decision making and could help significantly with buy-in and implementation for flood management schemes in the future. Also, when considering the socio-demographics, it is important to look more into occupations as this nearly had a statistical relationship with the overall ranking of the flood management options in the questionnaire. It would be interesting to delve deeper and see if there is differences in preferences with regards to those who work in the environmental sector and individuals working in other areas.

In conclusion, it was found that all of the elements considered in the objectives including appearance, effectiveness, benefits to wildlife and values influenced individual's preference towards flood management options. Furthermore, it was found that knowledge and other benefits that

the schemes bring also heavily influence decisions. This research can have a wide range of benefits for future flood management and overall river management.

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8. APPENDIX

Appendix 1 Questionnaire distributed online



INVITATION TO PARTICIPATE IN RESEARCH PROJECT

Public Perceptions of flood management schemes in the UK

I would like to invite you to take part in my research study. My name is Mikaela D'Souza and I am Masters of Research student at the University Of Nottingham. I am looking at the public's perception of different flood management schemes. These range from natural flood management to engineered interventions. I am also investigating if an individual's values influence their preferences for different management options. The research is needed as it is important to understand what people's preferences are of different management schemes so that these can be implement more in the future.

The research involves a questionnaire focused on different flood management schemes. The questions will ask about your values and your judgement of the appearance, benefits to ecology, and effectiveness of different flood management schemes.

Participating in this research is voluntary and you have the right to refuse to participant. All data that is collected is confidential and any results that are published will be de-identified and anonymised. Any personal data (e.g. your name, other information about you) will be visible only to the research team and kept securely on password protected servers at the University of Nottingham.

Signed consent forms will be retained in password protected university laptop until after my degree has been conferred. Original questionnaires in which all identifying information has been removed will be retained for a further two years after this. Under freedom of information legalisation you are entitled to access the information you have provided at any time.

Should you have any questions you can contact myself or my supervisor.

Mikaela D'Souza: lgxmd3@nottingham.ac.uk

Supervisors:

Matthew Johnson: lgzmfj@exmail.nottingham.ac.uk

Chris Ives: chris.ives@nottingham.ac.uk

Questionnaire

This study is looking at what people think about river management schemes that deal with flooding. We are also interested in how people's opinions are related to what they value in life.

This questionnaire is split into 3 sections. The first section contains questions about your general information. The second section contains questions about what is important to you in life generally. In the final section you will be shown a range of management schemes used for flooding and you will be asked to indicate which ones you prefer.

The survey should take about 5 minutes to complete.

Thank you for your time and assistance!

Section 1: General Information

Age: 16-24 / 25-34 / 35-44 / 45-54 / 55-64 / 65+

Occupation:

Highest level of Education: None / A-Levels or vocational equivalent / First degree (BA/BSc) / Higher Degree (MA/MSc/PhD etc.) / GCSE/O-Levels/BTEC or equivalent / Vocational Qualification / Rather not say / Other (please tell us).....

Gender: Female / Male / Prefer not to say

First half of postcode:

Have you ever experienced flooding at a property you have lived in? Yes / No

If yes:

Do you still live at this property? Yes / No

Section 2: Important principles in your life

For each of the statements below, please rank from 1-7 (1 being extremely important and 7 being least important) the degree to which these are guiding principles for your life.

- | | |
|---|-------|
| 1. A varied life, filled with challenge, novelty, and change | |
| 2. A world at peace, free of war and conflict | |
| 3. An exciting life, stimulating experiences | |
| 4. Authority, the right to lead or command | |
| 5. Curious, interested in everything, exploring | |
| 6. Equality, equal justice for all | |
| 7. Family security, safety for loved ones | |
| 8. Honouring parents and elders, showing respect | |
| 9. Influential, having an impact on people and events | |
| 10. Protecting the environment, preserving nature | |
| 11. Respecting the earth, harmony with other species | |
| 12. Self-discipline, self-restraint, resistance to temptation | |
| 13. Social justice, correcting injustice, care for the weak | |
| 14. Unity with nature, fitting into nature | |
| 15. Wealth, material possessions, money | |

Section 3: Flood management schemes

We are investigating preferences for flood management schemes. The six following images are all types of management practices used for flooding prevention.

Part 1: For each of the images please circle on the 5-point scale rating on (1 is low scoring and 5 is high scoring): (i) effectiveness for managing flooding, (ii) appearance, (iii) benefits for ecology / nature / wildlife

1. Dam



- (i) effectiveness for managing flooding
1 – 2 – 3 – 4 – 5
- (ii) appearance
1 – 2 – 3 – 4 – 5
- (iii) benefits for ecology / nature / wildlife
1 – 2 – 3 – 4 – 5

2. Dredging



- (i) effectiveness for managing flooding
1 – 2 – 3 – 4 – 5
- (ii) appearance
1 – 2 – 3 – 4 – 5
- (iii) benefits for ecology / nature / wildlife
1 – 2 – 3 – 4 – 5

3. Tree Planting



- (i) effectiveness for managing flooding
1 – 2 – 3 – 4 – 5
- (ii) appearance
1 – 2 – 3 – 4 – 5
- (iii) benefits for ecology / nature / wildlife
1 – 2 – 3 – 4 – 5

P.T.O.

4. Weir



(i) effectiveness for managing flooding

1 – 2 – 3 – 4 – 5

(ii) appearance

1 – 2 – 3 – 4 – 5

(iii) benefits for ecology / nature / wildlife

1 – 2 – 3 – 4 – 5

5. Wooden Dam



(i) effectiveness for managing flooding

1 – 2 – 3 – 4 – 5

(ii) appearance

1 – 2 – 3 – 4 – 5

(iii) benefits for ecology / nature / wildlife

1 – 2 – 3 – 4 – 5

6. Wetlands



(i) effectiveness for managing flooding

1 – 2 – 3 – 4 – 5

(ii) appearance

1 – 2 – 3 – 4 – 5

(iii) benefits for ecology / nature / wildlife

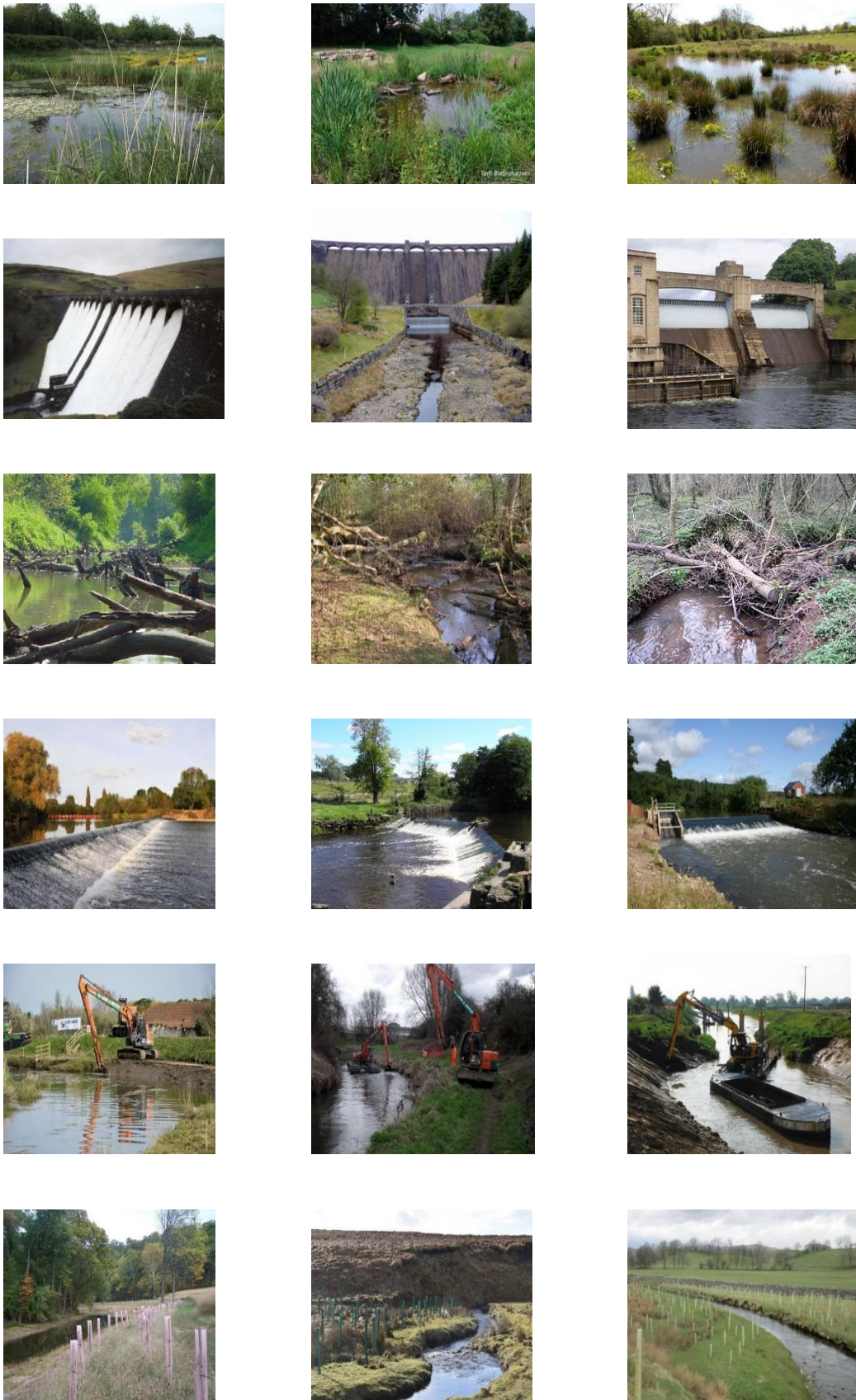
1 – 2 – 3 – 4 – 5

Part 2: Please rank the images from 1 – 6 (1 being the best and 6 being the worst) for the management scheme overall to assist with flood control.

(Best) 1st 2nd 3rd 4th 5th 6th (Worst)

Please give a brief description as to why you put the management scheme you have chosen at number 1:

Appendix 2 Images of natural flood management and ‘grey-infrastructure’ used for q-sort





Appendix 3 Output from SPSS showing the box plots from the Kruskal-Wallis Test

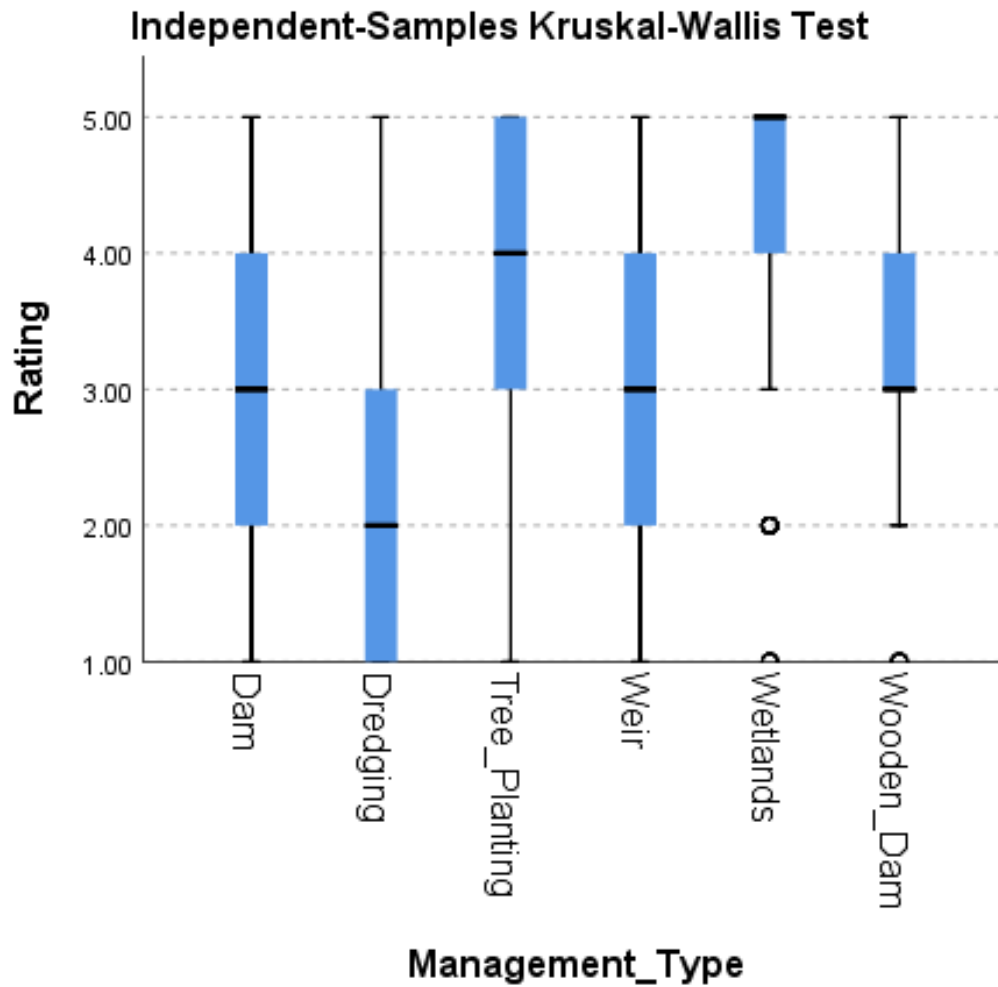


Figure 8.1 Boxplot comparing ratings given on the Likert scale in the questionnaire for effectiveness, appearance and benefits to wildlife and flood management type

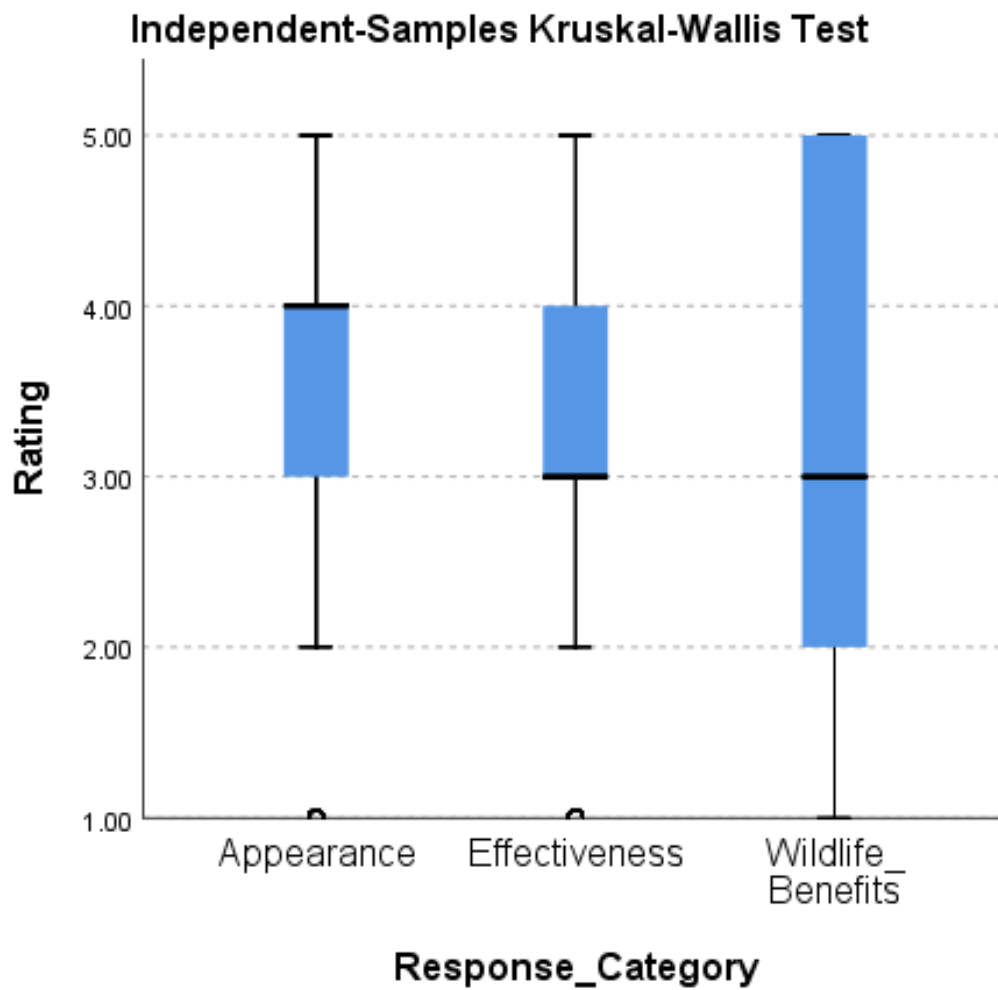


Figure 8.2 Boxplot comparing ratings given on the Likert scale in the questionnaire for effectiveness, appearance and benefits to wildlife and flood the response category (appearance, benefits to wildlife and effectiveness)

Appendix 4 Q-Sorts for factor 1, 2 and 3 with the natural management schemes in green and 'grey-infrastructure' in grey

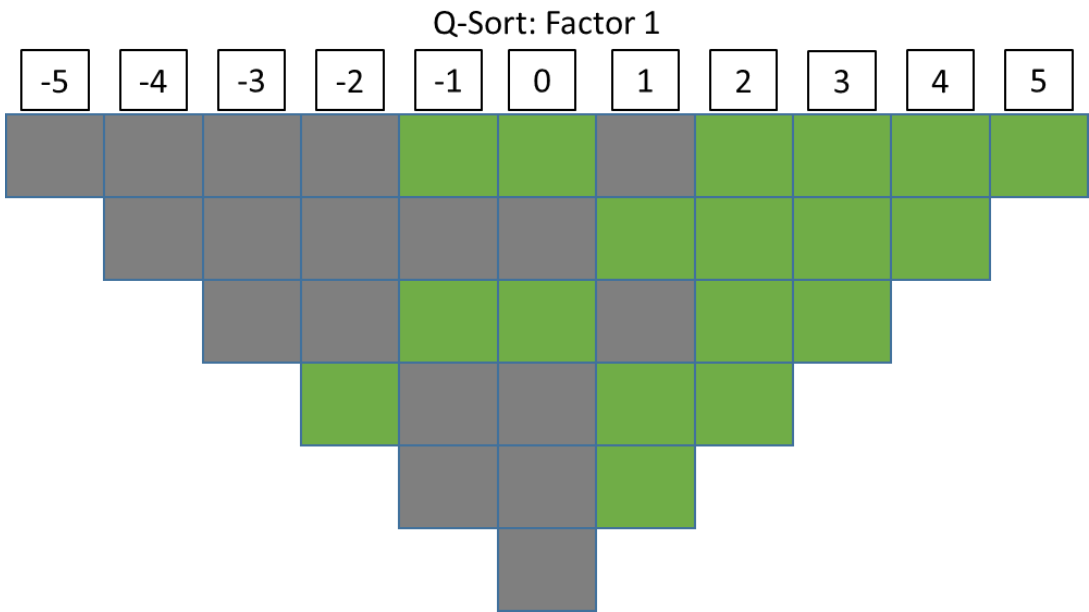


Figure 8.3 Q-Sort for Factor 1 splitting the management schemes into natural management (green) and hard-engineering (grey)

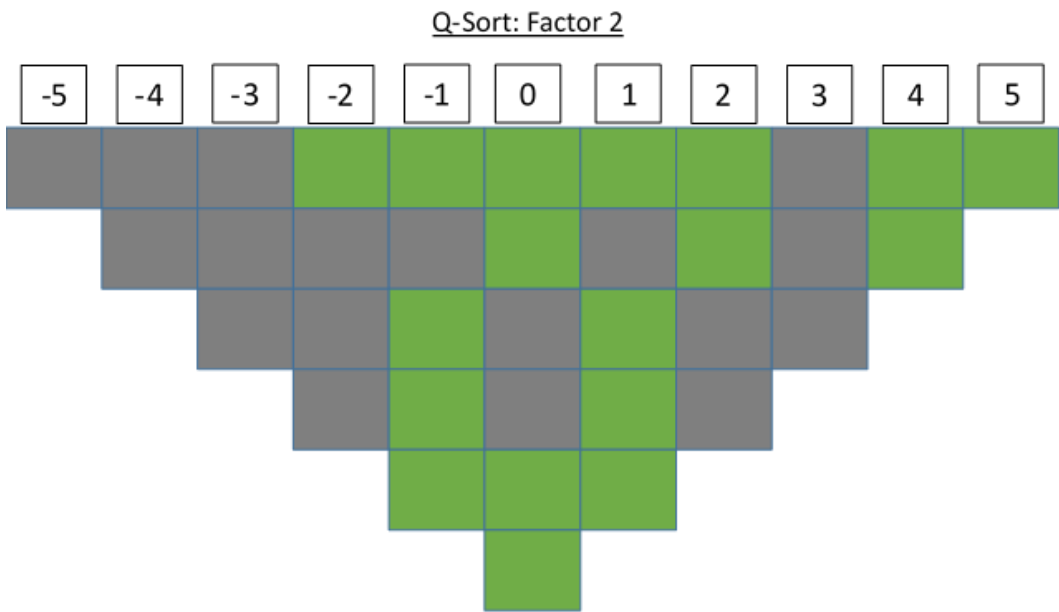


Figure 8.4 Q-Sort for Factor 2 splitting the management schemes into natural management (green) and hard-engineering (grey)

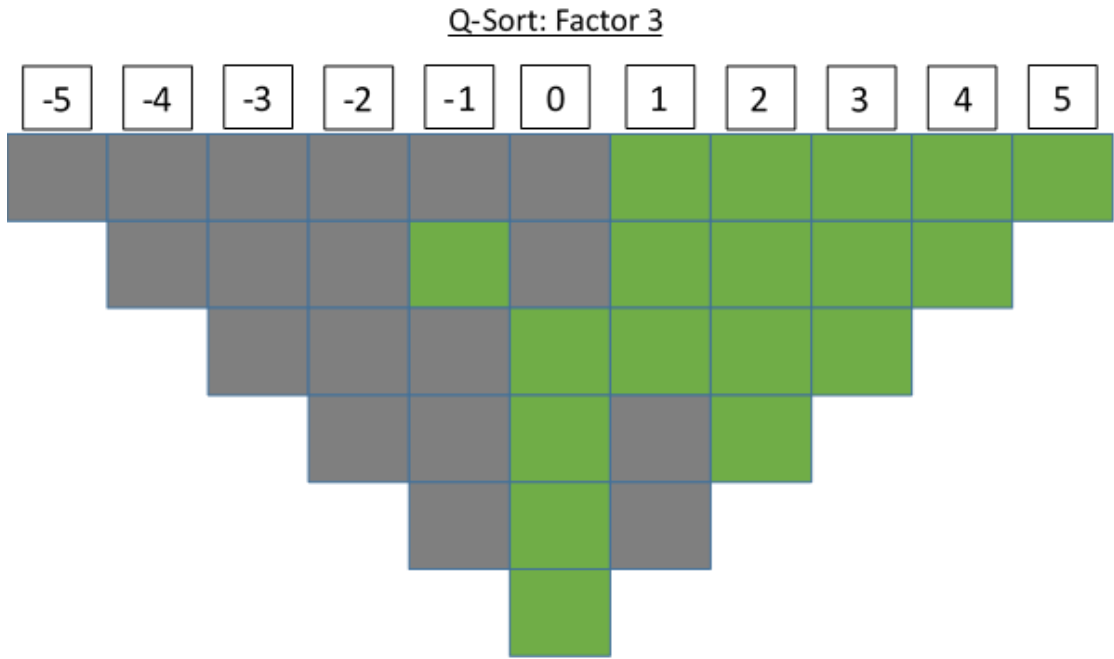


Figure 8.5 Q-Sort for Factor 3 splitting the management schemes into natural management (green) and hard-engineering (grey)

Appendix 5 Table showing the factor loadings of participants for each factor

Table 8.1 Factor loadings for each Q-Sort compared to the factors

Factor 1		Factor 2		Factor 3	
Q-Sort	Factor loading	Q-Sort	Factor loading	Q-Sort	Factor loading
6	0.7179	1	0.5735	3	0.7282
9	-0.7217	2	0.6678	5	0.6171
11	-0.8805	4	0.7266	7	0.6631
12	-0.8747	8	0.7336		
16	0.658	10	0.6512		
17	0.8011	13	0.7195		
		14	0.7503		
		15	0.605		
		18	0.598		

Appendix 6 Table showing the ranking of each image or each factor with the highest rank in bold

Table 8.2 Ranking of each image or each factor with the highest rank in bold

Picture name	Factor 1	Factor 2	Factor 3
Wetland Creation 1	9	7	2
Wetland Creation 2	16	13	4
Wetland Creation 3	10	17	6
Dam 1	31	10	30
Dam 2	28	30	25
Dam 3	25	18	26
Large woody debris 1	4	26	12
Large woody debris 2	2	24	13
Large woody debris 3	1	27	20
Weir 1	36	6	31
Weir 2	26	12	33
Weir 3	20	4	32
Dredging 1	13	34	14
Dredging 2	17	35	22
Dredging 3	11	36	15
Tree Planting 1	15	2	9
Tree Planting 2	6	3	7
Tree Planting 3	14	1	8
Levees 1	19	5	16
Levees 2	21	19	27
Levees 3	23	9	17
Detention Basin 1	30	16	3
Detention Basin 2	24	11	5
Detention Basin 3	22	8	1
Flood Wall 1	33	23	24
Flood Wall 2	35	32	28
Flood Wall 3	34	29	29
Channelisation 1	29	31	36
Channelisation 2	27	33	34
Channelisation 3	32	28	35
Leaky Dam 1	5	21	21
Leaky Dam 2	7	25	23
Leaky Dam 3	3	20	19
Flow deflectors 1	12	22	18
Flow deflectors 2	8	15	11
Flow deflectors 3	18	14	10

Appendix 7 A step-by-step guide of the interviews for the PARM and Q-Method

Interview questions for Q-Method and Questionnaire

1. Consent form and general information
2. Start recording
3. Sort the images into piles best, worst and neutral management scheme
4. Ask why for each of their choices?
5. Sort the images onto the grid
6. Ask the participant to explain their placements and why as they go
7. Take a picture of the q-sort with a post stick note with a number on to match the consent form
8. Name recording
9. Complete Questionnaire

Interview Questions for PARM

1. Consent form and general information
2. Start recording
3. Play the model
4. Development of Keswick
5. Do you know the Keswick area?
6. Play the Storm Desmond section
7. Explain that Storm Desmond is a flooding event that happened in 2015
8. Have you ever been flooded in the past?
9. Play the Management Options
10. For each scheme ask if they know what it is
11. Ask for thoughts on Appearance / Benefits to wildlife / Effectiveness of the scheme for each
12. Name recording