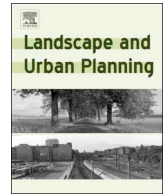




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Research Paper

Former metal mining landscapes in England and Wales: Five perspectives from local residents

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ABSTRACT

This study uses Q Method to examine how those living in former metal mining landscapes value this heritage and their preferences for the long-term management of abandoned mine waste. There are around 5000 former metal mines in England and Wales, many of which are protected for their ecological, geological or cultural value. Q Method is used to examine subjective viewpoints, in this study we asked 38 residents of six mining areas in England and Wales to 'sort' a series of statements based on their resonance with the resident's perspective. The statements covered a range of opinions of the mining legacy, its value and options for its management. This was supplemented with a qualitative questionnaire including their willingness to pay to manage the mining heritage in the long-term. Analysis revealed five perspectives on the mining heritage and differing priorities for long-term management. *Preservationists* felt the mines should be left alone to preserve the cultural heritage, whereas *Nature enthusiasts*, *Environmentalists* and *Landscape lovers* placed different emphasis on restoring the sites for nature conservation, to improve water quality or the visual appearance of the mines. In contrast the *Industry supporters* felt the potential contribution that reworking the mines could make to the local economy should be the priority. This research suggests that the views of local people are varied; they value their mining heritage in different ways and opinion is split on the most effective way to manage these sites especially where there is a need to revegetate or remediate the site.

1. Introduction

The extraction of metals has been essential for technological advancement and economic prosperity. However, this has come at a cost to the environment as mining activities pollute local surface waters and create dusts that can cause adverse health effects in people and ecological systems (Mayes, Johnston, Potter, & Jarvis, 2009; Svobodova, Sklenicka, Molnarova, & Salek, 2012). Mining also has a dramatic visual impact on the landscape, creating large areas devoid of vegetation that are seen as intrusive and unattractive (Svobodova et al., 2012; Wilker, Rusche, Benning, MacDonald, & Blaen, 2016). Although in many developed countries there are now stringent regulations in place that seek to mitigate the impact of mineral extraction, much of these operations took place during the 19th and early 20th centuries. This has resulted in an extensive legacy of metal mine wastes in countries like the UK, Sweden and Canada. Such sites are polluting environmental systems, for example, in the UK it has been estimated that 338 non-coal mines are discharging pollutants (Mayes et al., 2009). The wastes themselves have elevated concentrations of a number of metals

including As, Cd, Cu, Pb, Sn, and Zn often exceeding levels set to protect health (Crane, Sinnett, Cleall, & Sapsford, 2017). These concentrations of metals, as well as the low pH and poor conditions for plant growth, mean that vegetation has often not re-established even after decades of abandonment (Bradshaw, 2000).

The priority for the long-term management of these sites is, therefore, centred on reclamation or restoration geared towards reducing the visual impact of mining and sources of pollution, or mitigating their effects (Svobodova et al., 2012). However, abandoned sites provide unique habitats and are often recognised for their contribution to cultural heritage, with many in the UK being protected as scheduled monuments and World Heritage Sites (Sinnett, 2019). This can create a tension in their long-term management where reclamation of abandoned mines may be to the detriment of these assets. In addition, many of the old wastes are now being re-examined as an opportunity for metal recovery (Bloodworth, Scott, & McEvoy, 2009; Crane et al., 2017).

Decisions about the long-term management of abandoned mines are often driven by environmental protection (Howard, Kincey, & Carey, 2015), with some consideration of the preferences of those visiting

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restored sites (Blaen et al., 2015; Wilker et al., 2016). However, there has been little research on how local residents value their mining heritage and their preferences for its long-term management. This is important as it will be local people who ultimately are affected by both the positive and negative impacts of this legacy as well as any changes to the status quo. It is also essential to ensure that local people are supportive of any plans for the management of the sites, provide a 'social license' to operate (Walsh, van der Plank, & Behrens, 2017), and understand that they can inform this process (Howley, 2011; Svobodova et al., 2012). This paper addresses this gap in our understanding using Q Method (see Section 3.2) supported by willingness to pay to examine the views of local residents in mined landscapes. Specifically, this paper explores the following questions: how do those living in historic metal mining landscapes value them in terms of aesthetic appearance, role in preserving cultural heritage, nature conservation and tourism? What are their priorities for managing abandoned metal mines?

Q Method is used for discourse analysis and allows subjective views to be examined and analysed quantitatively (Watts & Stenner, 2005; Nguyen, Boruff, & Tonts, 2018). Developed in psychology it is increasingly used in environmental and landscape research to examine the different perspectives held by stakeholders (Nguyen et al., 2018). First, a 'concourse' of statements is developed representing the range of opinions on the subject of interest, here we focus on the different values placed on mining landscapes and abandoned metal mines, and the options for their long-term management. This paper, therefore, begins with a summary of the challenges of managing abandoned metal mines, which provides the basis for the 'concourse' of statements used in the Q Method. This is followed by a description of methodological approach to the research. The results of the study are presented as the five perspectives of those living in mined landscapes in terms of the value they place on this heritage and their preferences for its long-term management, supplemented with the findings from an assessment of willingness to pay for different management options. These results are then set in the context of existing literature and the contribution this research makes to informing abandoned mine management.

2. The challenges of managing mined landscapes

Many abandoned mine sites are located in areas associated with an otherwise high landscape quality, outdoor recreation and tourism (Sinnett, 2019). In these landscapes the presence of abandoned mines may be viewed negatively by those expecting what they perceive to be an unspoilt environment (Menegaki & Kaliampakos, 2012; Swanwick, 2009). Although there is a need to manage abandoned mines where they are causing negative impacts to the environment and health, these sites can make an important contribution to nature conservation and cultural heritage as a result of their abandonment (Crane et al., 2017; Howard et al., 2015; Kossoff, Hudson-Edwards, Howard, & Knight, 2016; Sinnett, 2019). Local communities often have strong ties to the mine sites and the industrial heritage that they represent (Swanwick, 2009). Previous mining activity has shaped the landscape in many areas, creating a sense of place (Cole, 2004), which can also generate revenue through tourism (Williams & Shaw, 2009) and engender pride in local history (Cole, 2004). This is recognised formally, either as part of landscape designations that celebrate the relationship between people and their environment (e.g. National Parks), or through specific protections for the mining heritage (e.g. World Heritage Sites, Scheduled Monuments) (Crane et al., 2017; Sinnett, 2019).

The unusual physiochemical characteristics of mine wastes make them suitable for plant species that have developed an ability to survive in these inhospitable environments, including mosses and lichens (Bradshaw, 2000; Tordoff, Baker, & Willis, 2000; Crane et al., 2017). This has resulted in many mine wastes being formally protected, for example in the UK, as Sites of Special Scientific Interest or the priority habitat Calaminarian Grasslands, and in Europe as Special Areas of

Conservation (Sinnett, 2019). The cultural and ecological value of mine sites means that many are managed for recreation (Wilker et al., 2016); either through granting informal public access or transformation to visitor destinations, partly as justification for the initial reclamation but also to generate income for long-term management. These conflicting impacts of mining heritage, on the one hand a source of pollution and scar on the landscape, and the other a remnant of our industrial heritage important for their ecological and geological characteristics pose a challenge to those responsible for this heritage. There is an inherent tension between the different objectives for restoration and long-term management of mine sites.

The absence of vegetation, in particular, increases the negative impact of mining and its re-establishment has often been seen as essential to the restoration process (Bradshaw, 1997; Tordoff et al., 2000; Wilker et al., 2016). There are, however, different approaches to achieving revegetation. In the past a 'technical restoration' was more common, where land was regraded and planted with fast-growing, tolerant plant species to ensure mines quickly blended into to surrounding landscape (Menegaki & Kaliampakos, 2012; Svobodova et al., 2012; Tropek et al., 2012). Indeed, the objective here was often to remove evidence of mining activity as quickly as possible. Although this can be desirable from an aesthetic perspective, it is expensive and difficult to achieve or sustain in the long term, and is often incompatible with nature conservation objectives (Tropek et al., 2012). More recently, a more natural restoration process is favoured in recognition of the benefits of mine wastes for nature conservation, particularly if left to regenerate naturally. Here, the mining topography is retained to some degree, and revegetation is achieved through relying on natural succession or habitat creation (Bradshaw, 1997; Conesa, Schulin, & Nowack, 2008; Tropek et al., 2012; Wilker et al., 2016). This is often more cost effective, and can result in a restoration that is beneficial for nature conservation and recreation, whilst improving the visual amenity of the landscape. However, where abandoned mines are concerned there has been much debate on how to achieve effective restoration without compromising the ecological and cultural value of the sites (Conesa et al., 2008; Mayes et al., 2009; Sinnett, 2019).

The shortage of raw minerals, particularly in Europe (European Commission, 2008), means that new sources of metals are needed and resource recovery from existing wastes is seen as a more sustainable source of metals than new extraction from mineral deposits (Crane et al., 2017; Sapsford, Cleall, & Harbottle, 2017). Given that many mined areas have suffered from significant economic decline since the cessation of metal extraction, this can be seen by some as an opportunity to reinvigorate declining industrial towns, bringing in new jobs and people (Glover, 2014). This creates its own tensions; mineral extraction is often unpopular (Bloodworth et al., 2009), particularly in areas where the landscape is valued and protected (van der Plank, Walsh, & Behrens, 2016), yet nature conservation can be seen as a barrier to economic development (Conesa et al., 2008). Although, mining heritage can generate revenue and create jobs, this is often relatively modest and dependent on other attractions in the area (Conesa et al., 2008). There can also be a complex relationship between local residents and tourism, with many concerned about a dilution of local identity through the creation of visitor attractions (Conesa et al., 2008; Jones & Munday, 2001).

Implicit in the tensions between these differing options for the management of the mining heritage is the role of decision makers and funders. The restoration of mines has been dominated by professionals working in the mining and environmental sectors, potentially to the detriment of recognising their importance for nature and heritage (Howard et al., 2015). A number of studies have examined the preferences of those visiting restored mineral extraction sites (Blaen et al., 2015; Wilker et al., 2016). Yet, unless significant funding is secured through resource recovery or charges to visitors, it is local or national governments that will bear the cost of abandoned mine waste rehabilitation (Mayes et al., 2009) and the management of any assets on site. Despite a requirement for consultation with local communities, local

residents are often not represented in the decision-making process (Landorf, 2009). Residents can be mistrustful of the process (Walsh et al., 2017), or the views of other stakeholders are prioritised leaving residents with limited opportunity to inform the process (Landorf, 2009).

The question of how to best manage the mining heritage is therefore critical with multiple, sometimes competing, priorities being presented by different stakeholders. These different perspectives informed the development of the concourse of statements presented to residents of historic metal mining landscapes to understand how they value this heritage and their priorities for its future management.

3. Methods

The value residents of six historic metal mining landscapes in England and Wales place on their mining heritage and their preferences for its long-term management were examined using the Q Method (see Section 3.2) in a workshop setting. This was supported by a questionnaire, which was used to collect qualitative data from participants related to the Q Method, and their willingness to pay into a hypothetical fund to manage the mining heritage for different objectives.

3.1. Workshop locations

The six locations for the workshops were selected because they are situated in areas with: high levels of previous metal mining activity, representing different commodities (e.g. Au, As, Cu, Sn, Pb, Zn) (Fig. 1); tourism associated with high quality landscapes and the natural environment (e.g. National Parks, Areas of Outstanding Natural Beauty (AONB)) as this is reported to be one source of conflict with the presence of abandoned mines; attractions associated with the mining heritage (e.g. Scheduled Monuments, World Heritage Sites, museums); nature conservation designations specifically related to the metal mining (e.g. SSSIs, SACs) (Table 1). In addition, many mined landscapes are relatively rural and often in areas with a high proportion of holiday homes, or in some cases student populations. Therefore, workshop locations were also selected where there was a suitable venue (e.g. a community hall) and a resident population of at least 500 households within 5 km of the venue.

3.2. Q Method

The Q Method was selected as it is suitable for contentious issues where there is no consensus of opinion (Webler, Danielson, & Tuler, 2009), it is a method for subjective analysis and is effective at ensuring participants prioritise different perspectives (Nguyen et al., 2018). Q Method is a five step process: 1. A concourse of statements, the Q set, are developed representing the breadth of opinion on the subject; 2. Participants, the P set, are recruited based on the objectives of the study; this is normally via purposive and snowball sampling; 3. Participants place the statements on a grid (Fig. 2), the Q sort, based on the degree to which the statement represents their perspective; 4. A factor analysis is undertaken to identify shared perspectives on the subject; 5. Narratives are constructed around these factors (Watts & Stenner, 2005; Živojinović & Wolfslehner, 2015; Nguyen et al., 2018). In contrast to other methods, where statistical analysis examines the relationships between individual variables, generating R values, in Q Method the factor analysis examines the relationships between the ranking of the variables, i.e. the sorts (Watts & Stenner, 2005). As a result, Q Method does not require large numbers of participants (Watts & Stenner, 2005).

Statements were derived by the researchers from the academic and policy literature, as well as articles in the local press from the mining areas. They covered a range of opinions and options on the mining legacy and its management, categorised broadly as: the need to rehabilitate abandoned mine sites; differing priorities for the rehabilitation and management of mine sites; and re-use of abandoned mines, for example for metal recovery from wastes, further mineral extraction, or as visitor attractions.

Initially, 240 statements were identified as representing the breadth of opinion on the mining heritage and its management. These were reviewed iteratively by the researchers using a sampling grid (Webler et al., 2009) to remove repetition between statements, prioritising those with the least technical language, resulting in 67 statements. These statements from the literature were then combined or adjusted, where necessary, to remove technical language or use similar language to convey differing priorities, but otherwise left intact, so that a draft set of 46 statements were selected. A pilot workshop was conducted with six participants to ensure that the method, statements and questionnaire were clear. As a result of this minor changes were made to some statements and others removed to simplify the process and reduce repetition, this resulted in the final set of 33 statements (Table 2).

Q sorts were conducted in a workshop setting, between September and November 2017. At each paired location one workshop was held in the evening (Tavistock, Matlock and Capel Bangor) and the other over the subsequent lunchtime (Redruth, Reeth and Barmouth). The aim was to ensure that workshops were attended by a range of people, rather than those with a specific interest in mining heritage. Therefore, residential addresses were randomly sampled from within 5 km of the workshop venue; from a population varying from around 600 people in Reeth to more than 20,000 in Redruth (Table 1). Initially, 100 invitations were sent out (Tavistock, Redruth, Matlock and Reeth), but participant numbers were relatively low, so this was increased to 150 invitations (Barmouth and Capel Bangor). Two workshops took place in Redruth as the first invitation generated three respondents, two of whom failed to attend the workshop. The second workshop took place in the evening at a different venue, and 200 residents were invited. Residents received an invitation to the workshop, explaining its purpose and a brief explanation of the method. Invitations were written in English for the workshops in England and in both English and Welsh for those in Wales. These were posted out with a pre-paid reply slip, email address and telephone number to reply to the invitation. A £25 voucher was offered to each attendant as an incentive for participation, and a light buffet was provided. The only conditions for attendance were being over 18 years old and a resident of the area for at least two years. Snowball sampling was then used with those residents' who replied to the invitation.

In total 38 residents took part in the workshops. Participants were first given a brief overview of the research question and wider project, followed by an explanation of the Q Method. Participants then spent between 45 and 90 min completing the Q sort individually (Fig. 2). All participants also completed a questionnaire, this asked why they placed statements at the extremes of the grid (i.e. -4, -3, +3 and +4) and any themes that were missing from the statements. In one case a resident had help from a relative to read the statements, and in another a researcher provided assistance in completing the questionnaire to a participant with dyslexia. Statements and questionnaires were provided in English and Welsh as appropriate. A Welsh translator was also provided for those that wanted to speak in Welsh.

Q sorts were analysed using PQMethod v2.35 (<http://schmolck.org/qmethod>). This software was used to conduct a principal component analysis (PCA) with a varimax rotation to examine the distribution of statements. Initially, two to six factor solutions were examined using a pre-flagging, where the software allocates sorts to factors based on their loadings. The number of defining sorts, the correlations between factor scores, and the simplicity and clarity of the narrative between the factors were considered. Following this, five factors, or perspectives, were identified and the analysis rerun, including manual flagging to allocate those Q sorts with a factor loading of greater than 0.41 (Webler et al., 2009).

This analysis was used to construct narratives around the five perspectives residents have of their mining landscapes. These narratives are focussed on the 'defining statements' for each perspective, that were placed in a significantly different location on the grid ($p < 0.05$) compared with the other perspectives. Responses to the questionnaires were used to provide context for the placement of the statements, and greater depth to the perspectives.

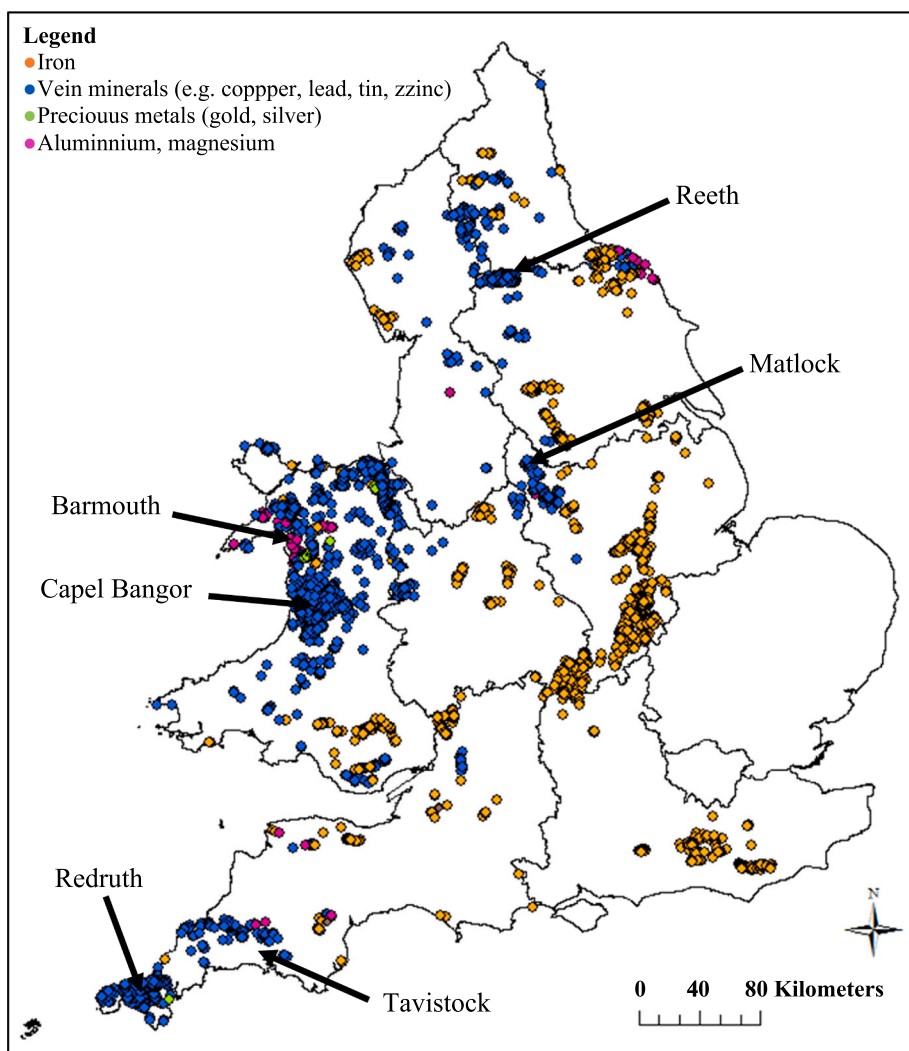


Fig. 1. Locations of workshops in areas of former metal mining (produced using BritPits database; Licence No. 2014/098BP ED British Geological Survey NERC. All rights reserved. Boundary data from UK Data Service <http://census.edina.ac.uk>).

3.3. Willingness to pay for the management of mining heritage

Willingness to pay is a stated preference technique widely used in environmental research to understand the value people place on certain characteristics or features of the environment (Wilker et al., 2016). Here it is used to supplement the results of the Q Method, and provide

some additional indication of the value placed on the mining heritage and the different options for its management based on the priorities outlined in Section 2. Participants were asked, as part of the questionnaire, whether they would be willing to contribute to a hypothetical fund to manage abandoned mine sites. If they answered positively, they were asked how much (in GBP) per month they would contribute to:

Table 1
Location of workshops with residents of former metal mining areas in England and Wales.

Location	Number of households within 5 km ¹ in Royal Mail's Postcode Address File	Mining activity, tourism, heritage	Number of participants
Redruth, Cornwall, England	1st workshop: 21,602 2nd workshop: 24,849	Copper and tin mines, King Edward Mining Museum, Cornwall and West Devon Mining Landscape World Heritage Site, SSSIs related to mining activity	1 7
Tavistock, Devon, England	6840	Copper, tin and arsenic mines, Cornwall and West Devon Mining Landscape World Heritage Site, near Tamar Valley AONB and Dartmoor National Park	3
Matlock Spa, Derbyshire, England	11,617	Lead mines, Peak District National Park, Peak District Dales SAC/SPA and associated SSSIs, Peak District Mining Museum, Derwent Valley Mills World Heritage Site.	5
Reeth, Yorkshire, England	639	Lead mines, Yorkshire Dales National Park, close to North Pennine Moor SPA/SAC (includes Arkengarthdale, Gunnerside and Reeth Moors SSSI and Lovely Seat – Stainton Moor SSSI)	5
Capel Bangor, Ceredigion, Wales	1645	Lead mines	10
Barmouth, Gwynedd, Wales	2061	Lead, zinc, copper and gold mines, Snowdonia National Park	7

¹ Using Royal Mail's Postcode Address File.

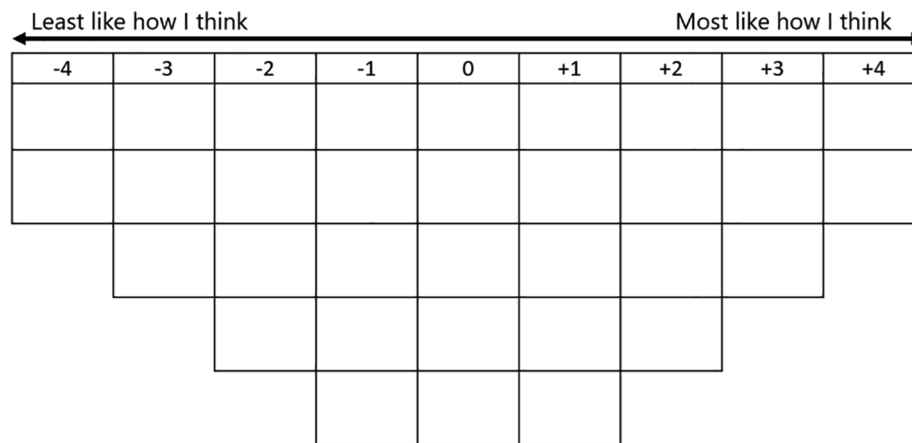


Fig. 2. The Q sort grid (based on Hermelingmeier & Nicholas, 2017).

manage the mine sites as they are; improve access to the sites but leave them largely as they are (e.g. paths, signage); manage the sites so that they are more in keeping with the non-mined landscape; manage the sites to enhance nature conservation; reduce the risk of water pollution; or protect and manage the historic features on the sites. The results of the willingness to pay supplemented those of the Q Method, providing an additional insight into the priorities of the residents regarding the long-term management of the abandoned mines.

4. Results

The analysis revealed five factors, or perspectives, of the residents on the mining heritage and their preferences for its long-term management (Table 2). Together the five perspectives accounted for 57% of the variance and all had at least two Q sorts (i.e. participants; Table 2) loading on to only that perspective suggesting they are stable (Watts & Stenner, 2005). The PCA found that most Q sorts loaded on to at least one perspective (35/38); three did not load on to any, and five loaded on to two perspectives. The five perspectives are described below, focussing on the statements that defined them as distinct from the other perspectives, followed by areas of consensus between them, finishing with the results from the willingness to pay. Codes in parenthesis indicate statement (e.g. S1) or participant numbers (e.g. P1).

4.1. Five perspectives of the residents of mined landscapes

4.1.1. Preservationists focussed on maintaining the status quo

This perspective is characterised by statements recognising the value of the mining landscape for its industrial heritage and, to a lesser extent, nature conservation, as well as a desire to see these sites left alone, and protected, primarily for their heritage value. The defining statements that elicited strong agreement amongst this group included S14 and S27 (Table 2). The preservationists felt that the mining heritage has a beneficial impact on place, suggesting that it is an “integral part of our cultural heritage here (P10)”, and concern that the loss of heritage features would “negatively impact on tourism (P12)”. There was also acknowledgement that difficult choices sometimes have to be made, for example “whilst a priority [cultural heritage] doesn’t mean that conservation should overrule development in every instance but must be carefully considered (P6)”. Preservationists were opposed to further mineral extraction on abandoned sites (S1).

In contrast to the other perspectives, who felt that mineral extraction was an acceptable land use (S12), preservationists were neutral on this point. Yet, they acknowledged the importance of the mining heritage, as one resident explained “mineral extraction is and has been an essential aspect of the development of this landscape, including its architecture, field patterns etc. (P6)”. Despite this, they also felt that the

conservation of nature and cultural heritage should not come at the expense of water quality and that remediation was a priority (S4, S15). The importance of water quality is an area of consensus and is discussed below.

However, the preservationists did not feel that abandoned mines should be the responsibility of the mining industry (S29). There were various reasons given for this stance, including a mistrust in the sector, for example “the mining industry would make a hash of it. They are only interested in profit (P20)”, and “the mining industry has long gone ‘they’ are not around to take care of the mines (P25)”.

4.1.2. Nature enthusiasts prioritised greening

This perspective had some commonalities with the preservationists but with a far greater emphasis on nature conservation and the establishment of vegetation on mine sites. This group expressed strong agreement with statements that were focussed on the contribution mine sites make to nature conservation (S3, S21, S28). Residents in this group were more interested in the restoration of mine sites, feeling that they should not be left as they are and that the re-establishment of vegetation was essential to mitigate the negative impact of mine sites on the landscape. However, their preference was for this restoration to use native species (S24), and involve extensive remodelling of the landscape (S9). As one resident explained “I live near an abandoned mine (Wheat Maid) that was stripped bare and abandoned. Nothing lives in the central area it is so toxic. I was I understand a lovely valley with fields and trees that supported a lot of native species (P38)”.

Nature enthusiasts were relatively ambivalent on the cultural value of the mine sites (S6, S17, S31). They were also less positive about the role of the mines for amenity uses (S11). Interestingly, they did not feel that the sites should be protected for their contribution to nature conservation, perhaps due to a scepticism that they were making such a contribution at the present time, for example “I don’t think they make a contribution to nature conservation and therefore do not need protecting (P25)”.

4.1.3. Industry supporters prioritised the local economy

These residents were supportive of mineral extraction in general and the reworking of mine wastes. They felt that reworking the mines would create jobs and bring in new people to the benefit of the local area (S2, S13). These residents recognised the positive impact of mineral extraction and its role in local economic development, as one explained “More work and more people to spend their money here is always a good thing! (P30)”. However, their qualitative responses suggest that their support is, at least in part, due to the economic decline experienced since the loss of industry as opposed to necessarily being pro-mining. For example, “Cambourne was once an affluent area with South Crofty and Holmans. Taking these industries away has depressed the area

Table 2

Statements and perspective loadings representing an idealised sort. Statements were ranked from least like how I think (−4, darkest red) to most like how I think (4, darkest green). Defining statements and the loading for each perspective are in bold; the consensus statement is italicised (based on [Hermelingmeier & Nicholas, 2017](#)).

Statement	Perspective				
	Preservationists	Nature enthusiasts	Industry	Environmentalists	Landscape lovers
1. Mine wastes should be reworked to extract more metals from the waste.	-3	2	3	0	-1
2. Reworking the mines or their wastes will bring an influx of new people which will be good for the community.	-2	-1	2	-1	0
3. The absence of greenery in large areas increases the negative impact of mine waste on the landscape.	-1	1	-1	0	4
4. The conservation of nature on mine wastes should not compromise water quality.	2	1	1	4	4
5. Further exploitation of the mine wastes should be avoided to preserve the character and unique quality of the area.	1	-2	-3	-2	0
6. Mine wastes always have a negative impact on the landscape.	-4	0	-3	-4	2
7. Mine wastes should be protected for the important contribution they make to nature conservation.	0	-3	-1	2	-2
8. Planting vegetation on mine wastes would improve their aesthetic appearance.	-2	-1	-2	1	2
9. Interventions on mine wastes such as levelling off sites and planting fast growing greenery should be avoided as they are not good for nature conservation.	0	-4	1	-3	-1
10. The development of greenery on mine wastes should be left to natural processes.	1	0	-1	2	-1
11. Those responsible for the future of mine wastes should prioritise recreational opportunities.	-1	-3	0	-1	-1
12. Mineral extraction is unacceptable compared with other land uses.	0	-2	-4	-4	-2
13. Reworking the mines or their wastes will bring jobs which will be good for the community.	-1	-2	4	-1	2
14. Those responsible for the future of mine wastes should prioritise the conservation of the cultural heritage.	2	0	0	-1	1
15. Those responsible for the future of mine wastes should prioritise cleaning up pollution.	1	4	3	4	2
16. It is essential that mine wastes that are important for nature conservation are not destroyed.	2	1	0	3	0
17. The remnants of the former metal mining industry are an important part of the culture, history and identity of this area.	4	0	4	2	3
18. The creation of mining attractions has increased community pride in local history.	0	1	3	-1	1
<i>19. The conservation of heritage features on mine wastes should not compromise water quality.</i>	<i>3</i>	<i>2</i>	<i>2</i>	<i>3</i>	<i>3</i>
20. On site reprocessing of the mine waste to remove metals should be combined with planting greenery on the site.	-1	0	2	0	1
21. Those responsible for the future of mine wastes should prioritise nature conservation.	1	3	-1	0	1
22. The mining heritage does not generate significant economic benefits.	-3	-1	-2	0	-2
23. Heritage-led tourism has resulted in the loss of the local identity.	-3	-1	-4	-2	-4
24. Plants that are native to this area are the best option for the greening of mine wastes.	3	4	-2	2	0
25. Community support for development of mining landscapes for heritage-led tourism should not be taken for granted.	1	1	1	-3	-1
26. Prioritising nature conservation is a barrier that can strangle economic development.	-4	-3	0	1	-3
27. It is essential that mine wastes that are important for the cultural heritage of this area are not destroyed.	3	-2	0	-2	-4
28. To achieve a successful restoration the mine waste has to be remediated and the greenery re-established.	-2	3	-2	-2	-3
29. The mining industry should take care of abandoned mines.	-1	2	2	1	-3
30. The public should not be responsible for funding the management of abandoned mines.	0	2	1	-3	1
31. Mine wastes should be left as they are, as authentic physical environments conveying a sense of place.	2	-4	-1	1	-2
32. The preference of the people living locally should be a significant part of the process for deciding the future of the post-mining landscape.	4	3	1	1	3
33. The future of post-mining landscapes should be shaped by experts.	-2	-1	-3	3	0
Number of sorts	16	6	5	5	8
Percentage of variance explained	19	11	9	7	11

(P37)". Industry supporters recognised that mine wastes were an important part of the cultural heritage and community pride (S18), although they were not necessarily in favour of this being used to prevent exploitation of the wastes (S27). In contrast to the other perspectives, these residents placed little value on the potential for nature conservation associated with mine wastes (S21, S24).

4.1.4. Environmentalists prioritised environment protection

These residents were motivated by water quality and pollution mitigation to a greater extent than the other perspectives. Although not defining statements, the three statements that focussed on addressing pollution were those that most strongly resonated with the environmentalists (S4, S15, S19). They felt that mine wastes would benefit from vegetation establishment and that their current contribution to nature conservation should be recognised (S7, S8).

Despite their concern for the natural environment, environmentalists did not feel that mineral extraction was always unacceptable or that the wastes are detrimental to landscape appearance. The environmentalists felt strongly that the public should be funding the management of mine sites (S30), for example stating "*The public should be prepared to contribute towards gains from well managed sites (P29)*". They also felt that there was community-level support for heritage-led tourism (S25), and were more positive on the impact of experts than the other perspectives (S33), as is discussed below.

4.1.5. Landscape lovers prioritised aesthetics

This perspective recognised the visual impact of the mines and prioritised improving the aesthetic appearance of mine wastes. Here, almost all of the defining statements that best represented their thoughts were concerned with the visual impact of mines or the lack of vegetation on the landscape (S3, S6, S8, S28). As one resident explained, "*Greenery enhances the scenery of all areas and without it, we become bland and grey which therefore will produce a negative impact of the environment (P36)*".

Despite agreeing that vegetation would enhance the appearance of abandoned mines (S8), the landscape lovers did not necessarily see that revegetation was essential to restoration (S28), or that native planting should be prioritised (S24). In common with the preservationists, they did not feel that the restoration of the mines should be the responsibility of the industry (S29), as one resident explained "*Many of the mines are quite old and as a community we are all responsible for the care of abandoned mines (P3)*". They were also more in favour of reworking the mines, recognising the benefit to the local economy (S13), explaining that "*My choices reflect keeping the identity and culture of the mining industry, if it generates jobs without sacrificing negative impact of the countryside is preferred (P35)*". Although, there was some scepticism as to how beneficial this would be "*It won't be jobs for local people. Outsourcing isn't good for the community, it's just transience and upheaval (P19)*".

4.2. Areas of agreement

The previous section focussed on how the differing perspectives of residents are defined. However, there were several areas of agreement. In particular, the analysis demonstrated that the statement '*the conservation of heritage features on mine waste should not compromise water quality (S19)*' was a point of consensus across all the perspectives, with scores of +2 or +3 (Table 2). Similarly, all residents, but particularly the environmentalists, landscape lovers and, to a lesser extent, preservationists felt that nature conservation should not compromise water quality (Table 2). These statements elicited a strong reaction from residents, who stated that, for example, water quality "*should never be compromised (P20)*" and that the "*cleaning up pollution has to be the main starting point to any reworking (P25)*". Other areas of agreement included using native plant species in the restoration of mine wastes and the importance of historic mining features to the identity of the area.

Another area of agreement was the importance of local people in the

decision-making process for the future of the mines (S32). Here, preservationists, nature enthusiasts and landscape lovers felt this statement most closely aligned with their views. Some residents pointed towards local people's longer-term relationship with the area as they "*...live, bring up families and their well being and future safety has to be of consideration (P24)*". Whilst others alluded to the residents' having a greater understanding of the local context: "*Really important issue of cultural history (P13)*" in contrast to experts who "*are unlikely to have the cultural history as their first priority (P13)*". Others were conditional in their preference for local people to have a role "*...as long as they are well informed (P29)*" and recognised that "*Local people should have a view but decisions need to take into account the wider regional and national interests (P12)*". Related to this, all perspectives, with the exception of the environmentalists, were reticent about the role of experts (S33). Some questioned the priorities of experts, as one resident asked "*Experts with what remit?! Obviously, experts are a flawed concept in many cases. (P14)*", whilst others highlighted the importance of involving locals with expert evaluations "*With advice from locals (P1)*", suggesting that it "*Won't work otherwise (P10)*". In contrast, the environmentalists valued the role of experts, with locals, in shaping the future of the mines: "*I believe that expert knowledge is very important, but the range of expertise is crucial, and that they work collaboratively with local people (P6)*".

4.3. Willingness to pay

The majority of participants were not willing to contribute to a hypothetical fund to manage the abandoned mines. In total 11 out of 38 participants (29.7%) indicated that they would be prepared to contribute to such a fund, with one participant not answering this question. Those that were prepared to contribute were split between the different perspectives: four preservationists (4/16), two nature enthusiasts (2/6), one each of the environmentalists (1/5) and landscape lovers (1/8), and no industry supporters said they would be prepared to contribute. Interestingly all three of the residents who were not placed in any group said they would contribute (Table 3). Although there were very few willing to contribute to such a fund, the results for the willingness to pay are largely in agreement with the Q sorts; for example, the preservationists are more prepared to contribute to activities that seek to maintain the status quo and protect historic features on the sites and the nature enthusiasts to manage them for nature. As indicated by the consensus in the statements regarding the importance of reducing water pollution, residents across the perspectives were prepared to contribute to this endeavour (Table 3).

The sums people are willing to contribute are relatively small, and several of the residents commented that their retired status reduced their ability to make a financial contribution. Several also indicated that they were already making a contribution via other mechanisms: "*I do not feel in a position to contribute beyond my current subscription to the Peak District Historical Mines Society who are engaged in these activities (P6)*".

5. Discussion

There are multiple objectives concerning the long-term future of abandoned metal mines in England and Wales. These are often driven by the disciplines involved in decision making with environmental concerns for water quality often taking precedence over the cultural and ecological assets on these sites (Howard et al., 2015). As far as we know our study is the first time the residents' perspectives of mined landscapes have been explored in the context of these multiple objectives. Here, we demonstrate that residents of these post-mining landscapes also exhibit differing perspectives on this heritage and the priorities for its future management, however there are some areas of consensus.

Table 3
Extent to which residents are willing to contribute to a hypothetical fund for the management of former metal mines.

Management option	Number (average amount per month) of participants prepared to contribute for each perspective						
	Overall	Preservationists	Nature enthusiasts	Industry supporters	Environmentalists	Landscape lovers	No perspective
To manage the mine sites as they are	4 (£5.50)	3 (£6.67)	1 (£2.00)	0	0	0	0
To improve access to the sites but leave them largely as they are (e.g. paths, signage)	4 (£3.50)	2 (£5.00)	1 (£2.00)	0	1 (£2.00)	0	0
To manage the sites so that they are more in keeping with the non-mined landscape	2 (£7.00)	0	1 (£4.00)	0	0	0	1 (£10.00)
To manage the sites to enhance nature conservation	8 (£11.19)	2 (£5.00)	2 (£3.50)	0	1 (£0.50)	1 (£10.00)	2 (£27.50)
To reduce the risk of water pollution	9 (£11.56)	2 (£30.00)	2 (£1.50)	0	1 (£3.00)	1 (£10.00)	3 (£6.67)
To protect and manage the historic features on the sites	8 (£5.69)	3 (£6.67)	2 (£1.50)	0	1 (£0.50)	1 (£10.00)	1 (£5.00)

5.1. Areas of consensus between the perspectives

Although most strongly expressed by the preservationists, all the perspectives we identified recognise the importance of the physical evidence of the mining heritage. Other studies have reported that, for example, vernacular architecture can positively influence the landscape (Svobodova et al., 2012) and increase place attachment (Stefaniak, Bilewicz, & Lewicka, 2017). There was also broad agreement that mining heritage increased pride in the area and positively impacted on the local economy. Other commentators have reported that initiatives focussed on local history can enhance place attachment (Stefaniak et al., 2017). Another area of consensus across the perspectives was the importance of managing the pollution associated with metal mining, particularly where there is an impact on water quality, as is the case in many abandoned mines in England and Wales (Mayes et al., 2009). This is often a cause of concern in communities where extractive industries are proposed (Nguyen et al., 2018).

5.2. Areas of divergence between the perspectives

Despite some consensus that the mining heritage is important, residents differ on how this should be prioritised against other considerations. The lack of vegetation on mined sites evokes negative impressions of landscape quality (Svobodova et al., 2012), with the degradation of the landscape often being viewed as the most significant detrimental impact of mineral extraction (Damigos & Kaliampakos, 2003). Three perspectives in our study focussed on the negative appearance of abandoned mines, yet differed on how this could be mitigated. The nature enthusiasts expressed a tendency towards restoring the landscape to its pre-mining condition, with more natural landscapes being preferred to those that appear managed, as is the approach in restoration projects (Bradshaw, 1997; Svobodova et al., 2012), where restoration for nature is often supported (Wilker et al., 2016). Similarly, the environmentalists prioritised the revegetation of the mines, yet were more positive about the role mining has had in shaping the landscape, recognising the current ecological value of abandoned mines. This suggests a certain pragmatism to the role of the industry on the economic development of the area, as long as appropriate mitigation is in place to protect the environment. Although it has been reported that mine wastes are often viewed as a negative addition to the landscape (Svobodova et al., 2012), the landscape lovers were the only perspective to agree with this sentiment. The focus of reclamation after mineral extraction is often on restoring the visual quality of the landscape (Menegaki & Kaliampakos, 2012; Tordoff et al., 2000), but the landscape lovers did not necessarily feel remediation was required to achieve this or that nature conservation should be the primary motivation. This perhaps suggests that the contribution the mines make to a sense of place is more important to the landscape lovers, than ensuring a more naturalistic landscape (Beery & Wolf-Watz, 2014).

Some of the perspectives elicited further differences in priorities. For example, the environmentalists did not feel that recreational uses should be a priority for the sites, which may reflect the tension between nature conservation and access for amenity uses (Selman, 2009). The built infrastructure of many abandoned mines is significant and many are protected for their heritage value (Crane et al., 2017; Sinnett, 2019), which the preservationists prioritised. This can represent a challenge to restoration, especially where substantial remodelling of the sites is proposed as this may disrupt the positive qualities of place (Devine-Wright & Howes, 2010).

With the exception of the preservationists, all perspectives felt that mineral extraction was an acceptable land use. Despite this, only industry supporters and, to a lesser extent, landscape lovers were open to the prospect of reopening and reworking the mines, although residents appeared more supportive if this were combined with restoration. Indeed, many rural areas are more dependent on tourism as traditional industries have declined (Williams & Shaw, 2009) and therefore

welcome the opportunity for job creation that reworking the mines may bring (Glover, 2014).

5.3. The role of local people and experts

All perspectives felt that local people's preferences should be a priority in the decision-making process, with some qualitative responses pointing to a scepticism that experts or the mining industry would act in the interests of the community. This scepticism is common in communities where mining is planned; who often feel that mining will not benefit them personally (van der Plank et al., 2016; Nguyen et al., 2018), and areas where there is perceived to be a disruption to place attachment (Devine-Wright & Howes, 2010). It is widely recognised that meaningful public participation is key to ensuring the support of the community (Svobodova et al., 2012; Howley, 2011) and securing a 'social license to operate' (Walsh et al., 2017). However, experience of local residents of consultation activities can be negative, and is likely to contribute to a mistrust of experts (Walsh et al., 2017; Nguyen et al., 2018). Certainly in our study, only the environmentalists felt that experts should shape the future of the mining landscapes. Mistrust of mine operators from local communities, particularly with regard to site rehabilitation is common (van der Plank et al., 2016; Walsh et al., 2017; Nguyen et al., 2018). In her review of the management plans of six World Heritage Sites, Landorf (2009) found that major stakeholder groups were often prioritised over local communities for consultation, with an assumption that residents share the aspirations of those managing the sites. Our study demonstrates that residents' preferences and priorities are varied and cannot be assumed.

The environmentalists also differed from the other perspectives in that they felt that the public should fund the management of the mines; a view shared by visitors to restored mineral extraction sites (Wilker et al., 2016). Despite this only one environmentalist indicated that they would be prepared to contribute to a fund to manage the sites. Overall, the proportion of residents willing to contribute to such a fund was relatively low, irrespective of perspective. Although the proportion of residents willing to contribute is less than that reported elsewhere, there is agreement that the objective of restoration influences the willingness to pay (Damigos & Kaliampakos, 2003; Wilker et al., 2016). For example, Wilker et al. (2016) reported that 79% of visitors would pay a single payment to restore a former quarry for nature, but only 21% would contribute if the site was to be restored to unmanaged woodland. In our study, the qualitative responses suggest that some of those indicating they were unwilling to pay may not be 'true zeros' as they cannot afford a regular commitment, or they may be 'protest zeros' concerned over the mismanagement of funds or a belief that the state or mining companies should pay (Damigos & Kaliampakos, 2003).

5.4. Limitations

There are a number of limitations to the study, and the use of Q Method. Participants are constrained by the statements offered (Živojinović & Wolfslehner, 2015). In our study the statements were drawn from an extensive review of academic and practice literature, as well as local press, to ensure that they were representative of the breadth of management options for abandoned mines. Participants were asked in the questionnaire if there were any areas that had been missed from the statements; the responses suggested that the range of statements offered allowed them to represent their views. Further, Q Method is criticised for its lack of generalisability and reliability (Živojinović & Wolfslehner, 2015). Our study met the criteria set by Watts and Stenner (2005) for the selection of factors; all perspectives had at least two defining Q sorts, and the explained variance was over 40%. Both limitations can be mitigated by combining Q Method with other qualitative techniques, such as focus groups, or those used in decision making (e.g. Multi Criteria Decision Analysis) (Živojinović & Wolfslehner, 2015) and future research could further explore the perspectives of the residents of mining landscapes using mixed methods.

6. Conclusions

This study demonstrates that many residents view their mining heritage positively for its contribution to place, culture and nature conservation. There has been little previous research on the value residents place on this heritage, particularly on how they prioritise competing objectives for the long-term management of the sites. This research addresses this gap in our knowledge and also considers residents' perspectives on the relatively recent global interest in extracting metals from mine wastes. We found that although it is likely that the majority of residents will view metal recovery from wastes or the reopening of mines negatively, they are also concerned about the adverse impact on water quality and the lack of vegetation on many sites. There is almost universal agreement that cleaning up pollution is a priority on the sites, particularly if this is sensitive to any cultural heritage, and combined with high quality restoration that includes vegetation establishment. This is an important finding as it suggests that residents may be more accepting of resource recovery if it is used as a mechanism for remediation and restoration. However, residents highlighted that their previous experiences have created feelings of mistrust towards experts and mineral operators, and residents are sceptical that any new activity will benefit them or their community. Only a small number valued the economic benefits that reworking the mines or their wastes may bring to the area as the primary objective for reworking the mines.

Interestingly, residents seemed less concerned with ecological objectives *per se* than they were with increasing vegetation cover and restoring the landscape aesthetics, expressing some scepticism as to their current ecological value. Given that many former metal mines have been left to regenerate naturally and are protected as important ecological and geological resources, more effective communication between expert stakeholders and residents should focus on understanding the different contributions they make to the area. This will inform a long-term strategy that seeks to acknowledge and balance competing needs, prioritising water quality improvement and sensitive restoration. There are thousands of abandoned metal mines globally, the wastes of which are now being re-examined for their potential economic value. This research contributes to our understanding of how residents in these landscapes value their heritage and the conditions that may be required for them to accept further metal extraction from these sites.

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Appendix A. Supplementary data

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