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Using secondary data to analyse socio-economic impacts of water management actions

Emma L Westling[1*], David N Lerner[1], Liz Sharp[2]

[1*] Corresponding author: Catchment Science Centre, Kroto Research Institute, University of Sheffield, North Campus, Broad Lane, Sheffield, S3 7HQ, U.K.

Telephone: 0114 2225734. Fax: +44 (0)114 222 5701.

Email: e.westling@sheffield.ac.uk

[2] Division of Archaeological, Geographical and Environmental Sciences, University of Bradford, Bradford, West Yorkshire, BD7 1DP, U.K.

Abstract

This paper provides an analysis of the socio-economic impacts of river restoration schemes, and is novel in considering how a wide range of socio-economic variables can be used to understand impacts on the entire resident population within an area. A control-impacted approach was applied to explore differences in socio-economic characteristics of areas within which a restoration scheme had been carried out compared to areas without such a scheme. The results show that significant differences exist between control and impacted areas for a range of socio-economic variables. However, due to constraints in the methods and the data available, there are currently limitations in the extent to which socio-economic impacts of river restoration schemes can be fully explored. Additional datasets that become available in the future may increase the ability to detect associations between improvements in the water environment and socio-economic benefits. However, whilst the secondary data used in this paper are potentially powerful, they should be used alongside other techniques for assessing the impacts of decisions as part of future frameworks to deliver sustainable water management.

Keywords: Sustainable water management, River restoration, Census data, The Index of Multiple Deprivation, Control-impacted analysis

1. Introduction

Sustainable and integrated approaches to water management are starting to gain recognition and acceptance among water managers as a route to more effective decisions (Galaz, 2007). Consequently, there has been a clear change in water policy, moving away from managing water in a fragmented way and towards more holistic approaches (Hooper, 2003; Steyaert and Olliver, 2007). An example of this change can be seen in the EC Water Framework Directive (WFD) which was transposed into UK law in 2000 (EC, 2000). The aims of the WFD include securing 'good' ecological and chemical status for all surface water bodies, and good chemical status for all groundwater bodies, by 2015. More interestingly, the holistic approach embodied by the WFD opens up new possibilities for future water management by requiring the water environment to be managed in an integrated way. Such a management approach should be in line with Meyer's (1997) definition of a healthy ecosystem as "sustainable and resilient, maintaining its ecological structure and function over time while continuing to meet societal needs and expectation". Hence, the costly and ambitious implementation of the WFD should aim to generate multiple environmental, social and economic benefits, and not only to achieve good ecological status (Wharton and Gilvear, 2006). These multiple benefits may include outcomes such as greater community well-being arising from a more amenable local river environment.

Despite increased pressure for sustainable water management, and new holistic policy approaches such as the WFD, environmental, economic and social impacts are currently not integrated in a way that will meet this demand (Pahl-Wostl, 2007). In particular,

social impacts are often neglected (Hooper, 2003; Eden & Tunstall, 2006), and little consideration is given to determining whether social gains have resulted from water management decisions and actions (Hooper, 2003). To achieve sustainable water management and fulfil the objectives of the WFD, on-the-ground implementation must be aligned with higher-level aspirations. However, contemporary implementation of many aspects of water management continues to be opportunistic rather than strategic, with clearly stated objectives, monitoring and post project appraisals largely absent (Skinner and Bruce-Burgess 2005). Such opportunistic approaches might be less likely to prioritise social and economic components, and decisions potentially more likely to be driven predominantly by technical and ecological aspects of the water environment. The aspiration of the WFD to implement holistic decision making and actions could be a key driver in moving away from opportunistic and towards more strategic water management approaches.

Evidence of the social and economic benefits derived from water management actions would help to support the development of strategic approaches to their implementation, and would help to ensure that social and economic objectives were prioritised alongside environmental goals in sustainable water management. There is some emerging evidence to suggest that improvements in the water environment can result in a variety of social benefits, such as increased recreational use of the environment, increased aesthetic values, increased local pride and reduced stress levels (see Tapsell, 1995; Tunstall et. al, 2000; Jungwirth et al., 2002; EA, 2006; Gobster et al., 2007). These observations are often based on surveys (see for example EA, 2006), which, although valuable, are often time consuming and costly to carry out. Water management actions

82 also have the potential to influence other areas of the socio-economic system, such as
83 the demographic, income or education characteristics of the resident population.
84 Demographic change due to a changing local environment has been subject to a range of
85 studies. Smith and Phillips (2001) concluded that 'green' residential space was a key
86 driver of in-migration to an area, and consequently caused socio-economic change in
87 the characteristics of the resident population. Similar observations were made by
88 Paguette and Domon (2003) who showed that the attractiveness of a landscape had
89 strong associations with in-migration flows and changes in the composition of the rural
90 community. Examples of such links can also be found in urban environments. For
91 example, Sieg et al. (2004) studied the impact of improvements in air quality on land
92 value and population change. They concluded that significant price increases could be
93 detected in properties in communities with substantial air quality improvements, relative
94 to communities with marginal improvements in air quality. Banzhaf and Walsh (2008)
95 also found strong links between improvements in environmental quality and changes in
96 local community demographics. Such research begins to suggest that improvements in
97 water environments not only have the potential to improve amenity values for the
98 resident population, but in the long term also have the potential to impact a range of
99 socio-economic factors, such as demographics, both in rural and urban areas. If these
100 wider socio-economic impacts are not understood in the context of environmental
101 processes, then this is likely to limit the understanding of ecosystems and of ecosystem
102 change in itself (Lazo et al., 1999 as cited in Habron et al., 2004; Eden & Tunstall,
103 2006). In contrast, if social dynamics are understood in the context of water
104 management, this could highlight key decision-making points and define activities

105 needed in order to successfully implement sustainable water management (Habron et
106 al., 2004), and to deliver multiple benefits from such activities.
107
108 Whilst survey methodologies have been used to detect impacts such as increased
109 amenity values or improved aesthetic quality of a river environment (Tapsell, 1995;
110 Gobster and Westphal, 1998; Tunstall et. al, 2000,) other methodologies are potentially
111 suitable for exploring long-term, large-scale effects, such as those resulting from
112 demographic changes as described above. Secondary data, i.e. data already available but
113 originally collected for other purposes, could potentially underpin such methodologies.
114 These data are often collected over long time periods allowing more gradual change,
115 such as that associated with in-migration, to be detected. They also cover a broad set of
116 socio-economic variables and capture a large proportion of the resident population
117 across national scales. Therefore, secondary data could be used to detect impacts, and
118 also to compare these impacts, across a large number of water management activities.
119
120 The aim of this paper is to develop a methodology using secondary data that enables the
121 social-economic impacts associated with water management actions to be explored. A
122 further aim is to apply this methodology to one set of actions, namely river restoration.
123 As a result of this work, the limitations and opportunities offered by secondary datasets
124 will also be examined.
125
126
127
128

2. Methodology

2.1 Datasets

A wide range of socio-economic data are available in the UK, which is the case study area used in this paper. The primary body responsible for collecting, analysing and presenting socio-economic data is the Office for National Statistics (ONS) for England and Wales, the General Register Office for Scotland (GROS) and the Northern Ireland Statistics & Research Agency (NISRA) for Northern Ireland. The most complete and significant socio-economic dataset in the UK is derived from the UK Census, which counts all people and households within the UK every ten years. The data cover information about the population in terms of housing, health, employment, transport, and ethnic groups, and are provided at national, regional and local scale (ONS, 2008a). Other socio-economic data such as crime, employment and health statistics can be derived from various UK governmental departments and local authorities. In contrast to the Census, these other data are updated on a more frequent basis, often annually or every second year. However, they are often not available at the same spatial resolution as the UK Census data.

Since socio-economic data include a wide range of variables, the sources of the data are often fragmented, the data are collected at different temporal and spatial scales, and for different purposes. As a consequence, socio-economic data derived from different sources can be difficult to compare. To overcome this problem, attempts have been made to combine different socio-economic data from different sources into coherent

153 datasets or indices and classifications. The two most complete and commonly used
154 indices in the UK are the 2001 Census Output Area Classification (OAC), and the Index
155 of Multiple Deprivation (IMD). The OAC and the IMD cover a wide range of socio-
156 economic variables, and serve as the basis for exploring the socio-economic
157 characteristics of a population in this paper.
158
159 *2.1.1 The 2001 Census Output Area Classification*
160
161 The OAC is the first freely available social classification covering the whole of the UK.
162 The spatial resolution of the data used in the classification is based on Output Areas
163 (OAs), which are the smallest geographical units for which 2001 Census data are
164 available (Vickers et al., 2005). The OAs are built from several postcode areas and are
165 designed to contain roughly equal numbers of people (ONS, 2008b). In the UK there are
166 223,060 OAs, and on average each OA contains 110 households and 264 people
167 (Vickers et al., 2005). The OAC is based on five main categories: Demographic
168 Structure; Household Composition; Housing; Socio-Economics; and Employment.
169
170 When initially developed, the aim of the classification was to use as few Census
171 variables as possible that adequately represented these domains. All Key Statistics (94
172 variables), the first statistics to be released at OA level, were initially considered for use
173 in the classification. Some variables were merged together and some were removed due
174 to high correlation, which resulted in a final set of 41 variables that were used to
175 produce the five categories described above (Vickers et al., 2005).
176

2.1.2 The Index of Multiple Deprivation

The Index of Multiple Deprivation (IMD) is available for England, Wales, Scotland and Northern Ireland. Even though some variability occurs across the indices in the different countries, in general they draw upon similar indicators. However, in this paper the IMD for England is used as an example, and will therefore be explained in more detail below.

The IMD is partially based on Census data, but uses a combination of Census data with further data derived from other sources such as the Inland Revenue, the Department of Health and the Department of Transport. The purpose of the IMD is to measure multiple deprivation at the small area level to identify the most disadvantaged areas in England (Noble et al., 2004). The index provides a total measure of deprivation, based on seven different domains which are summarised in Table 1. In addition to a total deprivation score, measures for each deprivation domain are also available. To create the total IMD score the deprivation domains were assigned different weights (Noble et al., 2004) as shown in Table 1.

200 Table 1. Summary of the seven domains constituting the Indices of Multiple
201 Deprivation (IMD), and the weight used for each domain in calculating the final IMD
202 score.

Indices of Multiple Deprivation (IMD)	
Domain	**Weight (%)**
Income deprivation	22.5
Employment deprivation	22.5
Health deprivation and disability	13.5
Education, Skills and Training	13.5
Barriers to housing and services	9.3
Crime	9.3
Living Environment deprivation	9.3

203

204 The IMD is based on data derived from Super Output Areas (SOAs), which are built
205 from groups of the OAs described above (see Figure 1). There are approximately 4-6
206 OAs within each SOA, and they are designed to be consistent in population size. On
207 average each SOA contains 1500 people (ONS, 2008c). The IMD is available in two
208 forms. Firstly as a rank, which shows how an individual SOA compares to other SOAs
209 in the country, and secondly as an absolute score (Noble et al., 2004).

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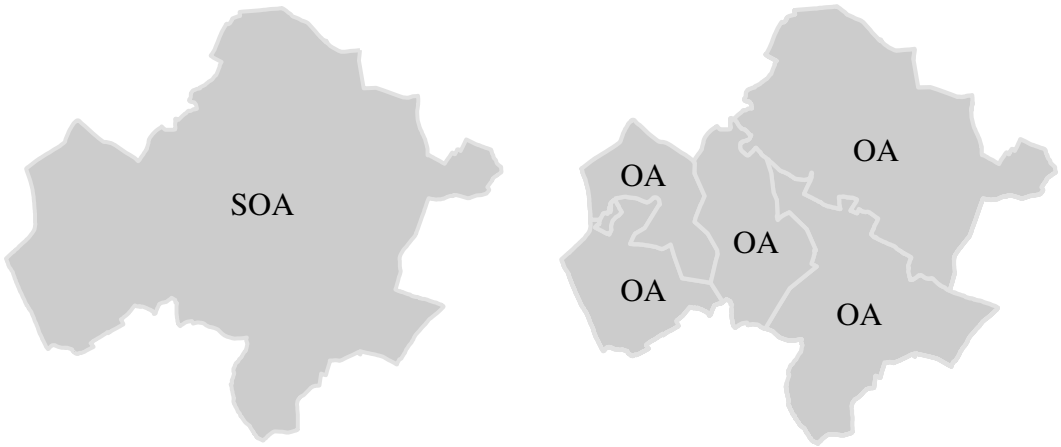

217 Figure 1. One SOA (a) and the same SOA built from five OAs (b).

218

2.2 Developing a methodology to investigate the socio-economic impacts of water management actions

Two commonly used approaches that can be applied to evaluate the impact of environmental management actions are the "before-after" approach, and the "control-impacted" approach (Osenberg and Schmitt, 1996). In a before-after approach the indicators, such as those related to socio-economic characteristics, are measured before and after the action of interest. The before scenario is used as a control against which the effects of the after scenario are compared. However, the limited timescale over which suitable socio-economic data are currently available in the UK does not generally allow an analysis of an area before and after the implementation of many water management actions. Some datasets have only been collected over relatively short periods of time, for example data for the IMD that are comparable over time are available for 2004 and 2007 only. Other data, such as that derived from the Census, have been collected over much longer periods of time, but the data released from each individual Census are not currently comparable.

Instead of comparing a set of indicators before and after an action, the control-impacted approach compares outcome indicators for an area within which an action has occurred, against outcome indicators in a control area without the action. Since the control-impacted approach compares areas with and without the management action at a specific point in time, the socio-economic datasets available in the UK are suitable for this type of analysis. The analyses in this paper are therefore based on the control-

242 impacted approach. This approach is a common field assessment approach, and is
243 widely used in monitoring activities (Osenberg and Schmitt, 1996).
244
245 *2.2.1 Focus on river restoration schemes*
246
247 Water management potentially includes a wide range of actions and decisions affecting
248 the water environment. At one extreme, implementation of international regulation,
249 such as the WFD, can be envisaged. At the other end of the extreme, water management
250 can include local actions such as introducing a fish pass to a weir to allow easier
251 passage of fish along a river. The difference in character and spatial and temporal scale
252 between different water management actions will have significant implications for how
253 suitable different secondary data are for analysing socio-economic impacts of particular
254 actions. A specific dataset that is suitable for analysing the impacts of one action may
255 not be useful for analysing the impacts of a different action. This paper will focus on
256 one common type of water management action, and develop and apply a methodology
257 to analyse the resulting socio-economic impacts.
258
259 The example that will be taken is river restoration, decisions about which are often
260 taken at the regional or local level. River restoration is defined as return to a pre-
261 disturbed state (Cairn, 1991 as cited in Wharton and Gilvear, 2006). So defined, river
262 restoration is often unachievable in many parts of Europe as rivers have been
263 substantially altered over many centuries. However, since river restoration is the most
264 common term for activities involving some form of re-naturalisation of the river it will
265 be used in this paper. River restoration is taken here to include a broad suite of activities

266 taking place within a river or the associated floodplain, which seek to improve the
267 environmental quality of the river. Such activities may include the introduction of
268 secondary channels, fish passes on weirs, or the reconnection of rivers to their
269 floodplains. The number of examples of river restoration schemes has increased
270 substantially in the UK over the last ten years, and this increase is likely to continue into
271 the future, not least because of the potential of river restoration to be employed as a
272 management action to deliver the objectives of the WFD (England et al., 2007).
273
274 River restoration is a particularly relevant water management action to analyse since the
275 schemes often claim to deliver multiple gains, including social and economic benefits
276 alongside environmental improvement (Tunstall et al., 2000). However, the evidence to
277 support such claims has not yet been thoroughly tested. This is primarily the result of
278 the lack of post-project monitoring and appraisal associated with many river restoration
279 schemes (Bernhardt et al., 2005), a feature that is certainly true for socio-economic
280 impact analyses (Purcell et al., 2002). One objective of the analysis described in this
281 paper was to evaluate whether evidence could be derived from secondary datasets to test
282 the claims that socio-economic benefits result from river restoration schemes.
283
284 *2.2.2 The Don as demonstration catchment*
285
286 The analysis of socio-economic impacts of river restoration reported in this paper is
287 based on eleven restoration schemes and associated control sites in the Don catchment
288 in the north of England (see Figure 2 and Table 2). The Don catchment covers an area
289 of approximately 1700 km^2 and has a diverse topography with the higher altitude, steep

valleys of the Peak District in the west contrasting with the low-lying floodplains in the east. Most of the catchment area is densely populated with a total population in the catchment of approximately 1.5 million people. The main rivers in the catchment are River Don (114.1 km), River Dearne (51.9 km) and River Rother (50.8 km) (EA, 2003).

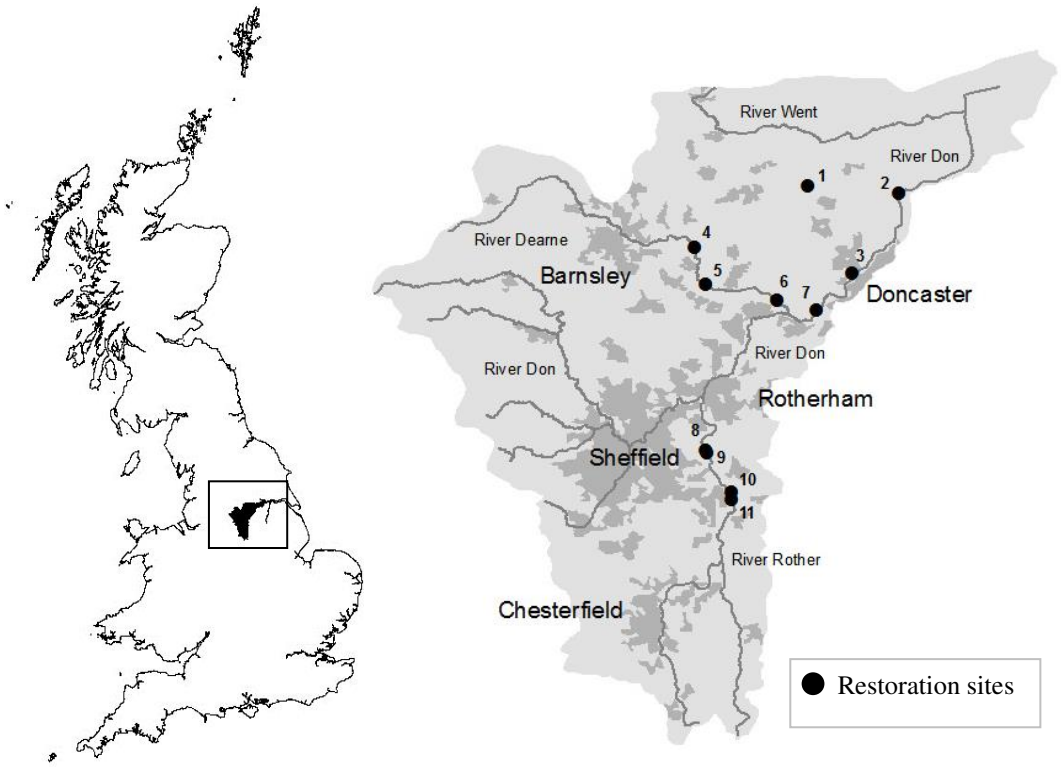

Figure 2. River restoration schemes in the Don Catchment. Note that the location of some sites is obscured by close proximity to others in Fig. 2.

2.2.3 Selection of river restoration schemes

Two approaches to selecting sites for analysing socio-economic impacts of river restoration schemes were considered. The first route was to include a smaller number of

schemes that were very similar in character, whilst the second route was to include a larger number of schemes but covering a broader range of type of scheme. The latter route was chosen in this paper in order to include a representative sample of restoration schemes within the Don catchment. The eleven restoration schemes analysed in this paper cover a continuum from small scale projects, such as the introduction of a fish pass or remeandering of a stretch of the river, to larger scale wetland and nature reserve creation. However, the majority of the schemes analysed in this paper were carried out at the river reach scale, rather than at larger scales. It might be assumed that larger scale river restoration schemes such as a wetland creation could have a larger impact on socio-economic characteristics than smaller schemes. However, social impacts may still be expected even from schemes where the 'physical' modification to the river is relatively small (Tapsell, 1995). For example, the installation of a fish pass on a weir is designed to 'restore' a far larger area of the river than is affected by the physical structure itself. By enabling free passage of fish upstream and downstream, more extensive and sustainable fish populations are expected, which would add to the amenity value of the river. In addition, secondary effects such as increased bird and mammal life might be expected to follow, as these populations are often dependent on fish as an important food source. Such environmental improvements have been shown to be highly valued by local residents (e.g. Tunstall et al. 1999), and may result in social benefits being derived from relatively small river restoration schemes. The aim of this paper is not to compare socio-economic impacts between individual schemes of different size. Instead, a control-impacted approach is adopted, comparing an area where a river restoration scheme has been carried out to a control area. A brief description of each river restoration scheme is given in Table 2.

338 Table 2. Restoration Schemes in the Don catchment.

River Restoration Scheme	Description	Year Completed
1. River Skell	A section of the river was meandered to improve habitat diversity and aesthetic value[1]	2000
2. Broad Ings	A straight river channel was re-meandered and connected to its old bends. Two lakes were also created as part of the scheme. The site is now an important wildlife area. [2]	1992
3. Crimpsall Sluice	A rock chute fish pass was created to replace the sluice that needed updating. The aim was to allow the movement of fish over the obstruction.[3]	2000
4. Little Houghton pond creation	A new channel was created to link the backwater area to the main river to provide a spawning area for fish and to improve wildlife opportunities[4]	1999
5. The Old Moor	A wetland was created on old industrial land and a stretch of the river was re-meandered to increase the biodiversity value of the washland. Old Moor is now a Royal Society for the Protection of Birds (RSPB) nature reserve[5]	2002
6. River Dearne - Low flow channel	To maximise the fishery and wider environmental potential of the river an extensive, sinuous, low-flow channel was created within a much wider flood channel. [6]	1997
7. Sprotborough Flash Nature Reserve	Created by mining subsidence in 1924 and now managed by Yorkshire Wildlife Trust. The site includes a controlled washland. In 1997 the EA carried out works at the site to allow the water levels to be more sensitively managed.[7]	1997
8. River Rother, realignment – Orgreave	The river was diverted and re-meandered through a new channel[8]	1999

[1] The RRC (year unknown) "River Skell channel rehabilitation and education". Project: 200631
[2] Firth C. (2007) Personal communication
[3] The RRC (year unknown) "Crimpsall Rock Chute". Project: 200567
[4] The RRC (year unknown) "Little Houghton pond creation". Project: 200419
[5] Carmichael et al. (2006) "Delivering regeneration through environmental improvement". Environment Agency. Science Project Number: SC040051
[6] The RRC (online). Creating a sinuous low flow channel in an over-widened river. Available from http://therrc.co.uk/pdf/manual/MAN_3_6.pdf (accessed on 22 July 2008)
[7] The Wildlife Trusts (2008) "RESPONSE FROM THE WILDLIFE TRUSTS", The Wildlife Trusts No. 207238.
[8] The RRC (year unknown) "River Rother realignment – Orgreave". Project: 200541

9.	River Rother, rock chute – Orgreave	Construction of a rock chute fish pass on a recently recovered section of the river to allow free passage of fish[9]	1999
10.	River Rother rock weir and introducing fish stock	A rock weir was created to increase the flow velocity to remove deposits of contaminated sediments. Fish was reintroduced to the river and after two years the population was reproducing.[10]	1994
11.	Rother Valley Country Park	Four lakes on old coal mining areas were created to increase recreation opportunities, provide habitats for plants and animals and to create a flood storage system.[11]	1983

339

340

341 *2.2.4 Criteria for identifying control sites in a control-impacted analysis*

342

343 The control-impacted approach relies on the assumption that the only significant
344 difference between the control and impacted site is the presence or absence of the river
345 restoration activity. Hence, all other factors should be as similar as possible between the
346 control and restoration sites (Kerr and Chung, 2001). Selecting suitable control sites is
347 therefore crucial to a robust analysis. Note that the impacted sites described in this paper
348 refer to river restoration sites, whilst the controls are sites without any restoration
349 activity.

350

351 In order to meet the assumption that, as far as possible, the only difference between the
352 control and impacted sites was the presence or absence of the river restoration scheme, a
353 number of criteria for selecting the control sites were applied in the analysis. Firstly, the
354 control site needed to have a river flowing within it that had not been affected by a river

[9] The RRC (year unknown) "River Rother - Orgreave Rock Chute". Project: 200566
[10] Firth C. (2007) Interview, 19/7/2007, Doncaster.
[11] Rotherham Metropolitan Borough Council (online). Available from http://www.rothervalley.f9.co.uk/ (accessed on 8 July 2008)

355 restoration activity. The preferred situation was that the control site included the same
356 river as the impacted site. Secondly, the control sites needed to be a sufficient distance
357 from the river restoration site to ensure that any influence of the restoration activity was
358 eliminated from the resident population within the control site. Research suggests that
359 greenways and recreation areas are mostly visited by nearby residents, often less than
360 two kilometres away (Gobster and Westphal, 1998). Hence, a distance of two
361 kilometres from the restoration site was chosen as a reasonable distance beyond which
362 direct impacts on the resident population due to the restoration activity were assumed to
363 be minor. The rivers within the control site and the impacted site also needed to be the
364 same or similar in terms of their General Quality Assessment (GQA) scores for biology,
365 chemistry, nitrate and phosphate. In addition, River Quality Objectives (RQO), and
366 whether these were complied with, were used to give the most complete check of the
367 control-impacted pairs possible with regards to chemical and biological data. To avoid
368 comparing rural and urban areas, the control site and the impacted site needed to have
369 the same or similar urban-rural characteristics. The Rural and Urban Area Classification
370 2004 was used to distinguish between rural, suburban and urban areas for this purpose.
371 The classification is provided by the Office for National Statistics (ONS) and is based
372 on differences in household density using clusters of postcode boundaries (Bibby and
373 Shepherd, 2004). In addition, the broad physical characteristics of the river needed to be
374 similar for the control site and the restoration site. For example, aerial photographs were
375 used to visually ensure that comparisons were not made between large rivers and small
376 streams. Finally, the closest site outside the two kilometre boundary that was able to
377 fulfil all the criteria described above was chosen as the control.
378

379 *2.2.5 Developing a methodology for comparing socio-economic indicators in control*
380 *and impacted sites*
381
382 Analysing socio-economic impacts of river restoration schemes requires a boundary
383 within which the socio-economic characteristics of the population, and the impacts on
384 those characteristics due to the restoration activity, can be assessed. Even though the
385 spatial resolution of the datasets used for the analysis is relatively high, they do not
386 necessarily serve as a sufficient base for the analyses. Figure 3 shows the location of a
387 river and floodplain restoration activity that occurred in the Rother Valley Country Park
388 near to Rotherham in the Don catchment, as well as the surrounding Super Output Area
389 (SOA) boundaries. Simply using the SOA within which the restoration activity lies as a
390 base for the analysis would give a potentially inaccurate result, by including residents
391 who live a considerable distance (over 3 km) from the restoration activity. Conversely,
392 residents living close to the site, more likely to be impacted by the improved water
393 environment yet outside of the specific SOA, would be excluded in such approach. It is
394 more appropriate to use distance from the restoration site to create a boundary for the
395 analysis, rather than apply the spatial units at which the socio-economic data were
396 originally released. A 1 km buffer was therefore created around each control and
397 impacted site. The grid reference for each restoration scheme was used to create the
398 centre point of the buffer. This assumes that the restoration scheme is a point, which is
399 not true for all of the restoration sites. However, all restoration sites were kept as points
400 in order to compare buffer areas that were uniform in size.
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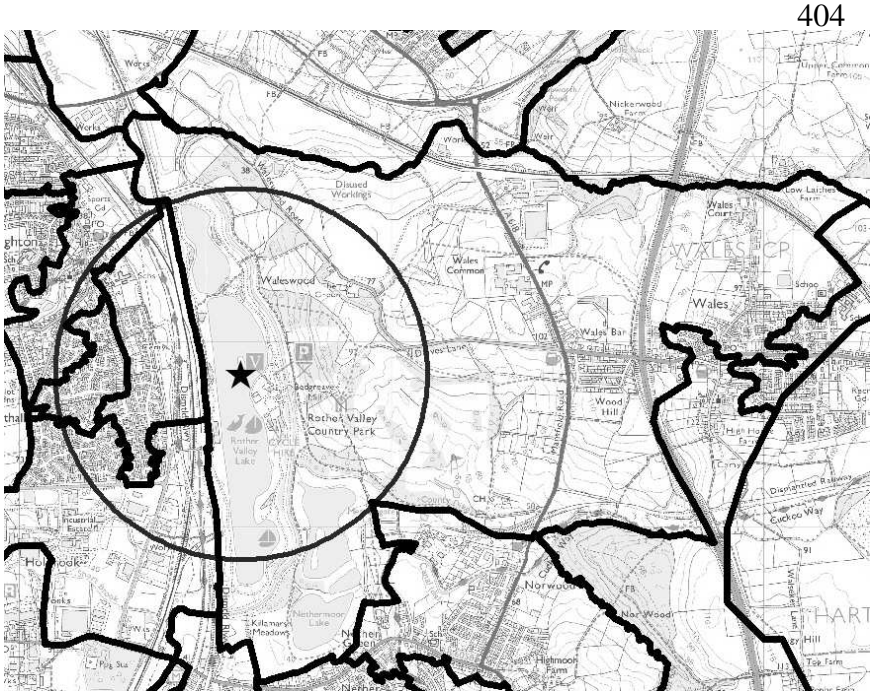

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424

425 Figure 3. Example of restoration scheme (star) with a one kilometre buffer including

426 multiple SOAs (black boundaries).

427

428 In calculating the socio-economic characteristics of the area within the buffer, a

429 weighting could be applied to each individual SOA based on the proportion of the area

430 of the SOA that falls within the 1 km buffer. However, applying this type of simple area

431 weighting assumes that the resident population is evenly distributed within the SOAs,

432 which is rarely the case. To address this problem, the location of the residents must be

433 taken into account in the analysis as far as possible. Therefore, the proportion of the

434 SOA's population, rather than the area of each SOA, inside of the buffer must be

435 estimated. The proportion of the total SOA population within the buffer can then be

436 used as a weight to apply to any socio-economic variable in the analysis. A

437 methodology to obtain a more accurate estimate of the population within the SOA, by

438 using the population data that is available at OA level, was developed. Using the
439 proportion of each OA within the buffer to estimate the SOA population within the
440 buffer still assumes that the population is distributed evenly across the OA. This
441 remains a simplification, but the error associated with the estimate of the population
442 within the buffer, and therefore the weighting factor, is reduced substantially compared
443 to using other approaches. The approach was applied to IMD total and IMD domain
444 data that are available at SOA level. A similar weighting approach has been developed
445 separately by Huby et al (2007) to calculate voter turnout percentage for SOAs. For the
446 analyses based on Census data, a second weighting was not necessary since the data is
447 already reported at OA level. Hence, the proportion of the OA area within the 1 km
448 buffer was used as a weighting factor.
449
450 Following Brunsdon et al. (2002), a weighted mean and weighted standard deviation
451 value were calculated for each buffer based on the weighted scores for each individual
452 SOA or OA within the buffer, using equations 1 and 2 below:
453

454 $$\bar{x} = \frac{\sum w_i \, x_i}{\sum w_i} \qquad (1)$$

455
456 where $\bar{x}$ = weighted mean, w_i = weight of the ith SOA or OA within the buffer, x_i = the
457 score of the ith SOA or the OA within the buffer
458

459 $$sd_w = \sqrt{\sum (x_i - \bar{x})^2 w_i} \qquad (2)$$

460

where sd_w = weighted standard deviation, all other terms are as defined for equation 1.

The data were tested to ensure that they met the assumption of normal distributions using the Sharipo-Wilks test. The results of these analyses indicated that none of the data had distributions that were significantly different to the normal distribution at p = 0.05. Paired t-tests were then used to establish whether differences between the control and impacted sites were statistically significant.

The methodology described above uses data and cases from England as an example. However, the methodology is potentially transferable to other areas where socio-economic data at similar temporal and spatial scales are available.

3. Results

The datasets used in this paper allow us to examine the socio-economic impacts of river restoration using data at index level, domain level and variable level. The IMD provides a total deprivation score as well as a score for each individual domain. The OAC allows analysis of socio-economic impacts at individual variable level. This index-to-variable hierarchy maximises the potential to gain insight into the responses of complex socio-economic systems to river restoration, responses that may be hidden if only one hierarchal level of data is used.

3.1 Results of analyses at index level

For the analysis based on the IMD, the deprivation score rather than rank was used. The score provides an absolute measure of the state of individual SOAs rather than a relative measure as provided by the rank, and is suitable for the calculation of weighted means that are used in this analysis. Figure 4 illustrates the total deprivation score based on 2007 IMD data for the control and impacted sites. The scale on both axes shows the deprivation score, which is based on a range from 0-100, where 100 represents the most deprived score. The 1:1 line represents the situation under which the control and impacted sites have identical deprivation scores. Data points above the 1:1 line indicate that a control site is more deprived than the associated impacted site. The total deprivation scores across all eleven control and impacted sites suggest that in eight of eleven cases the control sites were more deprived than the impacted sites. These differences were statistically significant at $p = 0.05$. A similar pattern was seen for total deprivation scores based on 2004 IMD data, where seven of the eleven control sites were more deprived than the impacted sites. These differences were also statistically significant at $p = 0.05$.

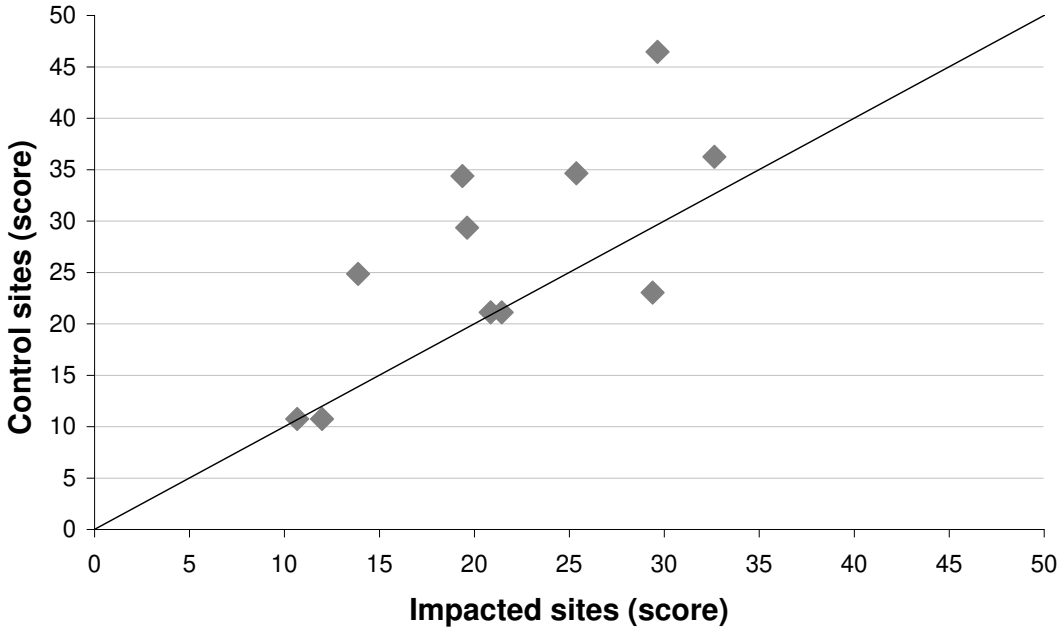


Figure 4. Total IMD score for 2007 for control and impacted sites.

3.2 Results of analyses at domain level

In addition to the total IMD, it is also possible to compare deprivation between the control and impacted sites using individual deprivation domains. Considering only the total score runs the risk of masking potentially important patterns of variability in deprivation at the level of individual domains. The data at domain level are based on the seven domains of deprivation described in Table 1. For each of these domains, higher scores are associated with more deprived SOAs. However, data for the individual domains are not provided on a standardised scale and they have different minimum and maximum values and ranges, making it impossible to directly compare deprivation across different domains for an individual SOA. Despite this, the domain level data allow for a more sophisticated analysis of different types of deprivation, particularly for comparison of individual domains across different SOAs (Noble et al., 2004).

Table 3 summarises the results of the domain-level analyses. The average value of C:I in Table 3 indicates the direction of the difference between the control and impacted pairs, considering all eleven sites together. Values exceeding one indicate that the control sites were more deprived than the impacted sites. Four of the seven domains show the same pattern as described above for the total IMD score, with impacted sites being less deprived that their associated control sites. For three of these four domains, namely Income, Employment and Education, these differences were also significant at $p = 0.05$. The same statistically significant patterns were also observed for these three domains when analysing IMD data from 2004. The four domains that showed impacted sites to be less deprived that their controls were also the domains receiving the highest weighting in the calculation of the total IMD data (Table 1), explaining why impacted sites were significantly less deprived than their associated controls in terms of total deprivation scores. Note that some of the average C:I values in Table 3 are relatively large, but the results of the t-tests indicate that the differences are not significant. This suggests that some individual C:I pairs differed substantially in their domain scores, but that consistent differences were not present for all eleven pairs. Similar patterns emerged from the analyses at variable level (see below).

Table 3. Deprivation domains indicating the direction of any differences between control and impacted sites (C:I), and significance at p¼0.05 (*¼ significant at p¼ 0.05, NS ¼not significant).

Domain	Significance	C:R
Income deprivation Domain	*	1.38
Employment deprivation Domain	*	1.27
Education, skills and training deprivation Domain	*	1.44
Health deprivation and disability Domain	NS	2.09
Barriers to Housing and Services Domain	NS	0.93
The Living Environment deprivation Domain	NS	1.04
Crime Domain	NS	0.89

3.3 Results of analyses at variable level

The choice of socio-economic variables included in the analysis in this paper is based on the list of variables identified in the original OAC (see Vickers et al., 2005). The OAC is different from the IMD in that it is based on a nominal rather than an ordinal scale, but it can be used to explore socio-economic differences and inequalities between the control and impacted sites. The chosen subset of the original OAC variables that was believed to be the most relevant for analysing socio-economic impacts of river restoration schemes, and the outcomes of the analyses, are summarised in Table 4.

560 Table 4. Census variables indicating the direction of differences between control and

561 impacted sites (C:I), and significance at p¼ 0.05 (* ¼ significant, NS ¼not

562 significant).

Variable	Significance	C:R
Demographic variables		
Resident population aged 0-18 (%)	*	1.19
Resident population aged 19-64 (%)	NS	0.98
Resident population aged 65+ (%)	*	0.92
Household Composition variables		
Residents 16+ not living in a couple and are separated/divorced (%)	*	1.16
Households with one person who is not a pensioner (%)	NS	1.06
Households which are single pensioner households (%)	NS	0.99
Lone parent households with dependent children (%)	*	1.79
Cohabiting or married couple households with no children (%)	*	0.93
Households comprising one family with non-dependent children (%)	NS	0.98
Housing variables		
Households resident in public sector rented accommodation (%)	NS	4.24
Households resident in private/other rented accommodation (%)	NS	1.32
All household spaces which are terraced (%)	NS	2.39
All household spaces which are detached (%)	*	0.82
Household spaces which are flats (%)	NS	5.16
Occupied household spaces without central heating (%)	NS	2.23
Average house size (rooms per household)	NS	0.99
Average number of people per room	*	1.08
Socio-Economic variables		
People aged between 16-74 with higher education qualification (%)	NS	0.89
People aged between 16-74 in routine or semi-routine jobs (%)	NS	1.13
Households with 2 or more cars (%)	NS	0.90
People who reported suffering from a limiting long term illness (%)	NS	1.02
Employment variables		
People aged 16-74 who are students (%)	NS	1.10
Economically active people aged 16-74 unemployed (%)	NS	1.42
Economically active people aged 16-74 working part time (%)	NS	1.01

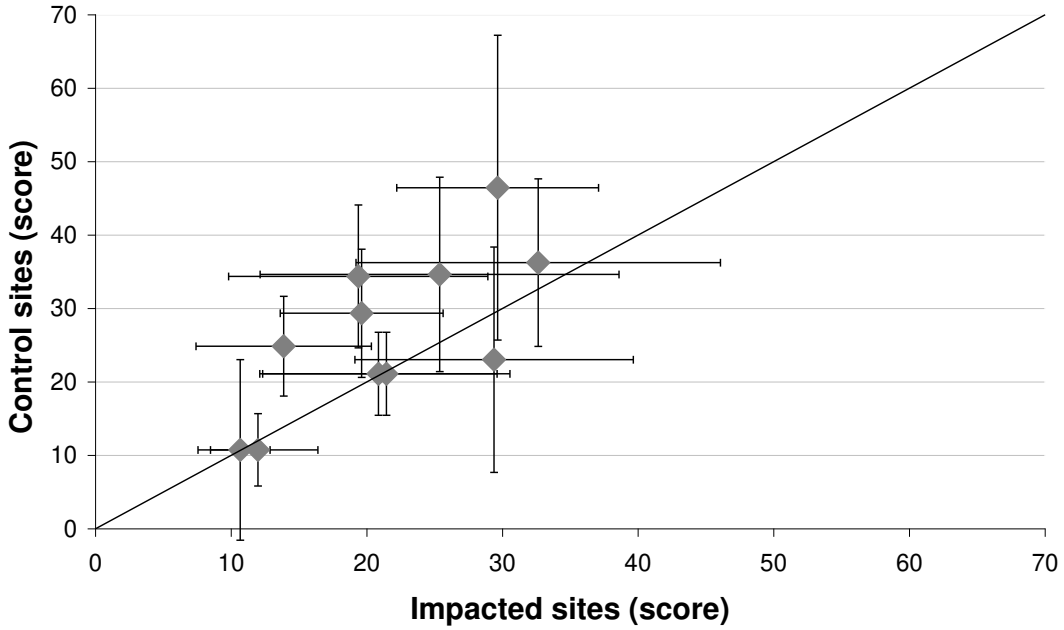
563

564

565

566 The demographic variables were included because they potentially explain differences
567 in other variables. For example households with no dependent children are more likely
568 in areas where the percentage of the population aged 65 or over is high. The results of
569 the analyses suggest that the age structure of the resident population differs slightly
570 between the impacted sites and their associated control sites. The control sites had a
571 higher percentage of the population aged 0-18, while the impacted sites had a higher
572 percentage of the population aged 65 or over. However, significant differences were
573 only observed for 5 of the 21 non-demographic OAC variables. For these 5 variables
574 there was no consistent direction of difference, for three of the variables control sites
575 had higher percentages than impacted sites, whilst for the remaining two variables this
576 pattern was reversed.
577
578 **3.4 Variability of socio-economic characteristics within impacted and control sites**
579
580 Statistically significant differences were observed between impacted sites and their
581 associated control sites at index, domain and variable levels. However, in analysing
582 only the weighted mean data there is no consideration of the variability of socio-
583 economic characteristics within the individual control and impacted buffers. The
584 methodology developed in this paper also allows examination of this variability. Each
585 individual buffer includes multiple geographical units (SOAs or OAs). Despite the fact
586 that these spatial units are relatively close to each other, they can still differ
587 substantially in socio-economic characteristics. To represent this variability, a weighted
588 standard deviation was calculated for each 1 km buffer for every dataset. Figure 4
589 showed that a majority of the impacted sites were less deprived than their associated

590 control sites in terms of their weighted mean total IMD score for 2007. In addition a
591 paired t-test confirmed that these differences were statistically significant. Figure 5
592 shows the same total IMD dataset as Figure 4, but here one weighted standard deviation
593 is displayed in addition to the weighted mean data. It is clear that the variability of the
594 IMD total score within any individual buffer is relatively large. Similar observations
595 were made for all other datasets analysed in this work. These findings suggest that
596 whilst average differences may exist between control and impacted sites, there remains
597 substantial variability in socio-economic characteristics even within the relatively small
598 buffers used in this work. This indicates that any interpretation of the mean differences
599 should be made with some care.
600



601 Figure 5. Total IMD score for 2007 for control and impacted sites with variability
602 shown as ± one weighted standard deviation.
603
604

605 ## 4. Discussion

606

607 River restoration schemes are often referred to as having the potential to generate
608 multiple benefits, including social and economic gains alongside environmental
609 improvement (see Tapsell, 1995; Tunstall et. al, 2000; EA, 2006; Gobster et al., 2007).
610 However, evidence to support the claims of multiple benefits is largely lacking. The
611 methodology and subsequent analyses presented in this paper provide one of the first
612 attempts to examine the impacts of river restoration activities using a broad range of
613 indicators relating to the socio-economic characteristics of the resident population. The
614 results have shown that significant differences exist between paired control and
615 impacted sites for a range of indicators at index, domain and variable level. For the
616 significant differences observed in IMD, control sites were more deprived than the
617 impacted sites, both for total deprivation and individual domains. For the nominal
618 variables based on Census data it is not possible to identify if an area is 'better' or
619 'worse' in terms of socio-economic characteristics. However, they do give an indication
620 of differences in socio-economic characteristics between control and impacted sites.
621 The analyses of these Census variables indicate that some significant differences occur.
622 However, there is no consistent direction of difference between restoration and control
623 sites, and the majority of the variables do not show significant differences. In summary,
624 the analyses in this paper highlight significant differences between control and impacted
625 sites for a number of variables. However, conclusive evidence to support the claim that
626 river restoration schemes result in significant impacts across all the variables analysed
627 in this paper was not found.

628

629 The ‘mechanisms’ responsible for the significant differences that were observed are
630 potentially related to perceptions about the attractiveness of the local environment.
631 These perceptions have been shown to be an important factor causing in-migration and
632 socio-economic change within an area (e.g. Smith and Phillips, 2001). For example,
633 according to Carter (2001) the environment and quality of life issues are highly
634 prioritised by what he refers to as a ‘new middle class’. Therefore improvements in the
635 local water environment brought about by river restoration may be particularly
636 attractive to these sectors of society, resulting in their relocation to areas in close
637 proximity to restoration schemes, and as a consequence generating shifts in the socio-
638 economic characteristics of the impacted areas. However, to assess these mechanisms
639 fully would require analyses at a different level, using techniques such as
640 questionnaires, focus groups or in-depth interviews with individuals. This paper
641 focuses on the development of a methodology to explore socio-economic impacts of
642 water management activities using secondary data. Analyses of primary data, such as
643 from interviews, and of how secondary and primary data could be combined, are
644 beyond the scope of this paper, but should be the subject of future research.
645
646 Secondary datasets are powerful in that they allow for meta-analyses, covering a large
647 number of examples of any particular water management action, and cover a broad
648 range of socio-economic components. Despite this potential, such analyses are rare in
649 the water management context. Socio-economic analyses have been included in
650 decision-support systems for flood risk management (see Haynes et al., 2008), which
651 often include an element of river restoration, but specific research covering the socio-
652 economic impacts of improved water environments is currently lacking. One study in

653 the UK analysed the social distribution of river water quality in England and Wales. The
654 analyses concluded that rivers were less natural and had poorer chemical water quality
655 in more deprived areas, but that there was apparently no relationship between aesthetics
656 and deprivation (EA 2002). There are however examples from other environmental
657 research where secondary data has been used to analyse change. Huby et al. (2006)
658 explored associations between socio-economic components and biodiversity in rural
659 England. According to their results, inclusion of socio-economic variables provides
660 better understanding of the distribution of biodiversity. Socio-economic datasets have
661 also been used to establish associations between the percentage of greenspace in a local
662 area and health. Based on Census and IMD data, Mitchell and Popham (2007)
663 concluded that the percentage of greenspace is associated with better health of the
664 resident population, but that this also depends on the degree of urbanity and level of
665 income deprivation.
666
667 The results of the analyses carried out in this paper support the findings of previous
668 work that have begun to show potentially important relationships between socio-
669 economic variables and the state of the environment. An increasing body of evidence
670 suggests that an improved natural environment can result in changes in socio-economic
671 characteristics (Smith and Phillips, 2001; Paguette and Domon, 2003; Sieg et al., 2004;
672 Banzhaf and Walsh, 2008). Such evidence, in combination with increased
673 understanding about the relationships between improved water environments and socio-
674 economic change, could provide a catalyst to encourage future improvements of rivers
675 and other watercourses, both for the environment and for people living close to them.
676 Secondary data has the potential to play an important role in demonstrating theses links

677 between water environments and socio-economic impacts. However, for this to be
678 successful, further developments in the way in which these data are collected, analysed
679 and reported are crucial. These issues are dealt with later in the paper.
680
681 Not all socio-economic components analysed in this paper showed significant
682 differences between control and impacted sites. This pattern of some significant and
683 some non-significant differences may reflect the 'true' effects of river restoration, in
684 that such schemes only have an impact on certain socio-economic components.
685 Alternatively, using secondary data as a base for analysis of socio-economic impacts
686 might introduce constraints that limit the degree to which significant impacts can be
687 detected. Any limitations could be particularly significant given the fact that social and
688 indirect economic benefits generated from river restoration schemes are often difficult
689 to identify (Findlay and Taylor, 2006). In light of this, some key limitations of the
690 approach used in this paper, based on the data currently available for analysis in the UK,
691 are addressed below.
692
693 **4.1 Key limitations in the analysis of socio-economic impacts of river restoration**
694 **schemes**
695
696 The first limitation relates to data availability and the consequences for the sampling
697 design used in this paper. Since the socio-economic datasets in the UK are only
698 available for a limited number of dates, the temporal coverage and resolution do not
699 allow the tracking of changes through time that could potentially have occurred due to
700 river restoration schemes. This means that significant differences between the control

sites and the impacted sites might have already been present before the restoration activity took place, and therefore not caused by the restoration scheme itself. Instead, the differences in socio-economic and demographic characteristics could be drivers behind the restoration activity, rather than reflecting responses to it. However, for this to be true two conditions must be met. Firstly, factors not related to the river restoration schemes must be responsible for the differences between control and impacted sites. A wide range of factors, such as employment opportunities, the standard of new or existing schools, or other macro-economic conditions, could be responsible for these differences. Such 'external' causal factors influencing the result is an issue faced in any place-based control-impacted design. Minimising this issue, and maximising confidence that any significant differences are associated with the river restoration activity, is dependent on using as robust criteria as possible to identify control-impacted pairs. The criteria used in the analysis, as described in the methodology, create what is believed to be a robust control-impacted sampling design. The second condition that must be met is that river restoration schemes must then occur in areas with 'better' existing socio-economic characteristics compared to the control sites, not only by chance but because of a specific reason. There is no evidence to suggest that this occurs, and since river restoration activities often follow an opportunistic approach rather than a targeted, strategic approach (Skinner and Bruce-Burgess 2005; Bernhardt et al., 2005), it is believed to be unlikely. Despite the fact that certain socio-economic characteristics such as demographics are believed to be related to pro-environmental behaviour (Carter, 2001; Kahn, 2002), it is not likely that the driving force behind the river restoration schemes analysed in this paper were determined by social factors. The vast majority of the restoration schemes included in this paper were funded and implemented by the

725 Environment Agency. The objectives of these schemes were almost exclusively
726 environmental, and showed little sign of being driven by any public concern or desire.
727
728 A combination of the before-after approach and the control-impacted approach would
729 potentially have provided a more robust sampling design, resulting in greater
730 confidence in the inference that river restoration was associated with significant
731 differences in socio-economic characteristics between control and impacted sites. Since
732 this combined approach allows analysis before and after any given action, it is likely to
733 be more effective in removing other potential causal factors driving differences between
734 the control and impacted sites. One method often used to determine environmental
735 impacts from a given action that combines the two approaches is the before-after
736 control-impact or BACI approach (McDonald et al., 2000). It is however important to
737 bear in mind that the BACI approach is not without limitations; it has been criticised in
738 particular for relying on the use of single control and impacted sites (McDonald et al.,
739 2000). Using several controls per case has the potential to generate more reliable results,
740 but this assumes that multiple, robust control sites can be identified. Given the stringent
741 criteria used in the selection of control sites in the analysis carried out in this paper, it
742 would be a significant challenge to identify further sets of control sites for each
743 impacted site that fulfil the criteria. It is believed that one robust control site rather than
744 a number of weaker controls will result in a higher quality analysis, and as a
745 consequence give a more accurate picture of the socio-economic impacts of water
746 management actions. Fundamentally however, the availability of data in the UK at
747 present cannot support a BACI design, although this situation may change in the future
748 with increased data availability, as discussed below.

749

750 The limited temporal coverage and resolution of the secondary socio-economic data is
751 also potentially important when considering the fact that different river restoration
752 schemes were completed at different lengths of time before the collection of the
753 secondary data used in the analyses. This could be important if the differences between
754 the control and impacted sites were expected to change through time, or if different
755 areas within which individual restorations have occurred were expected to respond at
756 different rates. If data were available at a high temporal resolution then both of these
757 issues could be addressed. Nevertheless, based on analyses of data used in this paper,
758 there was no indication that time since completion of the restoration activity was related
759 to the magnitude of the difference between a control and impacted site.

760

761 The second key limitation refers to scale of the river restoration activities analysed in
762 this paper. The restoration schemes generally involve site specific activities covering a
763 relatively small physical area, although the schemes used in the analyses span the
764 typical range of river restoration activities occurring in the UK (see Table 2). The socio-
765 economic data used to construct the IMD and the OAC represent population-level
766 characteristics that can be affected both by local and by larger-scale factors. The fact
767 that a number of the variables analysed in this paper did not show significant
768 differences between control and impacted sites suggests that they may not be affected
769 by the scale of river restoration schemes examined in this paper. Such variables may
770 require larger-scale interventions, such as extensive urban redevelopment schemes to
771 generate significant changes in their spatial distribution (Vickers et al., 2005).

772

773 **4.2 Opportunities for using secondary data to explore socio-economic impacts of**
774 **water management actions**
775
776 Despite the above limitations there are also emerging opportunities to use secondary
777 data to explore the socio-economic impacts of water management actions such as river
778 restoration. Most limitations are caused by current data availability, and the
779 consequences for the choice of methods that can be applied in the analyses. At present
780 Census data from different years are not comparable, but this is likely to change in the
781 near future. For the 2001 Census data, new geographies (OAs and SOAs) were
782 introduced. The OAs were created as a real 'statistical geography' rather than being
783 based on administrative boundaries that are often subject to re-organisation. Despite
784 difficulties in keeping the same statistical boundaries through time due to changing
785 population characteristics, there is a growing emphasis on publishing data using stable
786 geographies. However, the introduction of these new geographies makes comparison of
787 2001 data with previous Census years difficult. Hence, the potential to re-release
788 previous Census data, that would support time series analyses at the new geographies, is
789 being explored (ONS, 2005). If past and future data were released at stable output
790 geographies, a more sophisticated BACI approach could be applied to explore socio-
791 economic impacts of river restoration activities. This could result in more certain
792 conclusions regarding the magnitude and causes of differences between areas with a
793 restoration action and areas without such an action. In addition, data collected over time
794 would make it possible to explore whether delayed impacts occur some time after the
795 implementation of an activity. Looking at data from one point in time does not allow
796 this type of trend analysis, an approach which is often important when trying to

797 establish impacts from improvements in the water environment. Comparable indices of
798 deprivation that will become available in the future will, like Census data, increase the
799 potential for exploring socio-economic impacts of water management actions.
800
801 The likely evolution of river restoration itself also suggests that the socio-economic data
802 analysed in this paper could become increasingly important. To meet the demands of
803 flood mitigation and for the achievement of objectives under the WFD, which are
804 believed to be two key drivers for the future of river restoration, the schemes must move
805 away from a focus on isolated river stretches and evolve into larger scale, more holistic
806 restoration approaches (Skinner and Bruce-Burgess, 2005; Wharton and Gilvear, 2006).
807 Any resulting socio-economic benefits at these larger scales are more likely to be
808 reflected in the socio-economic indices, domains and variables reviewed in this paper.
809 These indices, domains and variables are therefore likely to become increasingly
810 important decision variables at these scales.
811
812 Future analysis of the socio-economic impacts of the full range of water management
813 actions should also have important implications for associated decision making
814 processes. If there is clear evidence of socio-economic impacts due to improvements in
815 the water environment, this evidence could be used in a strategic approach in order to
816 target where the benefits from specific actions, such as river restoration schemes,
817 accrued. Hence a strategic approach, including clearly stated objectives, monitoring and
818 project appraisals, to prioritise schemes generating real improvements is crucial.
819 However, the decision making process behind river restoration schemes, certainly in the
820 UK, is currently far from strategic (Skinner and Bruce-Burgess, 2005). Despite

increasing numbers of river restoration schemes, most are still undertaken on an opportunistic basis when new funding and land availability possibilities arise, rather than being strategically planned. In addition, the decision to restore a stretch of a river is often driven by priorities other than the restoration itself, for example river restoration schemes are often undertaken as part of a larger flood mitigation or development scheme. Consequently, little planning for monitoring and post-project appraisal is invested in the river restoration scheme itself, making it difficult to provide the evidence base needed to justify a strategic approach (Skinner and Bruce-Burgess, 2005). Similar observations have been made in the USA, where the vast majority of river restoration schemes are carried out without stated objectives or any form of assessment or monitoring afterwards (Bernhardt et al., 2005). A strategic approach towards river restoration would not only help to maximise environmental and socio-economic benefits, but would also contribute to the monitoring requirements stated in Annex V of the WFD.

Skinner and Bruce-Burgess (2005) suggest a framework for such a strategic approach, and highlight the importance of considering the restoration scheme as part of a larger catchment rather than the river reach in isolation. According to these authors, a strategic basis for river restoration must include baseline data, objectives, method, installation, monitoring, post-project appraisal, maintenance and dissemination. Their framework is however from a strictly ecological perspective, but could be extended to include social and economic components related to the water environment. If environmental, social and economic components were combined in a strategic framework as a base for river restoration schemes and other water management actions, such a framework would be

845 better able to capture the full range of benefits resulting from investment in the
846 schemes. In turn this would support more accurate assessments of management options,
847 leading to more robust decisions. However, for secondary socio-economic data to form
848 a base for such strategic approaches they must be comparable over time and collected
849 and released at a more frequent basis than they are at the moment in the UK. Ideally,
850 data would be collected and released annually, covering the full range of indicators
851 included in this paper.
852
853 Finally, policy- and decision-makers must better recognise the range of relevant values
854 that may be affected as a consequence of water management actions. Current
855 understanding of human values and the way to incorporate them in the decision making
856 process is limited (Lockwood, 1999), although different integrated frameworks
857 combining different types of values have been suggested to address this problem (see
858 for example Lockwood, 1999; Morton and Padgitt, 2005; Gobster et al., 2007).The
859 development of similar frameworks, able to integrate secondary data, such as IMD and
860 Census data, with primary data, for example from interviews or questionnaires, is a
861 pressing challenge, although it is outside the scope of this paper. Nevertheless, the
862 importance of adopting a range of methods and data to fully understand the complex
863 interaction between the water environment and human society should be fully
864 recognised.
865
866
867 ## 5. Conclusions
868

869 This paper describes an early attempt to develop a methodology and subsequently
870 analyse the socio-economic impacts of river restoration schemes for an extensive
871 resident population across a wide range of variables. The results show that significant
872 differences exist between control and impacted areas for a range of socio-economic
873 variables. Due primarily to limitations in the data currently availability, and
874 consequently the scope of the analyses, and because of the typical scale of river
875 restoration schemes, there are limitations in the extent to which socio-economic impacts
876 of river restoration schemes can be detected. However, new datasets which allow
877 comparisons through time are likely to be available in the near future. In addition, larger
878 scale and more holistic water management actions are also likely to be carried out more
879 frequently. These factors have the potential to increase the ability to explore
880 associations between improvements in the water environment and socio-economic
881 benefits using the secondary datasets examined in this paper.
882
883 Although significant differences were observed between some control and impacted
884 sites, drawing conclusions about the causal relationships between river restoration and
885 impacts on socio-economic components remains challenging. However, there are a
886 number of mechanisms that could potentially drive associations between the nature of a
887 local water environment and the socio-economic characteristics of the surrounding
888 resident population. To explore these mechanisms more fully requires qualitative
889 approaches to provide in-depth information on the relationships between people and
890 their local environment. Ideally, information from both qualitative and quantitative
891 approaches would be integrated into a single framework to examine the socio-economic
892 impacts of water management actions. This framework should support a move away

from opportunistic and towards strategic approaches to water policy formulation and implementation. Only when such strategic approaches are used to target socio-economic impacts during the design of water management actions, and to measure the impacts by evaluating the actions, will the aspiration for the integration of different sustainability objectives be achieved.

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