Appendix 1.1.H - Literature review on perception of local

Wessex Water

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Wessex Water
YTL GROUP

Business plan section		Supporting document	
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Literature Review on the Public's Understanding of 'Local' in the Context of Rivers

1. Background

PJM and Accent are currently working with Wessex Water to design and implement a stated preference research programme to investigate customers' priorities and their willingness to pay for improvements to their services. We recently presented the main results from this study to Wessex Water (5/6/17) and to the Wessex Water Partnership research subcommittee (13/6/17). This literature review on the public's understanding of 'local' in the context of rivers arises from a suggestion to this effect by Dr Ian Walker at the Wessex Water Partnership subcommittee meeting.

2. Objectives

The objective of this work is to review quantitative evidence on the size and nature of the area which is considered "local" in the context of rivers. This evidence will be useful in the context of deriving and justifying suitable scaling factors for use in the stated preference analysis. There are three service issues in particular where the scaling factors that should be used are potentially debatable in the context of the public's understanding of what local means to them in the context of rivers. These are the following:

- DILUTE SEWAGE occasionally spills from a Wessex Water pipe into a nearby river or estuary.
- RIVER WATER QUALITY in your local area is less than 'Good' quality partly due to Wessex Water's operations.
- RIVER WATER FLOW LEVELS in a nearby river are lower than ideal partly due to Wessex Water's operations.

The review focuses on any evidence that might contribute towards a judicious assumption, or range, for the area to be defined as 'local' for the purposes of setting scaling factors for the three service issues set out above.

3. Methodology

The following search engines were used for the purpose of this review:

- Scopus and Web of Science: Academic studies
- BASE (https://www.base-search.net): Open access studies, reports, journals not indexed on Scopus and Web of Science
- British Library Catalogue: Books, government reports, PhD thesis from British universities

The search strategy consisted of the following terms:

Figure 1: Search strategy

Concept	Search terms
Water body	*(river **OR** stream **OR** creek **OR** estuary **OR** riparian)*
	AND
Perceptions	*("local residents" **OR** "local perceptions" **OR** "public perceptions" **OR** "resident perceptions" **OR** (public **AND** attitudes) **OR** (local **AND** attitudes) **OR** (local **AND** awareness) **OR** "environmental concern" **OR** "place attachment" **OR** "place identity" **OR** "sense of place" **OR** "sense of belonging" **OR** "sense of ownership" **OR** rootedness* **OR** *familiarity*)
	AND
Local area	*(distance **OR** location **OR** proximity)*

4. Issues in the aggregation of willingness to pay for improvements in rivers

The estimation of willingness to pay for improvements in river water quality and other attributes of rivers usually produces unit values (per customer). There is no straightforward method to aggregate these unit values. The aggregation over the whole customer base of water companies can lead to an over- or under-estimation of the real magnitude of the benefits and costs. In the past, questions over the aggregation of benefits have contributed for the decision of the former Department of the Environment, Transport and Regions (DETR) to overturn a previous decision of the Environmental Agency to refuse a water company application to abstract water from a river (ENDS 1998, Moran 1999).

The study of Garrod and Willis (1996) about river water flows in the River Darent defined "local residents" as those living within 2 km from the river but aggregated willingness to pay values over an area extending 60 km from the river. The assumption was that the population in this area derived user and non-user benefits from improvements in the river water flows. However, the 60 km value was not based on any theory or on additional empirical research but was simply the geographic extent of the sample dataset, and so it is somehow arbitrary.

In the 2014 Price review, water companies aggregated unit willingness to pay values for improvements in attributes related to water, sewage, and environment at the level of their customer base. However, in the case of the Wessex Water price review, three attributes ("area sewer flooding", "river water quality" and "river flows") were assessed in relation to the "local area" of each participant in the stated preference survey that was used to estimate willingness to pay. The levels of the "area sewer flooding" attribute were shown to participants as the number of public areas affected by one incident within 30 miles (48 km) of a property. The levels of the river water quality and river flow attributes were shown as the length of river miles in each category in a 30-mile (48 km) area (NERA and Ipsos MORI 2013).

A report by Accent concluded that that other water companies performing the 2014 Price Review did not specify the relevant geographic areas for the improvements in those three attributes. The levels of the attributes shown to participants in the surveys were based on the number of properties affected (in the case of external sewer flooding incidents) and on unit level improvements in 1 km or 1 mile of river length (in the case of river water quality and river flow attributes) (Accent 2014).

The study of Sutherland and Walsh (1985) showed that it is more realistic to consider that the willingness to pay for water quality decays with distance, through the intermediate impact of distance on the number of visits people make to the river. Several other studies have confirmed this hypothesis (Georgiou *et al.* 2000, Hanley *et al.* 2013). However, there is still little evidence on how distance to water systematically affects willingness to pay (Van Houtven *et al.* 2007). Distance may not be linearly related to willingness to pay due to the influence of other (geographic and demographic) factors. In addition, the area over which improvements in river water quality and other attributes of rivers are aggregated depends on the levels of awareness of local residents about those improvements and more generally, on the perceptions of residents about the rivers in their local area. The main issue arising in the quantification of these perceptions is that "local area" is a subjective construct, linked to the characteristics of rivers, individuals, and communities.

The following two sections (Section 5 and 6) look at how the extent of "local area" can be derived from the results of stated preference and revealed preference studies. Section 7 and 8 then reviews studies relating distance to rivers and local residents' perceptions in terms of subjective attachment and concern about environmental aspects of those rivers. The comparison between the four types of studies show that the implicit "local area" in stated preference surveys is much wider than the area implicit in revealed preference surveys and in studies of resident attachment and concern about rivers.

5. Stated preferences

The extent of the relevant area that benefits from improvements in rivers can be calculated by using an estimated relationship between willingness to pay and distance and then solving the equation to determine the distance for which willingness to pay is zero. Moran (1999) estimated this distance as 214 km, using the results of a study of Bateman and Langford (1997) about improvements in the Norfolk Broads. This is a somehow crude estimate because the distance at which the willingness to pay equals zero depends on the size of the improvement. In a study about the River Tame in Birmingham, Georgiou *et al.* (2000) estimated that distance as 17 miles (27 km) for small improvements, 25 miles (40 km) for medium improvements, and 36 miles (60 km) for large improvements.

The study of Brouwer *et al.* (2016) in Austria, Hungary, and Romania used a more detailed approach to confirm the existence of distance-decay effects for two types of attributes: water quality improvements and reduction of flood risk. A 1 km increase in distance to the Danube is associated with a decrease of €0.11 per household per year in the willingness to pay for good water quality, in comparison with moderate water quality, and with a decrease of €0.004 per household per year in flood risk. The willingness to pay for good water quality is zero when the distance to the river is 301 km. The willingness to pay for a decrease in flood risk is zero when the distance is 280 km. These values, in the hundreds of km, are broadly comparable with the value of 214 km from the calculation made by Moran (1999) described above. Brouwer *et al.* (2016) also found that the impact of distance from homes to the river on preferences for water quality and flood risk is independent of the frequency of visiting the river.

Hanley *et al.* (2003) compared willingness to pay of residents at different distance intervals from the river, in a case study about the River Mimram in Southern England. Using this approach, it becomes clear that the willingness to pay for a reduction in low flow problems decreases rapidly with distance. For users of the river, the estimated average willingness to pay was £17.3 for users living within 500m of the river, £13.20 for those living between 500m and 3 km, and £4.12 for those living between 3 and 12 km. For non-users, the willingness to pay was £12.8 for those living between 500m and 3 km and £3.73 for those living between 3 and 12 km. Non-users living between 12 and 130 km had a positive average willingness to pay (£1.71). Despite the fact that average willingness to pay decreases rapidly with distance, the estimated distance-decay function suggests that willingness to pay is only zero when the distance to the site is above 1082 km.

Studies of preferences focusing only on users, such analyses of the benefits of improving rivers for recreational purposes, also found that willingness to pay decrease rapidly with distance. For example, a study in Sweden found that an increase of 1 km from home to the river is associated with a decrease of 1.22SEK (£0.11) in the willingness to pay for restoration of the river (Paulrud and Laitila 2013) and a study in Denmark (Jørgensen *et al.* 2013) found that one extra minute travel time to a river is associated with a decrease of 6.3DKK (£0.75) in willingness to pay for a project to improve the water quality in the Odense River.

Overall, the results of these studies suggest that the population who benefits from river water quality improvements is spread across a very wide geographical area. However, there are questions that still lack strong evidence, such as how the distance-decay pattern of willingness to pay differs between users and non-users of rivers and how it relates to the presence of substitutes (i.e. other rivers).

There are also different alternative ways to make use of the information provided by these studies on the extent of the area over which people benefit from improvements. This could be defined as the area where the average willingness to pay is positive, i.e. the area where there is at least one respondent in the survey with positive willingness to pay. In the examples above, this could be an area with a radius as small as 27 km or as big as 1082 km. Alternatively, if we assume that willingness to pay decreases linearly with distance, the area could be half of the area defined above, i.e. the area where half of respondents have a positive willingness to pay.

6. Revealed preferences

Revealed preference studies can also suggest the extent of the area over which local residents derive benefits from local rivers. For example, hedonic models explain difference in property prices based on a series of variables measuring the structural characteristics of the properties, and their location. Distance to rivers can be included as a variable in these models. Using this approach, proximity to rivers is understood as a proxy of the value of environmental attributes. The area over which this variable is significant can therefore define the river's "local area", i.e. the area over which the population benefits from the river.

Some studies use straight-line distance from homes to rivers as a quantitative variable in hedonic models. This approach allows for the calculation of the elasticities of the house prices to distance from rivers, i.e. the percentage decrease in house prices associated with a 1% increase in distance to rivers. Qiu *et al.* (2006) estimated this elasticity as -0.016 and Cohen *et al.* (2015) as -0.027. However, these are general values that do not take into account the type and quality of the water bodies. Cho *et al.* (2011) classified water bodies into rivers or streams and impaired or unimpaired. Property prices increase with distance to unimpaired rivers or streams and decrease with distance to impaired rivers or streams. In addition, the impact of distance to rivers is of a much higher magnitude than the impact of distance to streams, especially in the case of unimpaired water bodies.

Models where distance is used as a quantitative variable do not explicitly suggest the distance within which the attributes of the river are valued, as this also depends on the values of a large series of other variables included in the model. Some recent studies have included distance intervals from the river as separate variables, thus providing more immediate evidence on the distance within which the river attributes are valued.

Netusil *et al.* (2014) used this method to estimate the impact of water quality (measured by several indicators) on the price of single-family residential properties in two watersheds in Portland (United States). The size of the impact decreased rapidly with distance from the rivers. For example, in one of the case studies, a one mg/L increase in dissolved oxygen levels during the dry season was associated with an increase in property prices of 13.71% for properties within 0.25 miles (400m) from the river, but only 7.05%, 8.18%, and 3.12% for properties within 0.5 miles (800m), one mile (1.6 km), and more than one mile (1.6 km), respectively. A 100 count per 100 mL increase in E. coli during the dry season was associated with a decrease in property prices of -2.81% for properties within 0.25 miles (400m) from the river, but only -0.86%, -1.19%, and -0.71% for properties within 0.5 miles (800m), one mile (1.6 km), and more than one mile (1.6 km), respectively. These results suggest that 400m is an appropriate radius for defining the rivers' "local area", a value that is of a much smaller scale than the values that can be derived from stated preference studies described in the previous section.

This is again confirmed by the results of Walsh *et al.* (2017), who estimated the impact of pollution reduction in a river estuary in the United States, covering 14 different counties. An increase in light attenuation (the inverse of water clarity) was associated with a significant decrease in property prices for properties at the waterfront in 7 of the 14 counties. For properties at 0-500m distance from the estuary, there is a significant decrease in property prices in only 3 counties. For properties at 500-1000m distance, there is a significant decrease in property prices in 4 counties and a significant increase in one county. The magnitude of the impact was always higher for properties at the waterfront. In some counties there is a price gradient extending out to 1.5 and 2 km from the estuary, while in others the negative price impact does not extend beyond the waterfront. In a follow-up study, Klemick *et al.* (2016) ran a meta-analysis of all counties, and found that light attenuation on property prices is significantly negative for properties at the waterfront; significantly negative, but considerably smaller, for properties at 0-500m distance and 500-1000 distance, and insignificant for properties more than 1000m distant from the river. The study also explained variations in impact of distance, concluding that it depends on variables such as population density and the proportion of second homes.

It is also likely that the impact of distance depends on the quality of the river. For example, the study of Bonetti *et al.* (2016) in Milan found that residential housing sale prices decreased with distance only in the case of streams where the water quality is assessed with a score of 3 in a scale from 1 (worst) to 5 (best). When the water quality is assessed with a score below 3, the house prices increase with distance.

Other revealed preference studies found that the impact of distance to rivers on property prices can be felt at longer distances from the river. For example, Van Dijk *et al.* (2016) found that properties within 10 km of a small river in Switzerland had significantly higher prices than those beyond 10 km. However, properties, within 10 km of a large river had significantly lower prices.

It should be noted that although there is a positive amenity impact of living near rivers (at least in cases when the quality of the water and surrounding environment is of a minimum standard), but there is also a potentially negative impact, due to flood risk. This may explain the positive relationships between distance to rivers and house prices obtained in some cases in the studies mentioned in the two paragraphs above.

7. Place attachment

The definition of "local area" in the context of rivers can also be derived using information from studies that directly assessed the perceptions of residents about rivers. For example, distance has been included as variable in quantitative studies about attachment of people to rivers. Place attachment is a concept used to describe the relationship people form with places (Altman and Lowe 1992). This relationship includes an emotional element (known in the literature as "place identity"), which is related to the importance of the place in people's identity (Proshansky 1978) and a functional element (known as "place dependence"), which is related to the importance of the place to pursue some activity (Stokols and Shumaker 1981). The relationship also includes other elements of places, such as familiarity, rootedness, belonging, and bonding (Kyle *et al.* 2005).

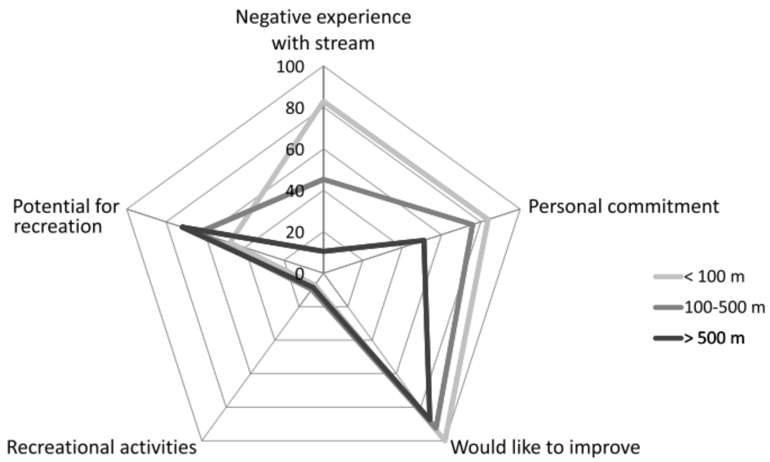
The hypothesis is that attachment to rivers decreases with distance and is stronger among residents in the surrounding areas. This is confirmed for example in the study of Todd and Anderson (2005) in New York State. Place attachment was measured using a questionnaire about place identity, place dependence, and place familiarity. The participants in the study lived an average of 3.5 miles (5.6 km) from the river. The group showing a low level of place attachment lived an average of 4.9 miles (7.9 km) away, considerably higher than those showing a medium level (2.5 miles, 4 km) and a high level of place attachment (2.6 miles, 4.3 km). The number of years lived in the area was not significant. Place attachment was also found to be correlated with the perceived recreational, environmental, and economic benefits of the river.

Ryan (1998) used a survey to assess perceptions and preferences towards rivers and riparian landscapes among residents in a rural area in the United States, comparing residents at different distances to the river (0-0.25 miles (0-400m), 0.25-0.5 miles (400-800m), 0.5-0.75 miles (800-1200m), and 0.75-1 mile (1200-1600m). Water quality problems were felt more strongly by residents living near the river (0-400m). In a scale from 1 to 5 these residents gave an average rating of 3.93 to problems of water quality, comparing with an overall average of 3.57. However, preferences regarding the river versus other types of riparian landscapes were not related to distances between homes and the river.

The study of Alam (2011) in Bangladesh also used different distance intervals, comparing perceptions about rivers for people living within 1 km of a specific river and outside 1 km, in a large study area of around 360 km^2. The majority (52%) of respondents living within 1 km visited the river more than once in the last 3 months. Only 24% of the people living outside 1 km visited the river more than once in the last 3 months and 62% of them never visited the river. 48% of the people within 1 km also reported economic and/or recreational dependence from the river and a further 10% reported recreational dependence only. In comparison, only 24% of people outside 1 km reported economic and/or recreational dependence and only 12% reporting recreational dependence only. 43% of people within 1 km reported a “great deal of concern” about the state of the river, comparing with only 13.6% of those outside 1 km. The study also found a time dimension to place attachment, as the group of people who lived within 1 km of the river for more than 10 years reported slightly less frequent visits and less dependence than the ones living within 1 km for less than 10 years.

The influence of distance on perceptions about rivers also applies in the case of negative aspects of the rivers. Johnson *et al.* (2015) looked at a comprehensive range of dimensions of people’s perceptions about rivers, using as a case study a polluted river in Buenos Aires. **Figure 1** shows the average scores of residents at different distance intervals from the river for composite indices of five perceptual dimensions: negative experiences with the river, recognition that the stream as potential for recreation, participation in actual recreational activities, and desire and personal commitment to improve the stream. Residents living more than 500m from the river had a smaller propensity to report negative experiences than those living nearer. The large majority (83%) of respondents living less than 100m from the river had negative experiences, and the majority (57%) of respondents living more than 500m away had no experiences at all. Residents living more than 500m from the river also showed a lower personal commitment and a slightly weaker desire to improve the river than those living nearer. Only half of respondents living more than 500m from the river would be willing to improve the river, comparing with 84% of those living within 100m and 76% of those living 100 to 500m. People living farther than 500m also had higher propensity to believe the river has a potential for recreation, although they reported the same level of use of the river for recreational activities.

Figure 1: Perceptions about a river (Source: Johnson *et al.* 2015, p.5).



Not all studies found a strong relationship between perceptions about rivers and distance from homes to rivers. For example, Smith and Moore (2011) analysed the role of distance in explaining the perceived community benefits of two rivers in the United States, comparing two types of benefits: “Ecological or affective” and “tangible”. Proximity to the river was significantly related to beliefs that the river provides ecological or affective community benefits. However, the magnitude of the impact of distance is small. A one mile (1.6 km) increase in distance from homes to rivers leads to a reduction of only -0.0003 in the score of perceived benefits (a standardized variable with mean 0 and standard deviation equal to 1). Furthermore, the distance to the river was not significantly related to beliefs that the river provides tangible benefits. These beliefs were mainly explained by age and gender and by the number of trips to the river within the past year.

8. Environmental concern

Distance to rivers has been used as a variable in quantitative studies explaining environmental attitudes in relation to those rivers and to nature in general, and concerns about flood risk. This allows for the assessment of the impact of proximity on perceptions about rivers, when controlling for other variables (such as age, gender, income, and political affiliation). This information can then be used to derive the extent of the “local areas” where people show a stronger concern about rivers.

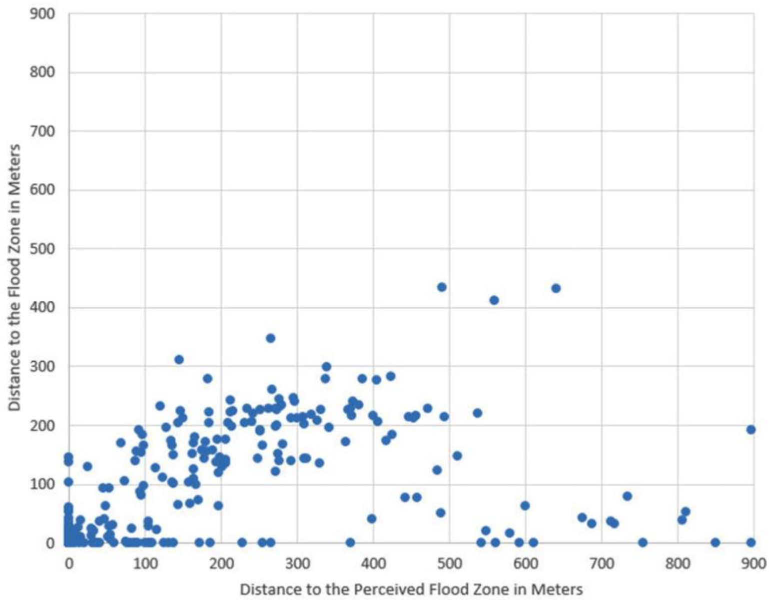
The results of some studies suggest “local areas” that are very wide, such as those that can be derived from stated preference studies, as mentioned in Section 5. For example, Brody *et al.* (2004) estimated the influence of proximity on people’s familiarity with and concern about pollution in two streams passing through San Antonio (United States). Proximity was assessed by the driving distance from residences to the streams. This variable was significant even when controlling for other geographic variables and socioeconomic variables. The results differed across case studies. In one case, people living at 140m distance had a probability of 73% of being familiar with the river and those living at 39 km distance had a probability of 8%. In another case, people living at 30m distance had a probability of 93% of being familiar with that river and those living at 44 km distance had a probability of 42.

However, most of the studies suggest relatively narrow “local areas”, comparable to those that can be derived from revealed preference studies and studies of place attachment. This is for example the case of the study of Larson and Santelmann (2007), who analysed attitudes toward water resource protection among residents at different distances from those resources in Portland (United States). The study started by comparing reported proximity to rivers and objectively-measured distances. On average, people who reported living adjacent to the stream in fact lived 60-90m away; those who reported living “very close”, but not adjacent, lived around 300m away; those who reported living “somewhat close” lived 400-800m away, and those who reported living “not close” lived more than 800 away. The authors then assessed the influence of distance on attitudes towards water resource protection. People living “very close” (~300m) were more likely to support regulations than those living adjacent or “somewhat close” (400-800m) or “not close” (>800m). People living “very close” (~300m) and “somewhat close” (400-800m) were more likely to support economic measures than those living “not close” (>800m). However, the influence of proximity was weak when controlling for other variables explaining environmental attitudes.

The study of De Groot and De Groot (2009) in the Netherlands about general environmental does not confirm the hypothesis of narrow “local areas” around rivers. The study tested whether distance to a specific river influences how individuals identify in relation to nature (as “master”, “guardian”, “companion”, or “participant”). These five types were identified through a factor analysis on the answers to a questionnaire. In general, comparing with participants living within 1 km of a river, those living 1-1.5 km, 1.5-2 km and more than 2 km away did not have a significantly different propensity to identify as one of the five types, when controlling for sex, age, education, frequency of visits, and political attitudes. The only exception was that residents living more than 2 km away from the river had a higher propensity to identify as “guardians” of nature than those living within 2 km. These results show that distance to rivers has a complex influence on people’s environmental concern, and suggest that people living 1 km of the river do not have stronger environmental concern about nature than people living farther away.

As suggested at the end of Section 6, rivers’ “local areas” can also be delimited based on evidence of a common understanding among nearby residents of the flood risks posed by the river and on the possible solutions to reduce that risk. The study of O’Neill *et al.* (2016) in Ireland found that a considerable proportion of residents perceive their homes as being much more distant from the flood zone of a river than it actually is (**Figure 2**). This gap is explained by variables such as elevation, income, length of residence, housing tenure, previous flood experience, undertaking flood preparedness measures, and beliefs about river management. In practice, this means that the aggregation of unit values of willingness to pay to reduce flood risk can produce very different results when it uses objective and perceived information on the extent of the flood risk.

Figure 2: Distance to perceived vs. objective flood zone (Source: O'Neill *et al.* 2016, p.2173)



The preferences of local residents about flood control measures also depend on distance. For example, in a study in Japan, Zhai *et al.* (2006), the preference for external flood control measures decreases with distance from a river, from 34% for residents living within 100m of the river to 0% for those living more than 5 km away. This suggests that the river's perceived "local area" is narrower that 5km. Once again, the study of De Groot and De Groot (2009) mentioned above provides more nuanced results, as it found that the propensity of people living within 1 km of the river to support all four types of measures presented (cut down trees, site channels, dike relocation, and dike reinforcement) was not statistically different from that of people living at other distance intervals.

9. Conclusions

This report reviewed quantitative evidence on the size and nature of the area which is considered "local", in the context of rivers. The aggregation of willingness to pay for improvements in river water quality and other attributes of rivers has usually been made at the level of water company boundaries. However, there is evidence that willingness to pay for these improvements decreases with distance. This may be explained by the fact that after a certain distance, local residents do not perceive rivers as being in their "local area". This review showed that this "local area" can be delimited in different ways, depending on the type of studies used to provide evidence.

Some stated preference studies have attempted to measure the distance-decay pattern of willingness to pay for improvements in rivers, deriving values for the elasticities of willingness to pay to distance, or comparing willingness to pay for residents living in different distance intervals from the river. It is possible to use these studies to identify a river's "local area" as the area within which there is a positive willingness to pay for improvements. However, in most cases, this results in a very wide area, with radii of hundreds of km or even more. However, if we assume that willingness to pay for river improvements decreases linearly with distance, the “local area” could be defined as half of the area defined above, that is, the area where half of respondents have a positive willingness to pay.

When comparing with stated preference studies, revealed preference studies using hedonic analyses to property markets suggest that the areas within which the positive and negative attributes of rivers are valued are relatively narrow, a maximum of 1 km or 2 km wide, but possibly only 400m or 500m wide. However, in practice, the size of the area depends on the type and quality of the water bodies. “Local areas” are different for clean and polluted rivers. There are also conflicting impacts of rivers on property prices, as the amenity value of rivers may be offset by concerns about flood risk.

The results of studies about perceptions of local residents regarding rivers, which measure people’s subjective attachment to rivers or concern about environmental issues also suggest that the “local area” around a river is relatively narrow, comparing with the areas implicit in the results of stated preference surveys. Studies comparing residents within and outside a 300m, 500m, or 1000m buffer from the river usually found significant differences in the levels or nature of attachment to rivers and/or concern about the river environment.

Considering the evidence provided by the different types of study, we recommend that the “local area” used for the purposes of aggregation of unit values of willingness to pay for improvements in river water quality and other river attributes should be no wider than 2 km around the river. The extent of area is compatible with that of the areas implicit in the results of studies of people’s perceptions and of revealed preference analyses to housing markets. The extent is not compatible with the area implicit in the results of stated preference studies. However, we believe that this is not a major concern, because there are reasons to believe that those results probably overestimate the willingness to pay of residents living very far from the river, as the studies do not usually take into account aspects such as non-linearities in the effect of distance in willingness to pay, differences between users and non-users of rivers, and the presence of substitutes (i.e. other rivers).

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