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Valuation of river restoration measures – Do residential preferences depend on leisure behaviour?

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ABSTRACT
The number of river restoration projects grew steadily in recent years. However, freshwater ecosystems attract diverse stakeholder groups and thus are frequently a source of conflicting interests. A growing number of studies analyses stakeholder preferences towards river restoration projects albeit without distinguishing between them. However, a differentiated analysis is highly important, since public participation in decision-making is often restricted to a limited number of stakeholder groups. We used a discrete choice experiment to unravel preference heterogeneity of local residents towards river restoration depending on individual leisure behaviour. Our results show that some user groups have contrasting preferences to the vast majority of users. This is of particular interest, as these well-organized and influencing groups are considerably small and do not represent the general opinion of residents. Our results illustrate the large challenges for decision-makers and planners who are obliged to ensure public participation in river restoration projects.

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Conflict; preference heterogeneity; public participation; recreation; stakeholder

1. Introduction

1.1 Policy changes in river management

Rivers and floodplains are heavily impacted by human intervention worldwide (e.g. Nilsson et al., 2005). With the continuous increase of human population, this trend will further intensify (e.g. Nilsson & Svedmark, 2002; Vitousek et al., 1997). Due to a better ecological understanding, the conservation of rivers and floodplains has become increasingly important (e.g. Wohl et al., 2015). For example, the US-Clean Water Act (Lave et al., 2010), the Japanese 'River Law' (Nakamura et al., 2006) and the EU-Water Framework Directive (Bouleau, 2008) resulted in a wide range of river restoration projects during the past decades (e.g. Bernhardt et al., 2005; Nakamura et al., 2006). In Germany, the 'Blue Belt Programme' started in 2017 which aims to ecologically upgrade the German waterway network in future. Minor waterways (rivers with no significance for commercial

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transport) are to be largely restored to increase biodiversity and develop recreational activities. Larger waterways with intensive commercial shipping are to be ecologically increased by implementation of 'ecological stepping stones' for years to come (BMUB, 2015; von Haaren & Albert, 2016). Despite the benefits for ecology and recreation the planned measures also carry the risk of conflicts with present river users.

1.2. Public participation

Consistent with the EU-Water Framework Directive, public participation in the planning and implementation of restoration measures must be ensured (Euler & Heldt, 2018; Perni et al., 2012). This point is of particular importance as rivers play a significant role in many people's everyday lives (Junker et al., 2007). However, a recent study of Szałkiewicz et al. (2018) indicated that more than half of European river restoration projects do not involve local participation. If stakeholders are involved river restoration projects are frequently a source of conflict (Junker et al., 2007). This is due to freshwater ecosystems are highly complex and thus attract various stakeholder groups (Kondolf & Pinto, 2017) with partly opposing demands (Buckley & Crone, 2008; Heldt et al., 2016). The most critical point in public participation is the integration of only established and well-organized stakeholder groups into decision-making as attitudes of integrated groups can differ from the non-integrated local population (Junker et al., 2007). In Germany, for example, several groups of water sports enthusiasts, rural districts and other water related organizations published a joint declaration demanding the maintenance of the status quo of waterways with degraded commercial transport (NDW, 2015). This request may contradict future restoration efforts and the dismantling of infrastructure as outlined in the 'Blue Belt Programme'. On the other hand, a nation-wide survey indicates that the German population gives high priority to wild, unspoiled nature (BfN, 2015). To what extent, this general attitude applies to river restoration is unclear. Detailed examinations are needed to illustrate the ratio of potential protest groups of river restorations to the overall population. An increasing amount of literature is dealing with valuations of river restoration projects worldwide (Brouwer & Sheremet, 2017). However, non-market valuation values can differ considerably between countries (e.g. Chen et al., 2018; Hanley et al., 2006). Furthermore, only very few studies distinguish between single stakeholder groups (e.g. farmers: Buijs, 2009; anglers: Meyerhoff & Dehnhardt, 2007).

1.3. Research questions

Against the background of large-scale river restoration projects in the course of the EU-Water Framework Directive and the German 'Blue Belt Programme' we intent to answer three research questions:

1. To what extant is the German population willing to pay for ecological improvements of local rivers?
2. How and to what extent are rivers used for recreational purposes by the local population?
3. Are there differences in preferences towards river restoration between single user groups which indicates potential conflicts?

The results of this study shall help to identify relevant stakeholder groups of rivers and their respective proportions within the overall population. We hope to raise decision-makers awareness of civil society's heterogeneity to reduce future conflicts in river restoration projects. Since non-marine water environments such as rivers constitute an exceptional attractiveness for leisure activities worldwide (Moreira & dos Santos, 2010) our results might also be helpful for restoration projects beyond Germany. Together with other studies conducted in densely populated countries such as China (Zhao et al., 2013), Spain (Perni et al., 2012) or Denmark (Kataria et al., 2012), we hope to contribute to the general knowledge of human appreciation of natural rivers and floodplains worldwide.

2. Methods

2.1. Study area

We choose two segments of the river Werra (89 km) and Fulda (109 km) in Central Germany as study area. Both rivers are part of the German waterway network. Commercial shipping has largely been abandoned during past decades. Thus both rivers belong to the core area of the future 'Blue Belt Programme' and constitute an ideal case study for large-scale river restoration projects in Central Europe. The floodplain areas of the rivers are heavily impacted by human intervention and consist of about 33% settlement and agricultural area respectively. Less than 5% of the floodplain is forested. In general, the floodplain status ranged between 'moderately' to 'severely' modified according to Brunotte et al. (2009). Near-natural riverbanks were barely present due to almost continuous artificial riverbank protection (riprap) (Neubeck, 2014). The study region comprised 262 communities in the German federal states of Thuringia, Hesse, North Rhine-Westphalia and Lower Saxony with geographical centres at a distance of no more than 30 kilometres from the respective river (Figure 1). This distance was obtained from a pre-study conducted in summer 2016. By interviewing 327 river users (anglers, boaters, campers, walkers and others) at the rivers Werra and Fulda we determined a distance of 30 kilometres or less for 2/3 of respondents. The overall population density within the study area is 150 inhabitants per square kilometre. Two cities with more than 100,000 inhabitants are located within the study region (Figure 1). About three quarters of the respondents (76.50%) lived in settlements with less than 100.000 inhabitants, which are considered as rural areas.

2.2 Survey and questionnaire

We conduct a large-scale randomized postal survey using a questionnaire to obtain information from a representative cross-section of society. In November 2017, 10,000 questionnaires were sent out by post to randomly selected residents of the study region. In December 2017, a postcard was used to remind the participants of their contribution to the survey. The questionnaire includes a discrete choice experiment (DCE) to identify the respondents' marginal willingness-to-pay (WTP) for potential river restoration measures. The method is based on the micro-economic theory (McFadden, 1974) which says that respondents chose the alternative with the highest individual benefit.

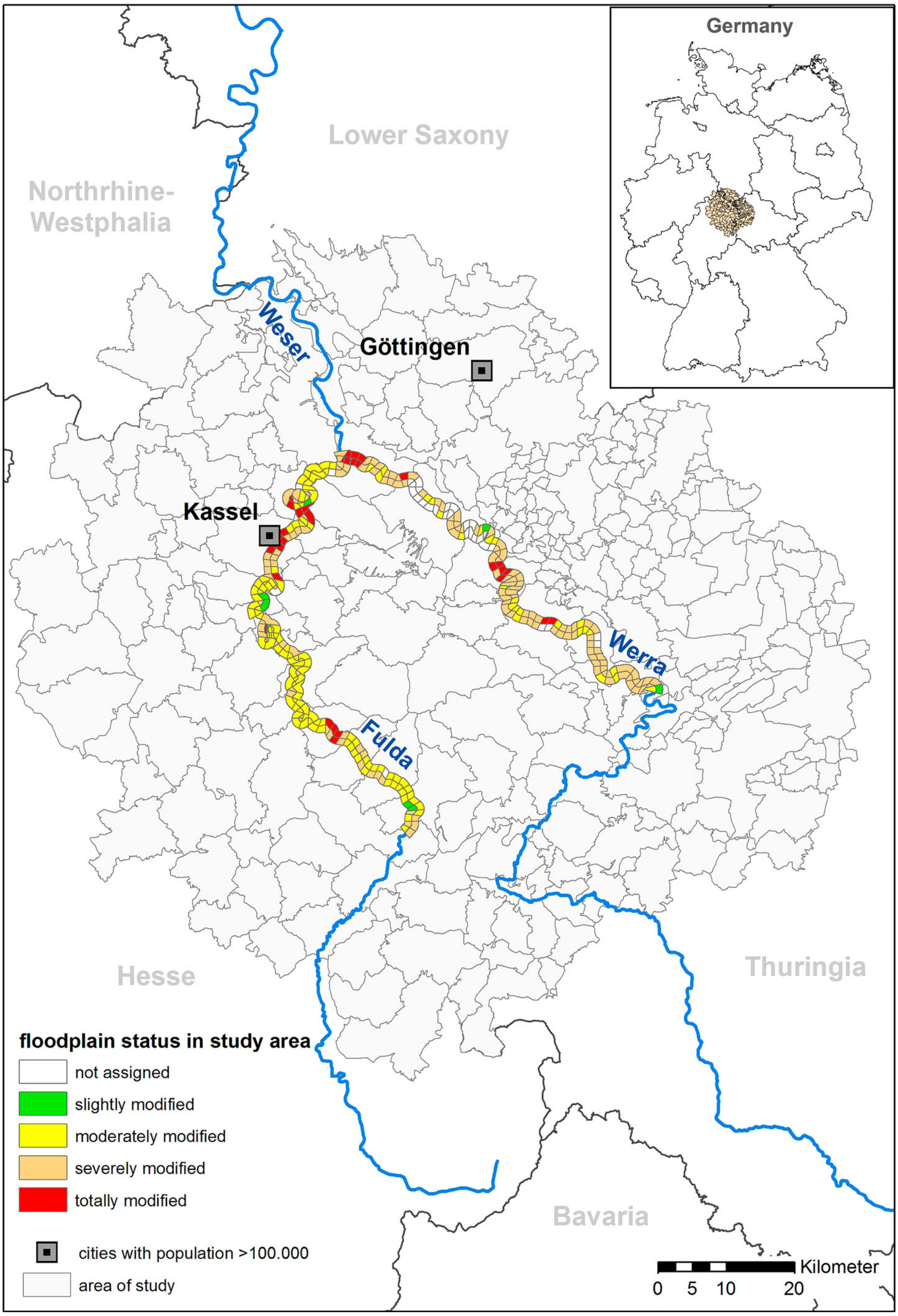

Figure 1. Location and expansion of the research area with information on the floodplain status according to the EU-Water Framework Directive (source: Brunotte et al., 2009).

This method is increasingly used to identify the personal preferences for selective alternatives (such as environmental goods) in a hypothetical choice situation (Pakalniete et al., 2017; Rakotonarivo et al., 2016). In our DCE, we focused on three attributes which are of major, yet partly conflicting interest regarding river restoration: biodiversity/ecology, river access and riverbank status/vegetation. These attributes are frequently used in other studies of river restorations evaluation (e.g. Hanley et al., 2006; Kondolf & Pinto, 2017; Zhao et al. 2013) and belong to the main elements of the 'Blue Belt Programme'. 'Biodiversity/ecology' was considered with different levels of aquatic and terrestrial species diversity. The different levels of the 'riverbank status/vegetation' were expressed by the occurrence of artificial riverbank protection (riprap) and riverbank vegetation. To measure the impact of 'river access', we defined different frequencies of access points to the river. Additionally, a fourth attribute in form of different rates of hypothetical taxes per household per year (hld/yr) were introduced to capture the WTP for above-mentioned river characteristics (Table 1). To compare our results with previous studies, we utilize the same price levels as Dehnhardt et al. (2016) who conducted a choice experiment on floodplain restoration in Germany. These levels are also very similar to other European river restoration studies such as Perni et al. (2012) and Doherty et al. (2014). Furthermore our approach closely matches the results of a trans-European case study of water quality improvements (Bateman et al., 2011).

On the basis of the mentioned attributes, an experimental design plan was developed for carrying out a Discrete-Choice-Experiment. A choice design consists of sets of several alternatives, and each set of alternatives is called a choice set. Each single alternative can be described by the different attributes and attribute levels. The chosen attribute levels are based on literature research and on expert judgment. The final choice task for the respondent is to choose the alternative she or he prefers most out of the given set. On the basis of the made decisions the logistic regression model can be applied for measuring the WTP for different river restoration measures.

In this study, a choice set or task consisted of a so-called status quo option (see Figure 2) and two other alternatives. For the status quo, the attribute levels (see Table 1) were fixed whereas for the two other alternatives the levels were varied according to the experimental design plan over in total sixteen choice sets. Out of this each respondent received eight different choice sets for that she or he had to make a decision one after the other. The applied experimental design plan was developed with the software Ngene (2012) and a D-efficient unlabelled design was generated (D-error = 0.24).[1]

To prevent ordering effects a randomization of choice sets within each block, as well as the positioning of the alternatives was conducted according to Loureiro and Umberger (2007). The DCE was depicted in pictograms (Figure 2).

To obtain an impression of representativeness of our collected data, we additionally requested personal information from respondents to compare them with the national average. These requests include gender (female, male, not specified), age (year of birth),

Table 1. Analysed attributes and their characteristics (levels).

Attribute	Levels			
Riverbank status	Riprap	Riprap removed		Riprap removed with natural riverbank vegetation
River access	Only at a few special places	In regular distances		Everywhere/no restrictions
Biodiversity	Low	Medium		High
Tax per household per year (hld/yr)	€0	€25	€50	€75

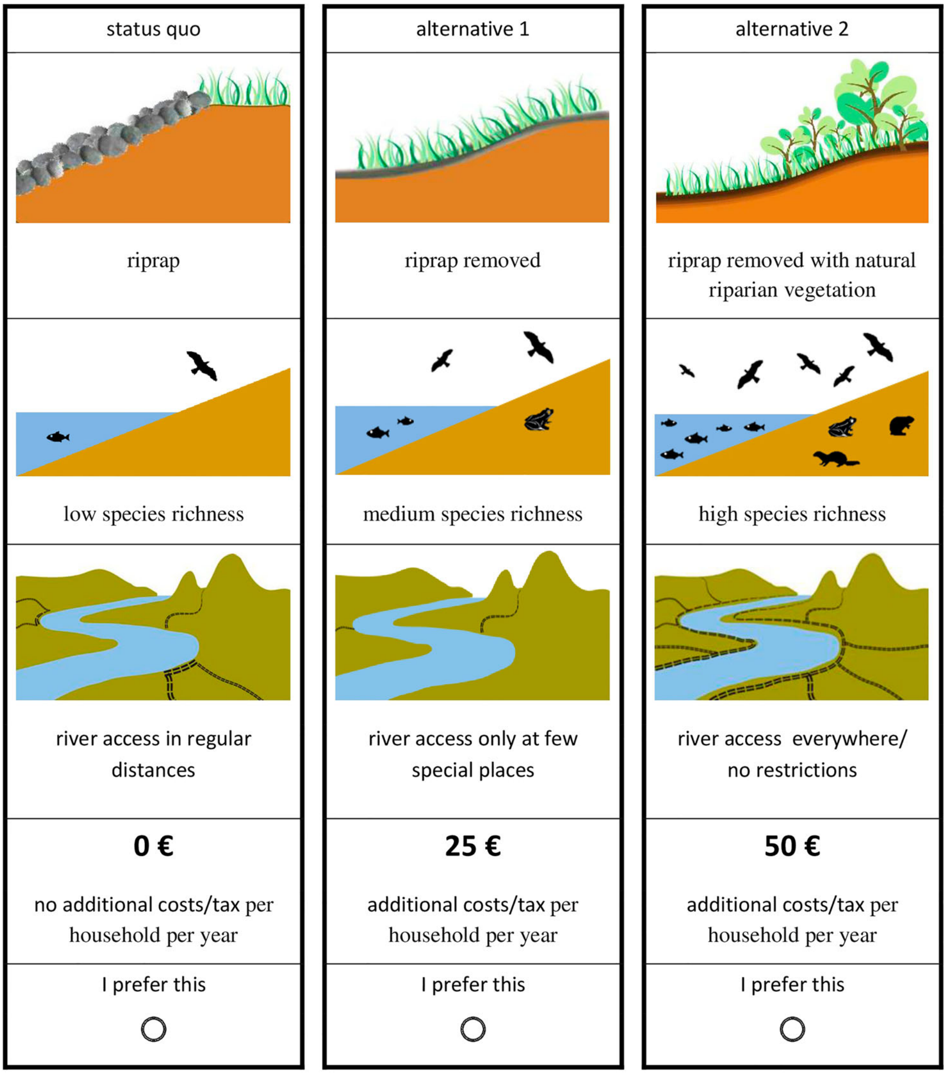

Figure 2. Example of a choice set (translated into English).

place of residence (postal zip code) and education (three main levels of school-leaving qualifications, none, not specified).

To allocate individual preferences to specific stakeholder groups the respondents had to indicate how intense they use rivers and their surroundings for walking, angling, cycling, canoeing and motorboat driving.

The extent of these leisure activities was specified by a five-level frequency scale from 'never' to 'very often'.

2.3 Statistical analysis

The levels of the riverbank status, the river access, and the biodiversity were dummy-coded (0, 1) and the base categories for the estimation were 'riprap', 'river access in regular distances' and the biodiversity level 'low'. The tax per year was entered in the applied regression as metric variable. For the estimation a Generalized Multinomial Logit Model (GMNL) in WTP-space was applied. The GMNL specification includes interaction terms between the different river restoration measures expressed by the levels of the three CDE attributes, respondents' frequency of different activities at and on rivers (e.g. walking, canoeing, cycling, angling and motorboat driving) and one demographic variable (urban place of residence). To consider the user groups with respect to the frequency of the different activities in the applied regression model as interactions, the scale values were cantered so that they have a mean of zero. A more detailed description of the applied model can be found in Balogh et al. (2016).

3. Results

3.1 Response rates and socio-demographics

The response rate of the postal survey was approximately 20% ($n = 2011$). Due to a lack of data for some parameters (e.g. indication of urban or rural residence), only 1745 individuals entered the final WTP-space regression. Table 2 shows the demographic characteristics of the respondents compared to the national average of the German population.

3.2 Model performance

Log-likelihood, AIC and BIC show that the GMNL-interaction models fit better to the data than the basic GMNL models with uncorrelated attributes. We thus apply the GMNL-interaction model to explain preference and scale heterogeneity as well as attribute interaction. In the GMNL-WTP-space model, we normalize the price coefficient to −1 and interpret the attribute coefficients directly as WTP values. The GMNL-WTP-space model was estimated applying the R package 'gmnl' (Sarrias & Daziano, 2015) using 1500 Halton draws. The random parameters were assumed to have a normal distribution. To receive a vector of starting values for the GMNL model with the same package, a scale heterogeneity multinomial logit with 100 Halton draws was estimated prior to this.

3.3 Research question 1: WTP for river restoration

In the GMNL model, the standard deviations of random parameters are different from zero, viz., respondents weighted the attributes differently. The results show clear evidence

Table 2. Demographic characteristics of the respondents compared to the German national average (source: Statistisches Bundesamt, 2017, Statistisches Bundesamt, 2018a, b, c); 'Abitur' is the highest of three general school-leaving qualifications which qualifies graduates to enter University. hld/yr = household per year, m = mean, sd = standard deviation.

	Respondents/[German census]		No indication
Sex	Female = 39.10%; [50.66%]	male = 56.80%; [49.34%]	4.10%
Age	*m* = 57.04; [45.20]	sd = 12.28	5.00%
Income hld/yr	*m* = €3,232 [€2,706]	sd = 3,526	10.20%
Education	no Abitur = 50.00%; [67.00%]	Abitur = 44.60% [33.00%]	5.40%
Region	Urban = 15.00%	Rural = 76.50%	8.50%

of residents support against the status quo (–€16.02). This corresponds to the finding that about 85% of the respondents chose either alternative 1 or alternative 2 which were displayed with different river restoration measures. Considering the ‘riverbank status’, most participants revealed a strong preference for the characteristic ‘riprap removed with natural riverbank vegetation’. In comparison to the base alternative ‘riprap’, the respondents would be willing to pay a yearly tax of €44.03 for this river restoration improvement. The WTP for the ‘riverbank status’-option ‘riprap removed’ was significantly lower (Wald-test, $\alpha = 0.01$) with €32.87, but still positive and significant. The WTP for an improvement of biodiversity to a medium level is 47.56€ and to a high level is €66.20. For most participants the access to the river is only of minor importance. Only the level ‘river access in regular distances’ revealed a significant positive, although low WTP of €4.57 compared with the base alternative ‘river access only at a few special places’.

The random parameters are defined as being correlated with each other. Table 3 presents the full correlation matrix of the random parameters for the GMNL-WTP-space model. There is a statistically significant positive association between the valuations of the options ‘riprap removed’ and ‘riprap removed with natural riverbank vegetation’. Furthermore, the latter is highly positively correlated ($r = 0.87$ resp. $r = 0.84$) with the parameter level ‘high biodiversity’. Both riverbank status options are also highly positively correlated ($r = 0.78$ resp. $r = 0.70$) with the ‘medium biodiversity’ level. The parameters ‘river access everywhere’ and ‘river access in regular distances’ are highly correlated with each other as well ($r = 0.78$). At the same time, individuals who prefer river access in regular distances are willing-to-pay less for the aspect ‘high biodiversity’ ($r = -0.46$). Likewise, individuals who prefer ‘river access everywhere’ are willing-to-pay less for the aspect ‘medium biodiversity’ ($r = -0.35$).

3.4 Research question 2: use of rivers for recreational purposes

The survey revealed five relevant groups of residents using the rivers Werra and Fulda for recreational purposes: walkers, anglers, cyclers and boaters (canoe and motorboat). The specific response behaviour of respective group is given in Table 4. The vast majority of respondents mainly use rivers and their surroundings for walking (84%) and cycling

Table 3. Correlation matrix of random parameters. *Significant at the 1% level.

		Riprap		Access		Biodiversity		
		Removed	Removed, natural vegetation	In regular distances	Everywhere	Medium	High	Status quo
Riprap	Removed	1.00*	0.91*	−0.44*	−0.13*	0.79*	0.87*	−0.16*
	Removed, nat. vegetation	0.91*	1.00	−0.49*	−0.19*	0.70*	0.84*	0.08*
Access	In regular distances	−0.45*	−0.49	1.00*	0.78*	−0.68*	−0.46*	−0.31*
	Everywhere	−0.13	−0.19	0.78*	1.00*	−0.35*	−0.28*	−0.13*
Biodiversity	Medium	0.79*	0.70	−0.68*	−0.35*	1.00*	0.83*	0.16*
	High	0.87*	0.84*	−0.46*	−0.28*	0.83*	1.00*	−0.11*
Status quo		−0.16	0.08	−0.31*	−0.13*	0.16	−0.11*	1.00*

(67%). Every fourth respondent does canoeing (28%) but only very few respondents do angling (7%) and motor boating (4%). The differences in leisure behaviour are even larger when comparing the frequencies of river use. Approximately one third of respondents do walking (38%) or cycling (29%) often or very often (scale value 4 and 5). On the contrary, only very few people frequently do canoeing (4%), angling (<4%) or motor boating (<1%).

3.5 Research question 3: preferences of different recreational users

The interaction effects between the type of recreational use, respondents' place of residents and the DCE attributes are shown in Table 5. The upper part of Table 5 contains the means and standard deviations of the random (respondent-specific) coefficients. The middle part shows the interaction effects of the variables 'urban' and the user groups 'motorboat', 'bicycle', 'angler', 'canoe' and 'walk' with the means of the coefficients. Concerning the different recreational user groups, a high degree of heterogeneity between the DCE attributes can be found as can be seen from the numerous significant interactions.

An urban place of residence significantly influences participants' WTP for the analysed river restoration aspects. Respondents from urban areas revealed significantly higher WTPs for the options 'riprap removed with natural riverbank vegetation' (+€13.22) and 'high biodiversity' (+€22.95) than respondents from rural areas. In contrast to the rural respondents, urban participants additionally revealed a significant positive preference for 'river access everywhere' (+€8.54). Respondents who use the river for motor boating have a much lower WTP for the attribute characteristics 'riprap removed' (–€5.50 per unit[2]) and 'riprap removed with natural riverbank vegetation' (–€8.43 per unit) than other users. To analyse the absolute interaction effect of respondents frequency of using the river for motor boating, the corresponding WTP interaction value had to be multiplied with the individual-specific frequency for motor boating ranging from 3.93 to −0.07 ($\text{mean}_{\text{motorboat}} = 0$) for the calculation of the WTP mean for the interaction effect of the attribute ' riprap removed'. If we focus on the heavy motorboat-user group, the value 3.93 (Table 4) must be used for this multiplication. The calculated value must then be summed with e.g. the main effect 'riprap removed

Table 4. Type and frequency of river use by respondents. Original and centred values calculated as follows: individual value – mean over whole subjects of the variable.

User group	Scale values				
	1 = never	2	3	4	5 = very often
Walking centred	−2.10	−1.10	−0.10	0.90	1.90
%	16.36	9.00	36.48	24.82	13.34
Angling centred	−0.18	0.82	1.82	2.82	3.82
%	92.51	2.00	2.10	1.92	1.46
Cycling centred	−1.60	−0.60	0.40	1.40	2.40
%	33.21	11.94	25.59	20.16	9.10
Canoe centred	−0.46	0.54	1.54	2.54	3.54
%	72.32	14.44	9.27	3.10	0.85
Motorboat centred	−0.07	0.93	1.93	2.93	3.93
%	96.30	2.01	0.75	0.50	0.45

Table 5. Estimation results in WTP-space. ***, **, *, ´, Significant at the 0.1%, 1%, 5% and 10% levels, respectively.

	WTP in €(coeff.)	Std. error	z-value
Mean estimates random parameters			
Riprap removed	32.87***	1.41	23.30
Riprap removed with natural riverbank vegetation	44.03***	1.26	34.83
River access in regular distances	4.57***	1.07	4.28
River access everywhere	−2.83*	1.37	−2.06
Biodiversity medium	47.56***	1.65	28.83
Biodiversity high	66.20***	1.83	36.13
Status quo	−16.02***	2.41	−6.65
sd. mean estimates random parameters			
Riprap removed	10.87***	1.68	6.46
Riprap removed with natural riverbank vegetation	22.26***	1.77	12.57
River access in regular distances	14.23***	1.43	9.98
River access everywhere	18.00***	1.94	9.26
Biodiversity medium	25.93***	1.62	16.02
Biodiversity high	27.69***	2.16	12.83
Status quo	15.37***	1.76	8.75
Mean estimates taste parameter 'urban'			
Riprap removed	6.94*	2.75	2.53
Riprap removed with natural riverbank vegetation	13.22***	2.77	4.77
River access in regular distances	−4.18´	2.50	−1.67
River access everywhere	8.54***	2.49	3.43
Biodiversity medium	8.18***	2.47	3.31
Biodiversity high	22.95***	3.46	6.64
Status quo x urban	4.48	4.30	1.04
Mean estimates taste parameter 'motorboat'			
Riprap removed	−5.50*	2.27	−2.42
Riprap removed with natural riverbank vegetation	−8.43***	2.16	−3.91
River access in regular distances	5.21*	2.51	2.08
River access everywhere	−0.69	2.07	−0.33
Biodiversity medium	−3.46´	1.84	−1.88
Biodiversity high	−9.64**	3.07	−3.14
Status quo	−4.55	3.44	−1.32
Mean estimates taste parameter 'bicycle'			
Riprap removed	−0.37	0.77	−0.49
Riprap removed with natural riverbank vegetation	0.68	0.76	0.90
River access in regular distances	1.83*	0.74	2.47
River access everywhere	2.71***	0.76	3.55
Biodiversity medium	−0.33	0.69	−0.48
Biodiversity high	0.45	1.00	0.45
Status quo	−1.53	1.21	−1.26
Mean estimates taste parameter 'angler'			
Riprap removed	3.12*	1.50	2.09
Riprap removed with natural riverbank vegetation	2.92*	1.45	2.01
River access in regular distances	−0.41	1.35	−0.31
River access everywhere	−1.91	1.58	−1.21
Biodiversity medium	1.78	1.41	1.26
Biodiversity high	0.65	1.94	0.33
Status quo	0.68	2.22	0.31
Mean estimates taste parameter 'canoe'			
Riprap removed	1.53	1.15	1.33
Riprap removed with natural riverbank vegetation	−2.42*	1.12	−2.15
River access in regular distances	1.78	1.11	1.61
River access everywhere	2.85*	1.11	2.57
Biodiversity medium	−0.60	1.05	−0.57
Biodiversity high	−2.44´	1.48	−1.65
Status quo	−0.29	1.85	−0.16
Mean estimates taste parameter 'walk'			
Riprap removed	2.11*	0.85	2.47
Riprap removed with natural riverbank vegetation	3.26***	0.84	3.90
River access in regular distances	−0.48	0.79	−0.61

(*Continued*)

Table 5. Continued.

	WTP in €(coeff.)	Std. error	z-value
River access everywhere	0.91	0.82	1.11
Biodiversity medium	1.34´	0.76	1.77
Biodiversity high	3.18**	1.07	2.98
Status quo	1.55	1.30	1.19
Scale (mean)	−2.11***	0.11	−19.17
Scale heter. (τ)	0.80***	0.08	10.30
Observations	13,960		
Log-likelihood	−8693.30		

with natural riverbank vegetation' to receive the total effect for this attribute for the described group. The calculation is:

$$\text{Total effect "riprap removed with natural riverbank vegetation"} = \beta_{\text{riverbank with natural vegetation}} + \beta_{\text{riprap removed with natural riverbank vegetation x motorboat}} \times \text{frequency motorboat driving.}$$

The calculation for the described case of the motorboat enthusiasts is therefore €44.03 + ((−€8.45) × 3.93) = €10.82. This means there is only a very low preference difference between the lowest and the highest attribute level for the riverbank status for this extreme group. For the medium level 'riprap removed', the total effect is similarly heavily reduced to €11.26 (€32.87 + (−€5.50 × 3.93)) but is, in comparison, absolutely higher. Furthermore, the WTP for a two-level improvement in biodiversity (low biodiversity level to near-natural) decreases likewise to €28.12 in this group (see Table 6). In contrast, this group has a higher preference for the option 'river access in regular distances'. If the above-described calculation is applied (€4.57 + €5.21 × 3.93), the WTP increases up to €25.05 and thus becomes the second most important (river restoration) attribute for the motorboat enthusiasts. If one compares, considering the WTP interactions[3] of the motorboat enthusiasts, the status quo to a scenario with the best values from a river restoration

Table 6. Annual WTP per household for different scenarios for the motorboat enthusiasts.

	Motorboat enthusiasts interactions		**Motorboat enthusiasts interactions and correlated random parameters**	
Parameter	**Scenario status quo**	**Scenario eco-best**	**Scenario status quo**	**Scenario eco-best**
Biodiversity	Low **€0.00**	High €66.20 + (−€9.69 × 3.93) **= €28.12**	Low	High
Riverbank status	Riprap **€0.00**	Riprap removed with natural riverbank vegetation €44.03 + (−€8.45×3.93) **= €10.82**	Riprap	Riprap removed with natural riverbank vegetation
Access	In regular distances €4.57+ (€5.21 × 3.93) = **€25.05**	Only at a few special places **€0.00**	In regular distances	Only at a few special places
SUM WTP	**€25.05**	**€38.94**		
Δ Scenario status Quo WTP vs. Scenario eco-best	**€13.89**		**−€3.00**	

point of view ('eco-best', see Table 6), one finds a delta of €13.89. That is, motorboat enthusiasts have a heavily reduced, but still positive WTP for river restoration improvements that is smaller by a factor of twelve in comparison to the sample mean (Table 6).

Concerning the other groups, it can be found that cyclists have an above-average WTP for 'river access everywhere'. As for anglers, it can be stated that this group has an above-average WTP for 'riprap removed' and 'riprap removed with natural riverbank vegetation'. Furthermore, they revealed an above-average WTP for medium and high biodiversity levels. Contrarily, canoeists have an above-average WTP for 'river access everywhere', whereas they evaluate the highest biodiversity level slightly worse. Walkers have an above-average WTP for 'riprap removed' and for 'riprap removed with natural riverbank vegetation'. Despite the found differences in preferences of the recreational users, it must be said that the interactions for the frequencies of the activities 'cycling', 'walking', 'canoeing' and 'angling' are much lower in comparison to interaction with the motor boating frequency.

4. Discussion

From a methodological perspective, DCEs and the WTP space model are appropriate methods to highlight preferences and have repeatedly been used to value river restoration attributes (e.g. Chen et al., 2018; Meyerhoff et al., 2014). The results of our study generally show clear positive perception of river restoration within the group of local residents using the river for recreational purposes. Moreover, we detect response heterogeneity depending on how the river is used. It is to highlight that our study is one of the first that analyses preferences of a wide range of users groups individually. Thus we obtain a more detailed insight into public attitudes towards river restoration and identify potential fields of conflicts between particular recreational users. The results can be useful for decision-makers and planners to argue with critics and protest groups in future river restoration projects.

4.1 Research question 1

Altogether, the highest WTP (€66.20 hld/yr) was obtained for high aquatic and riverbank biodiversity. This means, for people living near the rivers Werra and Fulda an enhancement in biodiversity is the most important effect of river restoration. In order to evaluate the reliability of our results a comparison with related studies may be helpful. However, in most cases a direct comparison is not possible since most previous studies on river restoration focus on fish diversity only (Richardson & Loomis, 2009). Other studies reveal a monthly WTP (e.g. Nicosia et al., 2014) or an individual instead of a household WTP (e.g. Doherty et al., 2014). Furthermore, only few studies considered both aquatic and terrestrial biodiversity in river systems. Hanley et al. (2006) analysed the perception of increased fish, water plant, insects and bird diversity. The authors estimated an annual WTP per household of €20 (£12.19) for the River Wear in England and €62 (38.70 £) for the River Clyde in Scotland. The latter is near to our value for 'high biodiversity' which is a first hint of the reliability of our survey.

With regard to natural riverbanks our results (€44.00 hld/yr) are supported by a recent study of Rayanov et al. (2018). The authors conducted a survey on larger and smaller rivers in Germany and obtained WTP between €38 and €61 hld/yr for natural riverbanks. Perni et al. (2012) evaluated a general restoration of riverbanks including the planting of riverbank vegetation along the Segura River in Spain and found an annual WTP of €28 per person per year. As mentioned before, this value cannot directly be compared with our study but the result shows that considerable WTP for this type of attribute can also be found in other European countries.

In contrast to other studies our WTP for river access is comparatively low or even negative (Table 5). A slightly increased WTP within our study area can only be seen in urban areas. Kataria et al. (2012) calculated a WTP of €20 hld/yr for non-restricted access to the Danish river Odense. Rayanov et al. (2018) came to an average WTP of €47-58 hld/yr for occasional access to several rivers in Germany.

Generally, it is significant that ecological attributes (biodiversity, riverbank status) often obtain considerably higher appreciation than recreational attributes (e.g. access). This tendency is clearly shown in our study but also in Kataria et al. (2012) who found a three times higher WTP for water quality than for access to the river. Doherty et al. (2014) estimated a twice as high WTP for natural diversity of terrestrial and riverbank wildlife than for access to the water body (rivers, lakes, sea). A similar proportion is reported in Rayanov et al. (2018) for WTP for 'near-natural riverbanks' and 'regular access' to larger rivers. An increased appreciation of unrestricted river access in urban areas as obtained in our study can also be seen in Chen et al. (2017). The authors received an equal appreciation of biodiversity and recreational facilities (e.g. trails) in an urban area in Central Europe. These results may indicate an increased conflict potential as biological and recreational attributes often compete in practice (e.g. Zajicek & Wolter, 2019). Thus, the achievement of ecological targets within river restoration projects might be more challenging in urban than in rural areas with lower anthropogenic utilization pressure.

To summarize our results, we can conclude that the overall WTP for an eco-best scenario ('high biodiversity', 'riprap removed with natural riverbank vegetation', 'river access at only a few places') in our study is €107.40 hld/yr. This value results from the sum of the three attributes studied here. The value is considerably higher than the mean WTP of €77 ($81.2) for wildlife habitats worldwide (Brouwer & Sheremet, 2017). Again a direct comparison of our results with previous studies is difficult due to unequal description of attributes. Kataria et al. (2012) obtained a WTP of €57 hld/yr to reach the 'very good ecological status' of the Danish river Odense. Rayanov et al. (2018) obtained an overall WTP for near-natural river surroundings of more than €120 hld/yr. Meyerhoff et al. (2014) reported a WTP between €72 and €181 per person for achieving the aims of the EU-Water Framework Directive in the metropolitan region Berlin–Brandenburg in Germany. The comparison of different studies shows that the WTPs for similar attributes can vary considerably. This is mainly due to studies vary in terms of levels of attributes, geographic region or extent of surveys. A detailed analysis of factors influencing the WTP must be conducted elsewhere. Albeit there are still uncertainties with respect to the exact height of WTP our results are on the same scale as other values reported from Germany. In this line, our results illustrate the overall public support towards river restorations and generate useful (even monetary) arguments for decision-makers when justifying for costs in the context of future river restoration projects.

4.2 Research question 2

To answer the second research question, our data analysis resulted in the aggregation of five relevant recreational user groups. The identified groups can be distinguished in active and passive users. Active users are in direct contact with the water body and use the river for particular leisure activities (angling, boating). Passive users do not have direct contact with the water body but use the river for targeted visit of river surroundings (e.g. cycling and walking). The largest group, by far are walkers, both in total number as well as user frequency (Table 4). These are followed by cyclists. Every third respondent does canoeing albeit occasionally. Around 1 out of 10 is an angler and 1 out of 20 uses the motorboat. Our findings are comparable to results of Doherty et al. (2014) who determined walking or jogging as the most common recreational reason for people to visit rivers in Ireland. Despite a broad and unbiased sending of questionnaires, our results do not claim for completeness. Relevant stakeholder groups might be missing mainly due to the chosen survey method. Tourists for example are a very important group of users with high economical relevance. However, tourists come from regions outside the survey area and thus cannot be reached by mail easily. Furthermore, a direct comparison of user frequencies would not be expedient. Tourists usually visit the river once or few times but are replaced by other tourists rapidly. Another important and influential group are local farmers (e.g. Buijs, 2009). This stakeholder group uses rivers and floodplain areas for agriculture and thus has large economic interests on riverine landscapes. However, this comparatively small group was not reached by our survey or probably was not interested in participating. We strongly encourage future studies to include further stakeholder groups by applying other methods. Until then, we give a good insight into relevant stakeholder groups useful for practitioners when planning public participation in river restoration projects.

4.3 Research question 3

To answer our third research question, we clearly see that the preferences of smaller and larger stakeholder groups differ considerably. While most passive user appreciate river restoration measures and expressed high WTPs for ecological enhancement, motorboat drivers have a much lower preference for ecological attributes and a comparably high appreciation for river access. Similar effects, albeit to a lesser extent, are obtained from canoeists who have an above-average preference for unrestricted river access (Table 5). Considering the interactions between attribute preferences the findings indicate that the WTP of motorboat enthusiasts are not only reduced by the interactions as reported, but by the correlation among these parameters as well. To demonstrate the effect of the correlation in the parameters, we calculated a simulation on the basis of the estimated WTP parameters and the covariance–variance matrix of the random parameters for a choice set that contained only the status quo and the alternative eco-best scenario (Table 6). For the simulation, we assumed that the respondents were all motorboat enthusiasts who use the river very often for motor boating, whereas the intensity for their other activities (canoeing, walking, cycling, angling) were set to the lowest value (no activity). In this simulation with two alternatives, each alternative received a 50% share when the eco-best scenario had a negative tax of –€3.00. Strictly speaking, motorboat enthusiasts would have to be compensated with this amount to prefer the eco-best scenario over the status quo. We would like to point out that in a comparison of interactions only, the sign of the WTP now changes to minus, what means that motorboat enthusiasts prefer the status quo against the eco-best scenario. However, if we compare the compensation claims of €3.00 for the few motor boat enthusiasts (0.45%) for moving from the status quo to the eco-best scenario with the high WTPs of all other groups for the attributes of the latter scenario, it becomes clear that all other groups could easily compensate the motor boat drivers in monetary terms. This speaks for an implementation of the eco-best scenario even if the motorboat drivers reject it.

Public participation in river restoration is generally seen as vitally important, though the appropriate implementation of stakeholder groups is difficult in practice. In Germany, for example, water sports activists are often well-organized and form a strong and well-regarded interest group. However, our findings show that only 5% of respondents use rivers frequently for canoeing or motor boating (scale value 4 and 5, Table 4). On the contrary, larger stakeholder groups such as walkers and cyclers are usually not organized in any association and thus are hardly to include into planning processes. Our results support the findings of Junker et al. (2007) who concluded that the local public should not solely be represented by established and organized stakeholder groups. However, even if all stakeholder groups could be included (e.g. by face-to-face interviews) their preferences cannot simply be equated. Instead, they must be weighted based on the proportion of individual user groups on the entirety of users. In any case, public participation is very challenging. To avoid future conflicts in river restoration projects planners and decision-makers should try to take quality and quantity of stakeholder groups into account.

4.4 Limitations of the study

Although we present clear results which are in line with comparable previous studies, we are aware that several uncertainties remain mainly due to the applied sample selection method. As mentioned before (see Section 4.2), few important stakeholder groups like tourists and farmers could not be reached so far and should be detected by other methods in future. Furthermore, we expect a certain self-selection-bias at present since male respondents are overrepresented in our sample (see Table 2) and respondents are significantly older ($p < 0.001$) than the national average. In addition, the average monthly net household income is above the average net income in Germany and there is also an above-average education level of respondents. To what extent these socio-demographic characters influence the obtained response behaviour is uncertain. Many studies indicate that higher income results in significantly higher mean WTP (e.g. Buckley et al., 2016; Meyerhoff & Dehnhardt, 2007). However, a few studies show an opposite correlation (e.g. Collins et al., 2005). With increasing age, the preference for river restoration usually declines (e.g. Collins et al., 2005; Meyer, 2013). But, again there are opposing findings such as Holmes et al. (2004). A few studies addressed the influence of respondents' education level to the WTP for river restoration with inconsistent results. Some studies show a positive (e.g. Collins et al., 2005) others negative correlation (e.g. Meyer, 2013). Finally, there are several studies that show no correlations of any of the socio-demographic characteristics discussed here (e.g. Hanley et al., 2006 Loomis et al., 2000;). If we look to the groups with the highest distinction from the general response behaviour of the local population (motorboat-driver and anglers), we see no significant difference between the average net income of the respective group and the remaining respondents ($p > 0.05$). The same accounts for the average age of anglers and non-anglers. Only the average age of motorboat drivers is significantly lower ($m = 53.3$ years) than the age of no-motorboat drivers ($m = 56.8$ years, $p < 0.05$). However, the effect size (Cohen's d) is comparatively small ($d = 0.29$) and does not indicate a general influence on respond behaviour. The main goal of our study was to identify preference heterogeneity between single stakeholder groups. Further integration of socio-demographic parameter into the regression analysis would be far beyond the scope of this study and will be published elsewhere.

Another field of uncertainty is the comparatively small number or participants of certain stakeholder groups. Only few motorboat enthusiasts and anglers participated. However, the proportions of these groups are slightly above the national average (Statista, 2019). An increase of participants from these small user groups would require an excessive increase of questionnaires and thus a disproportionate increase of study costs. The important main facts of our results are statistically significant (Table 5) and due to the efficient design of the DCE it was possible to analyse the preference structure even for these small sample segments. Nonetheless, to not run the risk of having too few respondents of a certain and perhaps important stakeholder group, quota sampling appears to be the appropriate instrument that should be used in further studies.

Finally the assumption of identical scales across individuals has to be rejected since scale heterogeneity was also statistically significant (Table 5). This relatively high value implies that in choice decisions a certain degree of uncertainty occurs. Some respondents can possibly not disentangle the complex relation between environmental attributes and utility changes within different restoration options. Last but not least, we are aware that the WTP method does have one major disadvantage which needs to be considered (e.g. Lee & Hatcher, 2001). A well-established literature documents the recurring phenomenon of hypothetical bias in stated preference studies such as DCE (List & Gallet, 2001). There is an overvaluation of products and services in the absence of economic incentives (Harrison & Rutström, 2008). In that line, Murphy et al. (2005) showed that conducting hypothetical experiments can lead consumers to overstate their true willingness-to-pay (WTP). For example, Sauer (2009) proves overestimates of 39% of hypothetical WTP compared to the real WTP of respondents supporting local measures of biodiversity improvement. While our choice experiment was conducted hypothetically, hypothetical bias must not necessarily impact the testing of the main hypotheses. If we assume that hypothetical bias is constant across participants and attributes, we can still confidently examine relative consumer WTPs for the attributes within the models. Our study is interested in understanding marginal WTPs (mWTP) rather than the total WTPs for a river restoration measure. Thus the WTP determined here should not be interpreted in terms of market prices. However, the results give us important hints to preferences of different recreational user groups regarding river restoration effects.

5. Conclusion

By obtaining high WTP for ecological restoration measures, our result once more illustrates the often-invisible benefit of natural ecosystems. This study is one of the first to identify different types and proportions of river stakeholder groups. The results give insight into perceptions of recreational river users and potential fields of conflicts. The majority of respondents within our case study appreciate high biodiversity and nature-near riverbank conditions. In contrast, river access for recreational purposes was only of minor importance. We reveal large differences in type and frequency of river use. Almost 90% of respondents are 'passive' users who frequently walk and bike along rivers. Only a small proposition of respondents actively uses rivers for angling or boating. However, these small but influencing groups have partly divergent preferences. This makes public participation in river restoration projects quite challenging. To avoid future conflicts, it is of great importance not only to consider all different types of relevant stakeholder groups but also their proportions. We are aware that this procedure will be very difficult to be implemented in practice and we are currently not able to recommend an easily applicable method to do so. However, we are convinced that a balanced consideration of preferences is decisive for the acceptance of restoration projects and in the sense of large restoration programs like the WFD.

Notes

1. The used priors based on coefficients found in the literature.
2. 'Per unit' indicates the change in WTP when the activity (walking, angling, etc.) increased about one unit of the applied scale.
3. This calculation is not completely accurate because we do not account for the correlation between the parameters. Nonetheless, for a better presentation and understanding at this stage the consideration of the correlations is dismissed.

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