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Managed Realignment for Flood Risk Reductions: What are the Drivers of Public Willingness to Pay?

Katherine Simpson and Nick Hanley

Keywords: Contingent valuation, Information, Knowledge, Ecosystem Services, Flooding, Flood Risk

JEL codes: Q51, Q57, D83

Managed realignment for flood risk reductions: what are the drivers of public willingness to pay?

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Abstract

Offering several advantages over traditional "hold the line" flood defences, including the supply of ecosystem services such as carbon sequestration and habitat provision, managed realignment is increasingly being used as a flood defence option. This paper seeks to add to the growing literature on public perceptions of the benefits of managed realignment by examining local resident's knowledge of estuarine management issues and identifying their willingness to pay (WTP) towards a new managed realignment scheme on the Tay Estuary, Scotland. Results showed that the majority of respondents were not aware of flood risk issues on the estuary or of different flood defence options. Furthermore a "miss-match" between flood risk perceptions was highlighted with respondents stating they were not at risk from flooding when in fact they lived in a flood risk zone. Household mean WTP for a specific managed realignment scheme was calculated as £43 per annum. Significant drivers of WTP included respondents perceived flood risk and worries about the state of existing flood defences. There was also significant spatial heterogeneity with those living closest to the scheme being WTP the most. Prior knowledge of flood risk issues and managed realignment was found not to significantly affect WTP.

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1. Introduction

As part of the UK Flood Risk Management Strategy, managed realignment is increasingly being used as an alternative form of flood defence along the UK coastline (Ledoux et al 2005; SEPA 2012). Managed realignment reduces the maintenance costs of hard defences by making use of the storm buffering capacity of intertidal habitats such as mudflats and saltmarshes (King and Lester 1995; Ledoux et al 2005; Moller et al 1999). Furthermore, managed realignment offers an opportunity to restore wetland habitats which have been lost through coastal squeeze and other anthropogenic stressors such as land reclamation (McLusky and Elliott, 2004). Restoration also provides additional ecosystem service benefits including carbon sequestration, the provision of nursery and spawning grounds for fisheries, and recreational activities. It can also contribute to biodiversity conservation through the provision of roosting and foraging sites for internationally protected waterbirds (Luisetti et al 2011).

A challenge for coastal planners is communicating both the flood defence benefits of managed realignment and the accompanying ecosystem service gains to the general public and local stakeholders (SEPA 2012). Historically, coastal protection has typically made use of hard engineered structures which have provided a view to the general public that the boundary between land and see is fixed rather than dynamic. This has led to local residents being opposed to managed realignment schemes which appear to "give land to the sea" (Coates et al 2001; French 1997). Surveys for the Freiston Shore, Orplands and Brancaster managed realignment schemes sought to gain an insight into residents understanding of flooding, their perceptions of managed realignment and which issues they considered important (Myatt et al 2003a; Myatt et al 2003b; Myatt et al 2003c). Results highlighted that the majority of respondents felt they were at risk from flooding, although in reality only a

"few properties are vulnerable to flooding at present" and over 60% of respondents considered the "effectiveness of managed realignment" to be a very important issue. Myatt et al concluded that local residents should be involved in the discussion of managed realignment and have direct inputs into decision making. This engagement is even more crucial in Scotland where there is requirement for SEPA raise public awareness of flood risk and future flood defence schemes (Scottish Government 2011). As such there is an increasing need to engage with local residents and to understand public perceptions of managed realignment schemes (Ledoux et al 2005).

Our research aims to explore this issue in the context of a potential managed realignment scheme in the Tay Estuary, Scotland using contingent valuation (CV). CV is a stated preference technique which uses questionnaires to create a realistic but hypothetical market for respondents to indicate their WTP for a change in an environmental good (Mitchell and Carson 1989). Scenarios are constructed which offer different policy alternatives to a baseline, which is often the current situation. The respondent is asked to state whether would support an alternative policy option depending on what the new policy will provide and when, how this will be delivered and how much it will cost (Carson 2000). In the case of managed realignment, this technique allows one to compare whether respondents prefer managed realignment over maintaining existing hard flood defences; and to explore which factors influence their WTP for management realignment. Additionally our survey includes a nine question flood defence "quiz" at the start of the survey, to allow us to identify what respondents already understand about flood risk, flood defence and managed realignment in the Tay Estuary, since one's knowledge of an environmental good may affect one's WTP for changes in this good (Czajkowski et al, 2015).

Previous valuation studies have tended to focus on valuing flood defence benefits using market value- based approaches such as replacement costs (Brander et al 2006). Turner et al (2007) undertook cost-benefit analysis for a variety of managed realignment scenarios for the Humber Estuary, England. Benefits valued included carbon sequestration and general habitat creation benefits whilst costs included capital costs of realignment and forgone agricultural incomes. Related to this was the work of Andrews et al (2006) who analysed the biogeochemical value of managed realignment in the Humber Estuary in terms of increased carbon sequestration and reduced metal contamination. Results showed that sediment burial at the site resulted in a saving of £1000^{a-1} in avoided clean-up costs for copper contamination. Luisetti et al (2011) furthered this work by identifying the recreational and fish nursery benefits of managed realignment for the Humber and Blackwater estuaries. Using a choice experiment the recreational value of saltmarsh at the Blackwater Estuary was estimated to be worth between £4,429,000 and £6,430,000 per annum. These studies however did not consider public perceptions of the whole flood defence scheme, instead focussing on one aspect of the ecosystem service benefits.

Our paper, in contrast, estimates public WTP for the total benefits of a managed realignment scheme. This study contributes to the existing valuation literature on managed realignment by capturing the use and non-use benefits of the new flood defence scheme, as well as considering the contextual and socio-economic drivers behind respondents WTP. Specifically the following research questions are considered:

1) To what extent are local residents familiar with local flood risks, flood defence and estuarine ecosystem services within the Tay Estuary? This is examined by asking survey respondents an initial nine question quiz about flood risk management on the Tay Estuary. Survey respondents were then asked a series of questions regarding their own

perceptions of flood risk and the state of current defences. This follows similar work Myatt et al (2003 a,b,c) into attitudes towards managed realignment schemes on the south coast of England.

2) Are residents WTP towards a new managed realignment scheme in place of the current status quo of maintaining hard defences? If so, what influences their WTP? Drivers considered are prior knowledge of flood risk management, personal flood risk awareness and residential location. There is an expectation there will be spatial heterogeneity in the WTP for the managed realignment scheme, with those living closest to the scheme prepared to pay the most.

The proposed managed realignment scheme valued for the survey was at Newburgh on the Tay Estuary, Scotland. Natural flood management is the preferred flood defence for this areas as detailed in the Fife Shoreline Management plan[1] and also the SEPA proposed natural flood management areas (SEPA 2015).

2. Methodology

2.1. Survey design

To assess WTP for the managed realignment scheme, an online questionnaire was designed following the recommendations of Carson (2000). Initially a focus group was held to review the flood risk management quiz and the valuation scenario. This was followed by a pilot survey with potential survey respondents and 50 people responded. The final survey was

[1] The Fife Shoreline Management plan is available online at http://www.fifedirect.org/minisites/index.cfm?fuseaction=page.display&pageid=C040877C-B767-3F71-8454BE5167C5BC58&siteID=C03E446A-0241-A6A5-7462DD169B215841. Last accessed 10/8/2015.

conducted throughout 2013. Survey participants were randomly selected from the Scottish Phone Directory. Only people living within the local authorities affected by the flood defence scheme were selected to take part. Respondents received a letter inviting them to take part in the survey and were given details of the survey website. A reminder card was sent two weeks after the first contact attempt.

The survey can be divided into three parts: knowledge of current flood risk management, contingent valuation question, and socio-demographics. Respondents first received an introductory text outlining the purposes of the survey, who would be using the results and why. In line with the recommendations of Carson and Groves (2007) and Vossler and Watson (2013) regarding consequentiality in stated preference surveys, it was made clear that the survey results would be shared with relevant policy makers and would be taken into consideration when planning future flood prevention schemes. This "policy consequentiality" has been shown to improve the demand-revealing properties of contingent valuation, so that respondent state a WTP which is closer to their true, underlying valuation of the good. Respondents were then asked to complete a nine- question multiple choice quiz. This was used to determine what individuals already knew about existing flood defence and flood risk in the Tay Estuary, as well as the costs and benefits associated with managed realignment. The quiz was developed with flood risk management specialists.

In the valuation portion of the survey, respondents were given text and graphics to inform them of the process of managed realignment, flood risk in their local area and the possible additional ecosystem service benefits of managed realignment (the phrase ecosystem services was not used in the survey). The managed realignment scenario was then detailed, including a map of where the scheme would take place, how many homes would be protected and the length of time before the defences would be completed. The status quo scenario of

continued hard defences was also included. The cost of the project was outlined and respondents were told that increases in council tax would fund the scheme. Council tax was a plausible payment vehicle as local authorities are responsible for funding flood defence in Scotland. Respondents were then presented with the payment card ranging from £0 to £150 and asked to tick all the amounts the household was willing to pay towards the scheme. A payment card was chosen as the valuation format to increase the statistical efficiency gains relative to the dichotomous choice format and lower the cognitive burden placed on respondents which is associated with the open ended format (Boyle and Bishop 1988; Mitchell and Carson, 1989). The values shown on the cards were chosen based on feedback from initial focus groups.

Following the valuation exercise a series of debriefing questions followed, including statement questions regarding perceived flood risk, whether respondents felt flood risk was increasing and whether the current defences were adequate enough to protect their home. Finally respondents were asked a set of socio-demographic questions. A summary of the survey is provided in Figure 1 . A full copy of the survey is available on request, and is attached to this version of the paper for the benefit of the referees.

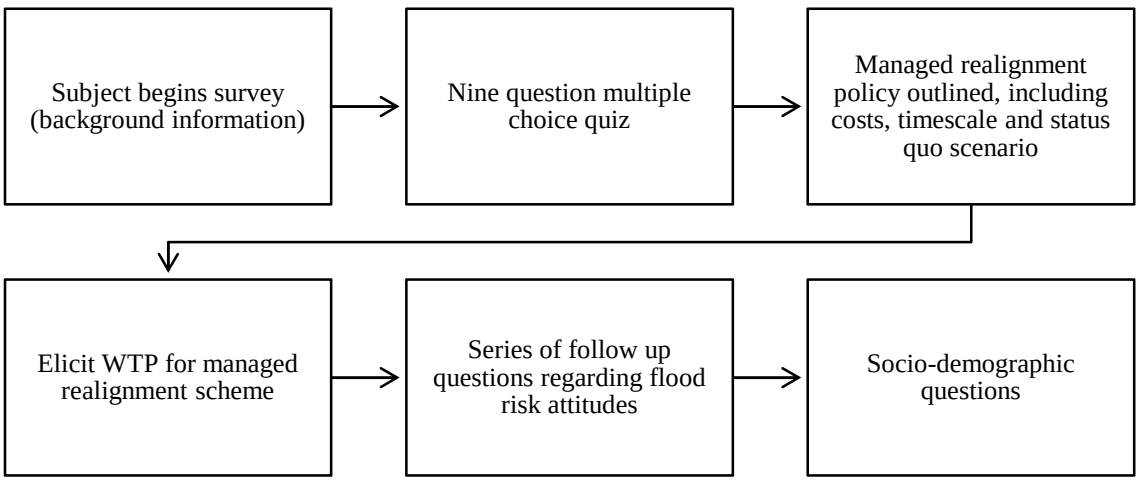

Figure 1: Survey summary

2.2. Empirical approach

The statistical analysis was conducted in STATA (version 14). There are a variety of estimation procedures available for estimating WTP from payment card data, including the Tobit model and Interval Regression model. The Tobit model, or censored regression model, is designed to estimate linear relationships between variables when there is either left or right censoring in the dependent variable (UCLA: Statistical Consulting Group. 2015). For WTP surveys left hand censoring is appropriate as it takes into account respondents who are not prepared to pay towards the scheme. However, it is recognised estimates from the Tobit model can result in a biased average valuation as the expected values between the upper and lower bounds of the payment cards are unknown (Cameron and Huppert 1989). Interval regression can overcome this issue by using the lower and upper bounds of the value chosen on the payment card (Haab and McConnell 2002). For this survey, respondents were asked to tick the highest value they were prepared to pay towards the scheme. However, their true value may lie between the highest bid they chose and the next highest amount, for example, the respondent ticked £100 and the next highest was £110. In this case their true value may lie between £100 and £110 and these bounds can be used in the interval regression estimation. Theoretically, there are K payments, $t_1 \ldots, t_k$ arranged in ascending order so that $t_k > t_{k-1}$. When a respondent picks payment t_k, the probability that WTP lies between t_k and t_{k+1}:

$$\Pr(choose\ t_k) = \Pr(t_k \leq wtp < t_{k+1}.$$

Responses to the payment card can be treated by specifying WTP as $WTP = \mu + \varepsilon$. If we let $\varepsilon \sim N(0, \sigma^2)$, then

$$\Pr(choose\ t_k) = \frac{1}{\sigma}\int_{(t_k-\mu)/\sigma}^{(t_{k+1}-\mu)/\sigma} \phi(z)dx,$$

which can be rewritten as

$$\Pr(choose\ t_k) = \phi\left(\frac{(t_{k+1} - \mu)}{\sigma}\right) - \phi\left(\frac{(t_k - \mu)}{\sigma}\right)$$

where $\phi\left(\frac{(t_{k+1}-\mu)}{\sigma}\right)$ is the standard normal CDF evaluated at $\phi\left(\frac{(t_{k+1}-\mu)}{\sigma}\right)$. The log likelihood function on for the responses can then be formed:

$$\ln L = \sum_{i=1}^{T} \ln(\phi\left(\frac{(t_{k+1}\,(i) - \mu)}{\sigma}\right) - \phi\left(\frac{(t_k\,(i) - \mu)}{\sigma}\right)$$

where individual i picks payment $t_k(i)$. This is a form of an interval model in which every individual picks some payment (Haab and McConnell 2002).

A variety of explanatory variables were included in the regression analysis as detailed in Table 1. In CV surveys there is an expectation that respondent's experiences with the good in question, personal motivations, their socio economic status and the distance they live from the site can all affect WTP (for examples see Cameron and Englin 1997; Kniivila 2006; LaRiviere et al 2014; Whitehead et al 1995). Experience in this case was whether a respondent had been flooded, whilst personal motivations were their perceptions of flood risk and whether they believed current flood defences were adequate enough to protect their home. Dummy variables for whether a respondent had been flooded (yes=1, no=0), whether the respondent believed they were at risk from flooding (yes=1, no=0) and whether they worried about existing flood defences (yes=1, no=0) were included in the regression analysis. Additionally, perceived risk and worry were interacted. There was an expectation that those

respondents who feel they were at risk and were most worried about current flood defences would be prepared to pay the most towards the scheme. There was an expectation that residents of Newburgh would be WTP the most towards the scheme as they would receive direct flood defence benefits and a dummy variable for whether the respondent was a resident of Newburgh or not was also included. Age, income, gender, age and whether the respondent belonged to an environmental group were also included. The model specification is outlined in Equation 1.

$$WTP_I = b_0 + \ b_1 FLOODRISK \ + b_2 WORRIED + b_3 FLOODRISK * WORRYIED + b_4 HOMEFLOOD \ +$$

$$+ b_5 INCOME + b_6 GENDER + b_7 AGE + b_8 ENV \ + b_9 NEWBRUGH\_RESIDENT \ + \varepsilon_I \ (1)$$

Table 1: Explanatory variables used in the estimation process

FLOODRISK	Statement questions response "My property is at risk from flooding" (0= strongly disagree, disagree or unsure no, 1=strongly agree or agree)
WORRIED	Statement questions response "I am worried the current flood defences are not adequate enough to protect my home" " (0= strongly disagree, disagree or unsure no, 1=strongly agree or agree)
HOMEFLOOD	Home has been flooded (0=no, 1=yes)
INCOME	Household income ranging from under £15,000 to over £100,000 per annum (six categories, midpoint of each category used in estimation process)
GENDER	Gender (female=0, male=1)
AGE	Age ranging from 18-19 through to 65 and over
ENV	Member of an environmental group (0=no, 1=yes)
NEWBURGH	Whether the respondent was a resident of Newburgh or not (0=no, 1=yes)

3. Results

3.1. Sample Characteristics

In total 4000 households were contacted by mail and invited to take part in an online survey. A reminder card was sent two weeks after the first contact attempt. Of 4000 people contacted, 749 people completed or partially completed the online survey with 593 responses completed in sufficient detail to be used in the analysis: a response rate of 15%. The response

rate is acceptable and comparable with a similar UK wide stated preference survey for flood defence (12%) (Rotimi et al 2015), as well as other UK postal stated preference surveys (Mentzakis et al 2014; Burton et al 2001; Hanley et al 2010) that had response rates ranging from 11 % to 22%.

Self-reported socio-demographic characteristics were compared with Scottish Neighbourhood Statistics for the Fife, Dundee and Perth & Kinross local authorities (Table 2). 60% of responses were from the Fife local authority, with 26% from Dundee and 13% from Perth & Kinross. Analysis revealed that the sample was not fully representative of the local population. The oldest age groups (40- 49 years, 50-59 years and 65 and over) were well represented in the survey whilst the youngest age group (18-29) was under represented (9% of sample compared to 22% in population). Males were also over represented in the survey (58% compared to 47%). 63% of sample respondents worked full time compared to 50% of the overall population. The modal income group was £20,000–£39,000 which was similar to the median income of the local authorities (£26,000). Over 80% of the sample owned their own homes compared to the Fife average of 64%. There were thus a range of selection effects occurring in the sampling process.

Table 2 : Socio-demographic characteristics of the respondents

	Percentage of Sample
Income	
Under £15,000	13.78
£15,000 - £19,999	12.11
£20,000-£39,999	32.99
£40,000-£69,999	25.68
£70,000-£99,999	9.60
Over £100,000	5.85
Gender	
Male	58.25
Female	41.75
Education	
Secondary school	20.04
Sixth form/College	24.75

Undergraduate Degree	25.74
Postgraduate Degree	29.47
Member of environmental group	33.40
Local Authority	
Fife	60.13
Perth & Kinross	13.44
Dundee	26.43
Age	
18-29	9.39
30-39	15.46
40-49	18.40
50-59	23.87
60-64	10.18
65 and over	22.7
Economic Activity	
Employed	63.53
Unemployed	36.47
Property status	
Property owner	82.32
Other	17.68
Distance from site	
At site	15.98%
Elsewhere	84.02%

3.2. To what extent are local residents familiar with flood risk, flood defence and estuarine ecosystem services within the Tay Estuary?

The majority of respondents appeared to be relatively un-informed about flood risk management issues and the mean quiz score was 3.05 (*SE*=0.08) (Figure 2). Respondents knew the least about estuarine flood risk and government flood defence spending (Q1 and Q2) although appeared to be familiar with historical flood protection measures (Q3). As expected, fewer respondents were aware that managed realignment could deliver a greater level of flood protection compared to traditional defences (Q4). Surprisingly over 50% of respondents knew wetlands were important spawning grounds for fish (Q6 although far fewer were aware that wetlands provided an important food source for wildlife (Q5). 45% thought brownfield land would be used for the managed realignment site, compared with 21% who

correctly knew that in most cases agricultural land is used. Respondents were relatively unfamiliar with the legal obligations regarding wetland protection Q9) although almost 50% were aware that erosion was the main cause of decline for waterbird populations (Q8).

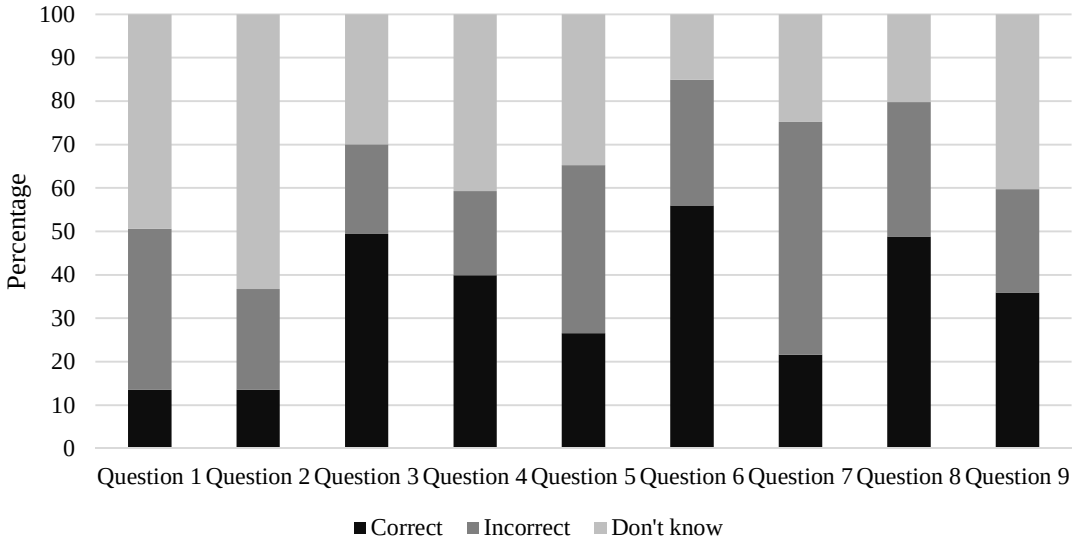

Figure 2: Estuarine management quiz results

The survey follow up questions revealed that approximately 18% of respondents felt they were at risk from flooding, 29% felt that flood risk was increasing and 23% were worried that the current flood defences were not adequate enough to protect their home. Over 67% of respondents felt that it was the council's responsibility to maintain and fund flood defences (**Table 3**). Respondent's postcodes were compared to SEPA flood risk maps in ArcGIS to determine whether the resident lived on a coastal or fluvial floodplain. Overall, 26% of respondents lived on a floodplain, 8 percentage points higher than the number of respondents stated they were at risk from flooding. This suggests that some respondents are unaware of the actual flood risks they may face. Additionally, 55% of those who were mapped as living on the floodplain either disagreed, strongly disagreed or were unsure that they were at risk from flooding. Similar figures of unawareness have been recorded in other UK wide flood risk surveys (Burningham et al 2008; Defra and Environment Agency 2004).

Despite the lack of flood risk awareness 68% of the sample had some level of insurance against flooding.

Table 3: Responses to the flood risk statement questions

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
My property is at risk from flooding	52.08%	24.43%	4.73%	12.31%	6.44%
Flood risk in the area is increasing	39.05%	28.00%	4.19%	21.71%	7.05%
I am worried that the current defences are not adequate enough to protect my home	41.49%	30.59%	5.35%	15.30%	7.27%
It is the councils responsibility to fund flood defence, not mine	9.75%	17.59%	5.54%	41.30%	25.81%

3.3. Public willingness to pay for the managed realignment scheme

The majority of respondents (82%) were prepared to pay towards the managed realignment scheme. The main reasons for not being prepared to pay were not being able to afford to contribute (26%) and believing it is the Scottish Government's responsibility to fund flood defence (27%). The mean WTP across all respondents was £43.03 per household per annum (SE=1.88Table 2) and the median bid value was £20 per annum (Figure 3).

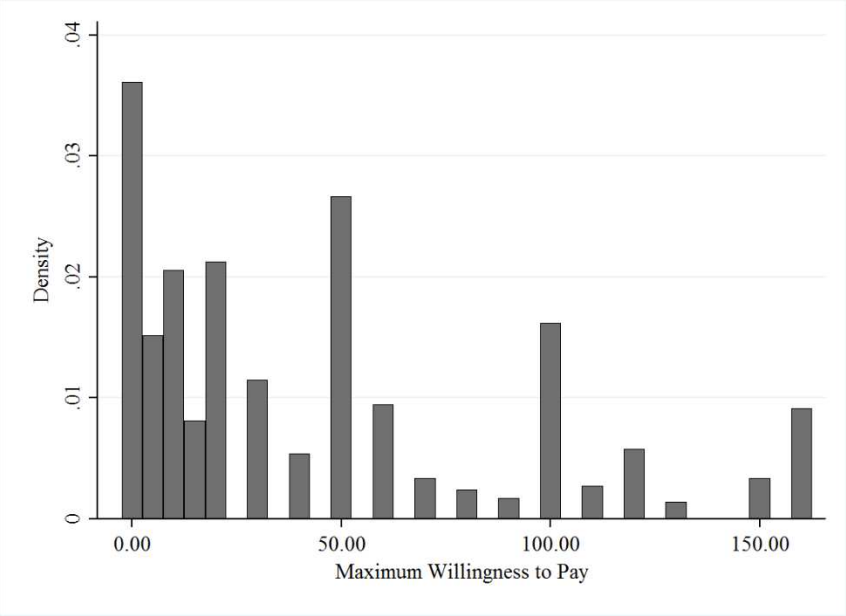

Figure 3: Histogram of willingness to pay

Responses from the flood risk quiz were grouped into two bands: below average score (0-2 correct) and above average score (3 or more correct). Table 3 presents the mean WTP of respondents grouped by their knowledge type. A Mann-Whitney test showed there were no significant differences in mean WTP between the prior information types ($H(2)= 0.72$, $p= 0.47$. There was also no statistical difference in the number of zero bids ($H(2)= 0.59$, $p= 0.56$). Overall the results suggest that what respondents knew prior to the survey, as measured by the first quiz, did not affect their WTP.

Table 4: Willingness to pay for the managed realignment scheme

	All respondents	**Quiz score**	
		Below average	**Above average**
Mean WTP	43.03	48.10	42.72
SE	1.88	3.57	2.50
95% CI	39.34-46.71	41.07-55.13	37.81-47.63
Median WTP	20	10	20
Number of zero bids	107	34	49
N	593	192	312
Mann Whitney Z ($p<$): zero bids		0.59 (p=0.56)	
Mann Whitney Z (p<): mean WTP		0.72 (p=0.47)	

Results from the interval regression model, presenting a more detailed exploration of factors influencing respondents' WTP are presented in Table 5. In line with many stated preference surveys, income was a significant determinant of WTP, with those on higher incomes prepared to more towards the scheme. A respondent in the highest income band (over £100,000) was, on average, WTP between £34.09 more per annum than a respondent in the lowest income band. Gender and environmental group membership also significantly influenced WTP although age did not. The result that males are WTP more than females may be due to the over-sampling of men compared to women as the survey was not representative of the sample in terms of gender.

Perceived flood risk and worry about existing coastal defences had the strongest effects on WTP. Respondents who felt most at risk from flooding and were worried about existing defences were WTP £30.04 more per annum compared to those respondents who were not worried or who felt that they were not at risk. Surprisingly, there was no significant difference in WTP between respondents who had been flooded previously and those who had not.

There was significant spatial heterogeneity in WTP for managed realignment with respondents living closest to the site WTP the most. On average, respondents from Newburgh, where the scheme is proposed, were WTP £21.45 more per annum compared to respondents from elsewhere. This was expected as these respondents are unlikely to receive direct flood defence benefits from the new scheme.

Table 5: Estimated Interval regression model explaining maximum stated willingness to pay for managed realignment

Explanatory Factors	Coefficient Estimate	Standard Error
My property is at risk from flooding		
No	0.00	
Yes	-2.86	(10.98)
I am worried the current flood defences are not adequate enough to protect my home		
No	0.00	
Yes	11.32	(7.34)
My property is at risk from flooding and I am worried the current flood defences are not adequate enough to protect my home		
	30.34*	(13.70)
My home has been flooded previously		
No	0.00	
Yes	6.03	(7.60)
Annual household income		
Less than £15,000	0.00	
Under £15,000	10.73	(6.92)
£15,000 - £19,999	17.37**	(5.77)
£20,000-£39,999	12.97*	(6.22)
£40,000-£69,999	24.90**	(8.05)
£70,000-£99,999	34.09***	(9.96)
Female	0.00	
Male	11.02**	(3.72)
Age		
18-29	0.00	
30-39	-1.18	(7.85)
40-49	-11.46	(7.52)
50-59	-3.07	(7.21)
60-64	-6.67	(8.25)
65 and over	-3.73	(7.33)
Member of an environmental group		
No	0.00	
Yes	13.30**	(4.22)
Newburgh resident		
No	0.00	
Yes	21.45***	(5.25)
Model summary statistics		
Yes	13.17	(7.83)
Lnsigma	3.61***	(0.03)
Degrees of freedom	17.00	
Log likelihood	-1483.73	
Number of observations	437.00	
* p<0.05, ** p<0.01, ***p<0.001		

4. Discussion

This paper aimed to explore two primary questions: 1) to what extent are local residents familiar with flood risk, flood defence and estuarine ecosystem services and 2) identify whether residents are WTP towards a new managed realignment scheme and if so which factors influence their WTP?

Firstly, results of the initial quiz highlighted that respondents were relatively poorly informed about current flood risk management in their area. Whilst the majority of respondents recognised the main type of coastal defence, far fewer were aware of the percentage of homes at risk from flooding and of current flood defence expenditures. Respondents also knew very little about the additional costs and benefits of managed realignment. This highlights the importance of providing information about managed realignment prior to undertaking the valuation exercise, as the full costs and benefits may not be readily understood or known by the general public. Our research overcomes this problem by controlling for each person's ex ante level of knowledge of the good, but this by no means always done. Encouragingly, the quiz revealed that over 40% of respondents felt that managed realignment had the potential to deliver a greater level of protection than traditional coastal defences. This is in contrast to previous findings where it is widely discussed that the general public have negative feelings towards managed realignment and do not see it as an adequate form of flood protection (French 2006). Overall, the results of the quiz demonstrate the need for policy makers to communicate their flood risk management policy more effectively as people are currently poorly informed about the issue.

Secondly, results from the flood risk attitude aspect of the survey highlighted there is a 'miss-match' between perceived flood risk and actual flood risk in the study area. 116 respondents were mapped as being at risk from either coastal or fluvial flooding, however 64

of these did not believe they were at risk from flooding. From a flood risk management perspective this is concerning as people may not be taking appropriate steps to protect their home, such as insurance. This has been a common finding in previous UK flood risk surveys (Defra and Environment Agency 2004; Harries 2008) . Encouragingly, in the case of the Tay survey, 69% of respondents who lived on the flood plain did have some level of insurance against flood damages. Previous surveys have shown the main driver behind flood risk perceptions are respondents own experiences of flooding. Burningham et al (2008) found that for the UK those who had previous flood experience, had lived in the area for longer and were in a higher social class were all predictors of flood risk awareness. Similar results were reported by Bradford et al (2012) where flood risk awareness was strongly correlated with flood risk experience in an EU wide study. The results of this survey showed that respondents who had already been flooded were more likely to feel at risk from flooding. This reinforces findings from previous surveys that direct flood experience raises perception of flood risk, as does worry about this risk.

Thirdly, the majority of respondents were WTP towards the managed realignment scheme rather than maintain the status quo of existing hard sea defences. The predicted mean WTP from the Interval regression model was £42.79 per household per annum (S.E = 1.06). This value increases to £73.65 (CI= £68.82 - £78.48) if the respondent was worried about flooding and increased to £87.11 (CI= £81.88 - £92.34) if the respondent was worried about flood defences and lived in Newburgh. These results are consistent with previous managed realignment surveys but lower than wetland values derived through meta-analysis. A meta-analysis of wetland CV studies by Brouwer et al (1999) found mean WTP for wetland regeneration was £83.65 per household per year. English Nature (2001) applied this value to managed realignment and derived a household WTP of £20 per household per year for England and Wales. Further wetland values for flood defence have been calculated by

Woodward and Wui (2001) with values calculated between $50 and $159 per hectare. More recently, Defra and Environment Agency (2005) assessed respondent's WTP to avoid health impacts associated with flooding and mean WTP values for flooded and at risk respondents were between £150 and £200 per household per year respectively. Overall, the values estimated in our survey are thus more conservative than previous UK valuation studies.

As expected, respondents in Newburgh were prepared to pay the most towards the scheme as they would receive the direct benefits of reduced flood risk. A distance-decay relationship was established with respondents living furthest from the site prepared to be the least towards the scheme. Respondents who believed they were at risk from flooding and also felt the current defences were not adequate enough were prepared to pay the most towards the scheme. This finding is similar to that of Bradford et al (2012) where worry was seen as important risk characteristic; an individual can be aware of a flood risk but if they are not worried about the risk it is less likely they will prepare against it. It was expected that those who had previously been flooded would be prepared to pay significantly more towards the scheme but this was not the case. Previous flood risk surveys have shown those who have been flooded are reticent to take personal responsibility for flood protection, and instead expect scientists and regulators to manage the problem for them (Soane et al 2010).

It is clear that within study area there are a number of different attitudes towards flood risk and flood defences, and this is something which needs to be addressed when proposing a new scheme through information campaigns and public consultation. This is already recognised as part of Flood Risk Management planning in Scotland (Scottish Government 2011), however results of this survey suggest that current communication may not be targeting the desired population. One drawback of this survey was that respondents were not specifically asked whether they were aware of existing flood risk campaigns in the area. As

such a causal link between information provision and flood risk awareness cannot be concluded. It could be inferred that the lack of awareness of some respondents may be an indication that information campaigns may not be reaching the desired audience, or some people are unwilling to take on board the information provided to them.

One of the main drawbacks of this study is that values for the individual ecosystem services were not generated. CV calculates the overall WTP for the whole policy change, which includes the value of the flood defence good itself, as well as the additional ecosystem service provision for wildlife and fisheries. CV proved to be a sound choice of method for answering the research questions posed in this paper. WTP for the different ecosystem service values could be elicited using a choice experiment. For this, the managed realignment site be described in terms of its attributes, i.e. the different ecosystem services provided, and respondents asked to choose between different "bundles" of attributes. This would allow the identification of WTP for each individual ecosystem service (for more information on choice experiments see (Hanley et al 2009).

5. Conclusion

This paper aimed to investigate whether respondents would be willing to contribute towards a managed realignment scheme on the Tay Estuary, Scotland. Specifically considered was respondent's prior knowledge of flood risk management, their attitudes towards flood risk and current coastal defences and how much they would be willing to pay towards the development of the scheme. This was achieved using a CV survey which included an initial quiz to test respondent's prior understanding of flood defence and a series of flood risk attitudinal questions.

The results showed that the majority of respondents supported the scheme's development and would be prepared to pay towards the scheme. The predicted WTP was

£42.64 per household per annum. Significant drivers of WTP included flood risk attitudes, income and distance from the site. From a flood risk management perspective a “miss match” between actual and perceived flood risk was highlighted, with many respondents stating they were not at risk from flooding when they in fact were. This is potentially concerning as respondents may not be taking adequate steps to protect their home from future flood risks and in the context of this survey may have been willing to pay less as they may not have felt they would directly benefit, when in fact the opposite may be true.

From a regulator’s perspective there is a challenge of how best to communicate flood risk to those without previous experience of flooding, and best to increase respondents’ understanding of the issue. There is an expectation that increasing flood risk knowledge will increase support for the allocation of public funds towards maintaining and building new flood defences, including the wider use of managed realignment and other ecosystem-based mitigation strategies.

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