Information and learning and the subsequent effects on public preferences for managed realignment in Scotland

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Abstract

Coastal planners are increasingly recognising the need for more environmentally and economically sustainable flood defences, such as managed realignment. These soft defences are often negatively viewed by the general public and public perceptions of new schemes are a crucial aspect of the planning process. This study undertakes a contingent valuation survey to assess public willingness to pay (WTP) for a managed realignment scheme on the Tay Estuary, Scotland. Embedded within the survey was a field experiment to test the role of prior, new information and learning on WTP estimates. Results indicate that whilst respondents did learn new information provided to them, this learning did not have an effect on the WTP estimate. Neither did respondents prior information or varying the levels of information respondents received. WTP was highest for those respondents who felt most at risk from flooding and felt current flood defences were not adequate enough to protect their home, suggesting personal relevance was a stronger motivation behind WTP responses. Further, it is possible to state that additional information regarding ecosystem service provision was redundant in forming the WTP estimates.

Keywords: Stated preference, Contingent Valuation, Information

JEL Codes: D83 Q51 Q57

1 Introduction

In Scotland there is a requirement under the Flood Risk Management Strategy for managed realignment to be considered as a form of flood defence in coastal areas (SEPA 2012). Managed realignment involves restoring estuarine and coastal wetlands (French 2006). This delivers two main flood protection benefits: i) reduces the costs of hard defences and ii) makies use of the storm buffering capacity of intertidal habitats (Ledoux et al 2005; King and Lester 1995; Moller et al 1999), as well as delivering a variety of other non-market benefits including increased recreation, biodiversity benefits and nursery and spawning grounds for fisheries (Luisetti et al 2011). A challenge for coastal planners is communicating the flood defence benefits of managed realignment to the general public and local stakeholders (SEPA 2012). Previous coastal protection has typically been hard engineered structures which have portrayed the view to the general public that the boundary between land and see is fixed rather than dynamic and this has led to local residents being opposed to managed realignment schemes which appear to "give land to the sea" (French 1997; Coates et al 2001). As such there is an increasing need to engage with local residents throughout the schemes development and study public perceptions of managed realignment schemes (Ledoux, 2005). This engagement is even more crucial in Scotland where local authorities are responsible for developing and funding the scheme which as discussed by Pethick (2002) could have political consequences. One possible option to gauge public opinion for new flood defence schemes is through a stated preference survey which directly asks the public what they are willing to pay towards a new scheme.

In this study a contingent valuation survey is used to gauge public willingness to pay (WTP) for a managed realignment scheme on the Tay Estuary, Scotland. One novel aspect of the survey is that respondents are "quizzed" at the start and end of the survey to understand what they know about flood defence prior to the survey, and whether they learn new information provided to them during the survey, and crucially tests whether this has an influence on the WTP estimates. The survey was carried out throughout summer 2013 with respondents selected from local authorities which would be affected by the managed realignment scheme. Respondents were grouped into low, medium and high

prior information levels based on their first quiz score, and subsequently given varying of levels of information about the flood defence scheme before undertaking the valuation exercise. There was also a control group who did not take the first quiz and received the high level of additional information. In all other aspects the questionnaires were identical.

Early stated preference research began to question the role of information in WTP estimates, particularly the amount of information presented and how this varied the mean WTP and also the variance of the WTP estimate. Boyle (1989) concluded that altering the levels of information did not affect mean WTP although estimates of the variances fell significantly as the level of information increased during his survey WTP to preserve a brown trout fishery. A similar finding was shared by Bergstrom et al (1989) who found that increasing information caused small changes in bids in the expected direction, but the individual information effects were not statistically significant. In contrast Hanley and Munro (1992) found that initially increasing information regarding scarcity and good characteristics did increase WTP, but adding to this information set further did not have a significant impact on WTP. Posing the question, how much can an individual's information set be increased before there are significant changes in WTP?

In their work on wetland valuation Whitehead and Blomquist (1991) began to question the role of prior, as well as additional information in WTP surveys. They argued that household WTP will not be accurate when based purely on what the household knows prior to the survey and that by introducing new information this should minimise over or under estimates of WTP that result from this differing level of prior information. Tkac (1998) showed that whilst prior information was positively associated with WTP, it also nullified the effect of new information. Respondents with less prior information were more receptive to new information and this was positively correlated with their WTP estimates. Hoehn and Randall (2002) extended this work, and found that since respondents are heterogeneous in their prior information, the effect of new information is uneven across respondents.

A further aspect of the information problem is personal relevance and how this is related to the respondent's information set. In a contingent valuation laboratory experiment Ajzen et al (1996)

concluded that under conditions of low personal relevance, respondents fail to process the information carefully and recommended that researchers obtain WTP for a variety of information scenarios. Cameron and Englin (1997) considered the respondent's information set in terms of experience with the good and found that respondents with more experience have smaller conditional variances. As discussed by Bateman and Mawby (2004) this suggests that information effects are likely to be strongest when respondents do not have clear prior preferences.

Research considering the effects of the "cheap talk script" (Cummings and Taylor 1999) has shown the magnitude of WTP change and direction is influenced by the survey context (Aadland et al 2007) and also that it has more influence on less informed respondents (Tonsor and Shupp 2011). More recent work by Hasselström and Håkansson (2014) looked at differences between detailed and fuzzy ecological information. Results showed that respondents were are unfamiliar with water quality problems, the WTP differed significantly between the detailed and fuzzy information sets. As with previous work however, in situations with high familiarity, more information does not affect mean WTP.

Overall, the literature shares a common standpoint; there is a need to include information within stated preference surveys so that all respondents have equal levels of information about the good being valued. It is also clear that experience has a role in respondent's information sets and ultimately their WTP estimate and this should also be considered when looking at the effects of information. This study acknowledges these as starting points and looks to further address the topic by considering the effect of new information on WTP estimates, and crucially, whether this new information is learned by respondents.

The study is presented in four sections. Section 2 describes the study are, the questionnaire and experimental design. Section 3 presents the results and Section 4 discusses the findings and conclusions of the paper.

2 Background and methods

2.1 The study area

The study area concentrated on the Tay Estuary, Scotland with a managed realignment site proposed at Newburgh on the southern shore of the estuary. At the time of planning the research project no detailed plans of the managed realignment scheme were available and a fictional site was created for the purposes of the project based on the Fife Shoreline Management Plan. Subsequently, SEPA released details of proposed natural flood management areas and the site valued for this study coincides with the area proposed at Newburgh (SEPA 2015).

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. 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 562 responses completed in sufficient detail to be used in the analysis; a response rate of 19%.

2.2 Survey and experimental design

The contingent valuation survey was designed following the recommendations of (Carson 2000) including focus groups and pre-testing. The design of the survey was as follows: initially respondents received an introductory text outlining the purposes of the survey, as well as making clear that the results would be shared with policy makers and would be used to help inform flood risk management in the area. This was followed by a nine question multiple choice quiz regarding flooding, flood defences and the costs and benefits of managed realignment. 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 become active. The status quo scenario of continued hard defences was also included. The cost of the project was outlined and it was made

clear that increases in respondent's council tax would fund the scheme. This was a plausible payment vehicle as local authorities are responsible for funding flood defence in Scotland. Respondents were then given additional information about flooding, flood protection and the additional costs and benefits of managed realignment. Household willingness to pay was then elicited using a payment card ranging from £0 to £150 and respondents were asked to tick all the amounts the household was WTP towards the scheme. A series of debriefing questions followed, including statement questions regarding perceived flood risk, whether they felt flood risk was increasing and whether the current defences are adequate enough to protect their home. Finally respondents were given a set of socio-demographic questions and one final statement question "do you believe the results of this survey will be shared with policy makers" to see whether the respondents believed the survey was consequential. The experimental design is outlined in Figure 1.

Experimental Design	1. Subject begins survey (background information) 2. Nine question multiple choice quiz 3. Randomly assigned treatment group 4. Managed realignment policy outlined, including costs, timescale and status quo scenario 5. Respondents receive their additional three, six or nine pieces of information 6. Elicit WTP for managed realignment scheme 7. Series of follow up questions regarding flood risk attitudes 8. Socio-demographic questions 9. Second quiz 10. Final question "do you believe the results of this survey will be shared with policy makers?"

Figure 1: Experimental design

To test for the effects of information and learning in the CV survey the following field experiment was embedded. After the first multiple choice quiz, the number of correct answers, as well as the specific questions answered correctly and incorrectly were recorded for each respondent. Respondents were grouped into *a priori types* as a function of the number of correct answers: low (L), medium (M) and high (H). *A priori* type L corresponds to 1-3 correct answers, type M corresponds to 4-6 correct

answers and type H corresponds to 7-9 correct answers. There was also a control group who did not take the first quiz.

Once respondents completed the initial quiz, they were randomly assigned to a treatment group. The treatment was the amount of additional information they would receive about managed realignment. Treatments could be low (L), medium (M) or high (H) and corresponds to a number (3, 6 or 9 for L, M or H respectively) of bullet points conveying precise and objective information about managed realignment. Each bullet point and/or figure corresponds exactly to one question asked on the multiple choice quiz. Consequently, each respondent can be summarized as a type/treatment pair, in addition to their correct and incorrect answers in the first quiz. For example, a type treatment pair could be LH: a subject who answered between zero and three questions correctly and who is then given all nine bullet points of information (e.g., the high information treatment). Respondents in the control group received all 9 pieces of information.

A crucial aspect of the design was that respondents were always given information they answered correctly before any additional information points were given as dictated by treatment. For example, assume respondent A gets questions 4 and 9 correct and are in the L *treatment*. Respondent A is type L since they only got two out of nine questions correct. Their information set would consist of two bullet points associated with questions 4 and 9 and one information bullet point selected at random from the remaining seven. The possible type-treatment pairs are shown in Table 1. There are nine potential type-treatment pairs, however, three of the pairs are uninformative and respondents with greater quiz scores are restricted to receiving equal or higher amounts of information, for example, if someone has a high information level (type H) then they will learn no new information when given the low treatment.

Table 1: Type-treatment pairs

A priori Information / Treatment	**L**	**M**	**H**
H	LH	MH	HH
M	LM	MM	--
L	LL	--	--
Columns represent the types (low, medium or high) defined by the first quiz score, and rows represent the groups based upon treatment (low, medium or high)			

Respondents received their additional three, six or nine pieces of information following the description of the managed realignment scheme and then went on to undertake the valuation exercise. A second quiz was taken at the end of the survey (including those respondents in the control group). Thus, at the end of the survey each respondent in the treatment group is summarized by an initial set of quiz answers (a priori information set), a type-treatment pair, a treatment information set (bullet points), a WTP response, and a second set of quiz answers. Respondents can also be categorised by their final knowledge sets (Table 2). These take into account the amount of information received (low, medium and high) and their second quiz score (low, medium or high). There are 9 possible final knowledge sets considered. Whilst unlikely, it is possible that a respondent could score higher than their treatment (for example someone who received low information scored 7) as they look for additional information elsewhere whilst completing the survey.

Table 2: Final information knowledge sets

Final score / Treatment	**L**	**M**	**H**
H	$L_S H_I$	$M_S H_I$	$H_S H_I$
M	$L_S M_I$	$M_S M_I$	$H_S M_I$
L	$L_S L_I$	$M_S L_I$	$H_S L_I$

2.3 Hypotheses and statistical analysis

Combing what the respondents already know about flood defence (as tested by the first quiz), the level of information they received and how much they learned during the survey (as tested by the second quiz) enables three aspects of learning and information to be explored:

i. The effect of a-prior information only;

ii. Whether the amount of information (low, medium or high) and the amount of information taking into account prior knowledge affects mean WTP (type-treatment pairs);

iii. And finally whether the information-knowledge set (combing the information set and the second score) influences willingness to pay.

As well as the effects of information and learning, respondent's perception of their perceived flood risk, whether they worry about existing defences and whether they have previously been flooded was included in the analysis. Distance from the proposed managed realignment site was also taken into consideration, as well as other socio demographic characteristics. The full list of control variables can be found in Table 3.

Table 3: Variables used in the estimation process

Flood Risk Variables	
FLOODRISK	Statement question response "My property is at risk from flooding" (0= no, 1=yes)
WORRIED	Statement question response "I am worried the current flood defences are not adequate enough to protect my home" (0= no, 1=yes)
COUNCIL	Statement question response "It is the councils responsibility to fund flood defence not mine" (0= no, 1=yes)
FLOODPLAIN	Respondent lives on a flood plain (0=no, 1=yes)
HOMEFLOOD	Home has been flooded (0=no, 1=yes)
INSURANCE	Respondent has insurance against flood damages (0=no, 1=yes)
Socio-Demographic Characteristics	
ENV	Member of an environmental group (0=no, 1=yes)
GENDER	Gender (female=0, male=1)
AGE	Respondent age ranging from 18-19 through to 65 and over (seven levels)
EDUC	Respondents education level ranging from secondary school to postgraduate degree (four levels)
ECON	Respondents economic activity ranging from employed (full time) through to unemployed (five levels)

PROPERTY	Property status ranging from own the property through to live at the property rent free (four levels)
INCOME	Household income ranging from under £15,000 to over £100,000 per annum (six categories)
DISTANCE	Distance from the site (road miles)
SURVEYTIMER	Time spent on survey
WTPTIMER	Time spent on WTP question
INFO TIMER	Time spent reading the additional information
CONFIDENCE	Statement question response "I believe the results of this survey will be used by policy makers" (1=strongly disagree through to 5=strongly agree)

2.3.1 Information and Learning

There is an expectation that respondents read and learn information presented to them in stated preference surveys in which case there is an expectation that the second quiz scores would be higher than the first quiz scores. An OLS regression was ran to test for the effect of type-treatment pairs on the second quiz score (Equation 1). Included in the equation were the type-treatment pairs, as well as a vector of control variables ($b_{\mathrm{i}}X$). If all information was learned by the respondent there would be an expectation that respondents who received all 9 pieces of information, regardless of what they initially knew would all score the same. Those who received the medium information set would score less with those receiving only low information scoring the least. Alternatively, if the respondents do not learn any of the additional information and only a priori information matters, those who scored least initially would score the least in the second quiz, regardless of how much additional information the saw.

$$Score = b_0 + b_1 LL + b_2 LM + b_3 LH + b_4 MM + b_5 MH + b_6 HH + b_{\mathrm{i}} X + \varepsilon_I$$

Equation 1: Regression equation to analyses the effect of treatment group on the second quiz score

An additional OLS regression was also used to compare differences in quiz score between the control group and the treatment group (Equation 4).

$$Score = b_0 + b_1 LL + b_2 LM + b_3 LH + b_4 MM + b_5 MH + b_6 HH + b_7 control + b_{\mathrm{i}} X + \varepsilon_I$$

Equation 2: Regression equation to analyses the effect of treatment group on the second quiz score

2.3.2 Information, Learning and Willingness to Pay

Two main methods were used to look at the effects of information, learning and knowledge on WTP. Initially, simple Kruskal-Wallis tests were used to identify significant differences in the mean WTP between i) the a priori groups (low, medium or high prior knowledge) ii) between the treated and control respondents iii) between the amount of information received (low, medium or high) iv) between the type-treatment pairs and v) between the information-knowledge set. Where significant differences in mean WTP were found interval regression analysis was then used to identify the mean willingness to pay for the managed realignment scheme. Regression analyses undertaken are detailed in Table 4.

Table 4: Willingness to pay regression analysis

$$WTP = b_0 + \ b_1 quiz\_score\_one + \ b_i X + \ \varepsilon_I$$

Equation 3: Regression equation to determine the effect of a priori information on WTP

Equation 3 considered the effect on a-prior information on WTP. The dependent variable was maximum WTP and independent variables included the first quiz score and a vector of socio-demographic characteristics ($b_i X$).

$$WTP = b_0 + \ b_1 treated + \ b_i X + \ \varepsilon_I$$

Equation 4: Regression equation to determine the effect of taking the first quiz on WTP

Equations 4 considered the differences between the respondents who took the first quiz and those who did not. Willingness to pay was the dependent variable with treated (coded a 1 treated, 0 control) and a vector of socio demographic characteristics ($b_i X$) as the independent variables. There is a possibility that taking the first quiz could have altered respondent willingness to pay, regardless of the additional information those respondent received.

$$WTP = b_0 + \ b_1 information\_final\_score + \ b_i X + \ \varepsilon_I$$

Equation 5: Regression equation to determine the effect of treatment-knowledge pairs

Equation 5 considered the effect of the treatment group (low, medium or high) and the respondent's final score (low, medium or high) on WTP. The dependent variable was maximum WTP and independent variables included the treatment-knowledge pairs and a vector of socio-demographic characteristics ($b_i X$).

3 Results

3.1 Sample Characteristics

Self-reported socio-demographic characteristics were compared with Scottish Neighbourhood Statistics for the Fife, Dundee and Perth & Kinross local authorities (Table 5). 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 representative for age or economic activity, but it was for gender and income. The largest age group (30 – 49 years) were well represented in the survey, however, the younger age groups were underrepresented (age group 18-19, 1.5% compared to 6.2% and age group 20-29, 6.6% compared to 17.1%). 49% of respondents worked full time which was very similar to the overall population (50%); 29% were retired and 4% were unemployed. The median income group was £20,000 – £39,000 which was similar to the median income of the local authorities (£24,684). Regarding property ownership over 80% of the sample owned their own homes, with 5% living in social housing, compared to the Fife average of 64% property ownership and 29% social housing.

Using an online survey enabled the use of survey timers for specific pages and the full survey. The mean survey time was 24 minutes, ranging between 4.5 minutes and 31 hours. Respondents were not able to "click back" through the survey, or leave the page without restarting the full survey. For the WTP question the mean time spent on the page was 1.5 minutes, ranging between 18 seconds and 10 minutes.

Table 5: Descriptive statistics for socio-demographic variables

Variable		Percentage of Sample
Income		
	Under £15,000	14.84
	£15,000 - £19,000	12.79
	£20,000-£39,000	33.56
	£40,000-£69,000	24.89
	£70,000-£99,000	9.13
	Over £100,000	4.79
Age		
	18-19	1.55
	20-29	6.62
	30-39	13.25
	40-49	19.21
	50-59	24.50
	60-64	11.04
	65 and over	23.84
Male (dummy)		57.06
Education (dummy)		
	Secondary school	21.06
	Sixth form/College	24.17
	Undergraduate Degree	24.39
	Postgraduate Degree	30.38
Economic Activity (dummy)		
	Employed full time	49.78
	Employed part time	11.95
	Studying	3.54
	Retired	29.87
	Unemployed	4.87
Property Status (dummy)		
	Own the property	82.52
	Rent privately	8.63
	Council house	4.65
	Live at the property rent free	4.20
Environmental group membership (dummy)		29.58
Local Authority (dummy)		
	Fife	60.13
	Perth & Kinross	13.44
	Dundee	26.43

3.2 Information and Learning

Figure 2 shows the histogram of treated respondents quiz scores for the first and second quiz. The figure suggests that respondents were learning the additional information as there was a significant difference between the first (mean = 3.17, SE = 0.87) and second quiz scores (mean = 5.09, SE = 0.11).

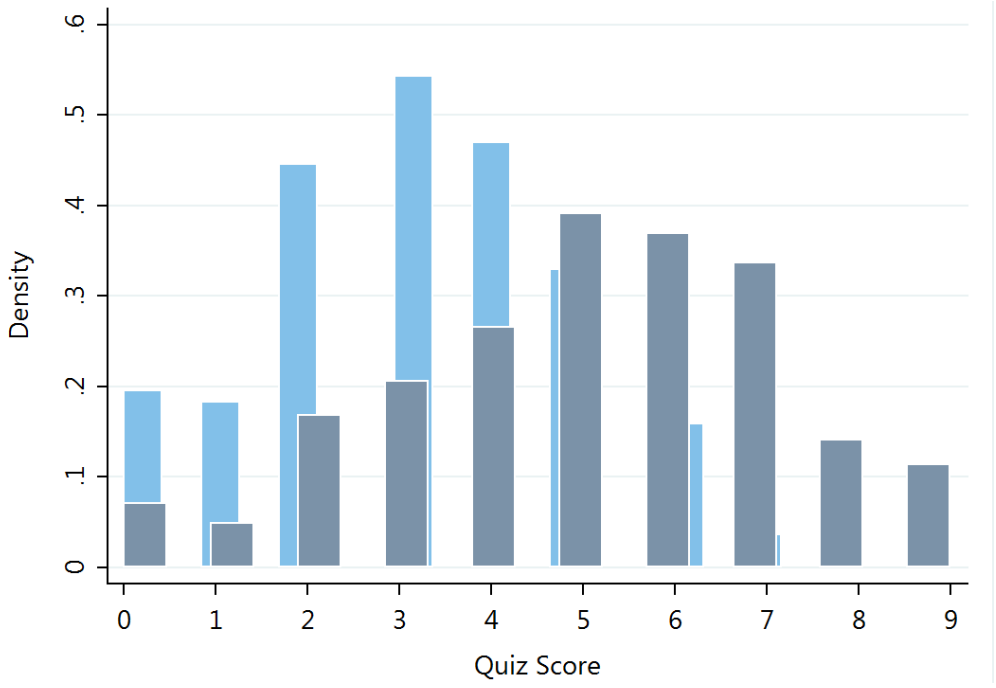

Figure 2: Histogram of the first (light blue) and second (grey) quiz scores for treated respondents only

Results of the OLS regression to test for differences in the second quiz score between the treated respondents only and between treated respondents and those in the control group are presented in Table 6. Results for Equation 1 show that second quiz score is dependent on information, and that increasing information between the six treatment groups (LL through to HH) leads to a higher score. Respondents in the HH group scored 4.42 more than those in the LL group. Including the control group as the baseline in Equation 2 highlights a possible framing effect as a result of taking the first quiz. . Respondents in the control group received nine pieces of information, the same as those in the MH and HH groups, however the MM and HH respondents, scored on average 0.89 and 2.57 more than those in the control group. This suggests that taking first quiz increases respondent's attentiveness and retention of new information. Respondents in the LL treatment group scored significantly lower than those in the control group. This was to be expected as they were given the

least amount of information. Including the vector of socio-demographic characteristics in both models does not significantly alter the treatment coefficients and this is evidence of a fully randomized treatment. Interestingly, those respondents who strongly agreed or agreed with the statement "the additional information affected my WTP" scored 0.51 more than those who disagreed or strongly disagreed with the statement. Also those respondents who felt "the information was too complicated for me to think about" score 0.89 less. Respondents with a post graduate degree also scored more than respondents with different education levels, scoring on average 1.12 higher in the second quiz.

Table 6: Second Quiz Score on treatment group (Equations 1 & 2)

	(1)				(2)			
VARIABLES	(a)		(b)		(c)		(d)	
Treatment Pair								
Control	-	-	-	-				
LL					-1.85***	(0.31)	-2.03***	(0.31)
LM	1.24***	(0.31)	1.46***	(0.31)	-0.61	(0.37)	-0.58	(0.37)
LH	1.68***	(0.32)	2.52***	(0.33)	-0.17	(0.38)	0.44	(0.37)
MM	1.81***	(0.27)	2.01***	(0.27)	-0.04	(0.33)	-0.04	(0.32)
MH	2.74***	(0.28)	2.93***	(0.28)	0.89***	(0.34)	0.90***	(0.33)
HH	4.42***	(0.69)	4.23***	(0.70)	2.57***	(0.75)	2.07***	(0.74)
The additional information confirmed what I already knew (strongly agree or agree)			-0.21	(0.27)			-0.17	(0.26)
The additional information affected my WTP (strongly agree or agree)			0.51**	(0.23)			0.61***	(0.23)
The additional information was too complicated for me to think about (strongly agree or agree)			-0.89**	(0.37)			-0.76**	(0.35)
Constant	3.70***	(0.17)	3.33***	(1.09)	5.55***	(0.25)	5.15***	(1.09)
Observations	389		353		454		409	
R-squared	0.26		0.43		0.21		0.38	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variable is second quiz score. Control variables in columns (b) and (d) are perceived flood risk, worry about existing flood defences, whether a respondent's home has been flooded, insurance, environmental group membership, gender, age, property ownership, income, education, economic activity and distance from the managed realignment site.

3.3 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 Governments responsibility to fund flood defence (27%). The histogram of WTP highlights that WTP is downward sloping and there is non-trivial anchoring around £50, £100 and £150 pounds (Figure 3). The sample mean was £39.87 per annum (*SD* = 43.15).

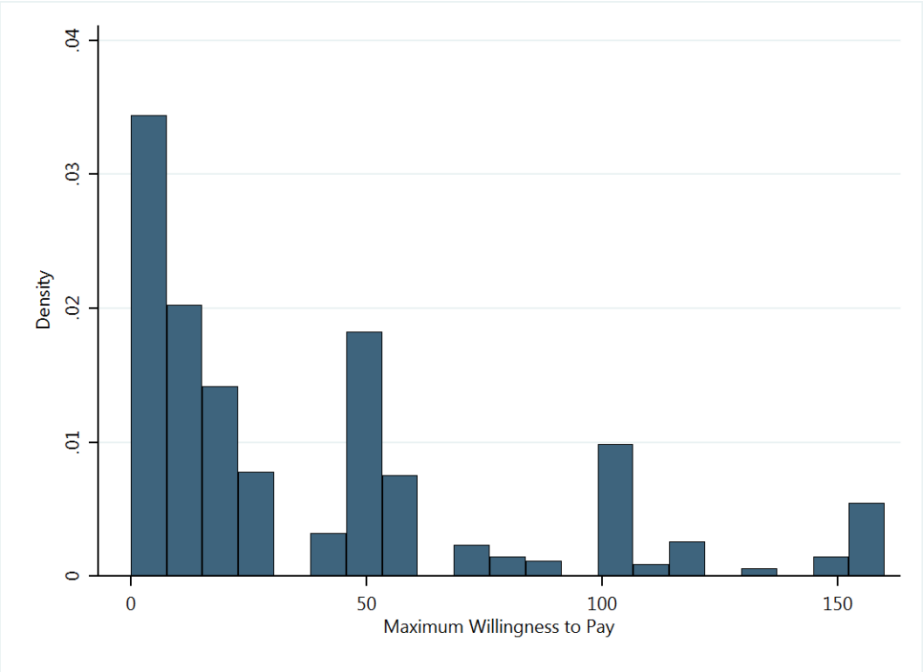

Figure 3: Histogram of WTP for all subjects. N = 454

3.3.1 Prior Knowledge on WTP

Table 7 presents the mean WTP of respondents grouped by their first quiz score (low, medium or high). A simple Kruskal-Wallis test showed there were no significant differences in mean WTP between the a priori information types ($H(2) = 0.262$, $p = 0.88$) suggesting that what respondents initially knew about flood defence, flood risk and the costs and benefits of managed realignment does not seem influence their WTP.

Table 7: Effect of prior knowledge on mean WTP

Prior Knowledge	Median WTP	Mean WTP	SE (mean)	Standard Deviation	Observations
Low	20.00	42.39	3.06	45.87	224
Medium	20.00	40.99	3.41	42.77	157
High	32.50	40.00	11.76	33.27	8

3.3.2 Quiz on willingness to pay

Table 8 presents the mean WTP of respondents grouped by treatment or control. A simple Mann Whitney test showed there was a significant difference in mean WTP between those respondents who took the first quiz and those who did not (z= -2.05, p= 0.04).

Table 8: Comparison of mean WTP between control and treated respondents

Treatment	Median WTP	Mean WTP	SE (mean)	Standard Deviation	Observations
No Quiz	20	28.54	4.14	33.34	65
First Quiz	20	41.77	2.25	44.33	389
Total	20	39.88	2.02	43.15	454

Results of the interval regression to examine differences in WTP between those who took the first quiz and those who did not (Equation 4) are presented in Table 9. There was a significant difference in WTP between the control and treated respondents, with those taking the first quiz WTP between £13.32 and £14.68 more. The difference remained significant when socio-demographic variables were included and also when only the respondents who received the high information treatment were included in the regression. Taking the first quiz has inflated respondents WTP and is further evidence that taking the quiz at the start of the survey increases attention. Other significant predictors of WTP included being worried about flooding and having a higher income, whilst living further from the site reduced WTP.

Table 9: Effect of taking first quiz on WTP (Equation 4)

VARIABLES	(e)		(f)		(g)		(h)	
Treated Respondents	13.32**	(5.84)	14.68***	(5.61)	13.47**	(6.29)	13.99**	(6.13)
Constant	31.72***	(5.41)	5.83	(8.75)	31.72***	(5.16)	-7.03	(11.52)
lnsigma	3.77***	(0.03)	3.64***	(0.04)	3.73***	(0.05)	3.58***	(0.05)
Observations	454		410		199		181	
Log Likelihood	-1620.88		-1404.08		-700.50		-608.55	-608.55
Likelihood-ratio chi-square	5.17		119.02		4.54		65.66	65.66
Prob > chi2	0.02		0.00		0.03		0.00	0.00

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variable is maximum WTP. Columns (e) and (f) include all respondents whilst (g) and (h) are restricted to the treated respondents who received all 9 pieces of information and those who did not take the first quiz. Control variables in columns (f) and (h) are perceived flood risk, worry about existing flood defences, whether a respondent's home has been flooded, insurance, environmental group membership, gender, income, and distance from the managed realignment site.

3.3.3 Type-treatment pairs on willingness to pay

Table 10 presents the mean WTP by the level of information received (low, medium or high) and also mean WTP by the type-treatment pairs. Considering purely the amount of information received, there was no significant difference between mean WTP regardless of whether a respondent received a low, medium or high amount of information ($H(2)= 0.25$, $p= 0.88$) suggesting that the level of information a respondent receives did not affect their WTP estimate. When also accounting for the respondents initial quiz score, there is also no significant in mean WTP between the treatment groups with mean WTP ranging between £38.89 and £45.48 per household per annum ($H(5)= 1.25$, $p= 0.94$). These results suggest that purely taking into account the amount of information receives as part of the survey, even when accounting for what they already knew does not have an effect on what the respondent is willing to pay.

Table 10: Comparison of mean WTP by level of information received

Level of information received [a]	Median WTP	Mean WTP	Standard Error (Mean)	Standard Deviation	Observations
Low	20.00	41.97	4.22	46.60	122
Medium	30.00	41.47	3.70	42.62	133
High	25.00	41.90	3.82	44.20	134
Total	20.00	41.77	2.24	44.33	389
Treatment Group	**Median WTP**	**Mean WTP**	**Standard Error (Mean)**	**Standard Deviation**	**Observations**
Control	20.00	28.54	4.14	33.34	65
LL	20.00	41.97	4.22	46.61	122
LM	30.00	45.48	6.46	46.61	52
LH	25.00	40.20	6.22	43.97	50
MM	20.00	38.89	4.44	39.93	81
MH	25.00	43.22	5.25	45.76	76
HH	32.50	40.00	11.76	33.27	8
Total	20.00	39.88	2.02	43.15	454

Notes: [a] only respondents who took the first quiz are included

3.3.4 Effect of information and final knowledge on willingness to pay

The final stage of the analysis considered the effect of the respondent's final knowledge "set" on WTP as determined by the information a respondent received (low, medium or high) and their final score (low, medium or high) (Equation 5). The possible final knowledge pairs, along with the mean WTP for the pair are detailed in Table 11. There was a significant difference in mean WTP between the final knowledge pairs) with mean WTP between £31.00 and £116.67 per household per annum ($H(8)= 15.13$, $p= 0.06$).

Table 11: Possible final knowledge pairs and mean WTP

Information	Final Score	Median WTP	Mean WTP	Standard Error (mean)	Standard Deviation	Observations
Low	Low	12.50	32.31	5.92	42.67	52
Low	Medium	30.00	46.12	5.71	46.77	67
Low	High	100.00	116.67	21.86	37.86	3
Medium	Low	10.00	41.43	11.87	54.41	21
Medium	Medium	50.00	46.23	5.02	44.04	77
Medium	High	20.00	31.00	4.81	28.46	35
High	Low	5.00	52.50	14.95	63.41	18
High	Medium	20.00	38.22	6.16	41.30	45
High	High	30.00	41.55	4.78	40.32	71
Total		20.00	41.77	2.25	44.33	389

The results of Equation 5 are presented in Table 12. The final knowledge pairs do not significantly affect respondents maximum WTP. As with previous results the significant drivers behind respondent WTP are whether they perceive themselves to be at risk from flooding (+£15.82), whether they are worried about the current defences (+£22.46) and are in the higher income groups (£39,000 band +£13.66; £85,000 band +£25.65; £100,000 band +£32.68). Interestingly, whilst the final knowledge sets are insignificant, respondents who selected that they strongly agreed or agreed that the information affected their WTP were WTP £18.49 more towards the scheme than those who disagreed or strongly disagreed with the statement.

Table 12: Maximum WTP on final knowledge pairs

VARIABLES	(i)		(j)	
Final Knowledge Pairs				
Low info, low score (baseline)	0.00	(0.00)	0.00	(0.00)
Low info, med score	14.52*	(8.14)	13.37*	(7.73)
Low info, high score	85.05***	(26.15)	41.09*	(23.17)
Med info, low score	8.64	(11.38)	-1.95	(10.81)
Med info, med score	14.83*	(7.90)	8.85	(7.14)

Med info, high score	-0.33	(9.63)	-1.47	(8.77)
High info, low score	19.51	(12.04)	10.99	(11.86)
High info, med score	6.73	(8.97)	3.65	(8.26)
High info, high score	10.01	(8.04)	3.88	(7.45)
Information statement questions				
The information confirmed what I already know (strongly agree or agree)			-8.63	(5.77)
The information affected my WTP in retrospect			18.49***	(5.04)
The information was too complicated for me to think about			-12.67	(7.92)
Constant	35.01***	(6.11)	12.28	(9.40)
lnsigma	3.78***	(0.04)	3.61***	(0.04)
Observations	389		354	
Log Likelihood	-1389.40		-1198.62	
Likelihood-ratio chi-square	15.73		134.83	
Prob > chi2	0.05		0.00	

Notes: Dependent variable is maximum WTP. Control variables in column (j) are perceived flood risk, worry about existing flood defences, whether a respondent's home has been flooded, insurance, environmental group membership, gender, income, and distance from the managed realignment site.

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

4 Discussion

The paper aimed to explore whether local residents were willing to contribute towards a managed realignment scheme on the Tay Estuary, Scotland and within this explore the effects of new information and learning in stated preference surveys.

A causal relationship was established between learning new information presented during the survey and the second quiz score. However, this learning did not appear to affect the WTP estimate. Additionally varying the levels of information did not affect the WTP estimate, nor did accounting for respondent's prior knowledge of the subject. These findings are in line with Bergstrom et al (1989) and Boyle (1989) who also found there was no significant difference in WTP as a result of different levels of information.

One significant finding was that those respondents who scored low on the second quiz, regardless of the level of information received, appeared to have a much lower median WTP than other respondents (ranging between £5 and £12.50 per annum) compared to those who scored higher on the second quiz (median WTP ranged between £20 and £50 per annum). One possible reason is that those respondents who scored low had little interest in the flood defence scheme and would not directly benefit from the new flood defences and as such did not choose to take the new information on board. In this case the survey was of low personal relevance and the results mirror the findings of Ajzen et al (1996). This argument is strengthened when the key predictors of WTP are considered. The strongest predictors of respondents WTP were their perceived risk from flooding and whether they were worried about current flood defences. Overall it appears that respondents who felt most at risk and were worried about the existing flood defences were prepared to pay most, regardless of the additional information received. There was also a distance decay relationship establish with respondents living closest to the site willing to pay the most.

Directly asking respondents whether their WTP was by the new information showed that those who strongly agreed or agreed with the statement were prepared to pay significantly more towards the

scheme. This suggests that what the authors considered additional information and what the respondents considered additional information was different. There is a possibility that the majority of the information bullets were treated as redundant information by respondents, and only the information directly related to the managed realignment scheme (the map of the site, current status quo and funding of the scheme) which all respondents received was perceived as the "additional" information rather than the nine additional bullet points. A regression was ran which included the second quiz answers as 9 individual dummy variables (1 correct and 0 incorrect) showed that only respondents answering the question relating to managed realignment delivering a greater flood defence benefit than hard defences was a significant predictor of WTP. Variables relating to flood risk throughout the Tay Estuary, ecosystem service benefits of managed realignment, as well as the costs of managed realignment were not significant.

From the regulators perspective the results were encouraging with the majority of respondents willing to pay towards the Newburgh managed realignment scheme rather than maintain the status quo of existing hard sea defences. The household mean WTP of £39.87 per annum is in line with previous research by English Nature (2001) that derived a household WTP estimate of £20 per year to fund managed realignment schemes in England. Other similar WTP results were reported by Brouwer et al (1999) who found mean WTP for wetland regeneration was £83.65 per household per year and Woodward and Wui (2001) who calculated wetland regeneration was worth $50 per hectare (1995 values) respectively. As the responses were representative of the affected population it was possible to derive aggregate WTP for the scheme and compare it to the net present costs of the managed realignment site being created (Table 13).

Table 13: Predicted aggregate benefits of the managed realignment scheme

Area[a]	Predicted Household Annual Mean WTP	Number of Households	Annual Aggregate WTP	Present Value Aggregate Benefits [b]
Newburgh	£59.01	1133	£66,858	£1,017,071
Fife Local Authority	£37.32	171,861	£6,413,853	£97,570,111
Households adjacent to the Tay Estuary	£40.03	294,922	£11,805,728	£179,593,490

Notes: [a] aggregate WTP was derived on for three scales: 1) Newburgh residents only. This population will directly benefit from the flood defence scheme; 2) Fife Local Authority Households. Council tax increases to fund the scheme would affect the whole of the Fife Local Authority area, regardless as to whether they directly benefit from the scheme and 3) Households situated in census output areas adjacent to the Tay Estuary covering the Fife, Perth & Kinross and Dundee local authorities. These households may receive flood defence benefits from the scheme.

[b] Present value benefits are also calculated using the Treasury Green book discount rate of 3.5% over a 20 year timescale (HM Treasury 2011).

The aggregate benefits of the scheme over the three scales (between £1,017,071 and £179,593,490) were compared to the predicted costs of creating the managed realignment site, as well as the existing hold the line approach. The present value costs of the managed realignment scheme were calculated following the method of Shepherd et al (2007) (Table 14). The predicted present value costs of the managed realignment scheme were calculated as £2,247,480.

Table 14: Net present value of managed realignment versus hold the line approach for the Newburgh Managed Realignment Scheme

Item	Value at time of reference	Year value relates to	Value adjusted to 2013-2014 financial year	Managed Realignment	Hold the Line
Capital costs of realignment	£811,893 per km	2001-2002	£1,073,609	£1,932,496	
Opportunity Costs (Grade 3 land)	£2,382 per ha	2001-2002	£3,150	£314,984	
Maintenance costs of non-realigned defences	5,000.0	2000	£6,772		£9,000
Replacement Costs	618,000	2001	£807,905		
Total Costs				£2,247,480	£900,000
Present Value Costs				£2,247,480	£291,463

As expected, respondents in Newburgh were prepared to pay the most towards the scheme as they will receive the direct benefits of reduced flood risk. The present value benefit for the scheme aggregated across Newburgh residents was £1,017,071. This is lower than the predicted costs of the scheme (£2,247,480). However, when considering the aggregate WTP across the whole of the Fife Population (who would be responsible for funding the scheme through their council tax) managed realignment is a feasible policy option and increases in annual council tax could be much smaller than the average WTP stated by respondents in the survey.

5 Conclusions

The use of a contingent valuation survey to gauge public perceptions of managed realignment has demonstrated that the public are willing to contribute to manage realignment to protect their homes from coastal flooding in the Tay Estuary and crucially aggregate WTP exceeds the predicted costs of the scheme. The information and learning portion of the survey yielded mixed results. Prior information and new information were shown not to have an effect on stated WTP despite a clear learning effect being observed. Respondents who felt the issue was of high personal relevance were prepared to pay the most, regardless of the level of additional information received. Further research will now focus on the effects of learning and information on the numbers of protest bids and the initial WTP decision (in line with the work of Boyle, 1989).

References

Aadland, D.M., Caplan, A.J. and Phillips, O.R. (2007) A Bayesian examination of information and uncertainty in contingent valuation. *Journal of Risk and Uncertainty,* 35 (2), pp. 149-178.

Ajzen, I., Brown, T.C. and Rosenthal, L.H. (1996) Information bias in contingent valuation: effects of personal relevance, quality of information, and motivational orientation. *Journal of Environmental Economics and Management,* 30 (1), pp. 43-57.

Bateman, I.J. and Mawby, J. (2004) First impressions count: interviewer appearance and information effects in stated preference studies. *Ecological Economics,* 49 (1), pp. 47-55.

Bergstrom, J.C., Stoll, J.R. and Randall, A. (1989) Information effects in contingent markets. *American Journal of Agricultural Economics,* 71 (3), pp. 685-691.

Boyle, K.J. (1989) Commodity specification and the framing of contingent-valuation questions. *Land Economics,* , pp. 57-63.

Cameron, T.A. and Englin, J. (1997) Respondent experience and contingent valuation of environmental goods. *Journal of Environmental Economics and Management,* 33 (3), pp. 296-313.

Carson, R. (2000) Contingent valuation: A user's guide. *Environmental Science & Technology,* 34 (8), pp. 1413-1418.

Coates, T.T., Brampton, A.H., Powell, K.A., Packham, J., Randall, R., Barnes, R. and Neal, A. (2001) Shingle beach recharge in the context of coastal defence: principles and problems. *Ecology and Geomorphology of Coastal Shingle,* , pp. 394-402.

Cummings, R. and Taylor, L. (1999) Unbiased value estimates for environmental goods: A cheap talk design for the contingent valuation method. *American Economic Review,* 89 (3), pp. 649-665.

French, P.W. (1997) *Coastal and estuarine management.* London: Routledge.

French, P. (2006) Managed realignment - The developing story of a comparatively new approach to soft engineering. *Estuarine Coastal and Shelf Science,* 67 (3), pp. 409-423.

Hanley, N. and Munro, A. (1992) *The Effects of Information in Contingent Markets for Environmental Goods: A Survey and some New Evidence,* .

Hasselström, L. and Håkansson, C. (2014) Detailed vs. fuzzy information in non-market valuation studies: the role of familiarity. *Journal of Environmental Planning and Management,* 57 (1), pp. 123-143.

Hoehn, J.P. and Randall, A. (2002) The effect of resource quality information on resource injury perceptions and contingent values. *Resource and Energy Economics,* 24 (1), pp. 13-31.

King, S.E. and Lester, J.N. (1995) The value of salt marsh as a sea defence. *Marine Pollution Bulletin,* 30 (3), pp. 180-189.

Ledoux, L., Cornell, S., O'Riordan, T., Harvey, R. and Banyard, L. (2005) Towards sustainable flood and coastal management: identifying drivers of, and obstacles to, managed realignment. *Land use Policy,* 22 (2), pp. 129-144.

Luisetti, T., Turner, R.K., Bateman, I.J., Morse-Jones, S., Adams, C. and Fonseca, L. (2011) Coastal and marine ecosystem services valuation for policy and management: Managed realignment case studies in England. *Ocean & Coastal Management,* 54 (3), pp. 212-224.

Moller, I., Spencer, T., French, J., Leggett, D. and Dixon, M. (1999) Wave transformation over salt marshes: A field and numerical modelling study from north Norfolk, England. *Estuarine Coastal and Shelf Science,* 49 (3), pp. 411-426.

Myatt, L., Scrimshaw, M. and Lester, J. (2003a) Public perceptions and attitudes towards a current managed realignment scheme: Brancaster West Marsh, North Norfolk, UK. *Journal of Coastal Research,* , pp. 278-286.

Myatt, L., Scrimshaw, M. and Lester, J. (2003b) Public perceptions and attitudes towards a forthcoming managed realignment scheme: Freiston Shore, Lincolnshire, UK. *Ocean & Coastal Management,* 46 (6), pp. 565-582.

Myatt, L., Scrimshaw, M. and Lester, J. (2003c) Public perceptions and attitudes towards an established managed realignment scheme: Orplands, Essex, UK. *Journal of Environmental Management,* 68 (2), pp. 173-181.

Pethick, J. (2002) Estuarine and tidal wetland restoration in the United Kingdom: policy versus practice. *Restoration Ecology,* 10 (3), pp. 431-437.

SEPA (2015) *Flood Risk Management Maps.* Available: http://map.sepa.org.uk/floodmap/map.htm .

SEPA (2012) *Natural Flood Management Position Statement. The role of SEPA in natural flood management.* SEPA. Available: http://www.sepa.org.uk/flooding/flooding_publications.aspx.

Shepherd, D., Burgess, D., Jickells, T., Andrews, J., Cave, R., Turner, R.K., Aldridge, J., Parker, E.R. and Young, E. (2007) Modelling the effects and economics of managed realignment on the cycling and storage of nutrients, carbon and sediments in the Blackwater estuary UK. *Estuarine Coastal and Shelf Science,* 73 (3-4), pp. 355-367.

Tkac, J. (1998) Award-Winning Undergraduate Paper: The Effects of Information on Willingness-to-Pay Values of Endangered Species. *American Journal of Agricultural Economics,* , pp. 1214-1220.

Tonsor, G.T. and Shupp, R.S. (2011) Cheap Talk Scripts and Online Choice Experiments:"Looking Beyond the Mean". *American Journal of Agricultural Economics,* 93 (4), pp. 1015-1031.

UCLA: Statistical Consulting Group. (2015) *Stata Analysis Examples.* Available: http://www.ats.ucla.edu/stat/stata/dae/tobit.htm .

Whitehead, J.C. and Blomquist, G.C. (1991) Measuring contingent values for wetlands: effects of information about related environmental goods. *Water Resources Research,* 27 (10), pp. 2523-2531.