CHAPTER 6

FLOOD RISK, ECOLOGICAL RESTORATION AND WILLINGNESS TO PAY: A CONTINGENT VALUATION APPROACH

Introduction

Economists have long understood the difficulty associated with the valuation of nonmarket goods and various techniques have been developed in an attempt to value such goods[1]. Nonmarket goods may have both public good and private good attributes. Whereas consumers reveal their preferences for private goods by interacting with sellers in markets, such markets do not necessarily exist for public goods. This is due to a market failure that results from non-identifiable individual property rights. That is, consumers cannot be excluded from enjoying the good once it is provided (i.e., the good is nonexcludible), and the good is also nonrivalrous in that one person's consumption does not inhibit another individual from also consuming the good.. Freeman (1979) notes that benefits from a good can also be characterized along another dimension (i.e., they may be direct or indirect benefits). Direct benefits are those that accrue directly to a given individual or group. In contrast, indirect benefits are experienced by the entire community.

The two goods under consideration in this study, flood control and ecological restoration are predominantly public goods with a degree of local excludability. These public goods are sometimes described as local public goods. In addition, the resulting benefits are both direct and indirect. Specifically, given the spatial nature of these benefits, some direct benefits can accrue to a subset of the population. For example, if a project reduces the probability of flooding, those residents living in the 100 year floodplain will be expected to experience less flooding and hence experience direct benefits. Publicly provided goods (e.g., roads, public buildings, etc.) are also less likely to be damaged. However, there are also indirect benefits to the wider community emanating from flood control projects. Indirect benefits may be commercial (e.g., businesses avoiding passing on increased costs due to flooding to their consumers) or they may be altruistic (sense of "doing the right thing" for the whole community, valuing the environment, etc.).

Likewise, improving the ecological quality of the urban watersheds also generates a local public good that creates both direct and indirect benefits. Among those residents who use the watershed for recreational activities such as hiking, fishing and birding, an improvement in ecological quality can improve the recreational experience. These outcomes may be classified as direct benefits. However, even local residents who are not users may want to improve the environmental quality of the watershed for their own private future use. This nonuse value is sometimes known as option value. Alternatively, economic value may be unrelated to current or future personal use of the resource. For example, existence values are benefits that an individual receives from knowing that a resource is preserved or enhanced even though the consumer never intends to use the resource (Krutilla and Fisher, 1975). Mitchell and Carson (1989) further classify existence values into vicarious consumption (by significant others, relatives or close friends, and diffuse others, the general public) and stewardship values (preservation or bequest). These would represent direct benefits to the consumer, even thought the good is public in nature. There may also be an enhanced sense

[1] A good is a product or service that generates positive levels of satisfaction to the consumer.

of civic pride that results from enhancing a local environmental resource, which represents an indirect public benefit.

Given that residents in the Milwaukee metropolitan area have experienced three so-called 100 year flood events in the last 15 years[2], the issue of flood control has had a high public profile. In addition, local environmentalists have focused on limiting development within one of the watersheds considered in this study. Thus, an important policy question that arises is how flood control attributes are valued vis á vis ecological protection and restoration initiatives. Since flood control projects may focus primarily on mitigation of flood risks (e.g., creation of retention areas, removal of brush and debris along the river, widening and dredging rivers and streams, etc.), or they may employ techniques that also improve the ecological health of the watershed (e.g., wetland restoration, expand green areas around rivers and streams, etc.), an understanding of the relative importance of these two objectives of watershed management is needed. This study will employ the Contingent Valuation Method (CVM) to evaluate community support for watershed management practices. The CVM model will be considered in this chapter. However, a parallel analysis utilizing the Theory of Planned Behavior (Ajzen, 1988) and communication variables, and testing at a more micro level the psychological correlates of willingness to pay. This analysis will be presented in Chapter 7.

Alternative Approaches to Benefit Estimation

Hedonic Housing Price Model

There are two primary approaches that would be appropriate to evaluate watershed management projects. One such approach is the Hedonic Housing Price Model (HHPM). The HHPM has its formal roots in the works of Lancaster (1966) and Rosen (1974), as well as the seminal work of Tiebout (1956) on local public goods. Households are assumed to choose that property that maximizes their level of satisfaction subject to their budget constraint. Properties that are located in neighborhoods with lower flood risk would command higher selling prices, just as properties with more square footage would be expected to sell at higher prices than smaller properties, other things equal. As a result, housing prices are expected to reflect a wide range of characteristics related to the structure (e.g., interior square footage, lot size, age, number of bathrooms, etc.), neighborhood (e.g., average commute time, median household income, etc.); the environment (e.g., air quality, flood risk reduction); and fiscal factors (e.g., property tax rates and school quality). Under certain assumptions, the marginal willingness to pay for a given attribute (e.g., reduction in flood risk) can be derived.

There are several underlying assumptions in this model. The HHPM assumes that the study area is a single market for housing services. It also assumes that all buyers and sellers have perfect information on the alternatives that exist and they are mobile between properties in the market. Finally, it assumes that the housing market is in equilibrium. This last assumption means that there is no surplus or shortage of housing in the market. Given that repackaging of the housing good is prohibitively expensive (e.g., a two-car garage can not be easily swapped for a one-car garage), the hedonic housing price equation is assumed to be nonlinear.

Given the previous assumptions, the market clearing price of the house is treated as parametric and can be represented as p(Z), where $Z = z_1, z_2, \ldots, z_n$ is a vector of n structural, neighborhood, and environmental characteristics. This market price p(Z) function is a reduced form equation representing both supply and

[2] Major flooding events took place in Milwaukee in 1986, 1997 and 1998.

demand influences in the housing market. The housing market implicitly reveals a market for housing characteristics. The implicit price of attribute n is given by the partial derivative of p(z) with respect to attribute n, or $p_n(z) = \partial p/\partial z_n$. That is to say, the partial derivative with respect to any of the aforementioned characteristics in the function can be interpreted as a marginal implicit price of that characteristic. This marginal implicit price is the additional amount that must be paid by any household to move to a bundle of housing services with a higher level of that characteristic. For example, the coefficient on the number of rooms in a home may be interpreted as the price that must be paid by the household to move from a house with eight total rooms to the same house with nine total rooms, all else constant. Since the function for housing is nonlinear, the marginal implicit price depends on the quantity of the characteristic being purchased[1].

There have been numerous HHPM studies that specifically address the issue of flooding. Schaefer (1990) examined the effect of floodplain regulations on residential property values whereas Shilling et. al. (1987) evaluated the impact of subsidized and nonsubsidized flood insurance on property values. Likewise, the impact of different measures of flood risk on property values have also been considered in a number of different studies (Barnard 1978; Park and Miller 1982; Thompson and Stoevener 1983; Donnelly 1989; Speyrer and Ragas 1991; Shabman and Stephenson 1996). For the most part, the results from these studies indicate that location in a floodplain, or proxies for flood risk, negatively impacts residential property values. One study examined a major flood event (Babcock and Mitchell 1980); however, this analysis was done by a comparison of prices before and after the event, and thus was vulnerable to bias due to omitted factors in the analysis. In a technical report to this project, Bartosova, Clark, Novotny and Taylor (1999) find that other things equal, real housing prices are 12% lower for homes selling in the Menomonee River 100 year floodplain, as compared to those selling outside the floodplain. In addition, housing prices rise as the recurrence interval rises within the 1000 year floodplain.

An important advantage of the hedonic approach is that benefit estimates are based on actual behavior in real world markets. However, the model has some shortcomings that limit its applicability in this application. First, the model is best adapted to evaluate nonmarket goods that are already in place. For example, the benefits of flood control can be derived by examining the housing price differentials that result from properties that face different levels of flood risk. In contrast, goods that are only proposed, such as ecological restoration, could not be evaluated if there were no experience with the good in the particular market. That is, no real estate impacts could be reflected if the improvements had not been realized at any location within the region. Second, the benefits that can be derived from the hedonic model would reflect private direct benefits, and would neglect indirect benefits to other residents (e.g., resulting from altruistic beliefs) within the community. As a result, they would be expected to underestimate the general level of benefits that could result if the good has important public good attributes.

Contingent Valuation Method

An alternative approach that is better adapted to the present study is the Contingent Valuation Method (CVM). The CVM is used to estimate values for environmental improvements, relying on individual responses to hypothetical circumstances obtained through a survey. Since a competitive market does not exist for most types of environmental improvements, the approach utilizes an artificially structured market to obtain estimated values. Contrary to the market for private goods where actual prices paid can be observed, the price that individuals are willing to pay for environmental improvements is not directly observable.

The use of survey methods to answer the question of how one may obtain values for environmental public goods (for which a competitive market does not exist) was first established by Ciracy-Wantrup (1952). However, it was not until the late 1960's that a significant intellectual interest and pursuit in finding an optimal survey approach was undertaken. There remains an ongoing debate and controversy regarding the use of CVM, and the accuracy of the responses.

Skepticism for the method is grounded in the following challenges it faces. These challenges include operational and methodological problems (i.e. information, starting point, vehicle biases); potential biases related to the hypothetical nature of the market; the implications for CVM made by decision theory and other areas of psychological research; the absence of precise guidelines for implementing the CVM and standards relating to the acceptability of CVM measures. After presenting the theory behind the model, the various shortcomings and potential biases will be discussed.

Theory of Contingent Valuation Method

Basic utility theory is used in this study to guide the development of a theoretical model to describe a household's willingness to pay for two separate goods: flood control and ecological improvement within the watershed. It is assumed that an individual maximizes his or her utility subject to a budget constraint. In this study, the household's utility can be described by a vector of market goods, X, and a nonmarket good, Z. From Samuelson (1954), the value of the nonmarketed public good, which is not priced and can only be provided in a fixed amount, is given by the household's WTP for the nonmarket good. This will be shown to be related to the consumer surplus, or area under the consumers demand for the nonmarket good. The optimization problems is defined by equation [6.1][2].

$$\text{Maximize } U(X; Z) \qquad \text{Subject to: } \textstyle\sum_i P_{i,} X_i < Y \qquad \textbf{(6.1)}$$

where Y is income and P is a vector of prices for the marketed good in vector X. Solving this optimization problem generates a demand function for the market good, defined by equation 6.2.

$$X_i = X_i\,(P,Z,Y) \qquad \textbf{(6.2)}$$

From equation [6-2] it is seen that the level of a nonmarketed good enters as an argument in the demand for a marketed good. However, because the nonmarketed good is not priced it is not possible to similarly derive a demand function for the nonmarketed good from the utility maximization system. However, the dual of the utility maximization problem is the expenditure minimization problem. Specifically, minimizing the expenditure function, conditional on a given level of utility, as shown by Eq. 6.3, can be used to derive the willingness to pay function.

$$\text{Minimize } \textstyle\sum_i P_{i,} X_i = M \qquad \text{Subject to: } U(X,Z) = U^* \qquad \textbf{(6-3)}$$

U^* is a reference level of utility and M is the minimum money expenditure required to attain U^*. By solving Eq. 6.3, the household's expenditure function results:

$$E = E\,(P, Z, U^*) \qquad \textbf{(6-4)}$$

A Hicksian-compensated demand curve is a demand curve where the level of utility is constant at every point on the function. In contrast, the Marshallian demand curve allows utility to vary along the demand function.

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[2] The distinction between the areas under the Hicksian-compensated and Marshallian-uncompensated demand curves will be discussed in more detail later in this section.

To generate the Hicksian-compensated demand function for the nonmarketed good, equation 6.4 can be partially differentiated with respect to a given price for the good, holding utility constant.

$$c^{*} = E_{c}\ (P,Z,\ U^{*}) \qquad \textbf{(6-5)}$$

Since utility does not change, the change in expenditure that is necessary to compensate for the change in the good, while holding utility constant, is the monetized value of utility derived from the good.

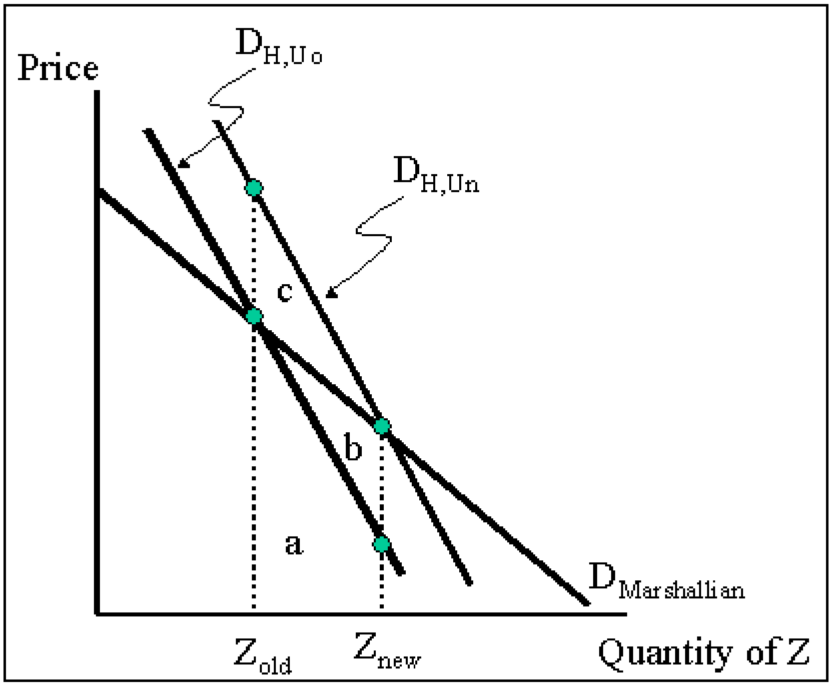

Figure 6.1. Willingness to Pay, Consumer Surplus, Compensating vs. Equivalence Surplus

Assume that an improvement in the public good increases consumption from Q_{old} to Q_{new}. Movements along the Marshallian-uncompensated demand curve result in changes in utility (i.e, Utility rises from U_o to U_n as the price for the good falls). The consumer surplus is defined as the area under $D_{marshallia}$ or area a+b. In contrast, assuming the individual has the right to the original level of utility, then the Hicksian-compensated demand curve, $D_{H,Uo}$ is appropriate, and the monetary value of the utility is given by area a. This value, which is also known as compensating surplus, represents the payment that the individual would be willing to make that would just compensate for any change in utility from consuming the higher level of the good. On the other hand, if the consumer has the right to the new level of utility, the demand curve $D_{H,Un}$ is the appropriate reference, and the area a+b+c represents the equivalent surplus. Note that for a quantity decrease, the equivalence and compensating surplus' would be reversed. If the consumer has the right to the original level of the good, then the consumer must pay for the new higher level, and hence the appropriate utility concept is compensating surplus, and hence willingness to pay (WTP). In contrast, if the consumer has the right to the new level of utility, then the appropriate surplus measure is equivalence surplus, and hence the consumer must be paid to accept the old level of utility (i.e., there is a willingness to accept (WTA) compensation along with the old level of the good). In either case, the individual is equally well off at either level of consumption.

Both equivalence and compensating surplus measures can be evaluated through equation 6.5 depending on the reference level of utility (Thunberg, 1988). To generate the Hicks-compensated inverse demand function for the nonmarketed good, equation 6.4 is differentiated with respect to Z. According to Mishan (1976), this is the theoretically appropriate surplus measure for welfare comparisons. It will further be argued that WTP, rather than WTA is the correct measure in this application (Mitchell and Carson, 1989).

$$m^* = E_Z (P, Z, U^*) \qquad \textbf{(6 - 6)}$$

In terms of money income transfer required to maintain the household's utility at U^*, equation 6.6 gives the marginal WTP for a change in the level of Z. The benefit to the individual for a change in Z is therefore given by

$$WTP = \int_{Zold}^{Znew} E_Z (P, Z, U^*)\, dZ \qquad \textbf{(6-7)}$$

The two goods being considered in this project are the maintenance of flood control at current levels in light of ongoing development throughout the watershed, and the enhancement of ecological quality for the streams and rivers in the watershed. Although the proposed project in this study would maintain the current level of flood risk, it is still impossible to know what the exact resultant level of flood protection services provided by such a project for each household. The valuation of the flood control project proposed in this study depends upon each household's subjective assessment of the flooding risk, which in turn depends on proximity to the river, location in the flood plain, and other factors. It also depends on the extent to which the proposed project will impact that risk. Likewise, the ecological risk reduction project impacts the resident in an uncertain way. To the extent that the resident uses the watershed for recreational purposes, some areas in the watershed will receive more attention than others, and hence the perceived enhancement will differ. Even if the enhancements were uniform, different residents have different beliefs about the current ecological health of the watershed, and hence their assessment of the resulting improvement will vary. An important question then becomes: What is the appropriate theoretical model of decision making under uncertainty?

One possibility is to employ the expected utility model, developed by Von Neumann and Morgenstern (1947). The authors argue that the rational decision maker, when faced with choices with uncertain outcomes, will maximize the expected utility of consumption. Many risk reduction WTP studies use this expected utility model (Brookshire et al., 1985; Smith and Desvouges, 1987). However, Mitchell and Carson (1989) as well as other researchers[3] indicate that the EU model's hypothesis are not appropriate for the analysis of decision making involving potential losses (i.e., the severity of flooding within the watershed will increase, and the ecological quality of the watershed will diminish as a result of continued development in the watershed, without the expenditures). An alternative proposed by Thunberg (1988:12), and applied to the issue of flood control assumes that flood plain landowners maximize the utility of the expected value of an investment in flood protection. The context of decision making under uncertainty is maintained as individuals [households] are assumed to form subjective judgements over future flood event and flood consequences. The same argument can be made regarding the future ecological health of the watershed. In the absence of the proposed project, the household's utility, U^o is conditional upon expected events related to flooding and ecological impacts, ads well as price levels, income, and general economic conditions. If flooding levels increase, or ecological quality degenerates over time, the household must pay out in order to maintain the current welfare position, the landowner's WTP for a river flood control project can be derived by forming a lifetime expenditure function

[3] See also Schoemaker (1982), Smith and Desvouges (1985), and Kahneman and Tversky (1979).

$$E = E\,(P, FP, EP, U^o) \qquad \textbf{(6.8)}$$

Where E is the minimum level of lifetime expenditures required to attain U^o , the current level of welfare, P is a vector of prices over the time horizon for consumption goods, FP is the flow of flood protection, and EP is the flow of services for ecological protection.. Differentiating with respect to one of the goods (e.g., FP):

$$\partial E/\partial FP = E_{FP}\,(P, FP, EP, U^o) \qquad \textbf{(6.9)}$$

then integrating from zero to a specific level of flood protection (FP^n)

$$WTP = \int_{FPo}^{FPn} E_{FP}\,(P, FP, U^o)\, dFP \qquad \textbf{(6.10)}$$

gives WTP which is equivalent to the compensating variation measure described in Figure 6.1. That is, equation 6.10 describes the maximum WTP that would maintain the household's current welfare position, U^o. As all the variables are considered over time, equation 4-10 measures the household's WTP as if the payment were lump sum. Consequently, the WTP decision represents an investment in a flood control project with the expectation of receiving a future flow of flood protection services in order to maintain the current level of flood risk. In other words, investment in a flood control project will be a function of the level of flood protection services provided. Generalizing Thunberg's (1988) model to accommodate both types of goods, the levels of risk are denoted by f for flood risk, and e for ecological risk. Both flood risk and ecological risk generates both property (P(f,e)) and nonproperty effects (NP(f,e)) effects, although the potential property effects are potentially larger for flooding. Nonproperty effects would include the expected impacts of enhanced flood risk on the community for example. The household's subjective probability distribution for varying risk levels can be defined as m(f,e). The expected net present value of the property and nonproperty effects that are avoided with the proposed project is the WTP, or value of the investment in the project. Therefore, the WTP can be stated as a general function of subjective probabilities, m(f,e), property P(f,e), and nonproperty, NP(f,e), effects, and the household's budget, B.

$$WTP = f(m(f,e), P(f,e), NP(f,e), B) \qquad \textbf{(6.11)}$$

Survey data will be employed to estimate equation 6.11 for two alternative projects related to flood control and ecological quality. Before discussing these empirical applications, several theoretical issues need to be discussed.

Relevant Theoretical Issues

There are a number of methodological issues that must be addressed in any CVM study. Careful design and implementation can mitigate the likelihood of serious problems. Several relevant issues are discussed below.
WTP vs. WTA

One of the questions that must be answered is to whether the survey should ask the respondent about their willingness to pay (WTP) for the project, or their willingness to accept compensation (WTA) for the project in question. As noted in Figure 6.1, the issue is one of the entitled property rights of the respondent. If the respondent has a right to the original level of utility, and the goal is to evaluate the value associated with a new higher level of the good, then WTP is has traditionally been advocated. On the other hand, if a reduction from the current entitled level of the good is being considered, then WTA would be the asked of the respondent. It was determined by the engineering team working on the project that although the ecological restoration project would reduce ecological risks, reasonable flood control objectives would not lead to appreciable reductions in flood risk. Rather, they would result in the maintenance of current flooding risk (i.e., prevent the expansion of the floodplain or increase in the frequency of flooding) in light of current urbanization trends. Thus, while it is clear that the ecological risk question can be phrased as a willingness to pay (WTP) question, it at first appears that the flood control question should be asked in terms of willingness to accept compensation. However, Mitchell and Carson (1989, pp. 40-41) argue that "(a) different set of dimensions is needed to define the property right to a public good which requires annual payments to maintain a given level" (see Mitchell and Carson, 1989, p. 38). Specifically, Mitchell and Carson focus on two dimensions; the extent to which the consumption of the good conveys individually held and/or collectively held rights, and the extent to which it is accessible. Collectively held rights are non-transferrable. Put another way, the good is nonexcludible, since once the good is provided, it is provided to all residents. In contrast, individually held rights imply some level of excludability. Thus the individual vs. collective property right addresses the public vs. private nature of the good. Typically, the less excludible the good, the greater likelihood that it is publicly held, and financed via taxes and fees. Goods that are collectively held (as is the case with both of the goods defined in this study) do not convey an individual right to transfer the quantity of the good to a different level.

Assuming the good is collectively held, the accessibility of the good represents whether there exists the ability to access a higher level of the good than currently exists. For collectively held goods in which there is there is a right to the existing level of the good, and for which improvements in quality current level of the good are possible (as is the case with the ecological quality of the watershed), the appropriate survey question is one of WTP. In that case, the response to the question give the compensating surplus for the good. On the other hand, when the good is collectively held, but higher levels of the good are not accessible (as was indicated by the engineering team), WTP is still the appropriate survey question for two reasons. There is an ongoing cost to provide flood control, and in light of continued development in the watershed, especially development upstream. Thus, in the absence of enhanced spending, the frequency of flooding will increase, as will the spatial dimensions of the 100 year floodplain. Again, WTP reveals the compensating surplus.

Open Ended vs. Discrete Choice Approaches

There are different ways to elicit WTP responses. Two alternatives are possible in this study; a modified open-ended (OE) approach and the discrete choice (DC) approach. The simple OE approach asks respondents to place their highest value on the project being described. This method is appropriate if the respondent has some experience valuing the good in question. Given the recent experience with local flooding, and the high-profile flood control efforts of the Metropolitan Milwaukee Sewerage District (MMSD)[4], it is likely that residents of the Menomonee River watershed have substantial experience with the flood control good. In contrast, local residents likely have less experience with the ecological quality good valued in the study
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The DC approach derives WTP estimates from a logistic model in which respondents indicate whether they would vote in favor of a project if it were presented in a referendum at a randomly chosen bid-price. This approach was advocated by an expert panel evaluating assembled by the National Oceanic and Atmospheric Administration to determine the value of CVM for cost-benefit analyses (Arrow et.al., 1993). Mitchell and Carson (1989) suggest that a combination of OE and DC formats may be appropriate in some applications. Specifically, an iterative DC approach, with a follow-up OE question is desirable when a sizeable number

[4] MMSD has taxing authority for the communities that are in the Menomonee River watershed. Currently, municipal sewerage bills reflect payments for the deep tunnel project, which cost in excess of $1 billion and are being financed over a 20 year period.

of zero bids are expected. There are several reasons to anticipate zero bids in this study. First and foremost, Wisconsin in general, and Milwaukee in particular has a relatively high tax burden. While attempts have been made to avoid direct references to specific types of taxes, some respondents will undoubtedly oppose any project because of its anticipated impact on the tax burden. Second, there has been growing public criticism of the MMSD in light of the substantial expenditure on the deep tunnel project. In addition, strong public disagreement exists over the appropriate manner in which to fund MMSD. The City of Milwaukee preferred a funding formula based on property value assessments, where as the suburban communities preferred a fee based on usage. The resulting legal debate was resolved in favor of the city, but this has led to ongoing criticism of any action undertaken by MMSD by some residents. Again, while we took steps to distinguish these proposed plans from any existing or proposed plans of MMSD, it is possible that respondents to the flood control question will oppose it because it could support an institution that they oppose. In light of the high Milwaukee tax burden and the significant expenditure that has already been undertaken locally to control flooding, it is not unreasonable to expect numerous respondents to make zero-bids. Hence, the modified iterative DC-OE approach is used in this study.

The Embedding Problem

CVM is also vulnerable to a problem, first identified by Kahneman and Knetsch (1992), known as embedding. Embedding results when a respondent "dumps" their allocation for all environmental causes into their stated WTP for the particular problem they are being asked about. Critics argue that responses in CVM surveys do not solely measure the WTP for the good being valued. Rather, they may also reflect values placed on other goods as well as giving the respondent the feeling of having done something praiseworthy, sometimes described as a "warm glow" effect. For example, the study by Kahneman and Knetsch (1992) focused on the valuation of increased availability of equipment and trained personnel for rescue operations in disasters. Three samples evenly split by gender were interviewed by telephone. Respondents were asked to value three levels of public goods related to environmental services related to wildlife preservation, protection of wilderness areas, disaster preparation, of the personnel and the amount of equipment purchased. A comparison of median responses revealed that WTP is almost constant for public goods that differ largely in inclusiveness. Kahneman and Knetsch also investigate the purchase of moral satisfaction. They put forth the hypothesis that "responses to the CVM question express a willingness to acquire a sense of moral satisfaction by a voluntary contribution to the provision of a public good," and furthermore, "that a narrowly defined cause can be even more satisfying than a cause that includes it." Their findings indicate that the WTP for public goods can be seen as an expression of willingness to pay to acquire moral satisfaction.

The results of the Kahneman and Knetsch study have been scrutinized heavily (Smith, 1992; Harrison, 1992; Nickerson, 1995) and have been criticized on a number of methodological grounds. Nonetheless, the potential for embedding exists, and as a result, several tests will be conducted in the present study to determine whether indications of embedding appear to exist.

Method

In this study, Willingness to Pay was measured as part of a two-wave, panel design sample survey of residents of two impacted watersheds in the Milwaukee area: the Menomonee River watershed on the west and northwest side of the area, and Oak Creek watershed on the south side. Focus groups were conducted to help the researchers prepare the survey design and questionniare.

Focus Groups

Eight focus groups were conducted with a random sample of adult residents of the Menomonee River and Oak Creek watersheds. The purpose of these focus groups was to help the research team develop questions for the telephone survey conducted in the winter of 1999-2000 and 2000-2001 in the same watersheds. In some focus groups participants were asked about perceptions of flood risk whereas other groups focused on the ecological health of the watersheds. The objectives and key results are as follows:

Objective 1: Examine the extent and nature of feeling physically and emotionally connected to the river and creek. There is great variance in people's connectedness to the river or creek. Some visit the river regularly to enjoy the scenery or walk or bike along the river while others avoid the river because they are too busy, because of pollution and lack of accessibility. Emotionally, some expressed anger at local agencies perceived as responsible for flooding/environmental quality problems.

Objective 2: Examine perceptions of the health of the river and creek. Most participants felt that the health the river and creek could be improved and that it had worsened over time. The following were seen as indicators of the health of the river or creek: (1) clarity and quality of water; (2) presence of fish; (3) presence of birds and other wildlife; (4) presence and condition of trees and plants; (5) ability for the water and areas surrounding the river and creek to sustain life; (6) the absence of fertilizers and chemical runoff from farms and homes; (7) the absence of industrial pollution.

Objective 3: Examine perceptions about flooding. Participants from Menomonee River groups perceived a much greater risk of flooding than respondents from Oak Creek, the latter often responding quizzically to questions posed to them about Oak Creek flooding. That response resulted in the researchers deciding to abandon plans to ask Oak Creek residents about flooding in the survey. In general, it was difficult for participants to identify the cause of flooding in their community. It was suggested that future research include a set of items that tap into respondent's attributions for the causes of flooding-- a consideration that could influence WTP estimates.

Objective 4: Examine understanding of WTP questions. Oak Creek residents had a hard time providing a WTP dollar amount because they did not believe the creek was flooding and did not see a creek flooding problem developing in their community. Interestingly, flood plain residents gave WTP estimates that were lower than other groups. In fact, 4 out of 9 gave zero bids. Some of the reasons for the lower estimates include: 1) the beliefs that current taxes should be covering these projects; 2) the beliefs that past projects didn't work; 3) anger at and mistrust of public officials and local agencies.

Objective 5: Examine salient behavioral beliefs about providing money for projects designed to hold the line on flooding and improve ecological quality of the river/creek. A number of salient behavioral beliefs were considered when subjects were formulating a WTP estimate. Among the most commonly held beliefs, later represented in the questionnaire, were: (1) Concern for those in the flood plain; (2) Effect on raising taxes; (3) Affordability and personal finances; (4) Belief that paying would be making a contribution to solve a community problem; (5) Belief that the project would improve the environmental quality; (6) Belief that homeowners and developers are responsible for the increased risk and should be held responsible; (7) Belief that the project would be ineffective.

Objective 6: Examine perceptions about their capacity to get information on this topic. Participants generated a long list of potential information resources, but a majority of respondents said they would turn to governmental sources for information. (This may have been an artifact of the social context of the focus groups, however.) Some expressed distrust about the accuracy of information coming from government agencies. Many perceived a great difficulty in getting and understanding the information they would need to make a more educated WTP estimate (because of access and interpretability of information). Some felt it was not their responsibility to get information about potential projects.

Objective 7: Examine beliefs about nature and quality of information about this topic from the mass media. A majority of participants said they would be unlikely to turn to the mass media for information. Participants varied greatly on the extent to which they held the following beliefs: (1) Stories with statistics are more believable than those without; (2) Someone's personal experience is more convincing than statistics; (3) In-depth features are more informative than single news articles or reports; (4) In-depth features are more trustworthy. A number of additional possible questionnaire items were suggested, designed to tap into people's beliefs about government agencies, experts, environmental groups and elected officials.

Objective 8: Examine the value placed on the prevention of flooding and ecological improvement relative to other community issues. Most participants placed the prevention of floods and the environmental improvement of the river/creek as a medium to high priority for their community. Most participants disagreed with the notion that only those who live in the flood plain should be required to pay the cost of flood control. However, results were much more varied when a similar question implied taxation and the participant possibly having to make a contribution ("Taxpayers have a duty to share in the cost of flood control even thought only a minority is affected by floods"). Most participants agreed that we have an obligation to protect nature even if there are not human benefits.

In addition, the focus groups reacted to various scales developed by the research team. Information from the groups was also be used to identify issues and concerns that residents near the watershed have, as well as their experiences with the two bodies of water.

Survey

Method

A two-wave, panel design sample survey was conducted by telephone in the winter of 1999-2000 (first wave, or T1) and 2000-2001 (second wave, or T2) by the subcontractor University of Wisconsin Survey Center (UWSC), a professional research organization. More than 900 individuals were interviewed in each wave. The sampled population was non-institutionalized adult resident heads of households of the two study watersheds in the Milwaukee area: the Menomonee River and Oak Creek. Heads of households were designated as respondents because of their decision-making roles in the households, roles which should make them aware of household finances and what the household could afford to pay for the projects. The design is based on the logic of the Solomon Four-Group Design (Campbell and Stanley, 1966) normally used for experiments in that newly sampled respondents from the watersheds were added to the data set at T2 to control for sensitization.

Sampling

The cases consist of randomly selected households that were located within census blocks corresponding to the two watersheds. A stratified random sampling strategy was used to obtain a probability sample of adult heads of households in each of the two watersheds separately. The sampling plan did not oversample floodplain residents because one of the goals was to ascertain the relative importance of watershed management strategies for all watershed residents, not just a select group. A random sampling strategy should guarantee that no single group of respondents is over-represented. UWSC obtained the sample of telephone numbers from Survey Sampling Inc. The sample is representative of currently working and listed residential telephone numbers in the census tracts located within the two watersheds. A census tract was included into the sample if the majority (97% or higher) of the census tract was located within one of the two watersheds. Survey Sampling, Inc. updates their sample approximately three times a year. It is estimated that approximately 5-7 percent of United States households do not have telephones, and would not be represented in the sample, and that this percentage is approximately the same for the state of Wisconsin. In addition, in order to insure that all sample points were located within the identified census tracts, UWSC was unable to include unlisted phone numbers. Approximately, 13% of Wisconsin households are unlisted.

*Selection of respondent in "new sample" (All in Wave 1 and "New" respondents in Wave 2)***:** When each telephone number in the new sample was called, the interviewers verified that a working residential telephone number had been reached. They then screened the household to determine how many adults, 18 years or older, were the head of household. If the household contained only one head that individual was chosen as the respondent. If the household contained more than one head of household, the interviewer first determined the gender composition of the heads of household, and then randomly selected one of the heads of household to be the respondent. Random selection of the respondent in households containing more than one head was carried out to insure that equal numbers of men and women participated in the study. Only that selected person could be interviewed, no substitutions were allowed.

Verification of follow-up respondents (Those from Wave 1 reinterviewed in Wave 2): After reaching a "follow-up" household the interviewer asked to speak to the person who was interviewed in wave 1. In most instances they had the full name of the respondent. In a small portion of follow-up cases in which they did not have the respondent name they asked to speak to the man or woman of the household. Prior to the start of the interview they verified that they had reached the correct respondent by confirming their date of birth. If the date of birth in our records was incorrect we verified the respondent's household address and gender. If household address and gender were confirmed they proceeded with the interview. After data collection they conducted additional verification checks using three demographic variables (date of birth, gender and race). Based on these steps UWSC determined that they had reached the correct respondent in all of the completed follow-up interviews.

Response rates

A total of 999 respondents were interviewed in the first wave and 967 respondents were interviewed in the second. In the first wave the overall response rate was 46% (Menomonee watershed 48%; Oak Creek 40%). In the second wave overall response rate for newly sampled respondents was 46% (Menomonee watershed 47%; Oak Creek 41%). In all, 77% of Wave 1 respondents were reinterviewed in Wave 2 (Menomonee watershed 78%; Oak Creek 71%), producing a combined (new and reinterviewed respondent) response rate of 64% for the second wave of interviewing.

Paths

The questionnaire was devised for three "paths" of questions, with questions in each path worded to be applicable to individuals responding to a given WTP question: the "Flood" path of questions, the "Environmental" path of questions, and the 'Combined" path of questions. In nearly all of the questionniare, the question stems were identical with only the object (e.g., the project designed to palliate flooding, the project designed to improve the ecological health of the river, and the project designed to do both) varying.

All Oak Creek respondents were assigned to the Environmental path[5]. Menomonee River respondents were randomly assigned to one of the three paths in proportions designed to maximize analysis power given N.

Removed for this analysis were respondents who, based on geocoding of addresses, lived outside the watershed (even if only by a matter of yards). Also removed from T2 data were those T1 respondents who either moved outside their T1 watershed or moved and would not provide a new address. Also excluded are those who refused to answer the WTP question. The purged sample breakdown is presented in Table 6.1.

Interviews

The interviews, which lasted an average of 21 minutes, were conducted by trained interviewers using the CATI (Computer Assisted Telephone Interviewing) system. Up to 20 attempts were made to interview a given respondent. Partial interviews were not included in the final data set. In all of these cases less than a quarter of the interview was completed even after UWSC had tried to recontact the respondent to complete the interview.

In this study, we investigate WTP using a referendum approach. Respondents are asked the most they would be WTP and still vote in favor of a plan if it were on the next referendum. This approach is appropriate given that spending on public projects is frequently determined in this fashion. Respondents were randomly assigned to one of three different hypothetical watershed management projects. The first group (Flood Path) were given a description of a project whose primary objective was the maintenance of flood risk at its current level. They are told that scientists indicate that as the region urbanizes, the problem of river flooding increases. The potential consequences are identified, and the magnitude of additional damage, and likely location of that damage is also identified. The respondents in the second group (Environmental Path) were given a description of a project aimed at improving the ecological health of the river and its surrounding area. The current condition was identified, and the respondents were told that the problem has resulted from the development that has taken place in the watershed. The benefits of the project in terms of improved water quality, enhanced survival of game fish, naturalization of stream linings , etc. are also described. The third group (Combined Path) were given a description of a project aimed at both objectives.

All respondents were provided with reference points of other types of local public expenditures[6], and then asked the WTP question in an iterative fashion. They were first asked if they would be WTP any positive amount of money for the project that was described to them. Payments would be made annually, and would

[5] The decision to eliminate the Flood path for Oak Creek residents was made after members of the Oak Creek focus groups indicated that they believed that the potential risks from flooding were essentially zero. Although Oak Creek has experienced surface flooding near roads (typically at underpasses) and in parks abutting the creek, no existing residents live within the 100 year floodplain. Hence, it was concluded that the flood risk question would not be meaningful to respondents from the Oak Creek.

[6] These benchmarks described other public goods and services that the respondents were currently funding and the level of annual household contributions to these goods for the typical resident within the four county metropolitan area for 1997. As a result of feedback from the focus groups, comparisons to controversial local programs (i.e., a highly controversial local tax being used to fund a new professional baseball stadium) or to national programs (i.e., the NASA space program) were avoided. Annual household payments for the following goods were included as benchmarks in the final survey (rounded to the nearest dollar): ambulance service $8; parks and recreation $54; highway construction, maintenance, and administration $95; law enforcement and fire protection $203; public education $1500.

continue for 20 years[7]. If they indicated the answer to that question was no, they were asked if they would be willing to provide an explanation as to why they would not support the proposal. These responses were used to classify protest bids. If they answered yes, then a randomly generated value between $5 and $500 was presented to them, and they were asked to indicate whether they would support that value. Based on that response, another dollar value was provided. The second value was either a number larger if they answered yes to the first question (approximately 50% of the way between the first bid amount and $500) or a number smaller (approximately 50% of the way between $0 and the first bid amount) if they answered no to the first question. Finally, the respondent was asked to provide the largest annual dollar payment that they would be willing to make and still vote in favor of the referendum.

Table 6.1. Subsample Sizes for Analysis

Path	Wave 1 1999-2000 n=		Wave 2 2000-01 n=
Flood	**294** **new sample** *Menomonee River*	←	**185** **reinterviewed** *Menomonee River*
			91 **new sample** *Menomonee River*
			(276)
Environmental	**441** **new sample** *(207 Menomonee River)* *(234 Oak Creek)*	←	**285** **reinterviewed** *(139 Menomonee River)* *(146 Oak Creek)*
			121 **new sample** *(57 Menomonee River)* *(64 Oak Creek)*
			(406)
Combination	**236** **new sample** *Menomonee River*	←	**155** **reinterviewed** *Menomonee River*
			64 **new sample** *Menomonee River*

[7] Representatives from both the MMSD and the Southeast Wisconsin Regional Planning Commission indicated that a typical watershed project would be financed over a period of 20-30 years.

		(219)
Wave n=	971	901
Cum. n=		1247

Prior to the WTP question for the respondents in the first two paths (i.e., Flood Path and the Environmental Path), various Likert-type questions were asked of the respondent so as to provide a proxy for beliefs and attitudes towards a wide range of issues related to the environment, flooding problems, the government, etc. This was done to facilitate the testing of theories of information processing in the risk communication literature. For the sake of benefit estimation, several scaled variables derived from these questions were included as controls. Following the WTP question, respondents were asked a variety of Likert-scaled questions that operationalize the Theory of Planned Behavior (Ajzen, 1988) as well as demographic questions, including their income level. The Ajzen measures were asked after the WTP questions so that respondents had a WTP reference point upon which to base their answers.

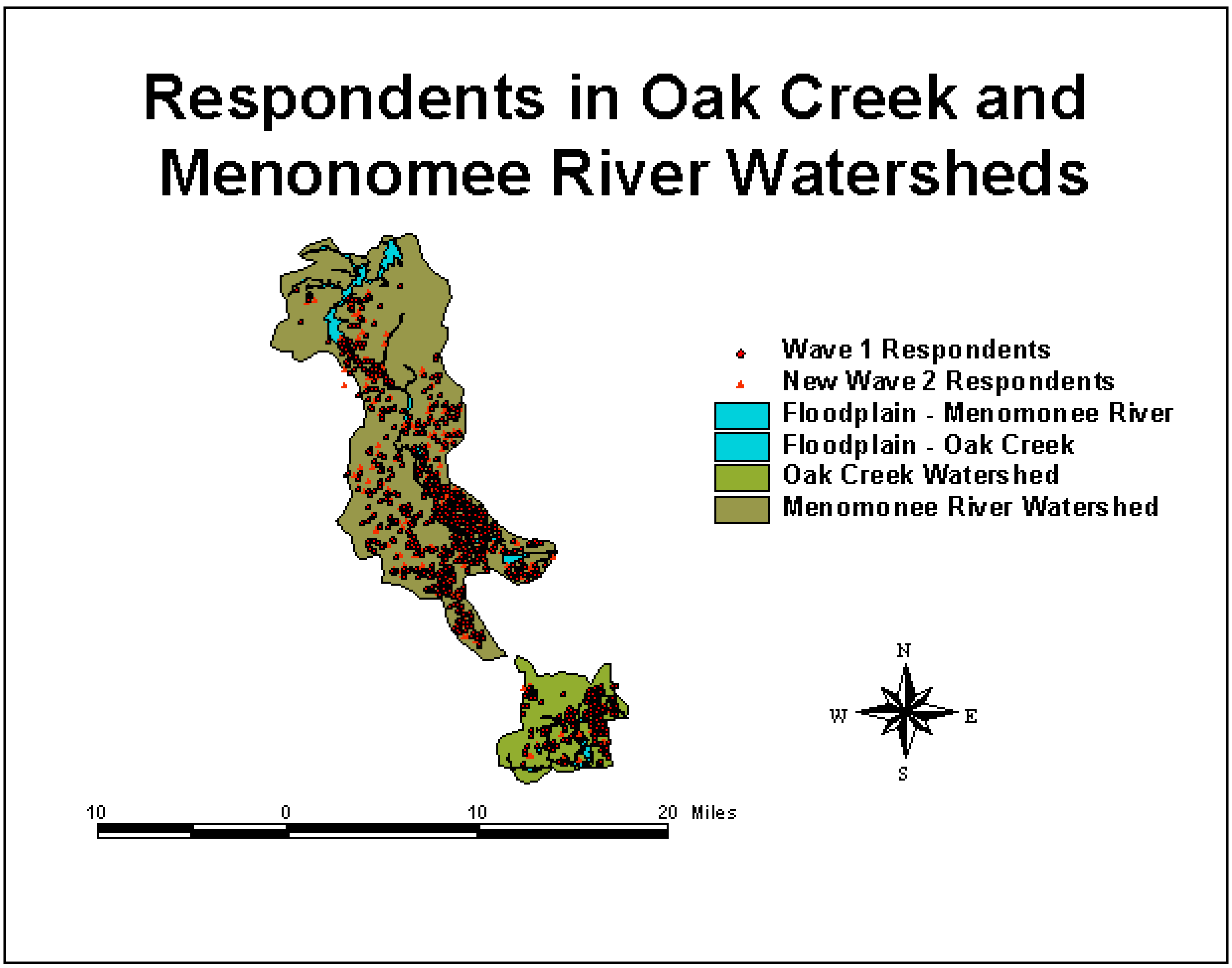

Figure 6.2. Location of Residents within Oak Creek and Menomonee River Watersheds

Geocoding

All of the respondents gave their address and hence they could be geocoded and mapped using the ArcView GIS software package. The respondents that could be geocoded are shown in Figure 6.2 As can be seen, most respondents were located within one of the two watersheds. A total of four respondents were dropped from the sample because they fell outside the watershed in the first wave. Three new respondents in wave 2 were found to be residing outside the watershed, and three wave 1 respondents moved outside the watersheds between their wave 1 and wave 2 interviews. In addition, 24 other wave 2 respondents were dropped for a variety of reasons including missing address information , incomplete address information, or the wrong respondent was interviewed in wave 2 when a re-interview was required.

ArcView was used to determine the flood risk for individual properties within the watershed, using the technique outlined in Chapter 3. A total of 14 monitoring sites, 6 in the Oak Creek watershed, and 8 in the Menonomee River watershed, were established to test the water quality, and evaluate ecological risk. ArcView was used to attach the closest monitoring site within the watershed to each respondent location. Finally, since much of the flooding within the Menomomee River watershed was in the region from the Village of Wauwatosa to the southeast, ArcView was also used to identify those properties.

<u>*Empirical Specification*</u>

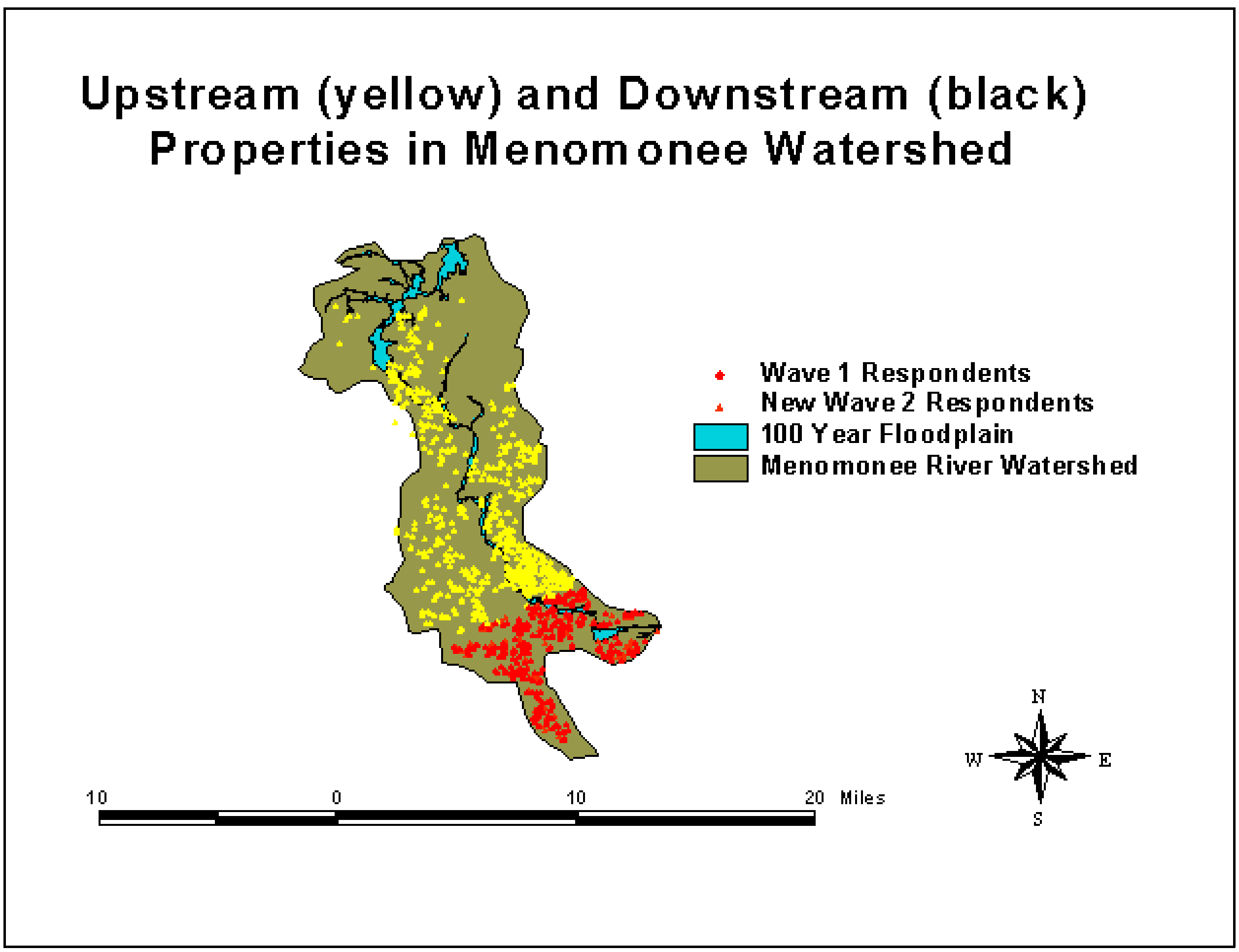

Figure 6.3. Upstream and Downstream properties in the Menomonee River watershed

The generalized model specified in equation 6.11 guides the selection of variables used in the empirical analysis. The model estimated is given by equation 6.12.

$$\text{Ln(WTP)} = f(\textit{demographic, residence controls, survey controls, psychological controls, risk, } \epsilon) \quad \textbf{(6.12)}$$

where *demographic, residence controls, survey controls, psychological controls,* and *risk* are vectors of variables contained in the models. The individual variables will be discussed in more detail below. Given that the lowest WTP is zero, the dependent variable is shifted by $1 to facilitate the taking of the natural log of the variable. Since ln(1)=0, the regression is censored at zero. When there are substantial numbers of zero observations, OLS regression can generate biased and inconsistent parameter estimates. In addition, OLS models could predict WTP to be less than zero. Since prediction accurate prediction of WTP is a goal in the simulations, the Tobit model is employed. In this model, the censored nature of the error term, ϵ, is considered[8]. A potential problem with the data is the potential that observations are not conditionally independent, because they are spatially clustered. To address this potential problem, the Huber/White robust variance estimator is used to correct the standard errors (Huber, 1967; White 1980, 1982).

The description of the variables and the descriptive statistics for each variable, in each of the paths, is given in Table 6.2. The dependent variable is the real WTP, with the CPI-Urban deflator for the Midwest used to account for the influence of inflation. The base month is defined as January 2000. Since individual subjective measures of risk must be controlled in the sample, we include several demographic control variables. These include the age of the respondent, their years of education, marital and minority status, number of children and the real income. Income is measured in natural log form, since WTP is expected to respond to proportional, rather than absolute changes in real income.

The variables in the *residence controls* category account for whether the respondent is a home owner and/or whether that individual resides in a single-family home. Two variables are included in the *survey controls* category to mitigate potential biases in the estimation. Another potential bias associated with the use of bidding procedures for CV is instrument bias, further breaking down into starting point and payment vehicle bias. The first of these is the starting point bias (Cummings et. al. 1986). Specifically, the WTP response may be influenced by the point at which the iterative bidding process begins. We include the starting point to control, in real terms to control for this potential bias. Second, some respondents provide zero bids because they truly place a zero value on the good. However, some zero bids reflect protest bids. For example, respondents may choose to offer a zero bid because they believe taxes are too high, or that it is the responsibility of government to take care of the problem. Others may be philosophically opposed to assigning a value to the good. When a zero response was given, the respondent was queried as to the reason for the response. Those responses were classified independently by two researchers Intercoder reliability (Cohen's Kappa) for this measure is good (.75), which makes the code system used to derive this variable replicable across observers. A zero-one dummy variable was used to control for protest bids.

Several *psychological control* variables have also been included in the model. While these variables are primarily used as control variables in this chapter, a more complete discussion of the derivation and interpretation of each of these variables is included in Chapter 7. The variables are derived from Ajzen's (1988) Theory of Planned Behavior as applied to this WTP study and represent (1) the Perceived Behavioral Control respondents believe they have over the amount they specified for the projects, (2) Subjective Norms, or perceived social pressures from other persons (e.g., family, friends) important to them, and (3) Cognitive Structure (or "indirect attitude"), which is comprised of a set of beliefs individuals have about the outcomes

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[8] The Tobit model is sometimes defined as a latent variable model where $y^*=\beta_0+\beta_1X+\epsilon$ where $\epsilon|X \simeq \text{Normal}(0,\sigma^2)$, and $y^*=\max(0,y^*)$. Thus, the model predicts $y^*=y$ when y is non-negative, and $y^*=0$ when $y<0$. For a more thorough presentation of the model, see Wooldridge (2000).

associated with providing funds for the project (e.g, the extent to which they believe that providing the money would help people who live in the flood plain) times their personal evaluation of that outcome (the extent to which they evaluate helping people in the flood plain as a good or a bad outcome). As noted in the following chapter, two cognitive structure factors emerged from factor analysis: one representing non-economic outcomes and the other related to economic costs (e.g., effects on taxes and personal affordability). Generally all these variables are expected to relate positively to WTP.

Finally, there are two different kinds of risk measures evaluated in this study. The flood risk is derived by evaluating the flood risk faced by each respondent, based on their geocoded address. A dummy variable for the 100 year floodplain is included, because those individuals currently must carry flood insurance as a condition for obtaining a mortgage. Thus, in the absence of the project described in the survey, it is argued that
the frequency of flooding will increase, and the floodplain will expand. From an insurance perspective, the consequences are inconsequential since they already reside within the 100 year floodplain, and it was not indicated that flooding risk would in any way decrease. However, the frequency of flooding will certainly increase with additional upstream development, and as such, the economic consequences will also increase.

A second floodplain dummy variable is the floodplain with a 101 to 1000 year expected recurrence. This is included separately to account for the fact that these respondents might reasonably expect to find themselves within a 100 year floodplain were the plan not adopted. Finally, the recurrence interval is included as a separate measure. However, it is reasoned that changes in the recurrence interval are unimportant for those outside the 1000 year floodplain. Thus, the variable is interacted with a zero one dummy for the 1000 year floodplain. The expected sign on the floodplain dummies is positive, whereas the higher the recurrence interval, the lower is the expected WTP.

Ecological risk is proxied by two measures. First, a score of habitat health was computed for each of the monitoring sites in the area, and the value of the closest site was assigned to the respondent. The higher the habitat score, the greater the habitat quality of the water. An alternative measure, that is impacted by the habitat score is the index of biotic integrity which was defined for fish species. This measure was tested and found to be inferior to the habitat score. Since the two variables are highly correlated, and since the IBI measures were not available for all sites, the habitat score was employed. A second measure included in this category is the frequency of visiting the watershed. While this is not a measure of risk, it is a factor that contributes to the appreciation of ecological quality, and hence it is included as a control.

Finally, there were several variables that were tested in the models developed in this chapter. The variables were found to be statistically unimportant, and were subsequently dropped from the analysis. Note that the findings for the WTP functions were robust to the inclusion of these variables. These variables were however used in the analysis investigating psychological drivers in Chapter 7, and hence are reported in Table 6.3

Table 6.2. Variable Definitions and Descriptive Statistics

Variable	Description	Descriptive Statistics		
		Flood Path (386 obs)	**Ecological Path (562 obs)**	**Combined Path (850 obs)**
Real Maximum WTP	Continuous measure of Willingness to Pay deflated to January 2000 using the CPI Urban for the Midwest	mean=78.57 σ=119.219 min=0 max=958.163	mean=88.31 σ=136.158 min=0 max=1192.76	mean=85.25 σ=129.24 min=0 max=1192.7
Age	Age of respondent in years	mean=51.89 σ=15.70 min=18 max=86	mean=52.37 σ=15.71 min=20 max=94	mean=52.90 σ=15.797 min=19 max=94
Years of education	Number of years of respondent's formal education, as derived from self-reported measure of educational achievement. The midpoint of the reported interval was used as a proxy for years of education.	mean=14.42 σ=2.689 min=4 max=18	mean=13.95 σ=2.13 min=4 max=18	mean=14.04 σ=2.26 min=4 max=18
Married (yes=1)	Is the respondent married?	mean=0.615 σ=0.483 min=0 max=1	mean=0.615 σ=0.485 min=0 max=1	mean=0.597 σ=0.488 min=0 max=1
# of Children	Number of Children in the household imputed from number of people-number of adults age 18 or over	mean=0.604 σ=01.017 min=0 max=9	mean=0.685 σ=1.120 min=0 max=7	mean=0.648 σ=1.084 min=0 max=7
Minority (yes=1)	Is the respondent a minority group member (0=non-hispanic white, 1=otherwise)?	mean=0.062 σ=0.242 min=0 max=1	mean=0.027 σ=0.161 min=0 max=1	mean=0.04 σ=0.193 min=0 max=1

Variable Definitions and Descriptive Statistics (continued)				
		Descriptive Statistics		
Variable	**Description**	**Flood Path (386 obs)**	**Ecological Path**	**Combined Path**
Real Income (in levels)	Total household income from all sources before taxes deflated to January 2000 using the CPI Urban for the Midwest	mean=59867 σ=35627 min=1919 max=300547	mean=56196 σ=35833 min=702 max=401460	mean=56035 σ=39.623 min=287 max=575567
Real Starting Point	Opening WTP bid price presented to individual, deflated to January 2000 using the CPI Urban for the Midwest.	mean=237.55 σ=119.21 min=1 max=473	mean=234.9 σ=136.18 min=1 max=476.7	mean=236.3 σ=137.2 min=1 max=476.7
Political philosophy	Self described political philosophy - 5 point Likert-type scale 1=Liberal, 2=somewhat liberal 3=middle of the road 4=somewhat conservative 5=conservative dk coded as 3	mean=3.489 σ=1.205 min=1 max=5	mean=3.446 σ=1.117 min=1 max=5	mean=3.41 σ=1.151 min=1 max=5
Subjective norms	Perceived social pressure to provide money for goals of project.	mean=-0.197 σ=1.001 min=-2 max=2	mean=0.144 σ=0.989 min=-2 max=2	
Awareness of Consequences	Beneral beliefs about effects of human actions on ecosystem and vice versa.		mean=2.249 σ=2.333 min=1 max=4	
Taxpayer duty	Attitude: Taxpayers have a duty to share in the cost of improving the health of urban rivers - 5 point Likert-type scale 1=strongly disagree 2=disagree 3=feel neutral 4=agree 5=strongly agree dk coded as 3		mean=3.784 σ=0.820 min=1 max=5	

Variable Definitions and Descriptive Statistics (continued)

Variable Definitions and Descriptive Statistics				
		Descriptive Statistics		
Variable	Description	Flood Path (386 obs)	Ecological Path	Combined Path
Biocentric Ethic	Attitude: The health of urban rivers should be improved for the sake of nature itself - 5 point Likert-type scale 1=strongly disagree 2=disagree 3=feel neutral 4=agree 5=strongly agree dk coded as 3		mean=3.868 σ=0.851 min=1 max=5	
Floodplain 100 year (yes=1)	Is the residence located within the 100 year floodplain? Derived by engineering team.	mean=0.015 σ=0.134 min=0 max=1		mean=0.012 σ=0.108 min=0 max=1
Floodplain 101 to 1000 year (1=yes)	Is the respondent located in the 101 to 1000 year floodplain?	mean=0.018 σ=0.134 min=0 max=1		mean=0.018 σ=0.132 min=0 max=1
recurrence interval*1000 year floodplain dummy	recurrence interval measured in years interacted with a 1000 year floodplain dummy variable.	mean=8.880 σ=74.132 min=0 max=922.74		mean=9.2250 σ=76.877 min=0 max=969.8
Habitat score	Score of ecological quality of closest monitoring site to property - increases in the score indicate the better habitat		mean=67.05 σ=28.27 min=26 max=106	mean=73.87 σ=27.34 min=26 max=106
Frequency of visits to the river	1=never 2=rarely 3=sometimes 4=frequently dk coded as mean value.		mean=2.456 σ=1.066 min=1 max=4	mean=2.364 σ=1.079 min=1 max=4

Table 6.3. Variable Definitions and Descriptive Statistics for Additional Variables used in Chapter 7 Analysis

Variable Definitions and Descriptive Statistics (Used in Chapter 7 Analysis Only)			
		Descriptive Statistics	
Variable	Description	Flood Path (n=580)	Ecological Path (n=862)
Sensitization (1=yes)	Was the wave 2 also in wave 1?	mean=0.318 σ=0.466 min=0 max=1	mean=0.331 σ=0.471 min=0 max=1
Lives Upstream (1=yes)	Does the respondent live upstream of the Village of Wauwatosa?	mean=0.605 σ=0.489 min=0 max=1	mean=0.262 σ=0.440 min=0 max=1
Married, Cohabitate (yes=1)	Is the respondent married, or cohabitating with another individual?	mean=0.652 σ=0.477 min=0 max=1	mean=0.662 σ=0.473 min=0 max=1
Years Living at Current Residence	How many years has the respondent lived at the current residence?	mean=39.64 σ=20.12 min=0 max=86	mean=41.132 σ=19.967 min=0 max=97
Plans to Move Away (yes=1)	Does the respondent plan to move away from the city within the next 2 years?	mean=0.236 σ=0.609 min=0 max=1	mean=0.180 σ=0.522 min=0 max=1
Menomonee River Watershed (1=yes)	Was the respondent in the Menomonee River Watershed?		mean=0.474 σ=0.500 min=0 max=1
Actual Distance to River or Creek	Computed distance of respondent to the river or creek (in meters)	mean=714.207 σ=523.304 min=23.012 max=2691.271	mean=623.856 σ=466.364 min=9.833 max=2542.477

Treatment of Missing Data

The problem of missing data was mitigated by the use of zero-order and first-first order missing data approaches (Pindyck and Rubinfeld, 1991). For most data, the mean of the sample from the specific survey path was used when data was missing. On five-point, agree-disagree, Likert scaled variables, respondents who failed to provide a response were coded as the scale mean and those who indicated "don't know" were coded at the midpoint of the scale (such that the midpoint is "feel neutral/don't know"). For income, a more in-depth approach was employed since it is not uncommon for respondents to refuse to provide details on their income. Missing data was assigned using the following hierarchical approach. First, if a continuous measure was not provided, the interviewer asked the respondent to provide a categorical measure of their income. Continuous measures were derived from the categorical measures by mapping the categories over the values for respondents who provided continuous income responses and computing the means of those categories. Second, in the event that neither continuous nor categorical data were provided for wave 1, the wave 2 response for that individual (assuming they were interviewed in both waves) was used, again, checking first for a continuous response, and then for a categorical response. Since data was deflated using the CPI, it was the case that all dollar denominated data are comparable. Likewise, for the second wave respondents, data was imputed from first wave data, if it was provided and wave 2 data was not. Finally, if neither continuous or categorical data was provided, then income data was imputed by running a regression relating the continuous income data that was provided to the median household income data from the census block group in which the resident is located. Since all respondents are in some census block group, this permits all remaining missing income data to be imputed.

Empirical Findings on Willingness to Pay

Willingness to pay functions were estimated separately for all three paths. The sample for each regression included all respondents from wave 1, and the new respondents from wave 2. Re-interviews in wave 2 who were also in the wave 1 sample were discarded from the sample since those responses are expected to be dependent on the wave 1responses. The findings are reported in Tables 6.4 and 6.5.

Flood Control Path

The model explains 38.5% of the variation in the latent variable, log of the real maximum willingness to pay, given that the log of real willingness to pay is zero. Note that the coefficients in the Tobit model do not have the same direct interpretation as the OLS model as the marginal impact of the right hand side variable on the dependent variable. Rather, they incorporate two distinct effects: the marginal effect of the regressor on the dependent variable, given that the dependent variable is non-negative, and the likelihood that the dependent variable is observed. However, the signs on the coefficients and their significance levels can be interpreted as they are in the OLS model.

Among the demographic variables only the *Log(Real Income)* is statistically significant, although the coefficients on *Years of Education* and on *Minority* would be significant at the 10% level in a one-tailed test. Not surprisingly, increases in income and education both increase the real maximum willingness to pay. In contrast, minority respondents had lower willingness to pay, even after controlling for the income level. Respondents who were home owners had significantly higher willingness to pay than non-owners. This may be reflecting an attachment to the community, since it is positive even after controlling for the flooding risk faced by the respondent. The survey controls were both statistically significant and in the expected direction. Higher starting points did increase the real WTP, whereas protest votes obviously would have a negative impact.

Table 6.4. Tobit Results for Flood Path Regression Model (Path 1)

Flood Path Tobit Regression Findings Dependent variable: Natural Log (Real WTP +1)				
	Coefficient	Std. Error	z-Statistic	Prob.
Intercept	-5.09805	2.514103	-2.028	0.0426
Demographic Variables				
Age	-0.00606	0.00854	-0.709	0.4782
Years of Education	0.08271	0.058298	1.419	0.156
Married	-0.16071	0.275838	-0.583	0.5601
Minority	-0.82741	0.553498	-1.500	0.1349
# Children	-0.08823	0.142893	-0.617	0.5369
Log(Real Income)	0.639147	0.240657	2.656	0.0079
Residence Controls				
Owner	1.03756	0.398541	2.603	0.0092
Single Family Home	-0.40095	0.348874	-1.149	0.2504
Survey Controls				
Real Starting Point	0.001957	0.0008	2.446	0.0145
Protest Vote	-19.8453	0.831001	-23.881	0
Psychological Controls				
Political Philosophy	-0.15707	0.093622	-1.678	0.0934
Subjective Norms	0.545537	0.113627	4.801	0
Perceived Behavioral Control	-0.02971	0.128348	-0.231	0.817
Cognitive Structure Economic	0.439486	0.176046	2.496	0.0125
Cognitive Structure NonEconomic	0.975432	0.124655	7.825	0
Flood Risk Measures				
Floodplain - 100 year	0.447801	0.913326	0.490	0.6239
Floodplain - 101 to 1000 year	1.70463	1.021888	1.668	0.0953
Recurrence * Floodplain1000 year	-0.00272	0.001407	-1.936	0.0528
Mean dependent var	2.956795	Adjusted R-squared		0.385415
S.E. of regression	1.631634	Log likelihood		-509.45
Left censored obs	108			
Uncensored obs	278			

Turning to the psychological proxy measures, the more conservative the political philosophy of the respondent, the lower is the real WTP, whereas perceived beliefs that those who are important to the respondent (*Subjective Norms)* increases WTP. Likewise, the cognitive structure (both economic and noneconomic) significantly increase real WTP. A more complete interpretation of the psychological measures is reported in the analysis in Chapter 7.

Finally, the findings on the flood risk measures provide some interesting insights. The coefficient on *Floodplain -100 year* is positive, but it is not significant. In contrast, the value for *Floodplain - 101 to 1000 year* is positive and significant in a one-tailed test. It is interesting that the latter variable is significant while the former is not. It may well be indicating that the respondents most concerned with flooding risk, are those that fear that they may be faced with higher risk of flooding in the event that the expenditure on flood protection is not made. In contrast, those in the existing 100 year floodplain are not concerned with the insurance ramifications, and apparently not concerned with the expected increase in frequency that development would generate. Finally, the variable *Recurrence* Floodplain 1000 year* has a negative and significant coefficient in a one-tailed test. Thus, the higher is the recurrence interval, the lower is the real WTP. Note that an upstream variable, measuring properties that are upstream of the Village of Wauwatosa was included but not statistically important, and hence was dropped from the specification.

Collectively, these findings suggest that a variety of factors contribute to willingness to pay for flood control projects, not all of which are related to the expected property damage that increased flooding would generate. after controlling for flood risk, other factors help account for variance in willingness to support flood control initiatives. Furthermore, the influence of flood risk is important in determining WTP, especially for those who might expect to face financial consequences related to higher insurance, should flood risks increase.

Ecological Risk Path

The regression results for the ecological path is reported in Table 6.5. The model explains 40% of the variation in the latent real WTP variable. Unlike the flood path regression, income does not have a statistically significant influence on real WTP, although it should be noted that it would be significant at the 10% level of significance in a one-tailed test. *Years of Education* does positively impact the real WTP, and older respondents have lower real WTP, other things equal.

Similar to the flood path regression, home owners have higher WTP, but the coefficient is only significant at the 10% level in a one-tailed test. In contrast, the *Real Starting Point* variable is not statistically significant, although as expected, the *Protest Vote* measure is negative and highly significant. Turning to the *Psychological Controls*, The *Subjective Norms* index, as well as both cognitive structure measures are positive and significant. In addition, three additional measures are included in this category; an *Awareness of Consequences* scale, and Likert-type questions related to the belief that taxpayers have a duty to share in the cost of improving the health of urban rivers (*Taxpayer Duty*) and a belief that nature should be preserved for its own sake apart from any human benefits (*Biocentric Ethic*). Only *Taxpayer Duty* is statistically significant and it is positive.

Finally, the habitat risk score is positive, and significant at the 10% level in a two-tailed test. This implies that higher levels of habitat quality, for the closest monitoring site to the property, lead to higher willingness to pay for reducing ecological risk. This at first seems counterintuitive, since one might believe that higher risk areas are more in need of cleanup. However, an alternative interpretation is that respondents believed that less environmentally damaged areas are WTP more to preserve its environmental integrity than more damaged area. That is, WTP is higher before an area is damaged as opposed to after the damage has occurred. Finally, the more frequently the respondent visits the river, the higher is the WTP.

Combined Ecological Risk-Flood Control Path

A two Tobit models are presented for the combined path. This path was included to test for the problem of embedding in the WTP questionnaire. Given that the flood path asks respondents to value WTP for flood control, whereas the combined path asks them to value both flood control and Unfortunately, psychological drivers were not included in this path of the survey questionnaire. Given the revealed importance of these variables in the first two regression models, the findings reported in Tables 6.6 and 6.7 are somewhat suspect because they are likely misspecified. In both cases, the fit of the model reflected in the R^2_{adjusted} is approximately 0.28. Note that this is a poorer fit than that reported in either the Flood Path or Environmental Path regressions which had R^2_{adjusted} of 0.38 and 0.40 respectively. Briefly, many of the *Demographic Variables* are statistically significant, especially in the model that combines paths 2 and 3. In that regression model, *Age* whereas *Years of Education* is positive and significant. In both regression models, the variable

Minority has a negative and

Table 6.5. Tobit Results for Environmental Path Regression (Path 2)

Environmental Path Tobit Regression Findings Dependent variable: Natural Log (Real WTP +1)				
	Coefficient	Std. Error	z-Statistic	Prob.
Intercept	-3.70531	2.03251	-1.823	0.0683
Demographic Variables				
Age	-0.02415	0.007015	-3.443	0.0006
Years of Education	0.155207	0.044112	3.518	0.0004
Married (yes=1)	0.091816	0.209753	0.438	0.6616
Minority (yes=1)	-0.54221	0.634789	-0.854	0.393
# of Children	-0.06237	0.082345	-0.757	0.4488
Log of Real Income	0.274747	0.187712	1.464	0.1433
Residence Controls				
Owner (yes=1)	0.481773	0.313434	1.537	0.1243
Single Family Home (yes=1)	-0.32418	0.262805	-1.234	-0.2254
Survey Controls				
Real Starting Point	0.000303	0.000595	0.509	0.6104
Protest Vote (yes=1)	-18.2058	0.581195	-31.325	0
Psychological Controls				
Political Philosophy	-0.06722	0.081281	-0.827	0.4082
Perceived Behavioral Control	0.080442	0.114861	0.700	0.4837
Subjective Norms	0.416326	0.097263	4.280	0
Cognitive Structure Economic	0.591539	0.120723	4.900	0
Cognitive Structure NonEconomic	0.449983	0.11871	3.791	0.0002
Awareness of Consequences Scale	-0.13471	0.216657	-0.622	0.5341
Taxpayer Duty	0.379618	0.138453	2.742	0.0061
Biocentric Ethic	0.052072	0.123504	0.423	0.6733
Ecological Risk Variables				
Habitat Risk Score	0.005945	0.003305	1.799	0.072
Frequency of Visits to River	0.323177	0.090919	3.555	0.0004
Mean dependent var	3.122078	Adjusted R-squared		0.400686
S.E. of regression	1.590953	Log likelihood		-986.311
Left censored obs	135			
Uncensored obs	427			

statistically significant influence (5% level in Path 1 and 3 model, and 10% level in Path 2 and 3 model). Respondents who are married have lower willingness to pay in both models, although neither is statistically significant at the 5% level of significance in a two-tailed test. Finally, income is positive and statistically significant in both models.

Table 6.6. Regression results for Combined Ecological Risk-Flood Path (Paths 1 and 3)

Combined Tobit Regression Findings - Flood Risk Path and Combined Risk Combined Dependent variable: Natural Log (Real WTP +1)				
	Coefficient	Std. Error	z-Statistic	Prob.
Intercept	-11.0932	3.276278	-3.3859	0.0007
Demographic Variables				
Age	-0.00991	0.012389	-0.79988	0.4238
Years of Education	0.110455	0.072677	1.519812	0.1286
Married (yes=1)	-0.58106	0.406033	-1.43106	0.1524
Minority (yes=1)	-1.63756	0.760849	-2.15228	0.0314
# of Children	-0.00227	0.172995	-0.01314	0.9895
Log of Real Income	1.12303	0.30499	3.682189	0.0002
Residence Controls				
Owner (yes=1)	0.046617	0.555606	0.083902	0.9331
Single Family Home (yes=1)	-0.13258	0.529037	-0.2506	0.8021
Survey Controls				
Real Starting Point	0.002181	0.00116	1.879978	0.0601
Protest Vote (yes=1)	-23.1455	1.038814	-22.2807	0
Flood Risk Variables				
Floodplain - 100 year	0.466561	0.53581	0.870758	0.3839
Floodplain - 101 to 1000 year	1.27128	0.9822	1.294318	0.1956
Recurrence * Floodplain1000 year	-0.0024	0.002212	-1.08624	0.2774
Ecological Risk Variables				
Habitat Risk Score	-0.01295	0.007607	-1.70203	0.0887
Frequency of Visits to River	0.767171	0.153007	5.013948	0
Combined Path Dummy				
Combined Path (yes=1)	0.049792	0.43226	0.115189	0.9083
Mean dependent var	2.879358	Adjusted R-squared		0.28097
S.E. of regression	1.853912	Log likelihood		-521.15
Left censored obs	92			
Uncensored obs	196			

The *Starting Point* variable is positive in both cases although not significant at the 5% level, whereas the protest vote variable is significant in both models. Interestingly, the only floodplain measure that is approaching significance is the dummy variable reflecting location within the 100 year floodplain, which is significant at the 95% level in a one-tailed test in the Path 2 and 3 model. This is in contrast to its insignificance in the regression from the Floodpath only model. The *Frequency of Visits to the Watershed* variables are positive and significant in both models, whereas the *Habitat Risk Score* is positive and insignificant in the Path 2 and Path 3 regression but negative and significant at the 90% level in the Path 1 and Path 3 regression. The latter finding is opposite of that found in the Path 2 regression.

Finally, the test of embedding is the sign and significance on the dummy variable *Combined Path,* which indicates whether the respondent was from the combined path (i.e., path 3). If there is no embedding, then one would expect that the coefficient on *Combined Path* would be positive and significant, since respondents from the good described in the combined path includes both flood control and ecological risk reduction. In both cases, the regression coefficient was statistically insignificant. This provides some indication that embedding could exist in these regression findings. However, as noted above, these regression results should be interpreted with caution, given the potential misspecification from the omission of psychological drivers. In addition, there is further evidence from the individual path 1 and path 2 regressions to suggest that the level of flood risk, and the level of ecological quality does influence WTP. Hence the evidence suggesting that embedding exists in these findings is not conclusive.

Table 6.7. Regression results for Combine Ecological Risk-Flood Path (Paths 2 and 3)

Combined Tobit Regression Findings - Flood Risk Path and Combined Risk Combined Dependent variable: Natural Log (Real WTP +1)				
	Coefficient	Std. Error	z-Statistic	Prob.
Intercept	-8.677126	1.811786	-4.789268	0.0000
Demographic Variables				
Age	-0.021721	0.006449	-3.368133	0.0008
Years of Education	0.168025	0.041595	4.039589	0.0001
Married (yes=1)	-0.268478	0.200143	-1.341431	0.1798
Minority (yes=1)	-0.914005	0.507428	-1.801251	0.0717
# of Children	-0.054443	0.082678	-0.658490	0.5102
Log of Real Income	0.794581	0.170885	4.649791	0.0000
Residence Controls				
Owner (yes=1)	0.296494	0.293062	1.011712	0.3117
Single Family Home (yes=1)	-0.277857	0.254039	-1.093757	0.2741
Survey Controls				
Real Starting Point	0.000874	0.000578	1.511706	0.1306
Protest Vote (yes=1)	-21.32373	0.534989	-39.85824	0.0000
Flood Risk Variables				
Floodplain - 100 year	0.905626	0.529510	1.710308	0.0872
Floodplain - 101 to 1000 year	-0.436572	0.883688	-0.494034	0.6213
Recurrence * Floodplain1000 year	0.001016	0.001164	0.872255	0.3831
Ecological Risk Variables				
Habitat Risk Score	0.003585	0.003168	1.131636	0.2578
Frequency of Visits to River	0.653950	0.084131	7.773036	0.0000
Combined Path Dummy				
Combined Path (yes=1)	-0.169516	0.371372	-0.456458	0.6481
Mean dependent var	3.039839	Adjusted R-squared		0.28305
S.E. of regression	1.797625	Log likelihood		-1586.212
Left censored obs	227			
Uncensored obs	623			

Simulation of Models for Benefit Estimation

One of the goals of this research is to derive benefit estimates of flood control and ecological risk reduction. The estimated WTP functions reported in Tables 6.4 and 6.5 are used to derive benefits at the watershed level. There are several issues that need to be resolved in order to do this. First, the total population for each watershed needs to be derived. Census block group data from the 1990 Census of Population and Housing was used as the source of data for population and demographic information in the community. Since Census block group boundaries do not coincide with watershed boundaries, ArcView was used to overlay the latter onto the former. When the watershed cut across a specific block group, the fraction of total block group land area *(fraction)* that is contained in the watershed was computed. Assuming a uniform distribution of population within each block group, the imputed block group population was then derived as the block group population times the fraction of land area contained in the watershed. Total watershed population was then derived by summing the imputed population across all block groups in the watershed.

The second issue that was addressed was to determine simulated values of WTP for the typical respondent for each block group. While some of the variables in the model vary spatially, others do not, or if they do, the variation could not be predicted with confidence. Since the census block group is the primary data unit, most demographic variables are easily imputed from census data. Thus, average values for the variables *Age, Years of Education, Married,* and *Number of Children* are used in the simulations. The income measure was imputed differently however. Since the household income variable in 1990 is denominated in different dollars, and since it included components not found in the income measures reported by respondents, a regression equation was estimated regressing the median household income in 1990 from the census block group in which the respondent resides, to their reported (or imputed) income level. That regression equation was then used to predict the average respondent income for each census block group.

For survey controls, average values were used for each variable from the sample in which the WTP functions were derived. While it might be tempting to assign average values for each block group, this was not possible, since some block groups had no respondents. In addition, among those block groups with respondents, several had very small numbers of respondents, and hence the confidence intervals around those mean measures would be expected to be high.

The variables in the *Ecological Risk* and the *Flood Risk* categories are a function of distance from the river. Thus, distance from the centroid of the block group was computed and separate OLS regressions were run on the *Habitat Risk Score, Frequency of Visits to River,* and *Recurrence* (within the 1000 year floodplain). Only the *Ecological Risk* variables generated a statistically significant coefficient on distance. For the *Ecological Risk* variables, the predicted values were generated for each block group and those values were used in the simulations. In addition, logit models were derived for the *Floodplain - 100 yr* and *Floodplain - 101 to 1000 year* variables, and the predicted probability that the census block group fell within the 100 year floodplain was computed.

The Tobit model was simulated to predict the actual value of the dependent variable as opposed to the latent variable, for both flood paths. The average household WTP was multiplied by the imputed population for the block group to derive total annual WTP for each of the Census block groups within the watershed. Since the projects described in the questionnaire indicated that the project would be conducted over a period of 20 years, the stream of payments must be discounted to the present value. The discount rate used for is the risk-free real market rate of interest (Kahn, 1995), which is the 30 year treasury bill rate minus the expected inflation rate. The treasury bill rate was averaged over the last 24 months (December 1999 to November 2001) and the expected inflation rate was determined by averaging inflation between 1990 and 2000. This generated a discount rate of 2.76% (i.e., 5.75%-2.99%). The findings from the simulation are summarized in Table 6.8.

Table 6.8. Benefit Estimates for Menomonee River and Oak Creek Watersheds

Policy Simulations - Benefit Estimation (constant January 2000 dollars)		
Watershed	**Menomonee River**	**Oak Creek**
Imputed Residents	127,598	14,985
$WTP_{Flood\ Control}$ - Annual	$602,585	$48,776
$WTP_{Flood\ Control}$ - 20 years	$9,167,152	$742,024
$WTP_{Ecological\ Risk\ Reduction}$ - Annual	$1,471,667	$161,341
$WTP_{Ecological\ Risk\ Reduction}$ - 20 years	$22,388,513	$2,454,481
Ratio of Ecological Improvement Benefits to Flood Risk Reduction	2.4	3.3

The flood risk simulation was conducted for Oak Creek, but since flood risk was derived for the watershed, it was deemed inappropriate to predict flood risk using the distance extrapolation. Furthermore, based on the 100 year floodplain maps obtained from FEMA, there are no residents in our sample living in the watershed. Thus, flood risk was assumed to be zero for all block groups. Hence, the spatial variation in flood benefits depends solely on the variation in demographic characteristics in the watershed.

Interestingly, the willingness to pay for flood control is less than half that of ecological risk reduction in both watersheds. The present discounted value of the benefits derived for flood control in Menomonee River watershed is $9.1 million, whereas the benefits for ecological risk reduction/habitat restoration is $22.4 million. Not surprisingly, the benefits for flood control in the Oak Creek watershed are quite low (i.e., just $48 thousand per year, or $742 thousand for the life of the project). This implies that projects that primarily are aimed at ecological risk reduction are valued between 2.4 and 3.3 times greater than similar projects aimed solely at flood control.

Benefit transfer approach

While the findings are of specific interest to the study area, an important policy question is whether the findings from this study can be generalized to other geographic areas. The application of empirical findings from the study site where data was originally collected to a new location is called is called the benefit transfer. The most important reasons for applying previous study results to a new policy site is cost effectiveness. According to Brouwer (2000) applying previous research findings to similar decision situation is very attractive to expensive and time-consuming original research to quickly inform decision-making. The approach has been successfully applied in various natural resources policy contexts, ranging from water quality management (Luken et al., 1992) and associated health risks (Kask and Shogren, 1994) to waste (Brisson and Pearce, 1995) and forest management (Bateman et al., 1995)

Boyle and Bergstrom (1992) suggested a systematic, conceptual foundation for conducting benefit transfer studies. They also defined technical criteria for the selection of potential study sites from which benefits could be transferred. These criteria are:

- The non-market good to be valued at the policy site must be identical to that already valued at the study site

- The population affected by the non-market good must be identical at each site
- The safe welfare measure should be theoretically at each site, e.g. property rights existing at each site should imply the use of either WTP or WTA measures.

Assuming these conditions are satisfied, the benefit transfer can be conducted using one of two alternative approaches: direct transfer of benefit estimates, or the transfer of an entire benefit function.

The first approach is straightforward; the benefit estimate from the study site is directly transferred to the policy site. In the second approach, the estimated benefit function for a study is transferred to a policy site. The benefit transfer function approach. One of the advantages of deriving benefits spatially using Census block groups as the underlying data unit in this analysis is that it facilitates the transfer of the estimated benefit function, which has been described as an ideal transfer approach (Devousges et al., 1992 and Loomis, 1992). We apply the benefit simulations to the Root River watershed, which is just south of the two watersheds primarily considered in this study.

Demographic Comparison of Watersheds for Study (Menomonee/Oak Creek) and Policy (Root River) Sites

Considering first the study site, the Menomonee River watershed is located in the east central portion of southeastern Wisconsin and covers an area of approximately 135 mi^2. The Menomonee River originates in southeastern Washington County, and flows approximately 28 miles through the northeastern corner of Waukesha County and through western and Milwaukee County to its confluence with the Milwaukee River in downtown Milwaukee. (SEWRPC, 1995). The Oak River Watershed is located in the east central portion of southeastern Wisconsin and covers an area of 28 mi^2. The main stem of Oak Creek rises in southwestern corner of Milwaukee County and flows easterly and northerly within the County for approximately 13 miles before emptying into Lake Michigan on the eastern border of the watershed. (SEWRPC, 1995).

The policy site, is the Root River watershed is located in the east-central portion of the Southeastern Wisconsin Region and covers an area of approximately 197 mi^2. The main stem of the Root River originates in Milwaukee County within the city of West Allis and flows approximately southeasterly with a discharge into Lake Michigan in the city of Racine. The watershed is located in four counties – Kenosha, Milwaukee, Racine, and Waukesha - and 18 cities, villages and towns (SEWRPC, 1995).

All of the rivers and streams in these three watersheds (Menomonee, Oak, Root) are part of the Lake Michigan drainage system. Location for each watershed, with the included portion of each of the block groups within the watershed is shown in Figure 6.4.

Since the ultimate purpose of management planning effort is to improve the environment in which resident population lives, an understanding of the size, characteristics, and spatial distribution of this population is fundamental to the planning effort. Resident population levels bear a direct relationship to the demand for land, water, and other elements of the natural resource base. The size and characteristics of the population of an area are greatly influenced by growth and change in economic activity. Percent distribution of counties over watersheds and population of the watersheds are given in Table 6.9.

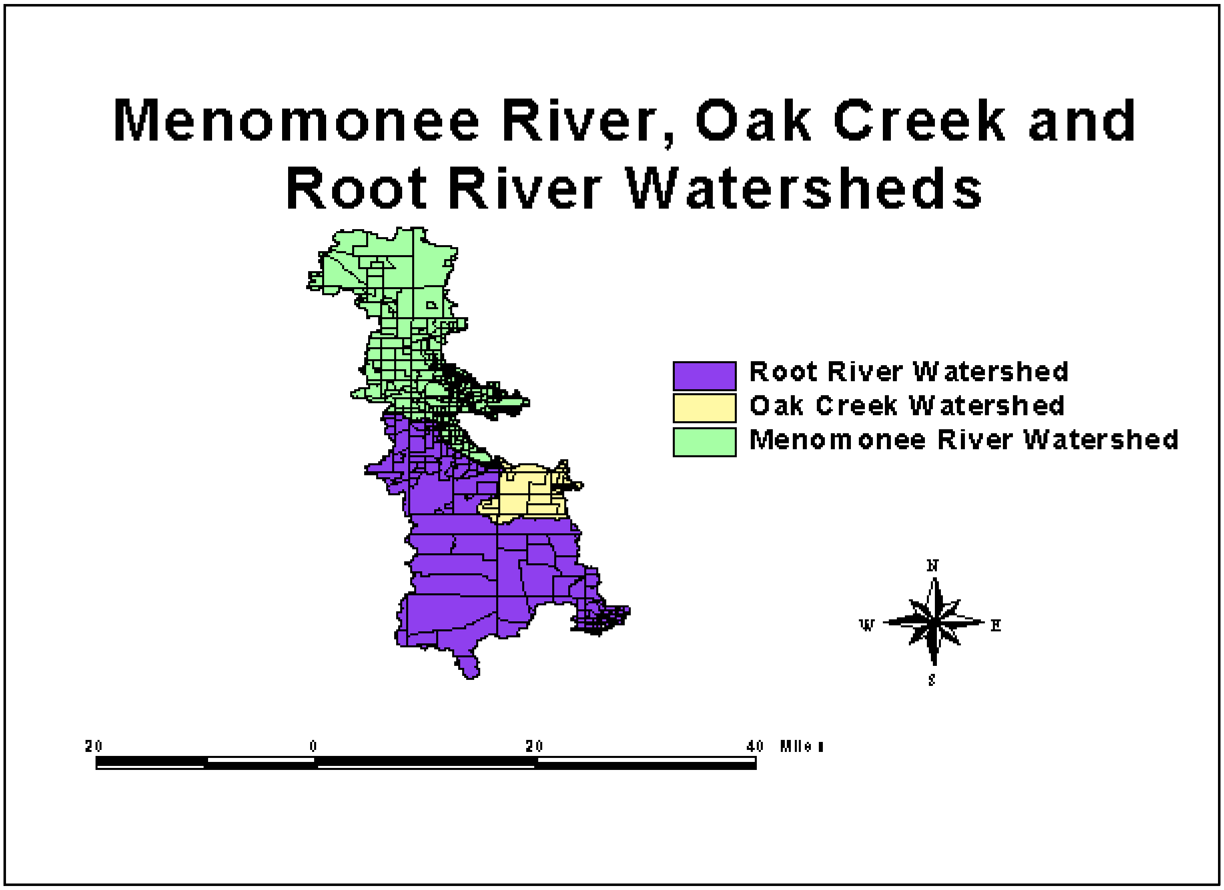

Figure 6.4. Location of the Watersheds with Southeastern Wisconsin

Table 6.9. Distribution of watersheds over counties

	County											
	Kenosha		Milwaukee		Ozaukee		Racine		Washington		Waukesha	
Watershed	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
Root River (156,488 persons)	2.18	1.11	58.65	29.79	--	--	122.94	62.45	--	--	13.1	6.65
Menomonee River (330,178 persons)	--	--	55.08	40.52	11.76	8.65	--	--	31.75	23.36	36.65	27.77
Oak Creek (40,499 persons)	--	--	26.33	100	--	--	--	--	--	--	--	--

One of the most important requirements of the benefit transfer process is that the population affected by the non-market good must be similar at each site (study and policy site). ArcView was used to compare and contrast the demographic features of the watersheds, again using Census block groups as the underlying data unit. The comparison of socioeconomic characteristics of the watersheds are given in Table 6.10.

Table 6.10. Comparison of Sociodemographic Characteristics of Watersheds

Demographic feature	Menomonee	Oak Creek	Root River
Area (sq.mi.)	136	27	197
Total Population	330178	40499	156488
Total housing units	134056	15688	59306
Household size	2.5	2.6	2.6
Population density (pop/sq.mi.)	2427	1478	795
Median Household Income	33058	37179	38243
percent male	47.7	49.3	48.8
percent married	51.88	59.37	58.84
percent hispanic	4.7	1.8	3.3
percent white	87	97.7	91.2
percent black	7.6	0.8	6.2
percent asian	2.1	0.3	0.8
average age	37.1	35.1	35.6
average education	11.97	12.05	12.06
percent owner occupied	57.9	64.9	68.5
percent vacant homes	3.8	2.4	3.9
percent nonmovers	55.1	62.3	60.4

Although the Root River watershed is larger geographically, it is more sparsely populated than the Menomonee River and Oak Creek watersheds. Demographically, a comparison of mean values reveals strong similarities between the three watersheds. To test whether the values of the *Demographic* and *Residence* control variables used in the regression equations differed, t-tests comparing mean values were computed. These findings are reported in Table 6.11. They reveal that most *Demographic Control* variables are statistically similar across the study (Menomonee River and Oak Creek watersheds) and policy (Root River) sites. The one exception is *Married*, for which the mean is higher in the Root River watershed. Both of the *Residence Control* variables differ between the study site as compared to the policy site. The fraction of homes that are owner-occupied and single-family is statistically higher in the Root River watershed. In spite of these differences, given the locational proximity of the study and policy sites, and given that most of the demographic variables do not differ significantly, the study site is judged to be sufficiently similar to apply benefit transfer.

Table 6.11. Mean Comparison on *Demographic* and *Residence* Control Variables

Mean Comparison across Census Block Groups				
	Unweighted Mean Values			
Variable	**Menomonee + Oak Creek (n=456)**	**Root River (n=135)**	**t-score (Prob. value)**	**Reject H_0: mean values are the same**
Age	36.56	35.52	t=1.63 (p=0.10)	no
Years of Education	11.87	11.76	t=1.26 (p=0.21)	no
Married	0.52	0.56	t=2.55 (p=0.01)	yes
Minority	0.12	0.14	t=1.01 (p=0.31)	no
# of Children	0.72	0.79	t=1.01 (p=0.31)	no
Real income	49,642	51,890	t=1.14 (p=0.25)	no
Single-family home	0.60	0.70	t=3.54 (p=0.00)	yes
Owner occupied home	0.60	0.67	t=2.81 (p=0.01)	yes

In the policy simulation, Census block group data take on the values specific to the specific block group and all other data are either evaluated at their mean value (evaluated at the mean for the combined Menomonee River and Oak Creek samples) or for the floodplain measures, assumed to be outside the 100 year and 1000 year floodplain. The income measure is derived in the same fashion as was income in the simulations for the Menomonee River and Oak Creek watersheds. The findings are reported in Table 6.12.

While flood risk benefits are minor, the calculated benefits for ecological risk reduction are more than 10 times greater. One potential shortcoming of this analysis is the necessity to use mean values for some independent variables that inevitably vary spatially. Specifically, the assumption of uniform flood and ecological risk has undoubtedly influenced these results. Thus, while the results suggest that public policymakers in the Root River watershed might want to emphasize watershed management projects that focus on ecological improvement of the watershed, some investigation of potential spatial relationships of the spatial variation of floodplain variables ecological risk variables is probably needed.

Table 6.12. Benefit Estimates - Root River

Policy Simulations - Benefit Estimation (constant January 2000 dollars)	
	Root River
Imputed Residents	42,246
WTP$_{\text{Flood Control}}$ - Annual	\$47,987
WTP$_{\text{Flood Control}}$ - 20 years	\$730,030
WTP$_{\text{Ecological Risk Reduction}}$ - Annual	\$484,876
WTP$_{\text{Ecological Risk Reduction}}$ - 20 years	\$7,376,430
Ratio of Ecological Improvement Benefits to Flood Risk Reduction	10.1

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