THE BENEFIT OF SOIL EROSION CONTROL IN PALMERSTON NORTH AND SURROUNDING AREAS

A thesis presented in partial fulfilment of
the requirements for the degree of
Masters of Agricultural Economics
in Resource Economics
at Massey University

ENDANG ROSAWATI
1993

TABLE OF CONTENTS

CHAPTER FOUR

FRAMEWORK AND METHODOLOGY

CHAPTER FIVE

RESULT AND DISCUSSION

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

Praise be to GOD, Lord of the universe.
Grateful acknowledgement is made to :

Professor Anton Meister from Department of Agricultural Economics and Business, Massey University for his significant assistance and supervision.

Mr. D. Harrison from Land Management Directorate, Manawatu-Wanganui Regional Council, for his helpful information.

Glenda, Ruth, Carol and Gerardo for their input and editorial assistance.

Nugroho and Steve for their help with the presentation of the graphs.

My family backhome and all good friends for their support and James Anderson for his encouragement.

ABSTRACT

Soil erosion is a major cause of land degradation in New Zealand. In the Manawatu area, including Palmerston North, the conversion of original vegetation to farm land, began at the time of its settlement by Europeans in the 1850's. This left rivers free to erode alluvial banks and change course, resulting in significant areas of high quality alluvial soils being replaced with poor quality gravels. Soil erosion also imposed substantial costs on the community through the loss of pastoral production and soil fertility, widespread damage to public and private assets, a reduction in water quality through sedimentation, and degradation of the habitat for wildlife and in-stream biota. Soil conservation activities produce benefits that do not only accrue to the land owners, but also to others in the region and to future generations. However, identification of the off-site benefits of soil erosion control appears to have been inadequately assessed and targeted. This study attempts to measure the benefit of soil erosion control received by residents in Palmerston North and surrounding areas. The research was undertaken by mail survey, using contingent valuation methods to elicit peoples' willingness to pay for the current level of soil erosion control and the willingness to pay for further increased levels of soil erosion control. The results showed that 54.6 % of respondents are aware of soil erosion effects in the area. The perceived benefits (as reflected in WTP) of the current level of soil erosion control varies from $204,321 to $1,393,666.95 per year whereas the benefit of having further increased levels of soil erosion control ranges between $320,083.07 - $1,020,998.63. In ascertaining the total value of soil erosion control, respondents took into account the preservation value, comprising bequest and existence value, in addition to use value and future use value.

CHAPTER ONE
STUDY BACKGROUND AND MOTIVATION

INTRODUCTION

New Zealand's geographic setting is geologically youthful with its dynamic tectonic setting. This, combined with high rainfall, results in widespread erosion and frequent flooding. The development of fragile lands for pastoral and arable use, with resulting soil erosion, imposed substantial costs on the community, the loss of pastoral production and soil fertility, widespread damage to public and private assets, a reduction in water quality through sedimentation, and degradation of the habitat for wildlife and in-stream biota (Manawatu Wanganui Regional Council, 1991).

The Government responded to these problems by providing substantial public funding for soil and water management works, such as tree planting and the building of stopbanks (Jakobsson and Dragun, 1990).

Under the Resource Management Act of 1991, the Manawatu-Wanganui Regional Council is responsible for soil conservation, hence a regional conservation policy which takes into consideration on-site and off-site benefits, and inter-generational concerns in the regional and national context.

Soil conservation activities produce benefits that do not only accrue to the landowners, others in the region can also benefits. For example, soil control erosion on hill country farms slows down the loss of productivity on farm and also produces lowers sediment loadings in streams and rivers therefore causing less environmental damage.

Identification of off-site benefits of soil erosion control appears to have been inadequately assessed and targeted. Inadequacy of assessment also occur toward values beyond 'use' value, referred to as option and existence

values respectively, the maximum amount an individual with uncertain future demand or supply of the resources would be willing to pay for the option to purchase a particular commodity at a specified price, and the value derived simply by knowing that adequate quantities of soil will be available in the future regardless of whether that individual will actually use the soil.

The aim of this thesis is to attempt to estimate the off-site benefits of soil erosion control, enjoyed by people live in Palmerston North City and surrounding areas, and the benefits for futher increased of soil erosion control.

The data will be obtained by means of a mail survey in which the contingent valuation method is employed to accommodate the questions of willingness to pay for current soil erosion control and willingness to pay for having more soil erosion control to be put into place. Respondents are to be chosen randomly of households living in Palmerston City and the surrounding areas.

OBJECTIVES OF THE THESIS

The objective of this thesis is to value the benefit of current erosion control and an increased level of control in Palmerston North and surrounding areas. The value obtained is compared with the costs budgeted by the Regional Council for erosion control.

Other objectives are :

- to identify the level of awareness that people have concerning the effect of soil erosion
- to identify the public preferred policy for soil erosion control funding
- to discern public valuation toward soil erosion control including the

valuation of the inter-generational issue
- to identify the factors affecting people allocating the willingness to pay for soil erosion control

THE ORGANISATION OF THE THESIS

Chapter Two is comprised of two parts. The first part is an introduction to an welfare economic theory, values, and non-market valuation techniques. The second part discusses soil erosion in New Zealand and its economic aspects.

Chapter Three describes the study area, Palmerston North and its surrounding areas and the condition of its soil resources, this includes a brief explanation of its management and the Manawatu-Wanganui Regional Council.

Chapter Four outlines the framework and methodology used for the survey, with a short discussion of questionnaire design.

Chapter Five presents the results and a discussion of the survey, discussion of each objective and the method used to obtain an adequate model with which model estimate the benefit of soil erosion control.

Chapter Six contains a summary of the survey, its methods, evaluation and conclusions.

CHAPTER TWO

LITERATURE REVIEW OF BENEFIT VALUATION AND SOIL EROSION

BENEFIT ESTIMATION

1. Economic Welfare Theory

Economic policies cause welfare changes. Measurement of such changes is of great importance in determining if they are welfare increasing or not. A basic assumption underlying economic theory is that individuals make welfare optimising consumption decisions. This means they will trade their given initial endowments of resources until a position is reached where there are no possible trades left to increase their utility. By observing individuals and their buying behaviour, individual willingness to pay for goods and services can be determined. These observations yield demand curves for goods and services which present information on the marginal and total satisfaction individuals receive from those goods and services . These demand curves form the basis from which the effects of policy measures on welfare can be measured (Mitchell and Carson, 1989; Braden and Kolstad, 1991).

Dupuit and later Marshall proposed to measure the change in welfare, due to an economic policy, as consumer surplus. The concept of consumer surplus, as the excess of individual willingness to pay for a good over and above actual payment, is reflected by the triangle-like area below the demand curve and above the price line (see Figure 2.1)

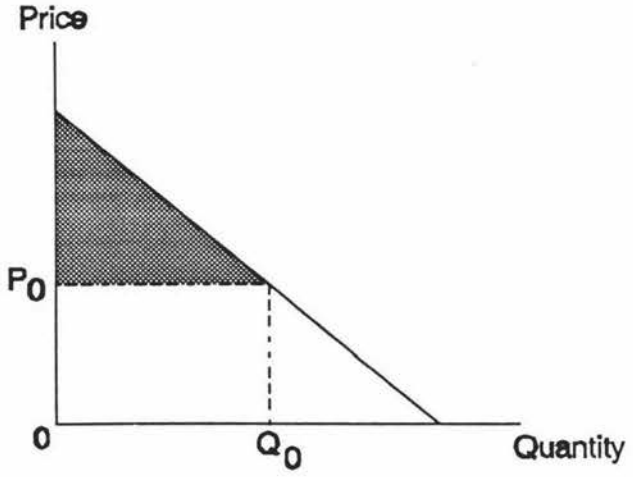


Figure 2.1 Consumer Surplus

Dupuit (in Currie et al, 1971) referred to the area by the use of a monetary measure, whereas Marshall, 1930 (in Currie et al, 1971) interpreted the concept of consumer surplus, on the assumption that marginal utility of money is approximately constant, as an acceptable cardinal index of utility given the assumed constancy of marginal utility of money, the consumer's demand curve will provide the measure of the total utility from the commodity.

However, in fact, Marshall recognised that marginal utility of money (MUM) would never be exactly constant.

Under the condition that MUM is not constant, the change of income due to a change in price cannot be translated directly to a change of equivalent utility and there will be a substitution effect and income effect as illustrated in Figure 2.2 (Devine, 1987)

As the price falls from P_A to P_C the budget line on the Figure 2.2a will shift

from b_1 to b_2. Given the initial indifference curve U_1, at the price P_A the consumer would like to consume as much as X_A, and at price P_C the quantity chosen is X_C as the consumer maximises the utility. The shift from point A to point C brings about two effects namely the substitution effect and income effect. Firstly the consumer gains a cheaper commodity as the price falls to point B. Secondly, there is an increase in the welfare level due to the rise in relative real income, which leads to the shift to point C. Hence, the demand curve derived from (X_A, P_A) and (X_C,P_C) along the curve represents constant level of income but different levels of utility. And since the points A and C correspond to different utility levels, the area under $P_AP_CX_AX_C$ cannot provide an income equivalent measure of the utility change between the two points.

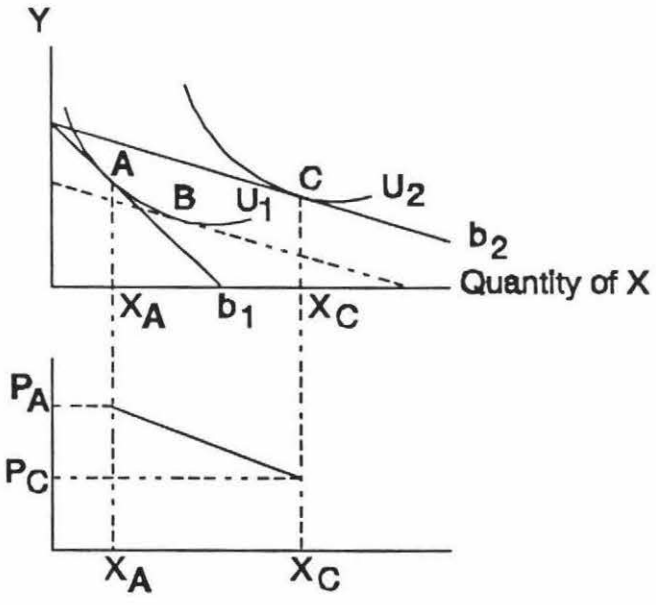


Figure 2.2. Substitution Effect and Income Effect

Hicks (1943) (Currie et al (1971), and in Hovis (1984)), defined four basic measures of welfare changes. The four measures are :

Compensating Variation (CV)

The maximum amount of income paid or received by the consumer at his initial utility level following the change in price if he is free to buy any

quantity of the commodity (see Figure 2.3). Given the budget line l_1 and initial utility U_0, the consumer is maximising his utility at point a.

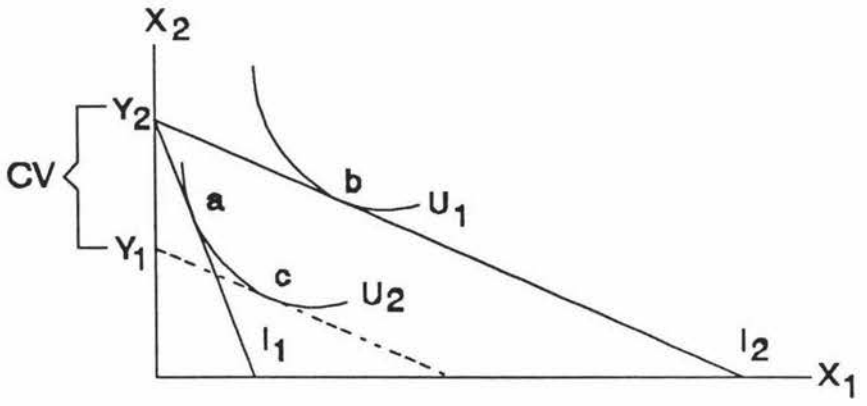


Figure 2.3. Compensation Variation As A Measure Of Welfare Gain From A Price Decrease (Source : Hovis, 1984)

Figure 2.3 shows the decrease of commodity price which leads to new budget line l_2 and brings about a new point of maximum utility at b. The consumer would like to pay as much as $Y_2 - Y_1$ to reach point b. Hence CV is the maximum willingness to pay of a consumer to make herself as well off as at point a; and point c is the point of consumption under the new price.

Equivalent Variation

The minimum amount of compensation paid or received , that will leave the consumer in his subsequent welfare position in the absence of the price change if he is free to buy any quantity of the commodity at the old price. Hovis (1984) specified EV as the minimum lump sum payment the individual would have to receive to induce him to voluntarily forego the opportunity to purchase at the new price set (see Figure 2.4).

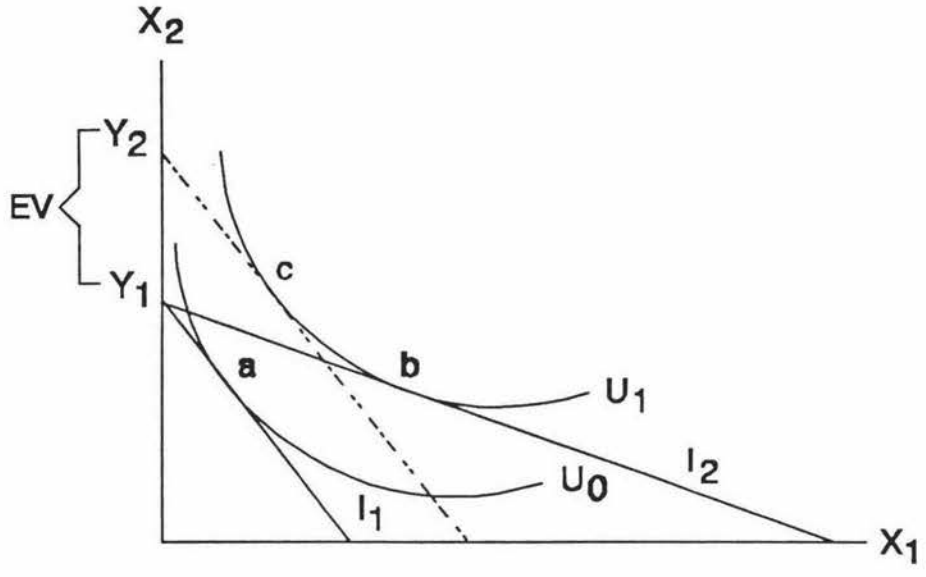


Figure 2.4. Equivalent Variation As A Measure Of Welfare Gain Under A Price Decrease (Source: Hovis, 1984)

Figure 2.4 shows the initial point is at a. When the price of X_1 decreases the consumer would have adjusted the position of maximum utility with the new price (l_2) at b, but the consumer is constrained to consume at the initial price set (l_1). Hence, the payment should be made as much as Y_2 - Y_1 to allow the consumer to be as well off as at point b on the higher indifference curve U_1 but force him/her to pay the original prices (point c).

Sometimes it is not possible for the consumer to respond to the price change by purchasing more or less of the good, for the choice may be either to have the facility to purchase or not. The Hicksian compensating and equivalent surplus restrict the quantity of the good purchased to be either the level of subsequent state (compensating) or the initial state (equivalent) (Devine, 1987).

Equivalent Surplus

The minimum amount of compensation paid or received that will leave the

consumer in his subsequent welfare position in the absence of the price change if he is constrained to buy at the old price, the quantity he would have bought in the absence of compensation. Figure 2.5 shows the consumer is willing to accept compensation up to AD rather than have the change, while being restricted to consume the original quantity X_1".

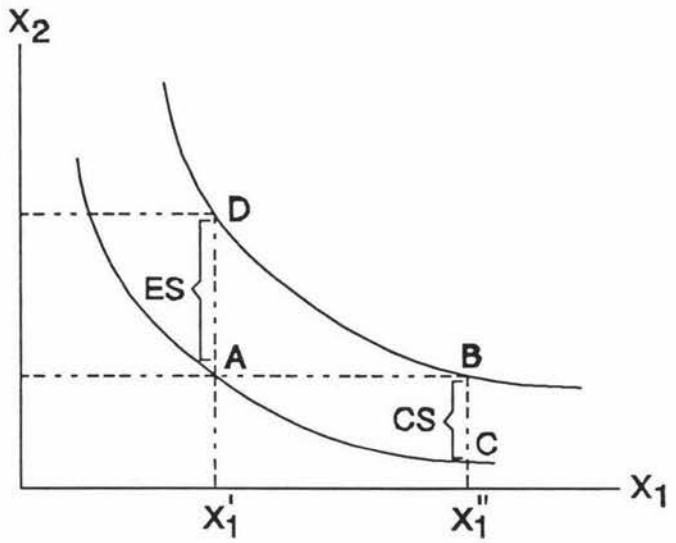


Figure 2.5 Compensating And Equivalent Varia n As A Measure Of Welfare Gain From A C ntity Increase

Compensating Surplus

The maximum amount of compensation paid or received that l leave the consumer at his initial utility level following the change in ice. If he is constrained to buy at the new price, the quantity he would ' e bought at that price in the absence of compensation.

Figure 2.5 depicts a consumer operating at A, when quar changes from X_1' to X_1" the consumption quantity shifts to B. The co sating surplus is the amount of income that the consumer is willi ay rather than return to the original welfare while being restricte nsume the new quantity X_1".

These four measures give rise to the differences between the Hicksian Compensated Demand Curves and the Ordinary Marshallian Demand Curve, as illustrated in Figure 2.6.

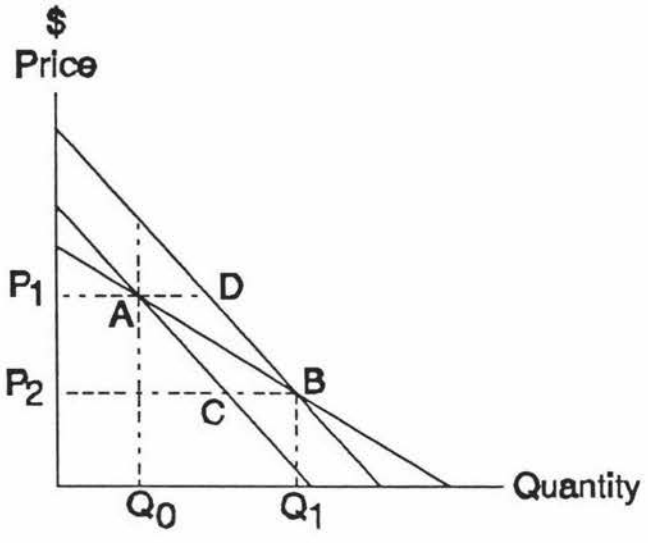


Figure 2.6 Compensating Demand Curve And Ordinary Demand Curve
(Source: Mitchell and Carson, 1989)

Marshallian Consumer Surplus is represented by the area P_1P_2BA, whereas the consumer surplus under compensating variation is P_1P_2CA. The equivalent variation is represented by the area P_1P_2BD. These three areas can be compared as $P_1P_2CA < P_1P_2BA < P_1P_2BD$. If compensating variation is interpreted as the willingness to pay (WTP), the compensation for a welfare gain, and vice versa for welfare loss, will be : WTA > MCS> WTP (Devine, 1987)

The Marshallian Demand Curve and Hicksian Compensating Demand Curve will coincide if the income effect is zero since zero income effect will imply zero income elasticity of demand for the good so all the measures

will be identical (Kerr and Sharp, 1985/1987; Mitchell and Carson, 1989).

2. Aggregation Over Individuals

For a private goods the simple change of welfare in society is obtained by horizontally summing the individual compensated demand curves derived from the initial utility level of each individual.

However, a welfare gain/loss in society depends on the value judgements produced by society's established decision process. For example, if society has a high regard for the individual made worse off and a low regard for the individual made better off (because one is poor and the other rich), then society as a whole may be worse off with the change. Hence economic welfare analysis should examine the effects on affected groups and let the policy maker(s) make a subjective evaluation of which distribution is better (Just, Hueth and Schmitz, 1982).

Since utility is not observable, a technique for actual measurement in quantitative terms of the welfare effect is needed. The measurement chosen is the amount of money the individual is willing to pay or accept to move from one situation to another. It is an observable alternative to measuring the intensities of preferences of an individual for one situation versus another.

The aggregation of such individual perceptions of value will be worthwhile in identifying the impacts of a project, especially if the project concerns non-market goods that cannot be directly valued in monetary terms. As for public goods, the aggregation is the vertical sum of the individual's demand curve, since once a resource is provided it will be available for everyone, thus leading to zero marginal cost of provision for an additional user (Hufschmidt et al., 1983).

Hicks in Currie et al. (1971) suggested that if the price of one good only is

changing then the area below the aggregate compensated demand curve which is derived for the initial utility level of each individual and obtained by horizontally summing the individual compensated demand curve will also be representative of the aggregate compensating variation.

3. Values

Total economic value of the environment is made up of several values all of which affects one's satisfaction or utility :

Use Value

The value of the service flows that the public would derive from the resource/environment in its natural state (Krutilla and Fisher, 1975), specifically by the actual use of the environment (Pearce and Turner, 1990).

Option Value

Considering the risk associated with future demand or supply of the resource, people may anticipate to have an option of using the environment as a potential benefit as opposed to actual present value; and therefore payment may be made to retain the option of possible future use in addition to expected consumer surplus (Pearce and Turner, 1990; Walsh et al., 1984; Cicchetti and Freeman, 1971).

Quasi-Option Value

Quasi-option value is based upon uncertainty regarding the future availability of information upon uses and value associated with resources facing possible irreversible development (Mitchell and Carson, 1989; Kerr and Sharp, 1987).

Existence Value

The willingness to pay for the knowledge that a resource exists even though no actual use is contemplated (Walsh et al., 1984). Existence value

also includes bequest value, that is, the willingness to pay for the satisfaction derived from endowing future generation with a resource (Walsh et al., 1984; Krutilla, 1967 in Kerr and Sharp, 1987)

Concerning non-use value Weisbroad and Krutilla (in Cicchetti and Wilde, 1992) indicated that uniqueness and irreversibility were necessary conditions for the presence of significant option or bequest value. However, Cicchetti and Wilde (1992) argued that all non-use values are linked to actual use of a natural resource by someone. This argument was accommodated as follows :

"First as far as uniqueness is concerned, it is clearly linked to the use value component of total value because complements to a unique resource will have a more inelastic compensated demand curve than complements to a resource with many substitutes. However, there is no clear relationship between uniqueness and the inherent value component of total value. Second, if one interprets irreversibility as 'extent of injury' then a more irreversible injury will presumably increase both the use value component and the inherent value component of total value, although the magnitude of the latter is open to question."

4. Valuation Methodologies

Measurement of welfare change due to alternative use of resources for which competitive markets do not exist, commonly use non-market valuation technique (Seller, Stoll and Chavas, 1985).

There are several techniques for valuing benefits (costs) of non-market goods. Forbes (1984) divided the technique of valuing benefits into two broad categories; Surrogate market approach and Survey technique approach.

Surrogate Market Price Approach

This approach uses the price of substitute or complimentary goods to value an unpriced good. This method determines demand curves indirectly and therefore consumer surplus (Kerr, 1986). Two methods widely applied for this approach are the Travel Cost Method and the Hedonic Pricing Method.

1. Travel Cost Method

The Travel Cost Method has been extensively used to estimate the aggregate demand curve of a recreation site by using travel costs as a surrogate for the price of the site (Clausen and Knetsch, 1966 in Stoll and Chavas, 1985)

The basic concept of this method is to find the change in the number of visits to a particular site in response to a price increase for visiting the site.

The demand curve is derived from visitation data of people coming from various distances to the particular site. Travel cost is assumed to be one of the main determinants of visitation besides other variables (i.e income, the availability of substitutes, multiple destination trips, education) that may significantly influence the model (Kerr, 1986).

However, one should be aware that travel can be used to infer the demand for a recreation site only if it is a necessary part of the visit, otherwise the demand for transportation does not capture all the demand for recreation (Braden, Kolstad and Miltz, 1991). Valuation with the Travel Cost Method is based on actual behaviour as the method expresses preferences for non-market goods in terms of observable market relationships (Carson, 1991), and the value is attributable only to the resource in its present state (Kerr, 1986).

The Travel Cost Method is limited to use values because values that do not

entail direct consumption cannot be estimated by looking at complements or substitutes (Mitchell and Carson, 1989).

2. Hedonic Price Method

This method analyses value of a resource of a resource (i.e. environmental quality) by using property values (house, land) to determine an implicit price for the environmental amenity. The method relates house price to house, neighbourhood and environmental characteristics (clean air, noise levels, etc). It is hypothesized that part of the variation in house prices is due to the environmental quality parameter (Kerr, 1986).

The method assumes that the price of a marketed good is a function of its differential characteristics, thus :

$$P_i = f(Q_1..Q_j..Q_n)$$

where P_i = price of good i

Q = characteristics attributable to i

The implicit price of a particular characteristics Q_j, is obtained by differentiating P_i with respect to that Q_j :

$$dP_i/dQ_j = P_j$$

(Mitchell and Carson, 1989).

Based on this, one can calculate the effect of Q_j on P_i when the other characteristics are held constant. Given this price function, the marginal cost of Q_j can be derived. This information, under strict assumptions, can be used to value changes in environmental goods or 'bads'. As with the travel cost method, the hedonic approach uses observed market behaviour and it values use values (Mitchell and Carson, 1989; Braden and Kolstad, 1991). The hedonic price method relies on an informed public aware of the relevant environmental attributes (Kerr, 1986).

The hedonic approach identifies how much of a property differential is due to a particular environmental difference between properties and infers how much people are willing to pay for an improvement in environment quality, including inferences of social value of improvements. The approach requires that market data must be readily available, otherwise the data collection costs may be high relative to other non-market methods. Analysis of the data requires considerable statistical proficiency (Pearce and Turner, 1990; Kerr, 1986).

Difficulties also exist when people have to deal with risk levels posed by chemicals, or with colourless or odourless air pollutants, for indivisibility of some attributes may invalidate the result (Mitchell and Carson, 1989; Kerr, 1986).

Survey Technique Approach

Survey techniques aim to measure changes in utility, in monetary terms, of a resource by simulating a hypothetical market situation to test consumer preferences (Forbes, 1984). Thus valuation is based on a hypothetical situation rather than actual consumer behaviour, as has been exercised in surrogate market approaches (Hufschmidt, 1983; Mitchell and Carson, 1989; Braden and Kolstad, 1991).

The hypothetical basis has advantages in that it enables one to obtain *ex ante* judgements. A further advantage is that this approach can also measure option and existence values (Mitchell and Carson, 1989).

1. Contingent Valuation Technique

The Contingent Valuation Method (CVM) is the most widely used survey technique. Compared with the Hedonic Price and Travel Cost methods, Contingent Valuation has some superiority as:

a. Under uncertain circumstances one will need ex ante valuation

whereas other methods are usually considered ex post values estimated from decisions made after the certainty has been resolved (Braden and Kolstad, 1991).

b. Total value consists of use value plus non-use value. The contingent valuation method being based on hypothetical market structure can deal with the measurement of non-use value in contrast with the use value of a resource (Braden and Kolstad, 1991; Mitchell and Carson, 1989; Bishop and Heberlein, 1987).

2. The Approaches of Contingent Valuation Method

There are several approaches within the broad grouping of CVM. Some of them will be briefly discussed here : Bidding games, open-ended question, dichotomous choice question and payment card format.

Bidding Games

The assumption underlying this approach is that the price of goods or services varies in response to a change in the equilibrium quantity or quality of the goods supplied (Bohm, 1971, 1972; Sinden and Worrel, 1979 in Hufschmidt et al., 1983).

This approach entails asking people for their willingness to pay for an improved bundle of goods (compensating variation) or willingness to accept compensation for an inferior bundle of goods (equivalent variation) (Hufschmidt et al., 1983). Respondents are asked whether they would be willing to pay a specified amount for the good. A positive answer leads to higher bid until a negative answer is obtained. At this stage the interviewer lowers the bid progressively until the respondent reaches an acceptable amount (Hufschmidt et al., 1983; Bishop and Heberlein, 1987).

However, the bidding game approach suffers from several drawbacks, one of them is the starting point bias that may influence respondents to have an upward valuation of the good.

Open-ended Question Approach

This alternative approach asks how much a person would be willing to pay to avoid the loss of an additional unit of the good or, willingness to accept compensation to receive an inferior quality/quantity of the good without the aid of a bidding price. Obviously the product would have to be well defined and the payment vehicle needs to be described. This method allows a mail survey to be undertaken and avoids influencing respondents by not using a starting bid (Bishop and Heberlein, 1987).

However, this single bid tends to result in much higher standard deviations around the mean, especially if there is no indication given of the expected range of answers (Hufschmidt et al., 1983). The reason for this is that most people have not valued such a resource before and may never have considered what their economic worth might be (Cummings et al., in Bishop and Heberlein, 1987).

Payment Card Method

The payment card method was developed by Mitchell and Carson (1989) to avoid starting point bias in the bidding games approach.

The payment card method involves providing the respondent with a visual aid which contains a large array of potential willingness to pay amounts. The card also shows the various amounts spent for other public goods such as highways and public education, by households in taxes and other payments. The question asked of respondents is : "What amount on this card, or any amount in between, is the most that you would be willing to pay for the level of good being proposed ?" (Mitchell and Carson, 1989).

Presumably however, there is an anchor-point analogous to possible starting point-bias in bidding games (Bishop and Heberlein, 1987). A study conducted by Boyle and Bishop (1984, in Bishop and Heberlein, 1987) found that a bidding game and payment card produce statistically

indistinguishable value estimates for the same environmental asset, and both values were biased upwards due to starting-point bias and anchor-point bias respectively.

Dichotomous Choice Format

Instead of asking respondents to express an exact maximum dollar amount, this approach asks respondents to answer "yes" or "no" for the specific willingness to pay a specified amount for the good being proposed, with no further iteration. The prices are randomly assigned to respondents so that it is possible to predict the probability for any person, of given characteristics, being willing to pay a given amount (Mitchell and Carson, 1989; Kerr, 1986). Analysis is based on plotting the probability of being willing to pay against the dollar amount nominated, as illustrated in Figure 2.7.

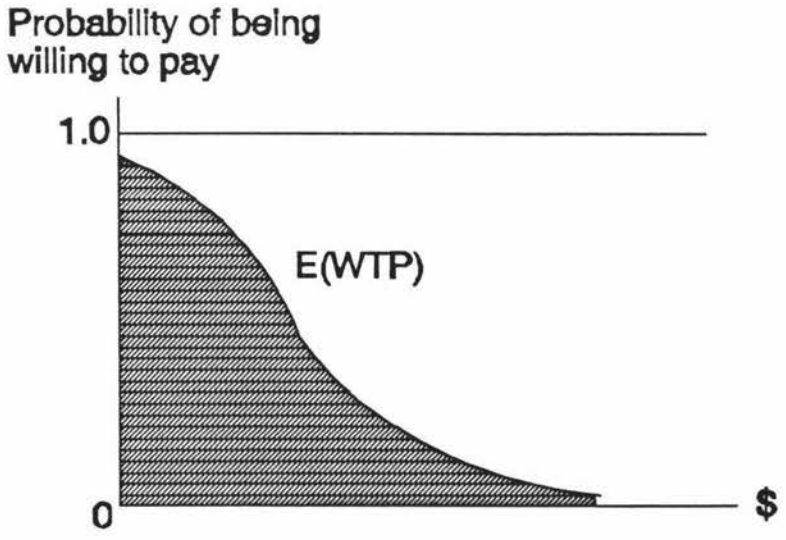


Figure 2.7 Expected Willingness To Pay
(Source : Kerr, 1986)

This method allows for a mail survey and might not require visual aids. It also seems free from the influence of strategic behaviour since the respondent will say "yes" if their willingness to pay is greater than or equal to the price asked, and say "no" if otherwise (Hoehn and Randall, 1987 in Mitchell and Carson, 1989).

3. The Analysis Of Data

The data from bidding games, open-ended question, and the payment card approaches normally allows for simple straight forward analysis. However, problems may arise when there are zero bids or extreme values bids (very high and very low bids) of willingness to pay, which need to be analyzed without hampering the level of representativeness of the sample.

Randall, Hoehn and Tolly (1981) in Devousges, Smith and Fisher (1987) asserted that estimates from contingent valuation surveys may be affected by the procedures employed to determine the final sample used in the analysis of responses. Zero bids obtained by survey can be interpreted as :

1. Legitimate expression of the value of the good indicating that the good is not worth anything, or that this is all the respondent could afford.
2. As a protest reaction toward the payment vehicle or a rejection of the idea of assigning a dollar value to the valuation item (Devousges, Smith and Fisher, 1987).

For these reasons, valid zero (legitimate zero) bids can be included in data analysis while others are excluded. In practice it requires follow up questions to ascertain whether the respondents really place no value on the resource or are expressing a protest (Bishop and Heberlein, 1987).

A study led by Devousges, Smith and Fisher (1987) used the t-test to examine the prospects for differences in means between zero and non-zero bidders. They are also used a logit analysis to examine the potential

determinants of zero bids. The extreme values (very high and very low bids relative to the mean) may indicate a false bid (Brookshire, Ives and Schulze, 1976 in Devousges, Smith and Fisher, 1987). These outliers can be identified by employing a statistical index based on the influence that each observation has on the estimated regression coefficient (Devousges et al.,1983, in Edwards and Anderson, 1987).

In addition, Edwards and Anderson (1987) revealed sample related biases in estimates of aggregation benefits resulting from sampling errors and non-response biases. Both problems can be handled by using systematic approaches such as Chi-square comparisons of distributions among variables between the sample and the population, and between respondents and non-respondents respectively.

Data analysis in the dichotomous choice approach calls for econometric models such as the logit model, to predict the probability of accepting an offer as a function of the stated price and other socio-economic variables. Subsequently, the probability is used to calculate either the mathematical expectation of maximum willingness to pay or, the median value (where the probability of acceptance equals 0.5)(Bishop and Heberlein, 1987).

SOIL EROSION

New Zealand's geographic setting is geologically young with a dynamic tectonic setting. Earthquakes along the many active faults are frequent and rates of uplift are high, more than 4 mm annually in many parts of the country. Major volcanic eruptions have occurred in the central North Island throughout the Quartenary and continue to the present. (Blaschke, 1991; Jakobsson and Dragun, 1991).

Mountains and hilly landscape dominate New Zealand. Mountainland

above 1000 m occupies around 20 % of the land area while at least 40 % is steep, non arable hill country below 1000 m referred to as 'hill country' (Blaschke,1991).

New Zealand's climate is extremely variable and rapidly changeable. There is a very steep rainfall gradient between the wet western flanks of the axial ranges and the 'rain shadow' areas to the east. Northern and eastern districts are also subject to moist northerly airstreams, associated with complex depression and tropical cyclones, causing high intensity or prolonged rain (Blaschke, 1991).

The wholesale clearance of forest and tussock and conversion to grazed pastures following the arrival of European settlers led to an increase in the extent and severity of erosion (Eyles, 1983).

1. The Nature Of Erosion

The action of erosion by water involves the process of detachment, transportation, and deposition of soil particles (ASAE, 1977). The major erosive agents are impacting raindrops and runoff water flowing over the soil surface (ASAE, 1977).

Detachment is the dislodging of soil particles from the soil mass by the erosive agents. Transportation is the entrainment and movement of detached soil particles (sediment) from their original location. Sediment travels from upland sources through the stream system and may eventually reach the ocean (ASAE, 1977), some might be deposited at the base of slopes, reservoirs, and on flood plains along the way (ASAE, 1977).

Detachment and transport are basic processes occurring on source areas while transport and deposition are basic processes occurring on sink areas. Soil Particles are detached by either raindrop impact or flowing water.

Individual raindrops strike the soil surface at velocities up to 9 m/second creating very intense hydrodynamic forces at the point of impact (ASAE, 1977).

Multiplication of the amount of soil particles detached by a single raindrop by the number of drops in a rainstorm (several million/square meter) shows that raindrop impact is a major producer of sediment and can easily detach more sediment over landflow on short slopes (ASAE, 1977).

2. Type Of Erosion

The following section describes soil erosion types occurring in New Zealand, derived from Eyles' article in 'The Distribution And Severity Of Present Soil Erosion In New Zealand'.

Types of erosion can be divided into 3 general groups : surface erosion, mass movement erosion, fluvial erosion.

Surface Erosion

Three erosion types have been recorded under this general group : sheet, wind and scree.

Sheet Erosion

Sheet Erosion was recorded where it was considered that bare ground was losing a thin layer of soil by sheet flow. In North Island the most severely affected being in Tongariro National Park and the Kameka Range, while in the South Island the most severely affected areas are inland Marlborough, inland Canterbury and Central Otago.

Wind Erosion

Wind erosion was recorded where it was considered that bare ground was losing soil particles by detachment and transportation by wind. In the North Island wind erosion is very localised and occurring in three main

environments :

- areas of dune sands
- ash covered slopes aver 700 metres above sea level
- argilite hill and terrace country on the eastern side of Southern Hawkes Bay and Wairarapa

Scree

"Scree" was recorded wherever significant accumulations of loose, often angular, rock debris mantled slopes. No distinction was made between stable scree, and presently active scree erosion. In the North Island 'scree' is concentrated along the axial greywacke ranges and on the central volcanic mountains. In the South Island over 75 % of the total area of which scree was recorded was in the sub-alpine and alpine region, 49 % being underlain by greywacke and a further 34 % by schist.

Mass Movement Erosion

Mass movement erosion is extensive throughout New Zealand, covering 44 % of the North Island and the 30 % of the South Island. Five types were identified : soil slip, earth slip, debris avalanche, slump and mudflow erosion.

Soil Slip Erosion

Soil slips are rapid sliding (or flowing) movements of soil and subsoil exposing a slip surface which is approximately parallel to, and usually less than one metre below, the original surface. Soil slip erosion is widespread with most slopes greater than 15 ° in the North Island being susceptible except the slopes on Taupo Pumice Formation (or younger tephras).

Earth Slip Erosion

Earth slips are rapidly sliding or flowing movements of soil and subsoil which expose a concave slip surface usually extending to more than one

metre below the original surface. Earth slips occur in more deeply weathered sediments than soil slips and therefore generally result in greater volumes of debris per unit surface area. The slip scars are frequently eroded further by rill erosion before revegetation occurs.

Debris Avalanche Erosion

Debris avalanches are rapid flows or slides on steep slopes which result in long narrow slip scars. They have been mapped in two distinct environments, both of which are on steep (greater than 25°) slopes. The distribution of this type of erosion is restricted to the mountainlands or steep forested hill country in the North Island, and steep tussock hill and mountainlands as well as the forested mountain country in the South Island.

Earthflow Erosion

Earthflow is a flow of soil and underlying regolith, characterised by retention of surface cover, often broken by tension cracks and smaller secondary movements. Such flows do not result in a separate slip scar and debris. Earthflow is a very general term encompassing a wide variety of flow types, from deep seated to shallow, and from slow to rapidly moving.

Slump Erosion

Slumps were recorded where the landslide is characterised by a rotation movement along a curved slip surface.

Mudflow Erosion

Mudflow erosion was taken as very rapid earthflows caused by very high water content of earth and rock. The only area of occurrence noted was in the severely earthflow eroded areas of the Gisborne-East Cape region where it has occasionally occurred in the centre of major earthflows.

Fluvial Erosion

Four types of erosion were recorded in this grouping : rill, gully, tunnel gully, and streambank.

Rill Erosion

Rill erosion was mapped where the bare ground contained numerous, closely spaced channels resulting from removal of surface soil by overland flow. These channels were less than 60 cm deep and less than 30 cm wide- larger ones were mapped as gullies. Generally, rill erosion was restricted to recently cultivated rolling and hill slopes.

Gully Erosion

Gully erosion was mapped where distinct channels that were larger than rills had been formed by running water. Gully erosion is the third most extensive erosion type recorded in the North Island and the sixth in the south Island.

Tunnel Gully Erosion

Tunnel gully erosion was recorded where surface cave-ins, initiated by sub-surface tunnelling, or gullying resulting from these cave-ins, were observed. Tunnel gully erosion is more extensive in the North Island and less extensive but more severe in the South Island. In the North Island tunnel gully erosion most commonly occurs on the strongly weathered sandstone downland and hill country and the colluvial slopes of the Tertiary hill country.

Streambank Erosion

Streambank erosion was recorded where soil or underlying material was removed from the bank by stream action. Only in a very few cases was a map unit defined on the basis of stream bank erosion alone. Severity assessments were also difficult, usually because only relatively small areas of soil were eroded, often within stopbanks.

3. Economic Aspect Of Soil Erosion

Water erosion and encroachment by wind blown sand have been major factors affecting the rate of soil loss in the Manawatu Wanganui Region. To overcome these, works were carried out under subsidies made available to stabilise sand dunes for productive use and to protect adjacent productive land from encroachment by wind blown sand. Subsidies were also provided to land owners to carry out a variety of soil conservation works, including tree planting, retirement fencing and improvement of drainage (Manawatu Wanganui Regional Council, 1991).

There is an argument that analysis of policy measures to reduce the external costs of land degradation associated with agricultural and forestry land use requires estimates of the private and external costs, which sum to the social costs, and the social benefits of production. The private cost include the cost of land degradation borne by the individual land user, while the external cost is the cost of land degradation borne by others beyond the source of production. The social benefits are equivalent to the net revenue generated from production (Blyth and McCallum, 1987).

McConnel, 1983 (in Blyth and Mc Callum, 1987) has developed an economic model for analysing the optimal private and social use of land resources. It is assumed that the land user aims to maximise the present value of the stream of profits from the land and the value of the land at the end of planning period. So, the land user will degrade the land resource to the point where the return with the additional soil erosion is equal to the cost, which is the profit foregone as a result of the loss of future productivity and the decline in the terminal land value as a consequence of soil loss.

However, the presence of some forms of land degradation, such as sheet erosion, may not be obvious. Therefore, it is possible that some land

degradation may not be accounted for by individuals in their land purchasing decisions, even though it may have an impact on productivity and returns from the land (Blyth and McCallum, 1987).

The measurements made on hillslopes in the Wairarapa and in Hawkes Bay show declines in potential productivity (due to soil losses) of 18 % (Manawatu Wanganui regional Council, 1991; Hawley, 1987). This decline is a cumulative, long term one, having crept up on the farmers over a period of 100 years, at an average at 0.18 % each year. Therefore, no farmer could detect the 0.18 % loss in potential productivity (Hawley, 1987).

Hence, Hawley (1987) puts forward four tenets which are economically not appropriate to be applied to soil conservation.

(a) Beneficiaries of soil conservation works are identifiable - the farmers - and they should pay the full cost.

In fact, there are not only farmers, but the people who are engaged in dependent industries (shearers, stock transporters, freezing workers, etc) gain the added value products of the land in the same sense that the farmer does. They are so numerous and so well distributed throughout the population that it is appropriate for subsidies to be paid by the whole population i.e. by central government.

On average farms change ownership every 7 years and price is not strongly influenced by the existence of soil conservation measures designed to preserve productivity in the long term.

(b) A farmer can judge best what he should spend his money on : he should not have his judgement distorted by subsidies.

Returns on successful preventive soil conservation measures will be correspondingly small but cumulative long term ones. Unless encouraged by subsidy to do so, he will otherwise invest in things which produce a much more immediate return.

(c) Market forces will sort everything out for the best.

Market forces are always "this year's" market forces. These are of limited relevance because virtually all soil conservation undertakings are dominated by the 5 to 50 year outlook, i.e by consideration of the welfare of the future generations rather than of maximizing profits this year. So, market forces do not necessarily sort everything out for the best.

(d) Future benefits should be discounted to "present value".

The practice of discounting future benefits implies a policy of "the welfare of future generations is of less monetary value to present generations.

Currently the subsidies are using public funds, with two fold rationales: first, it is argued that not all the benefits of soil conservation accrue to the landowner. Rather, some of the benefits are " off-site'. Second, it is argued that even the "on-site" benefits of soil conservation accrue very slowly, and that many are enjoyed only by the future generations (Manawatu-Wanganui Regional Council, 1991).

Pre-1987 the principal influence and targeting of subsidies has been the landowners' ability and willingness to contribute rather than the recognition of 'on-site' and or 'off-site' benefits generated from the soil erosion control. It has been difficult to make a convincing case for continued public subsidy to soil conservation. Data relating to off-site benefit are simply lacking, so it has been difficult to refute claims that the majority of the costs should be borne by the landowner.

The lack of 'off-site' benefit data is partly attributable to an attitude that the off-site benefits of soil conservation are self-evident; and partly attributable to a failure to allocate resources to identification, targeting and monitoring of off-site benefits.

However, in 1987 central government drastically changed the funding for soil conservation. While some funding for soil conservation might still be available under Resource Management Grants, the criteria for such funding would require much more precise identification of, and targeting for, off-site and inter-generational benefits, and closer monitoring of performance in achieving these benefits.

Because of the reductions in central government funding, intervention with subsidies to physical works is unlikely to be sustainable at present levels. Alternative means of addressing under-investment in soil conservation may have to be considered, including increased use of regulatory powers e.g by controls over inappropriate land use (Manawatu-Wanganui Regional Council, 1991).

CHAPTER THREE
SOIL RESOURCES IN
PALMERSTON NORTH AND MANAWATU

LAND USE HISTORY

Agriculture has been the most important sector in the New Zealand commercial economy over the last 140 years of European occupation (McKenzie, 1982). In fact, even before any human colonisation of New Zealand, at least 75 % of its land area was forested until about 1200 years ago (Wards, 1973 in Blaschke, 1991). However, considerable transformation of the vegetation cover began upon polynesian occupation, and the rate of deforestation increased along with European contact and settlement (Blaschke, 1991). The settlers converted the soil into resources for their living requirements and in purpose of productivity they replaced large areas of native forest, tussock, and swamp vegetation with either crop or pasture grassland (Gibbs, 1976). Large areas of forest were also heavily modified by timber extraction (Blaschke, 1991). Deforestation occurred by hand-felling of forest trees followed by burning and sowing of grass for extensive pastoral use (Blaschke, 1991). Until the present day land use is still dominated by pastoralism. Farmed land occupies just over 60 % of the total area of New Zealand although grazed pasture and crop land accounts for only about two thirds of this (New Zealand Department of Statistics, 1990; Newsome, 1987 in Blaschke, 1991).

PALMERSTON NORTH AND THE MANAWATU

The transformation of the vegetation of the Manawatu began at the time of its settlement by the Europeans (1859). The vegetation mainly consisted of forest, with portions in scrub, dune vegetation, swamp vegetation, and natural grassland. Much of these areas have been converted to farm land in less than a century (Esler, A.E. 1964).

The City of Palmerston North is situated on an alluvial plain laid down initially by the Manawatu river and subsequently overlaid by the flood plain of the Mangaone and Kawau streams (Universal Business Directories, 1993).

The original settlement of Palmerston North began on a natural clearing situated on a gravelly terrace which extended from the present business centre to Terrace End.

Initially settlement of the town was concentrated on the gravelly soils of the original site and areas such as Hokowhitu and Takaro remained largely undeveloped because these areas were liable to flooding from the Manawatu river and the Mangaone stream. With further expansion of the population and stopbanking of the Manawatu river and Mangaone stream, remaining areas were steadily urbanised and by about 1949 new moves were made to incorporate areas of land from Kairanga County into the City boundaries (Cowie and Osborn, 1977).

1. Climate

Palmerston North has a typical New Zealand climate. The temperature range from day to day is small compared to world standards. The daily maximum in January is 21.9 °C, in July it is 11.9°C (Universal Business Directories, 1993). Overnight temperature in Palmerston North fall below zero on average of only 14 times a year.

Rain is evenly spread throughout the year with a winter maximum and summer/autumn minimum. There are on an average between 150 and 175 rain days per year. Heavy rain is not a feature of Palmerston North, either in short or long durations. The City has an average rainfall of just 995 mm (Information Centre Palmerston North, 1990).

2. Recreation And Sport

Palmerston North provides facilities for leisure time and visitor attractions. Some of the many recreation activities people can enjoy include fishing, golf, and horse riding. A range of walking tracks such as The Riverside Walkway and Bridle Track extend from Maxwell line to Staces Rd, providing a beautiful walk along the Manawatu River. Tracks, river, courts, pools, rinks, links, and fields allow participation in many activities and sports. There is also whitewater rafting, jetboating, fishing and camping trips in the Manawatu providing to satisfy the most rugged adventurers (Universal Business Directories, 1993).

SOIL RESOURCES IN PALMERSTON NORTH AND MANAWATU

For the purpose of the Town and Country Planning Amendment Act 1973 which states in section 2B that 'as a matter of national importance' there should be avoidance of encroachment of urban development on, and the protection of, land having a high actual or potential value for the production of food'; Cowie and Osborn (1977) classified 3 classes of soil of the Manawatu and Palmerston North City recognized as high, moderate and low value. The high class is subdivided into high actual value and high potential value. The rating is outlined as follows :

Class 1a. Soils of high actual value for food production

Soils of high actual value for food production include the river flats of the Manawatu, Orua and Pohangina rivers. They are deep, friable and well drained loamy soils with good physical characteristics, this coupled with their high natural fertility makes these soils suitable for a wide range of intensive uses including town milk supply dairying, nurseries, orchards, market gardening and specialised crops such as strawberries, tomatoes and asparagus.

The area of soils which are of high actual value for food production is fairly

limited in this district and much of it has already been taken up with urbanisation within the city and by recreational and industrial development in the Kairanga County. The two main remaining large areas of these soils occur in the Te Matai Road area and at States Road near Aokautere.

Class 1b. Soils of high potential value

Soils which are of high potential value for food production include Parewanui, Kairanga, Opiki, Makerua and Te Arakura soils and occur mainly to the west and south-west of the city in the Kairanga, Lockwood, Longburn and Te Arakura districts. They are deep soils, ranging from fine sandy loams to clay loams and peaty loams with high to moderately high levels of plant nutrients. They have a slight to moderate limitation of imperfect to poor natural drainage, but with adequate drainage these are versatile soils suitable for intensive uses such as market gardening, cash crops for example peas, potatoes, maize, wheat or barley and town milk supply dairying. Production under these uses is high. However, deterioration of topsoil structure is also likely to occur with continuous cropping and periodic spelling under pasture is required.

Class 2. Soils of moderate, actual or potential value for food production

Soils of moderate, actual or potential value for food production occur mainly on the terrace country north of the city towards Ashhurst and Bunnythorpe, and east of the Manawatu River in the Aokautere, Fitzherbert, and Linton districts. The soils have moderate limitations for cropping. and these limitations include imperfect to poor natural drainage; poor physical characteristics such as compact subsoils and weakly developed soil structure; and wide variations in moisture content during the year from very wet in winter to very dry in summer. Many of these limitations are difficult or impossible to correct and land use is not as versatile as in class 1 soils and is restricted to dairying, fat-lamb farming

and cereal cropping in rotation with pasture. Even with these uses, artificial drainage of the land is necessary and with dairying, care has to be taken in winter to avoid pugging of the ground.

Class 3. Soils of low actual or potential value for food production

Soils of low value for food production occur on frequently flooded flats bordering the rivers and in hilly and steep land of the Tararua Range and dissected terrace land. This land, because of its liability to flooding or steepness of slope is not considered suitable for cash cropping, but is suitable for pastoral farming or forestry.

Kelman (1964) divided the Manawatu Catchment Board into six Soil Conservation Regions. Soil conservation can be defined as 'the use and treatment of land in a catchment for its overall benefit over a long term period'. Thus, it is inappropriate to only consider soil conservation in the Manawatu District, because two-thirds of the catchment of the Manawatu River lies to the east of the Tararua ranges and Ruahine ranges. The division are : Greywacke Areas; 'Papa' and Limestone Areas; Rolling and Moderately Steep Areas; Coastal Sand Areas; The Unconsolidated Steep Inland Sandstone Area; and mainly Flat or Undulating Area. Palmerston North City is located in the mainly flat or undulating area, as depicted in Figure 3.1.

Greywacke Areas

Greywacke is found in the Tararua, Ruahine and Waewaepa Ranges. The higher parts of these ranges are unsuitable for farming and are best left under forest. In fact, a cover of forest is desirable in order to prevent the extensive development of screes and the associated movement of shingle to the main streams.

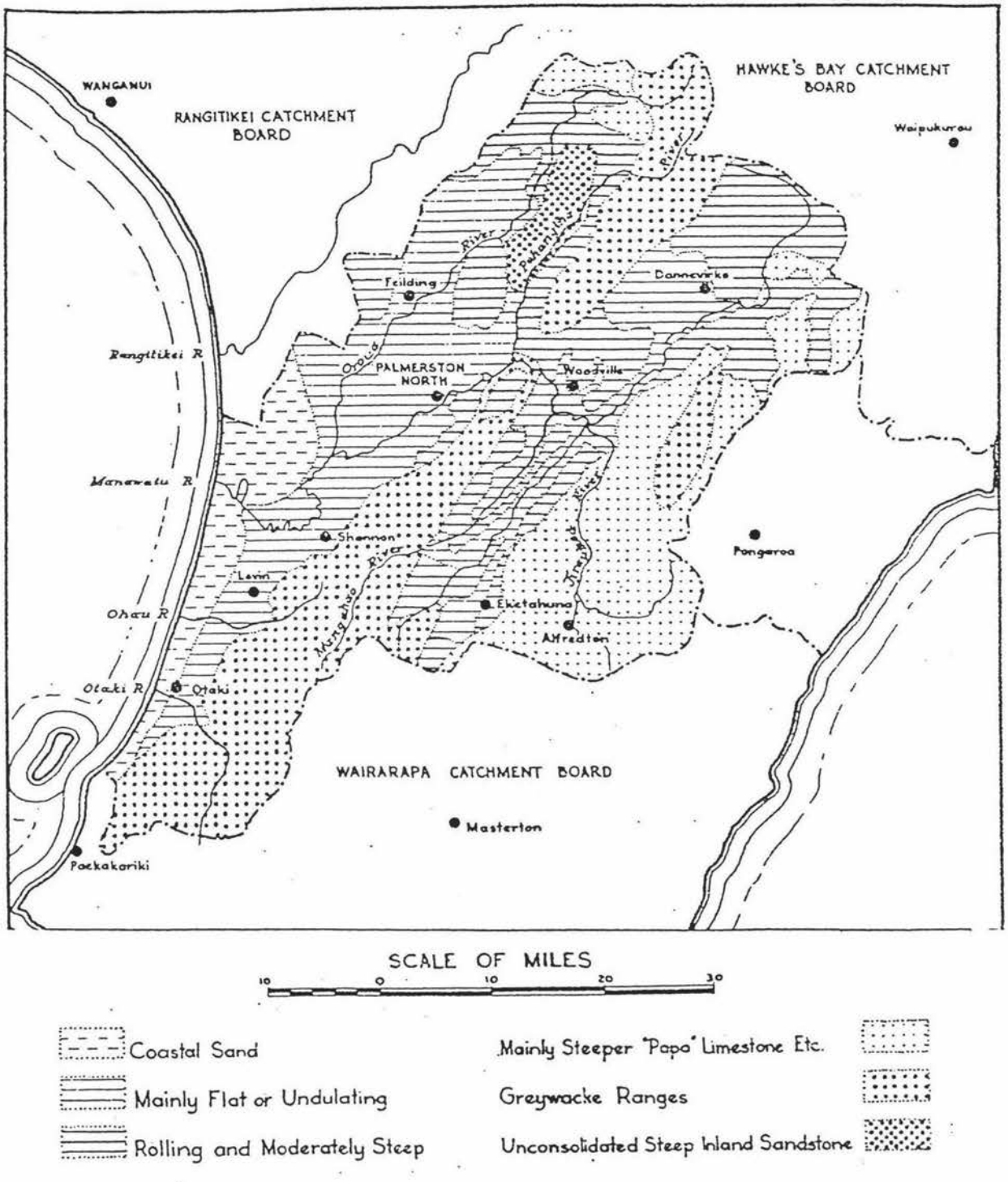


Figure 3.1. Manawatu Catchment Region

The key to the conservation of the forest areas in the Manawatu is in the control of pests: goats, deer and the opposums. One of the most critical forest areas in the Manawatu Catchment is the Kamihi Forest. Two problems have arisen here. First, the main canopy is very susceptible to opossums. Second, the leatherwood and turpentine plant zone together with the higher beech forest immediately below and the tussock grassland above, is very susceptible to deer.

Some of the lower greywacke areas have been developed for farming. The two principal factors involved in preventing much of this land from being reduced to shingle screes are rabbit control, and pasture improvement in place of frequent burning programmes. Aerial topdressing has undoubtedly been an important element in the fight against reversion and in the establishment of improved pasture cover on both sides of the range.

'Papa' and Limestone Areas

'Papa' and Limestone areas, which include a variety of types of generally steep country, are found typically on the eastern side of the Manawatu Catchment and also near Rangiwahia. The actual and potential erodibility of these areas varies with the type of underlying rock.

It has been clearly shown, that the older rocks which occur towards the east coast, typically crushed mudstones, bentonitic mudstones and argillites, are subject to some of the most serious forms of erosion, such as gully erosion, large-scale slumping and flow erosion. If such areas are to to remain in farming without serious erosion, strategic planting of willows and poplars, particularly against gully erosion, is required. Already several farmers have begun planting programmes along these lines.

Rolling and Moderately Steep Areas

These areas are subject to large slumps and flow erosion wherever the

underlying rocks strata dips down towards stream beds. Two factors contribute to this erosion problem : first, water which percolates through bands of shingle and sand to finer grained rocks below causes a 'greasy back'; second, gully or bank erosion in the stream at the bottom removes the toe of the slump.

On the rolling country many farmers use one or two years for supplementary feed cropping before sowing back to pasture. This practice does not create serious erosion problems, for only in exceptionally high intensity storms does sheet wash and rill erosion take place. These can be prevented by graded banks and diversion banks which are designed to check surface drainage.

Coastal Sand Areas

The present condition of the coastal sand belt varies from very unstable sand dunes to well developed stable pastures and forests. The two major factors influencing susceptibility to sand drift erosion are the age of the soil and the position of the water table.

Work on sand stabilisation has been mainly confined to dealing with isolated 'blows' on farms. These can be stabilised by fencing and treatment, although in many cases this may not be the most economic or best approach. the laying of hay and effective farm management appears a less costly line of defence.

The Unconsolidated Steep Inland Sandstone Area

This area of approximately 40,000 acres of steep sandy country is the Manawatu Catchment Board's number one priority for soil conservation work. Representing less than 3 percent of the total Manawatu Catchment, it is at the present time the contributor of at least half the silt to the Manawatu River. The streams from this area drain into the Pohangina

and Orua Rivers which carry their heavy silt load to the Manawatu River.

The main source of silt is severe canyon gully erosion which typically occurs in storms of very high intensity with rain falling at a rate of up to 2.5 inches per hour. Fortunately such storms are of short duration, but once active gully erosion has commenced low intensity storms can do considerable damage and keep the gully erosion active.

It should be noted that gully erosion affects the farming of the area in several ways. Fences are wrecked, grazing land and cattle are lost, there are difficulties in mustering and problems of access.

Two lines of approach to the canyon gully problem suggest themselves. One is to restore something equivalent to the original forest cover so that peak run off into gullies is reduced to its quantity during the pre-farming days. The other is to strengthen all places where water is channelled, so that degrading and gullying cannot occur. The former must play at least some part in some of the most severely affected gully catchments. The latter, however, need involve no major upset in present land utilisation. By the use of the willow and its dense fibrous root system serious gully erosion can be effectively prevented. The usual practice is to plant the willows in pairs, one on each side of the gully channel, at suitable intervals along the channel course. The willows can be supported by poplar plantings where necessary on the gully slopes.

In some cases active control methods for gully erosion are more elaborate and expensive. The particular approach varies with the circumstances of each gully. Sometimes flood retention dams, large dams with small pipes through them so that water can be held back during peak storms to drain away slowly through the pipe later, are used to cut down the peak quantity of water which flows down the gully. The same effect is achieved with

pine trees planted in the catchment above the gully. Various structures are used to gain stability of the gully bottom. In every case work done has the ultimate aim of establishing willow or poplar growth in the gully bottom and side channels.

The Manawatu Catchment Board has intensified its efforts in the area and is getting a very positive response from farmers. The approach used is to draw up, with cooperating farmers, farm programmes which integrate protection against erosion with other good farming practices. Tasks include the establishment of small nurseries to grow the best material for planting; an emphasis initially on prevention planting; the fencing off of gullies in the interest of erosion control and in order to prevent stock losses and the establishment of farm woodlots where appropriate. Farm management practices such as subdivision, oversowing and topdressing are recommended in order to get the correct protection planting established and increase in farm production.

In 1975 the Ruahine Range Control Scheme Committee, a sub committee of the Soil Conservation and Rivers Control Council was formed due to concern about erosion in the Ruahine Range and its possible effects on downstream river systems. Part of Palmerston North City (See Figure 3.2) is located on the Lower Manawatu River Flood Control Scheme which is one of the control schemes of river catchments in the Ruahine Range.

There is evidence that erosion is widespread throughout the range and it has increased since the 1940's. The present erosion rate is estimated to be about 25 m^3/ha/year, which is high by New Zealand and world standards (Cunningham and Stribling, 1978)

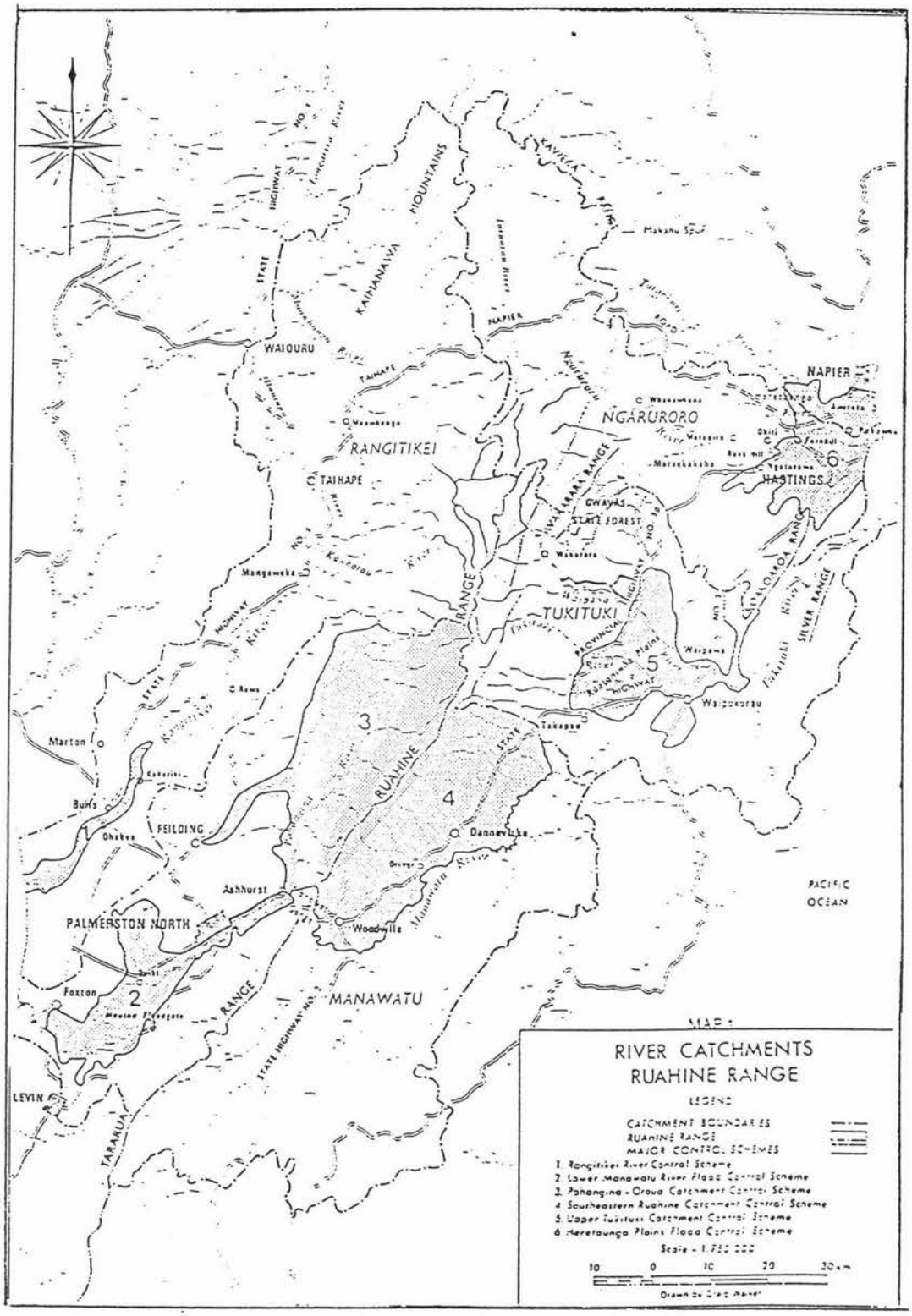


Figure 3.2. River Catchments Ruahine Range
Source : National Water And Soil Conservation and New Zealand Forest Service

CAUSES OF EROSION

Following is a summary from Cunningham and Stribling (1978) outlining the causes of soil erosion originating in the Ruahine Range.

Although erosion is a natural process, in recent years the frequency of its occurrence in the Ruahine Range has increased. It is common on steep slopes throughout the range often without clear relationship to known geological or botanical patterns. There are few signs of forest recolonisation on old erosion scars. Many scars are so active that it seems impossible for plants to become re-established.

Concern over large quantities of shingle entering the upper river channels has led to speculation on the causes of erosion. It is important to understand the causes in order to appreciate the significance of the erosion, or to plan for its control.

Most observers agree that there must be several factors predisposing a hill side to mass movement. These generally include lithology, geological uplift, water saturation and unsatisfactory condition of the vegetation. The latter is often linked with fires, introduced animals, or storms. There has also been some speculation on the influence of climatic change, and the possibility of an increase in earthquake frequency.

The report postulates that most of these factors contribute to erosion and that introduced animals by modifying the vegetation have played a most important part in initiating erosion. On sites lacking a protective cover of vegetation (i.e. on a burnt over area or on slip faces) the cloven hooves of sheep, goats and deer have initiated sheet erosion. Where this occurred on porous soils (particularly in the northern Ruahines), frost heave, rain splash, and wind blow caused rapid extension of the erosion, culminating

in coalescence of eroded areas which have now become erosion pavement or debris falls. Animals have penetrated throughout the forests, feeding off the more palatable plants and thus favouring the growth of less palatable species. Where this process has been gradual, the forest structure and water regulating factors have been preserved in spite of a change in species composition. Where the process of the change has been too fast to allow the forest to adjust, many species have been subjected to unaccustomed physiological stresses. Ill thrift and even collapse of a portion of the forest has followed, sometimes finally precipitated by storms. Herbaceous plants now tend to occupy sites which formerly carried trees. Evapotranspiration is reduced, and the soils are more frequently saturated. As the dead tree roots decay, the site becomes more vulnerable to mass movement. Landslides occur during high intensity rainfalls, depositing soil and logs in the stream channels. Freeze and thaw erosion of the exposed rock subsequently supplies rock particles into stream channels.

SIGNIFICANCE OF EROSION

Cunningham and Stribling revealed that erosion rates in the Ruahine Range appear to have increased during recent decades. Little is known of the long term average rate of erosion, but one calculation places it at about 16 m^3/ha/year. Estimates of recent erosion rates range from 20 to 34 m^3/ha/year. It appears that present Ruahine erosion rates may be in the vicinity of 25 m^3/ha/year.

The increased rate of erosion is causing gravel to accumulate in river channels flowing out of the range. In headwater channels the quantity of gravel held in storage fluctuates noticeably. For example after a heavy rainstorm large quantities of fresh gravel up to several metres deep may be found in upper stream channels. During successive small storms most of this material is carried downstream.

In the southeast Ruahine Scheme area, surface water is used for municipal, domestic, and stock purposes, particularly from the Tamaki, Manawatu, Raparapawai, Kumeti, and Mangatera Rivers.

The Manawatu River below the gorge is a source of water for irrigation, industry, and stockwater. The river has limited recreation uses. About 500,000 m^3 of gravel is extracted per year in the vicinity of Palmerston North. Gravel is also extracted from the Pohangina and Orua Rivers (15,000 m^3 per year and 45,000m^3per year respectively).

The problems of the southeast Ruahine catchment are :

1. Deposition of gravel on farmland which can severely affect small farm units that are marginally economic.
2. Channel and bank instability, caused by excessive bed load, changes in stream bed gradient, sharpening of flood peaks, and the piedmont riparian vegetation change from forest to grassland.
3. Periodic flooding which is aggravated by perched rivers and reduced waterways under bridges.
4. Manual alteration of channels to improve drainage, of which the Kumeti stream is the prime example.
5. The Mangaatua catchment has in its lower reaches special problems due to backing up of Manawatu floodwater. This occur during high flows , the Manawatu river in the basin rises because of the constricting effect of the gorge. This causes water to back up in the Mangaatua, particularly if it also has a high flows. In this lower reach the Mangaatua flows between terraces up to several metres high, with smaller terraces above of these. The Manawatu Catchment Board has attempted to alleviate the flooding of these terraces, techniques including the stripping of top soil, raising the terrace levels with the gravel from streambed, and replacing with soil. Flooding in lower reaches of the Mangaatua is aggravated by inadequate waterway areas

beneath road and rail bridges.

Minor problems exist in the Pohangina River, including bank undercutting (due partly to river control works narrowing the channel) and siltation of the berm.

A major problem shared by the Orua and Pohangina catchments is an area of approximately 16,200 ha of steep sandy outcrops prone to gully erosion. The Manawatu Catchment Board prepared the Pohangina- Orua Catchment Control Scheme in 1968 to deal with these problems and this scheme also provides for channel stabilisation in the Pohangina and Orua Rivers.

An increase in the erosion rate of catchment headwaters along the southwestern Ruahine could lead to further farm and road damage along the eastern banks of the Pohangina River and possibly to aggradation of this river depending on the degree of gravel extraction downstream.

Provided the headwater vegetation is restored to and maintained in good health, no immediate problems can be envisaged in the Orua catchment.

A survey undertaken by Manawatu Catchment Board in 1976, has shown that at present there appears to be a balance between the extraction of metal and its replenishment from upstream sources. Bank erosion has been taking place along the river channel and the Catchment Board has been placing riprap to protect the banks.

The review of soil conservation activities by Manawatu-Wanganui Regional Council (1991) revealed that erosion in the region is widespread and most significant throughout the region's hill country area, and on the recent coastal sand country from Waitotara to the region's southern boundary.

Below is the report taken from soil conservation activities review by Manawatu - Wanganui Regional Council, 1991.

Mass movement erosion forms are widespread in the region. Around 35 % of the region is prone to varying severity of soil slip and earthflow erosion with wind erosion affecting a further 8 % of the Region.

However reformation of soil and eroded areas does occur, but the rate of which is dependent on the rock type and rainfall influencing the rate of weathering. Studies in the Wairarapa hill country (DSIR Aokautere) showed soils take in excess of 50 years to return to within 80 % of the pre-slip productive capacity.

River bank erosion and debris deposition forms occur predominantly in the alluvial plains in the Rangitikei and Manawatu Catchments. Clearing of native vegetation near the early settlement left rivers free to erode alluvial banks and change course, resulting in significant areas of high quality alluvial soils being replaced with poor quality gravels. River bank protection is carried out by the Regional Council through river engineering schemes, which also protect stopbanking works.

The Review also recognised economic consequences of soil erosion for it is a continuing risk. Continued monitoring and maintenance are required to ensure the works remain effective. Yet, there are still significant areas which remain untreated. Therefore, if cash subsidies to soil conservation works were reduced or removed entirely it is unlikely that many of these areas will be treated, unless knowledge of the benefits of soil conservation become much more widespread.

WATER AND SOIL MANAGEMENT

Before the period of the Labour Government of 1984, a high level of assistance was given to all forms of agricultural production in New Zealand. Most government assistance was directed to increasing agricultural production. There were specific policies such as Livestock Incentives Scheme, aimed at increasing stock numbers, while others such as the Land Development Encouragement Loans encouraged the clearing of new land. Price support schemes and fertiliser subsidies, encouraged farmers to use or develop marginal land. Ironically some of this marginal land then attracted subsidies for soil conservation works to control the land degradation problem which was the result of the higher production pressure stimulated by the original subsidies for development (Jakobsson and Dragun, 1991).

Most catchment authorities have preferred to encourage conservation works which attract government subsidies, such conservation works include afforestation or revegetation in high country, building stopbanks and floodgates as well as tree planting along the streams and river channels, and also on-farm conservation measures. On-farm works consisted mainly of tree planting, pasture improvement and land retirement. Farmers were given assistance to develop their land as a trade off for retiring their heavily eroded land or accepting restriction on land use in the form of limitations on stock numbers or grazing time. The Forest Service carried out wild animal control on public land and mountain revegetation (Jakobsson and Dragun, 1991).

In 1987 there were subsidy reductions in the Budget which required cost sharing in soil conservation to be assessed in terms of the nations, the region's and the individual's contribution. The assesment also required that as far as practicable direct beneficiaries of activities were identified

and must contribute to costs according to benefits they received (Manawatu-Wanganui Regional Council, 1991). In the budget of 1987 the Government decided to introduce a new basis of grant funding. This grant system was referred to as a block subsidy. It was provided for national funding to a level of 35 %. In the 12 month financial year 1990/1991 Central Government provided about $ 42,500,000 per annum to Water and Soil activities through Vote Environment. The change to a 35 % grant rate resulted in a reduction funding level to around $26 million per annum (Manawatu-Wanganui Regional Council, 1991).

THE MANAWATU-WANGANUI REGIONAL COUNCIL

The Manawatu -Wanganui Regional Council came into being on the 1 of November 1989. It is an amalgamation of 40 former authorities from within the Manawatu-Wanganui Region, included are Catchments and Regional Water Boards, United Councils, Noxious Plants Authorities, Pest Destruction Boards, and Drainage Boards. In addition, it has taken on devolved function from Central Government. The Manawatu-Wanganui Region has an area of 22179 km. The region is comprised of the following constituences :

	Population
Tararua	19475
Horowhenua	29476
Palmerston North	70318
Manawatu	27182
Rangitikei	16649
Wanganui	45082
Ruapehu	18104

Parts of Waitomo, Stratford,
and Taupo Districts are within the

Manawatu-Wanganui Region 330
(Manawatu-Wanganui Regional Council, 1992)

Prior to the act, legislation tended to focus on central control by the Government. The Resource Management Act (1991) changes the emphasis and devolves a large proportion of policy formulation and management responsibilities to regional and local levels. The Resource Management Act 1991 superseded 54 statutes including much of the Soil Conservation and Rivers Control Act 1941, and all of the Water and Soil Conservation Act 1967, and Town and Country Planning Act 1977 (Manawatu-Wanganui Regional Council, 1992)

The mission of the Regional Council is to ensure the natural and physical resources of the Manawatu-Wanganui Region are sustainably managed for the benefit of present and future generations.

The Council has some discretion as to how it funds activities. The Rating Powers Act 1988 sets out the Council's powers to make and levy rates, although the Act does limit the type of rating system which can be used. The range of funding options for the Council includes :

- Loans
- General rates based on capital value
- Classified rates. These rates are collected on a basis to reflect benefit eg. river protection works
- Differential rates. Some services may be related to population and residential need, eg. urban transport.
- Government grants and subsidies, eg.land transport
- User pays, fees and cost recoveries. This is justified for some Council functions, eg. consent administration and compliance monitoring
- Income from investment, eg. activities beneficial to the Region which are the ownership or part ownership of the Council providing a return on

investment eg. Port companies

For 1992/1993 the Council's total estimated funding from revenues and reserves is $ 17,101,327 (including GST), with the sources of funds and its proportion depicted in Figure 3.3.

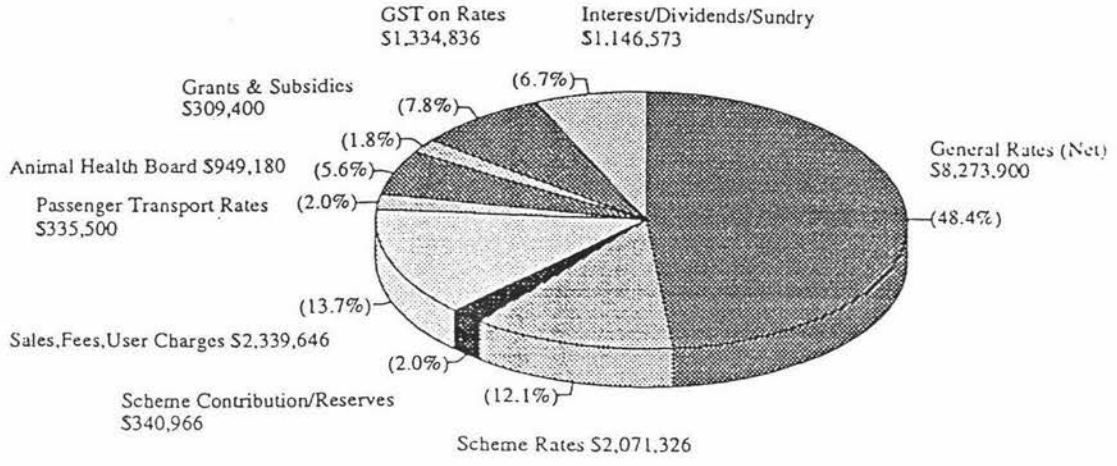


Figure 3.3. Source Of Funds 1992/1993
Source : Corporate Plan & Annual Plan 1992/1993
Manawatu - Wanganui Regional Council

The general rate expenditure is allocated as outlined in Figure 3.4

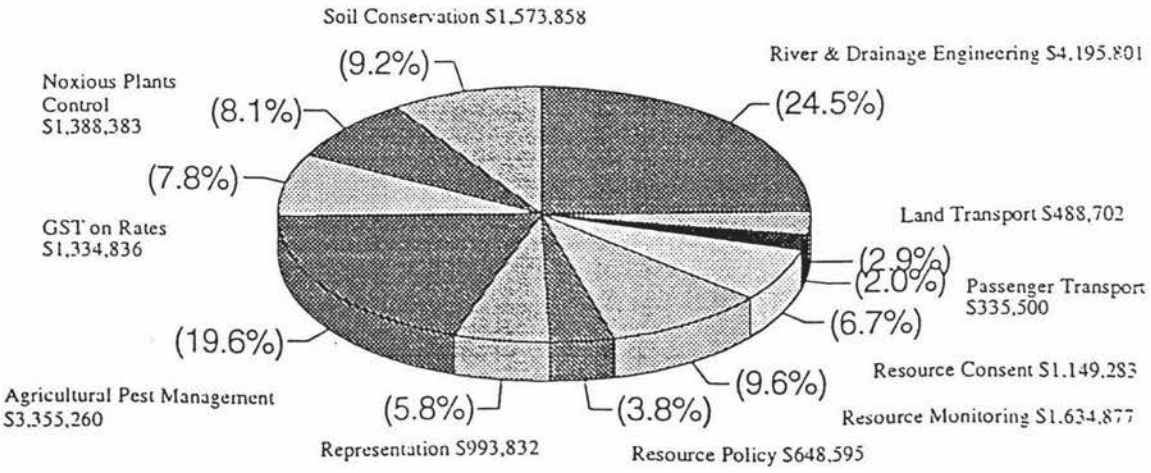


Figure 3.4. Indicative Costs For 1992/1993
Source : Corporate Plan & Annual Plan 1992/1993
Manawatu - Wanganui Regional Council

The Annual Plan of 1992/1993 proposes maintenance at current cost levels. The general rate chosen for the Manawatu-Wanganui Region is $ 76.34 per $100,000 of equalised capital value. The indicative city and districts general rating is depicted in Figure 3.5.

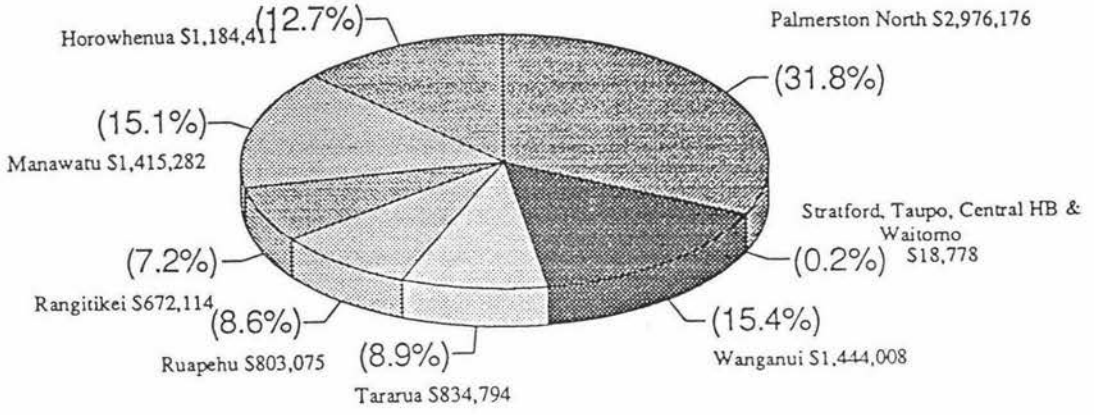


Figure 3.5. General Rates Distribution 1992/1993
Source : Corporate Plan & Annual Plan 1992/1993
Manawatu - Wanganui Regional Council

As had been mentioned earlier, cost sharing by beneficiaries is required to pursue the erosion control. Therefore, the identification of the benefit of soil erosion control needs to be assessed. In the survey, the assessment is addressed to the downstream beneficiaries in particular Palmerston North and surrounding areas for an attempt has not yet been made to quantify the benefit of soil erosion control received in this area.

CHAPTER FOUR
FRAMEWORK AND METHODOLOGY

CONTINGENT VALUATION METHOD

The contingent valuation method (CVM) is carried out by setting up a hypothetical market for goods for which otherwise no market exists. People are confronted with the hypothetical market and are asked how much they would be willing to pay to obtain a higher quality of resources or how much they would be willing to pay to prevent having a lesser degree quality and/or quantity of the environment.

1. The Strengths

When dealing with the total value of natural resources or environment, non-use values have to be considered as well as use value. To do so, many researchers have used contingent valuation method. For example, Greenley, Walsh and Young, 1981; Devousges, Smith and Fisher, 1987; Thayer, 1981; Schulze, d'Arge and Brookshire, 1981.

One of the advantages of contingent valuation is its flexibility, particularly in valuing environmental commodities or aspects of environmental commodities which are difficult to value using other benefit estimation techniques (Carson in Braden and Kolstad, 1991; Pearce and Turner, 1990). The method also directly obtains willingness to pay or willingness to accept of respondents for having indifferent utility position of having increment or decrements in the quality/quantity of the good being valued.

The *ex ante* valuation by participants allows uncertainty to be introduced in the framework while assuming that participants in a constructed market naturally take into account both the uncertainty in their demand and any revealed uncertainty of supply when they make their decisions (Carson in Braden and Kolstad, 1991).

Moreover, besides valuing the good in question, a contingent valuation market is also able to evaluate the institutional context in which it would be provided, and the way in which it would be financed (Pearce and Turner, 1990; Mitchell and Carson, 1989).

This method lends itself to a mail survey approach which means saving of time and money.

2. The Weaknesses

The contingent valuation method suffers some shortcomings concerning the accuracy of the result, due to potential biases (Hufschmidt et al., 1983; Kerr and Sharp, 1987, Mitchell and Carson, 1989). The four principal biases associated with the contingent valuation method are as follows:

1. Hypothetical Bias

Being hypothetical, i.e an actual market does not exist, respondents may not able to assess the true value of the public goods. They also may lack an incentive to determine their own preferences. To reduce the possibility of this bias occuring, the situation must be made as real as possible to encourage people to behave as if they would face a real life situation. This require a carefully designed questionnaire a realistic situation and payment instrument(Kerr, 1986; Thayer, 1981).

2. Strategic Bias

This bias occurs when a respondent gives a willingness to pay amount that differs from his/her true willingness to pay amount (conditional on the perceived information) in an attempt to influence the provision of the good and/or the respondent's level of payment for the good. For example, if respondents believe that the actual fee will be contingent on their offer they tend to bid lower than their true value.

To overcome this bias, contingent valuation surveys should avoid making suggestions that the good will be provided whatever the respondents says, and there should be no evidence that this contingency lacks credibility (Mitchell and Carson,1989).

One approach to reduce the incentive to bias the result is to emphasize the hypothetical nature of the survey (Kerr, 1986). However, empirical tests of strategic bias have not found it to be a major problem (Bohm, 1972; Scherr and Batt, 1975); Smith, 1976 in Hufschmidt et al, 1983).

3. Instrument Bias

Instrument bias arises from the choice of the 'vehicle', or instrument of payment used in the approach. Such vehicle include changes in local taxes, entrance fees, surcharge on bills, and so on. Respondents may be 'sensitive' to the vehicle used (OECD,1989). Randall et al., 1974 (in Harris, 1983) showed that instrument bias can significantly affect willingness to pay (WTP) results, but careful design and testing should alleviate most of the problem.

4. Information Bias

Information bias results from incomplete or misleading statements about the proposed changes (Hufschmidt, et al., 1983). The nature of a hypothetical situation may not enable respondents to completely visualize all changes or predict the actions of others (Kerr, 1986).

To avoid the biases one should build the linkage within the contingent market between the environment attributes, institutional setting, and the bidding instrument, which must be realistic and acceptable to the respondents. Also one needs to establish a concise contingent market i.e "good" must be well defined (Schulze et al., 1981 in Kerr, 1986).

The existence of these biases does not necessarily invalidate the results obtained. Rather, it indicates that the contingent valuation method cannot be used for fine economic decision making, but it does provide some information on the likely values of non-market goods and services, which is useful in decision making (Kerr, 1986)

CVM APPLIED TO SOIL EROSION

The purpose of the survey is to value the benefit of current erosion control and of improved levels of control. Because many of the impacts of soil erosion occur beyond the boundaries of the properties where the erosion is present, any control measures will benefit people within and beyond the property boundaries. Presumably the value of these benefits could be elicited from those people that stand to gain from erosion control. This includes the benefit of simply knowing that soil is being maintained or even enhanced, in light of future uncertainty regarding the use of these soils.

Given the constraints of time and money, the survey was carried out by mail survey and the contingent evaluation method was chosen to estimate the uncertain benefit of soil erosion control.

Two willingness to pay questions were introduced in different format. A question dealing with soil conservation measures was put in an open-ended question format, whereas the question with respect to willingness to pay for increased level of soil erosion control was placed in a binary response question.

To analyze the two willingness to pay answers, two models are employed, a regression model and a logit model. The regression model is used to

analyse the relations between different explanatory variables and the WTP. The logit model is used to measure the probability of raising funds used for additional soil erosion control measures.

The question dealing with WTP was placed after a scenario which emphasized any possible impact of soil erosion on Palmerston North and this was succeeded by the hypothetical statement: " *If we now assume that from next year onward all soil erosion control work will be funded from a special fund set up for this region and to which all households in this region will be asked to contribute (which would mean that people will no longer be charged for soil erosion control work in their rate bill) then....*"

The dichotomous choice question was preceded by a statement describing the uncertainty of the effect soil erosion would have in the long term. To deal with the uncertainty a particular bid above and over the amount of WTP stated earlier was offered to assure that more soil erosion control work will be put into place.

QUESTIONNAIRE DESIGN

In order to achieve a reasonable response it was important that the questionnaire was plausible and relevant. This called for thoughtful questionnaire design. Mitchell and Carson (1989) give some points to be considered in drawing up a scenario:

1. The Property Right

   Respondents have to be note that they are currently paying for a given level of supply, and they might have improved level of the goods over the current status or potential declines in the absence of sufficient payments.

2. Disposable Income

Respondents have to realize that WTP would place them in a fixed long term obligation. Related to the unit of analysis, if the household is the unit of analysis then the income reference should be the households' income.

3. The Nature of The Public Goods

The particular type of public goods being valued should be explained and described clearly to avoid respondents valuing any other improvements of other goods which are actually not intended to be valued in the survey.

4. The Relevant Prices of Other Goods

If there is a change or effect on other goods caused by the change in the public good, this impact has to be conveyed to the respondents. With this information respondents could take the impact of the change on their buying patterns into account.

In respect to the above requirement the questionnaire was designed to include a scenario which could arouse the awareness of soil erosion existence. The arousal of awareness was required to make the survey plausible for respondents and thereby encouraging people to respond. This is accommodated on the first two paragraph of questionnaire : *" A feature of some of soil types in Manawatu regions is that they are structurally unstable and erosion prone under cultivation. Also the coastal sands in the Manawatu region are extremely susceptible to wind erosion if their vegetation is disturbed..... The impacts of soil erosion not only affect the private land owners but also the region and appear in various forms...."*

The survey audience was also informed that current levels of soil erosion control are partly financed by their rate bill, thus they might have been

stimulated to participate in the survey as they would feel entitled to evaluate the use of the fund.

The contribution of participants was stated in yearly payments so that respondents would realize that WTP would imply a long term commitment; in this survey the payment would be withdrawn from pre-tax household income.

Furthermore, the nature of soil erosion was explained. However it was not an easy task, since soil erosion takes place in a variety of ways. Therefore, the questionnaire also described, where possible, the visible soil erosion effects that might occur in the region.

Other indicators obtained from the questionnaire were socio - economic variables of respondents, recreational participation rates people derived from outdoor recreation or enjoyment in Palmerston North and the opinions on various policies that could be used to collect money for soil erosion control.

To avoid instrument bias, several payment method options were presented, for example : existing system (Rate Bill), income tax, special fund/proposed system and any option which respondent prefer and to be specified.

SAMPLING FRAME AND PROCEDURE

With Palmerston North and the Manawatu lying in the major river catchments of the Ruahine Ranges the effects of soil erosion are felt in the region.

To obtain the sample for the survey area, the Telephone Directory was

used. The reasons for so doing were, it was reasonably up to date, that it reduces the duplicate household problem which usually found in using electoral role, and that it could be done at an acceptable sampling cost (Kirkland, 1988). Additionally, the area defined in the directories is part of the survey area.

To randomly draw a sample, four names was chosen from every page of '1992 Manawatu Telephone Directory'. Due to limited time and research funds, 1.58 % of population, that is equal to 520 households, were chosen as participants in the survey. Before the survey was carried out, a pilot survey was sent to 20 respondents, followed by reminder letter two weeks later. The result was 40 percent or 8 responses received with the range of WTP falling between $ 0 - $ 50. Later, this range was used as a bid offered in close ended question. The question about people's valuation of soil erosion control, as asked in the pilot, was reviewed for the survey and a new paragraph explaining soil erosion conditions in the Manawatu was added to the final survey.

Both questionnaire, pilot survey and survey, were sent with personal address and introduction letter with Massey University Letterhead. Free-post return envelopes were also provided.

The main survey questionnaires were posted by 8 February 1993 and two weeks later (22 February 1993), 380 reminder letters were sent out. The cut off period was set at two weeks after the reminder letter was sent. Responses which arrived after this point were not included in the data analysis. A second reminder letter and the use of a telephone were not used in the survey. To use these methods required additional two weeks of time and this could not be afforded.

CHAPTER FIVE
RESULT AND DISCUSSION

CHARACTERISTIC OF RESPONDENTS

Of the 520 questionnaires that were sent out, 163 (31.35 %) were returned as valid responses. The relatively low level of response was due to factors such as wrong address, refusal to participate in survey because soil erosion was not a concern, and not capable of answering the questionnaire because of old age. These reasons are presented in Table 5.1.

Table 5.1 Questionnaire Responses

Type of Response	Respondents	Percentage
Valid responds	163	31.35
Non valid (not completely/poorly filled)	10	1.92
Refuse to participate, soil erosion is not a concern	10	1.92
Too old	18	3.46
Wrong Address	42	8.08
No response	277	53.27

Gujarati (1988) indicated that it is common for researchers using questionnaire type surveys to get less than or at most 40 percent response. Brown et al., 1989, showed that saliency of the topic in combination with the type of survey audience, the amount of hypothetical questions used, the number of pages, the height of the type used and the month the survey is implemented in are all statistically significant predictors of response rate.

For this survey, the audience turned out to be heterogenous in terms of socio - economic factors and interest, since the public good being valued is not attached to any specific amenity or user group. This lack of attachement to a specific amenity of interest causes the survey to be more susceptible to non-respondent bias when using a mail survey. Moreover, the pilot survey that was implemented during the summer term (including the Christmas and New Year holiday) also had a low return rate (40 %), which meant that little input was present to improve the survey design.

From the valid responses received, the social economic characteristics of the sample are summarised in Table 5.2. The Table showed that the survey mainly reached non-farmer respondents (96.3 %) which is appropriate with the purpose of this survey being to value uncertain benefit of soil erosion control from non users.

Households are almost equally distributed among the income groups, with the smallest percentage coming from the group with income of less than $ 10,000 (8.7 %). Households with two members (45 households ,27.6 %) are the most frequently occurring households in the sample population. Fifty two (31.9 %) respondents are in the age range of 25 - 40 years, while the second biggest group of respondents is from the range age of 40 - 55 years old (45 people, 27.6 %). The elderly who participated in the survey represent 7.4 % of respondents. The proportion of respondents living in Palmerston North and outside Palmerston North are 75.3 % , 24.7 % respectively.

Table 5.2. Characteristics of Respondents

Characteristics	Number of Respondents	Percentage	Missing
Sex			
1. Male	106	65.0	
2. Female	57	35.0	
Occupation			
1. Unemployed	72	44.7	
2. Employed/non farmer	83	51.6	
3. Farmer	6	3.7	2
Income ($, annually)			
1. Less than 10,000	14	8.7	
2. 10,001 - 20,000	35	21.7	
3. 20,001 - 30,000	32	19.9	
4. 30,001 - 40,000	29	18.0	
5. 40,001 - 50,000	23	14.3	
6. 50,001 +	28	17.4	2
Number Of Household Member (Person)			
1	34	20.9	
2	45	27.6	
3	35	21.5	
4	27	16.6	
5+	22	13.4	
Age (years)			
17 - 25	13	8.0	
26 - 40	52	31.9	
41 - 55	45	27.6	
56 - 70	41	25.2	
70 +	12	7.4	
District			
Palmerston North City	122	75.3	
Outside PN City	40	24.7	1

AWARENESS OF THE EFFECT OF SOIL EROSION

To find out whether people are aware of the existence of soil erosion or not, they were asked about any noticeable effect of soil erosion in their area. This indicator is recorded in Table 5.3.

Table 5.3. Awareness of Noticeable Soil Erosion Effect

Awareness	Answer	Number of Households	Percentage
Notice any effect of soil erosion	YES NO	89 74	54.6 45.4
Total		163	100.0

People who noticed effects of soil erosion were requested to specify the impact of soil erosion on them and the landscape and the severity of this impact, this is depicted in Table 5.4

Those aware of the effects of soil erosion, particularly noticed flooding as one soil erosion effect, 35.18 % and 13.6 % saw it as a bad and severe problem respectively. Thirty percent of respondents noticed landscape scaring as a moderate problem and 33,8 % thought it was a bad problem. As many as 42.6 % of respondents stated that decline in soil stability is not a problem. Declining land productivity was perceived as a moderate problem by 48.6 % of respondents, whereas decline in water recreation was a moderate problem for 30.2 % of respondents.

However, there are a large numbers of respondents who did not identify any particular effects of soil erosion as a noticeable effect, as for flooding,

Table 5.4 Soil Erosion Effect and Its Severity

Type	Flooding	Landscape Scaring	Decline of Soil Stability	Decline in Land Productivity	Decline in Water Recreation
No problem	2 (2.5 %)	6 (7.5 %)	26 (42.6 %)	8 (11.4 %)	14 (22.2 %)
Slight Problem	13 (16.0 %)	16 (20.0 %)	14 (23.0 %)	18 (25.7 %)	13 (20.6 %)
Moderate Problem	26 (32.1 %)	24 (30.0 %)	9 (14.8 %)	34 (48.6 %)	19 (30.2 %)
Bad Problem	29 (35.8 %)	27 (33.8 %)	10 (16.4 %)	9 (12.9 %)	9 (14.3 %)
Severe Problem	11 (13.6 %)	7 (8.8 %)	2 (3.3 %)	1 (1.4 %)	8 (12.7 %)
Total	81 (100 %)	80 (100.1 %)	61 (100.1 %)	70 (100 %)	63 (100 %)

this number was as many as 82 respondents (50.3 %), landscape scaring and decline of soil stability the number made up by 50.9 % and 62.6 % of respondents respectively. As many as 57.1 % and 61.3 % respondents did not identify decline in land productivity and water recreation as an effect of soil erosion.

Other ways in which soil erosion affects the respondent/household are listed below:

- pollutes water supply (moderate problem)
- increases track maintenance (moderate problem)
- road and walkways affected (bad problem)
- shingle beds in rivers (bad problem)
- wind eroded soil (bad problem)
- denuding of vegetation (bad problem)
- dust (severe problem)
- river bank erosion (moderate problem)
- soil erosion creates continuing ongoing costs of schemes (bad problem)
- flooding in golf course (bad problem)
- soil erosion affects the work failing (slight problem)

OUTDOOR RECREATION

One of the possible effects of soil erosion is its impact on recreational quality in the region. Some of the recreational activities in which respondents participated in Palmerston North and surrounding areas is illustrated in Table 5.5.

Table 5.5. Outdoor Recreation and Enjoyment Derived in Palmerston North

Frequency Type	Very Often	Often	Sporadic	Seldom	Never
Fishing	4 2.5 %	7 4.3 %	35 21.5%	45 27.6 %	72 44.2%
Boating	0 0 %	4 2.5 %	13 8.0 %	52 31.9 %	94 57.7 %
Water Sports	5 3.1 %	13 8.0 %	30 18.4%	35 21.5 %	80 49.1 %
Tramping	4 2.5 %	11 6.7 %	35 21.5%	40 24.5 %	73 44.8%
Picnicking	7 4.3 %	32 19.6 %	60 36.8%	27 16.6 %	37 22.7%
Enjoying Scenery	42 25.8 %	51 31.3 %	42 25.8%	3 1.8 %	25 15.3%

Enjoying the scenery is the type of recreation most households in the sample noted as important (57.1 % for frequency very often and often), even though 25 respondents (15.3 %) stated that they did not consider it as something they enjoyed. Sixty households (36.8 % of the sample population) went picnicking sporadically, whereas the other activities households enjoyed sporadically were taking pleasure from scenery (25.8 %), tramping (21.5 %), fishing (21.5 %), water sports (18.4 %) and boating (8 %). Boating is the type of recreation fewest respondents participated in,

as many as 57.7 % never took part in this activity.

Other outdoor activities which respondents specified are listed below:

- sports : rugby, cricket, golf, lawn bowls, cycling, running
- camping
- walking
- deer shooting

Table 5.6 shows the number of outdoor activities people participated in in Palmerston North.

Table 5.6. The Number of Different Types of Outdoor Recreation Activities Derived in Palmerston North

Total Activities	Number of Household and Its Percentage
0	3 (1.84)
1	18 (11.04)
2	24 (14.73)
3	35 (21.47)
4	15 (9.20)
5	10 (6.14)
6	46 (28.22)
6 +	12 (7.37)
Total	163 (100)

The table shows that 46 households (28.22 %) participated in 6 different types of outdoor activities in Palmerston North, whereas only 3 households (1.84 %) did not participate in any outdoor recreation at all in Palmerston North.

Presumably, people who are very often engaged in outdoor recreation would be more aware of the impact of soil erosion on the quality of the

recreational environment. Table 5.7 illustrates this by grouping respondents into those who are aware and those who are not aware.

Of those who very often participate in fishing, 2.45 % stated that they did notice an effect of soil erosion and those not aware, did not fish very often. Of those who took part in fishing, regardless of the frequency of participation, 34.36 % noticed the effect of soil erosion, whereas 22.09 % of respondents stated they did not see any effect. 25.15 % of respondents who joined in boating activities recognised the effect of soil erosion while the other 17.17 % did not. For water sports, 26.38 % of respondents never participated in, and were not aware of any effect of soil erosion whereas other 22.70 % who never enjoyed the water sports perceived the impact of soil erosion. Water sports was an outdoor recreation for 31.90 % of people who are aware of the soil erosion effect and were joined by 19.02 % of respondents who did not perceived the effect of soil erosion. For tramping, the percentage of respondents who were aware of soil erosion and very often took part in this outdoor enjoyment was equal with those who were not aware of soil erosion impact, that is 1.23 %. However, from 11 respondents who often participated in tramping, 7 (4.29%) noticed the effect of soil erosion while the other 4 (2.45 %) respondents did not. There were 7 respondents (4.29 %) who very often enjoyed picnicking, and all of them had noticed soil erosion effects. Enjoying scenery was participated in very often by 15.95 % of respondents who are aware of the impact of soil erosion and joined by 9.82 % participants who did not perceive any effect of soil erosion.

From the results in the Table, it follows that the more often people participate in a particular recreational activity the more likely they will be aware of the effects of soil erosion which could reduce their respective utility. The same holds for people who participate in a large number of outdoor activities. These results are presented in Table 5.8.

Table 5.7. Outdoor Recreation and Awareness Of The Effect Of Soil Erosion

	Very Often	Often	Sporadic	Seldom	Never
Fishing					
Aware	4 (2.45)	3 (1.84)	22 (13.50)	26 (15.95)	34 (20.86)
Not Aware	0 (0.00)	4 (2.45)	13 (7.98)	19 (11.66)	38 (23.31)
Boating					
Aware	0 (0.00)	3 (1.84)	10 (6.13)	28 (17.18)	48 (29.45)
Not Aware	0 (0.00)	1 (0.61)	3 (1.84)	24 (14.72)	46 (28.22)
Water Sports					
Aware	5 (3.07)	7 (4.29)	21 (12.88)	19 (11.66)	37 (22.70)
Not Aware	0 (0.00)	6 (3.68)	9 (5.52)	16 (9.82)	43 (26.38)
Tram-ping					
Aware	2 (1.23)	7 (4.29)	25 (15.34)	18 (11.04)	37 (22.70)
Not Aware	2 (1.23)	4 (2.45)	10 (6.13)	22 (13.50)	36 (22.09)
Picnic-king					
Aware	7 (4.29)	21 (12.88)	32 (19.63)	8 (4.91)	21 (12.88)
Not Aware	0 (0.00)	11 (6.75)	28 (17.18)	19 (11.66)	16 (9.82)
Enjoying Scenery					
Aware	26 (15.95)	25 (15.34)	23 (14.11)	3 (1.84)	12 (7.36)
Not Aware	16 (9.82)	26 (15.95)	19 (11.66)	0 (0.00)	13 (7.98)

Table 5.8 Awareness And Total Outdoor Activities

Total Activities	0	1	2	3	4	5+
Aware (%)	0.61	5.52	6.13	11.66	4.91	25.77
Not Aware (%)	1.23	5.52	8.59	9.82	4.29	15.95

Table 5.8 illustrates that 41.72 % enjoyed 5 or more types of outdoor recreation, 25.77 % of them are aware of the effect of soil erosion compared with 15.95 % who were not.

PAYMENT VEHICLE

More than one method of collecting money was proposed to respondents to identify the most suitable elicitation method and to avoid protest value towards payment vehicle (method of collecting money) as well. This is important since when people do not understand or do not accept the payment vehicle, the issue of vehicle bias may appear and the response may not be a true indication of willingness to pay (Sandrey, 1986). Before introducing the options for methods of payment, it was explained that the money to be collected would go into a special fund for soil erosion control (this was done, to create a neutral payment vehicle so as to avoid vehicle bias). However, it was also clearly stated that current soil erosion control is carried out by the Regional Council which is partly financed by rate payers and the fund devoted to soil erosion control would replace current rating for soil erosion (see Appendix 2). The people surveyed were asked to give their opinion on which vehicle they preferred. The results are presented in Table 5.9.

Table 5.9 Method of Collecting Fund for Soil Erosion Control

Policy	Agree	Not Agree
Existing System (Rate Bill)	107 (66.05 %)	55 (33.95 %)
Income Tax	20 (12.35 %)	142 (87.65 %)
Proposed System	28 (17.28 %)	134 (82.72 %)
Other	7 (4.32 %)	155 (95.68 %)
Total	162 (100 %)	162 (100 %)

Note: there is one missing value.

Other ways of payment put forward by respondents are listed below :

- people causing erosion and reap the profit from it have to pay/have to be charged
- taxes for higher income groups
- local tax for all people, not just for wage/ salary
- dedicated tax or land owner rebates for reafforestation programmes carried out by landowner
- work in return for benefit
- national levy

As many as 107 respondents (66.05 %) prefer soil erosion control to be paid from rates as is currently done, whereas only 28 (17.28 %) households would like to have a special fund set up for soil erosion control as was proposed.

PRESERVATION VALUES VERSUS USE VALUES

To measure preservation values, respondents were asked to weigh the importance of soil erosion control in respect to present use, future use, existence value and bequest value. Present use value is the utility derived for the next 10 or so years; future use value is the benefit that may be

enjoyed by the households for the years 10 and beyond; existence value is the satisfaction of just knowing sufficient soil is being maintained for future use, and bequest value is the desirability to endow future generations with sufficient environmental quality.

From the non-zero bid, the weight for each value was recorded in Table 5.10, which showed that 3 (2.83 %) and 6 (5.66 %) respondents put an importance value of 76% to 100 % toward existence value and bequest value respectively, whereas the use value for either present or future use was only 1 respondent for the same range of weight.

As many as 83.02 % respondents rated the importance of present value and future value at 0 - 25 %; 63.21 % and 42.45 % of the respondents gave the same weight of importance to the existence and bequest values.

The average value of present use value was 17.13 %, for future value the average weight was 18.01 %, whereas existence and bequest value had an average weight of 23.99 % and 35.33 % respectively.

Putting these average values in proportion was calculated by dividing each average value by the total mean weight value and multiplying it by 100 %. The results are as follows:

- Present use value 18.13 %
- Future use value 19.07 %
- Existence value 25.40 %
- Bequest value 37.40 %

Table 5.10 The Importance Weight for Preservation and Use Values

Range of Weight	Present Use Value	Future Use Value	Existence Value	Bequest Value
0 - 25 %	88 (83.02 %)	88 (83.02 %)	67 (63.21 %)	45 (42.45 %)
26 - 50 %	11 (10.37 %)	14 (13.21 %)	33 (31.13 %)	46 (43.40 %)
51 - 75 %	6 (5.66 %)	3 (2.83 %)	3 (2.83 %)	9 (8.49 %)
76 - 100 %	1 (0.94 %)	1 (0.94 %)	3 (2.83 %)	6 (5.66 %)
Freq. missing	57	57	57	57
Total	163	163	163	163

WILLINGNESS TO PAY FOR CURRENT SOIL EROSION CONTROL

To evaluate the benefit of the current level of soil erosion control, respondents were asked open-ended question to obtain their maximum willingness to pay (WTP).

The value of this variable was between $0 to $ 500 per year, as depicted in Table 5.11. Nine missing values were recorded for respondents who answered 'don't know' for the willingness to pay questions. However, the zero value reported may not be a genuine value; it could be a protest toward the question or the payment vehicle. To check this possibility, the answer from this question was compared with the answers to the question

asking for the reason why the respondent is willing or not willing to pay.

Table 5.11 Willingness To Pay Sample Population

Maximum Willingness To Pay ($)	Number of Households	Percentage
0	42	29.68
5	4	2.82
10	12	8.45
15	3	2.11
20	13	9.15
25	6	4.23
30	2	1.41
40	1	0.70
50	29	20.42
52	10	7.04
75	1	0.70
100	12	8.45
200	3	2.11
300	2	1.41
365	1	0.70
500	1	0.70
Total	142	99.98
Missing Value :	9	
Protest Value :	12	

An examination of the answers shows that 27 respondents expressed protests and 12 of them gave zero values to the open-ended question on willingness to pay for current control. The reasons for protest were :

- suspicious about the use of fund (7 answers)
- dissatisfied with current control
- those affected should pay
- catchment boards not fulfilling tight budget commitment
- funding should come from those who benefited (4 answers)

- regional council responsibility (2 answers)
- rate collection should cover any work (2 answers)
- those responsible for causing erosion should pay for its prevention, especially farmers
- central government and people outside the region should be made to pay (2 answers)

All zero values from the protest answers were not considered as genuinely zero, but were treated as missing value.

Some variables are cross tabulated with willingness to pay groups to see if there is any relation between them. Table 5.12 displays the cross tabulation among age, willingness to pay and the awareness of soil erosion impact.

Table 5.12 Cross Tabulation, Variable Age, WTP1 and Awareness

Age	Awareness	Willingness To Pay ($)			
		0 - 5	6 - 20	21 - 50	50 +
20 - 33	Aware (%)	16.25	15.63	21.87	12.50
	Not Aware (%)	12.50	12.50	12.50	6.25
34 - 40	Aware (%)	12.50	4.17	16.67	33.33
	Not Aware (%)	8.33	4.17	8.33	12.50
41 - 51	Aware (%)	3.33	10.00	20.00	23.33
	Not Aware (%)	10.00	20.00	10.00	3.33
52 - 63	Aware (%)	14.81	22.22	18.52	0.00
	Not Aware (%)	18.52	11.11	3.70	11.11
64 +	Aware (%)	17.24	10.34	6.90	3.45
	Not Aware (%)	44.83	0.00	13.79	3.45

Before discussing Table 5.12, it should be noted from Table 5.11 that from the 46 people who are willing to pay between $ 0 - 5 as many as 42 respondents (91.30 %) put $ 0 for the current control. Thereby, in general the WTP ranging from $ 0 - 5, mainly consisted of $ 0 value.

The table shows in the age group of 20 - 33 years old, 34.47 % respondents are willing to pay on WTP range $ 21 - 50, of which 21.87 % are aware of an effect of soil erosion and 12.50 % are not. The willingness to pay is higher in the age group 34 - 40 years where 33.33 % respondent are aware of soil erosion effect and 12.50 % were not aware but were willing to pay more than $ 50. In the age group of 41 - 51 years old 30 % respondents are willing to pay $ 6 - 20 and $ 21 - 50 respectively however 23.33 % from this group who noticed the effect of soil erosion were willing to pay more than $ 50 for current soil erosion control. As many as 22.22 % of respondents aware of soil erosion effects are willing to pay $ 6 - 20 in contrast to 11.11 % from those who were not aware in the same range of WTP. However, none of those who were aware in this age group are willing to pay more than $ 50 in contrast to 11.11 % who are not aware but willing to pay this amount for soil erosion control. The oldest age group (more than 64 years old) were concentrated in WTP of $ 0 - 5 (62.07 % of this age group).

The number of household member was also assumed to be one of many factors influencing willingness to pay for having soil erosion control. Table 5.13 illustrated the relation among awareness, number of household member and WTP of current level of soil erosion control.

Table 5.13 Cross Tabulation of Number Of Household Members, Awareness and Willingness To Pay Current level of Soil Erosion Control

Number of House-hold members	Awareness	Willingness To Pay ($) 0 - 5	6 - 20	21 - 50	50 +
1	Aware (%)	23.33	10.00	3.33	6.67
	Not Aware (%)	23.33	13.33	13.33	6.67
2	Aware (%)	10.81	10.81	16.22	5.41
	Not Aware (%)	29.73	10.81	10.81	5.41
3	Aware (%)	3.12	25.00	18.75	9.38
	Not Aware (%)	12.50	9.38	9.38	12.50
4	Aware (%)	8.00	4.00	28.00	36.00
	Not Aware (%)	0.00	12.00	4.00	8.00
5 +	Aware (%)	5.56	11.11	22.22	22.22
	Not Aware (%)	27.78	0.00	11.11	0.00

For the single household member group, the percentage of respondents who did not notice the effect of soil erosion, but were willing to pay for current soil erosion control, is the same or greater than the percentage of those who were aware. Households with 2 members who are willing to pay $50 or more have similar percentage to respondents who did not recognise the impact of soil erosion and for those who noticed the existence of soil erosion effects, that is 5.41 %. As for the group with 3 members in the household , 25 % of respondents were aware and were willing to pay $ 6 - 20 annually. A number of people who were willing to pay larger amounts were found in household with 4 members, as many as 28 % and 36 % were willing to pay $ 21- 50 and $ 50 or more, respectively. 27.78 % of

respondents who did not observe the soil erosion effects occurring in the area, appeared to have willingness to pay in the range of $ 0 - 5, whereas the other 22.22 % and 22.22 % of those who acknowledged the impact of soil erosion are willing to pay with the range $ 21 - 50 and $ 50 or more.

On the basis of occupation, one may assume that people who are unemployed are not as willing as those who are employed. Table 5.14 tries to outline these relations.

Table 5.14 Cross Tabulation of Occupation, Awareness and Willingness To Pay For Current level of Soil Erosion Control

Occupation	Awareness	Willingness To Pay ($) 0 - 5	6 - 20	21 - 50	50 +
Retired/ unemployed	Aware (%)	15.87	15.87	11.11	4.76
	Not Aware (%)	26.98	6.35	11.11	7.94
Employed	Aware (%)	5.41	10.81	20.27	20.27
	Not Aware (%)	13.51	13.51	9.46	6.76
Farmer	Aware (%)	25.00	0.00	25.00	50.00
	Not Aware (%)	0.00	0.00	0.00	0.00

As Table 5.9 shows, of the respondents willing to pay $ 0 - 5, 91.30 % put $ 0 for their willingness to pay. Supposing that this proportion remains constant in every occupation group willing to pay between $ 0 - 5, it appears that almost 42.85 % of respondents who are retired and or unemployed were not prepared to pay for soil erosion control. In contrast for the same range of willingness to pay ($ 0 - 5) only 18.92 % of the employed, non-farmer group recorded a willingness to pay in this range. The remaining 81.08 % of this group recorded a willingness to pay as follows : 24.32 % in the $ 6 - 20 range, 29.73 % in the $ 21 - 50 range and

27.03 % in the WTP more than $ 50. So it would appear that the employed, non-farmer group has a higher overall WTP to maintain the current level of soil erosion control. As might be expected, people who described themselves as farmers had the highest percentage (50 %) in the range of WTP of more than $ 50 per year to have the current level of soil erosion control.

As floods are recognised as one effect of soil erosion, people who live closer to rivers would be more willing to pay to have the current level of soil erosion control. Table 5.15 figures out the association of distance with willingness to pay.

Table 5.15. Cross Tabulation of Distance and Willingness To Pay For Current Level of Soil Erosion Control

Distance (km)	Willingness To Pay ($) 0 - 5	6 - 20	21 - 50	50 +
0.5 - 0.9	12.00	20.00	28.00	40.00
1.0 - 1.5	28.26	15.22	32.61	23.92
1.6 - 3.0	44.74	26.32	21.05	7.89
3.1 - 4 +	28.13	28.13	25.00	18.75

Forty four percent of respondents who were living 1.6 - 3 km from the nearest river indicated willingness to pay less than $ 5/year for current level of soil erosion control. In contrast the 40 % of respondents who live less than 1 km from the nearest river are willing to pay more than $ 50/year to maintain soil erosion control at the current level. While respondents living 1.0 - 1.5 km from the nearest river had the highest percentage (32.61 %) of respondents willing to pay on the range $ 21 - 50 per annum. Despite the high percentage of respondents not willing to pay (44.74 %) from the distance group of 1.6 - 3 km, 26.32 % of respondents were willing to pay $ 6 - 20 per year for current level of soil erosion

control. This range of WTP was fortified by 28.13 % of respondents living more than 3 km from the nearest river.

MODEL STATISTIC OF WILLINGNESS TO PAY FOR CURRENT SOIL EROSION CONTROL

A model, relating willingness to pay for current soil erosion control to a series of explanatory variables was formulated. Nine possible explanatory variables were included.

WTP1 = (AW, UT, HH, SX, AGE, OC, Y, DSC, DTR)

where:

WTP1 = Willingness to pay for current soil erosion control
AW = Awareness
UT = Total recreational participated in Palmerston North (0 - 8)
HH = Number of household members
SX = Sex of respondent (female= 0 , male = 1)
AGE = Age of respondent
OC = Occupation (retired, student, unemployed = 1, employee = 2, farmer = 3)
Y = Income (1 - 6)
DSC = Distance from the nearest river
DTR = District (Palmerston North = 1, outside Palmerston North = 0)

To obtain an adequate model explaining willingness to pay for soil erosion control, six test statistics were used. Three of them measure goodness of fit and evaluate the predictive accuracy of the regression equation, whereas the rest are tests of the individual variables in predicting willingness to pay.

1.Goodness of fit

1.1. R^2 - Coefficient of determination.

The quantity of R^2 is defined as the proportion or percentage of the variation in the dependent variable explained by the regression model (Gujarati, 1988). A high value of R^2 is associated with a good of fit of the regression line and low value of R^2 with a poor fit (Pindyck and Rubinfield, 1981).

1.2. Standard Error of Estimate

Standard error of estimate(s) measures the dispersion of the error term associated with regression line or the amount of deviation between actual and predicted WTP (Pindyck and Rubinfield, 1981).

$$s.e.e = \sqrt{\left[\frac{\Sigma (Y_i - \hat{Y}_i)^2}{n - p - 1}\right]}$$

where s.e.e = standard error of estimate

Y_i = WTP

$\hat{Y}_i$ = estimated WTP

(n-p-1) = degrees of freedom

1.3. Coefficient of Variation (CV)

CV provide a measure of the dispersion of the estimates (as do the sample estimates of variances) about their means. CV is simply the expression of:

$$CV = \frac{(100)\ s.e.e}{\hat{Y}}$$

where s.e.e = standard error of estimate

$\hat{Y}$ = estimated WTP

2. Test Statistics of Individual Regression Variables

2.1 Coefficient of Correlation (r)

Coefficient of correlation (r) is a measure of degree of linear association/linear dependence; so if X and Y are statistically independent (no linear relation), the correlation coefficient between them tends to be low or zero. The value of r is a number between -1 and +1 and this indicates how closely two variables move together.

2.2. t-statistic

The t-statistic is used to test the significance of regression coefficients. This test of significance approach tests whether the computed value of $ß_i$ lies within reasonable confidence limits around the hypothesized value. When the t-statistic value is relatively large, one can be relatively confident that $ß_i$ is significant in the prediction of independent variables.

2.3. F-test

The F statistic is commonly applied to test the hypothesis that none of the explanatory variables are able to explain the variation of the dependent variable about its mean. The null hypothesis can be expressed as :

H_0 = all regression coefficients = 0

İn single regression coefficient F-test reduces to a t-test as a ratio of estimated coefficients and estimated variance.

MODEL DEVELOPMENT OF OPEN ENDED QUESTION

Three stages of model development have been implemented to find the acceptable model of willingness to pay for the current level of soil erosion measurement. The dollar amount respondents revealed was grouped into ranges that break the population into approximately equal size groups. In this case the willingness to pay is grouped into 10 groups. Each group has its own score which are integers 0 to (n-1). The lowest value is in the first group; the highest value is in the last group. The specification is outlined

in Table 5.16 and the distribution is depicted in Figure 5.1.

Table 5.16 The Groups of Variable WTP

Group	Score	Value ($)
1	0	-
2	1	0
3	2	1 - 4
4	3	5 - 10
5	4	15 - 20
6	5	25 - 40
7	6	45 - 50
8	7	52 - 75
9	8	76 - 99
10	9	100 - 500

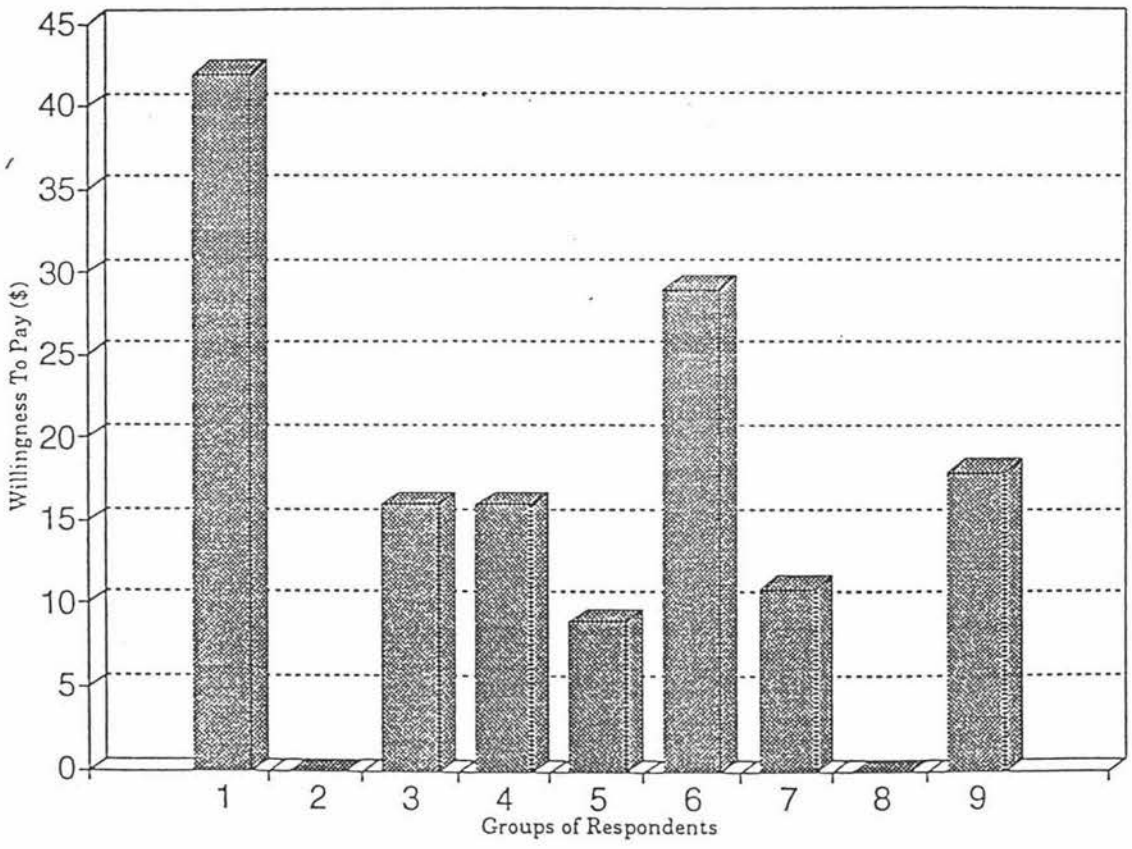
The next step was the estimation of the three models (Table 5.17). The inclusion of all 9 variables produced a model with an F value significant with $\alpha = 0.01$. However, some of the variables have a low level of t-statistic and the probability of acceptance of the null hypothesis lay outside the confidence interval of $\alpha=0.05$. This result suggested the exclusion of these variables (UT, Y, DTR, SX).

For both model 1 and model 2, the t-statistic for the intercept is relatively low and the null hypothesis that the intercept is zero under confidence interval of $\alpha= 0.05$ could not be rejected, which suggested the following modified model (model 3);

WTP1 = 0.4306HH + 0.9973AW + 0.0103AGE + 1.6951OC - 0.2429 DSC

t =	(2.74)**	(2.18)*	(1.16)	(4.61)**	(-2.17)*
s.e.e=	0.1571	0.4575	0.0089	0.3675	0.1120

* = significant with $\alpha=0.05$
** = significant with $\alpha=0.01$



.igure 5.1. The Groups Of Respondents By Their Willingness To Pay

In model 3, all variables except AGE are significantly different from zero under a confidence interval of α=0.05 (for variable AW and DSC) and under a confidence interval α=0.01 (for variables HH and OC). For the model as a whole, 75.93 % of variation in the dependent variable (WTP1) was accounted for by the model. The F value indicates that all parameters combined significantly with a confidence interval of α=0.01. The coefficient of variation = 59.3979, describes the amount of variation in the population. The magnitude of the coefficient of variation indicated that given a normal distribution of WTP1 roughly two-thirds should fall within 59.3979 percent of their regression-predicted values.

Table 5.17. Model Development of Willingness To Pay For Present Soil Erosion Control

Parameter	Model 1	Model 2	Model 3
INT	3.1820 (1.72)	2.8228 (1.90)	
UT	-0.0895 (-0.72)		
HH	0.2099 (1.01)	0.2131 (1.10)	0.4306 (2.74)**
Y	0.0489 (0.26)		
DTR	0.0377 (0.06)		
SX	-0.0183 (-0.03)		
AW	0.9688 (2.01)*	0.9477 (2.09)*	0.9973 (2.18)*
AGE	-0.0204 (-1.06)	-0.0174 (-1.02)	0.0103 (1.16)
OC	1.1820 (2.14)*	1.2282 (2.80)**	1.6951 (4.61)**
DSC	-0.2711 (-2.36)*	-0.2758 (-2.46)*	-0.2429 (-2.17)*
F	3.60 **	6.56**	84.53**
R^2	0.2018	0.1979	0.7593
CV	59.8711	58.8292	59.3979

WILLINGNESS TO PAY FOR INCREASED LEVELS OF SOIL EROSION CONTROL

The dichotomous choice model is used to estimate the benefits of having more (quantity) soil erosion control. With this method respondents answered 'yes' or 'no' to the certain bid amount to have soil erosion control increment over and above current levels, in light of uncertainty about future availability of productive land.

This model has some advantages as concluded by Loomis (1990):

1. Respondents will not be burdened of having to place a value on the good.
2. The question format is more alike to that of a market setting in which the price is stated and the individual will act as a price taker to buy or not to buy at the price.
3. There is an incentive compatible device for respondents to reveal their true preferences about provision of the good.

Despite these advantages, dichotomous choice has some shortcomings, such as : it needs larger sample size and requires sophisticated statistical analysis. The result obtained is sensitive to the specific functional form of the equation.

Being a binary response this is theoretically characterised by a cumulative distribution function (CDF) which underlies the argument that each individual would answer 'yes' or 'no' by comparing the utility (U_i) of having improvement in soil erosion control to some critical value of the random utility (U^*); and if many independent factors determine U_i for each individual, the U^* may be assumed as a normally distributed random variable (Judge et.al, 1980). The argument can be presented as :

$$\text{Prob}(Y/U_i) = \text{Prob}\ (U^* \leq U_i) = F\ (Z_i) \qquad (1)$$

where : $F(Z_i)$ is the normal CDF. The logistic CDF is :

$$P_i = F\ (Z_i) = 1/(1 + e^{-Zi}) = 1/(1 + e^{-(\beta o + \beta i Xi)}) \quad (2)$$

where: e = natural logarithm

ßo,ßi = parameter estimates

X_i = the value of the i^{th} attribute of the i^{th} individual

The logit model is illustrated as in Figure 5.2

In practical terms, the refined model is as follow:

$$Z_i = \log\ (P_i / 1 - P_i)$$

$$\log\ (P_i / 1 - P_i) = \beta o + \beta i Xi \qquad (3)$$

Equation (3) performs the transformation of the dependent variable from the problem of predicting probabilities within (0.1) interval to the problem of predicting odds of an event occurring within the range of the entire real line. The independent variables would have the greatest impact on the probability of answering 'yes' or 'no' at the midpoint of distribution since the slope of the cumulative logistic distribution is greatest at P = 1/2, and they would need large changes in Xi to affect the WTP2 (dependent variable) at the low slopes near the endpoints of the distribution (Pyndick and Rubinfield, 1981).

In this study, the response for saying 'yes' for a particular bid offered is set equal to 1, otherwise zero. X is identified as a vector of explanatory variables (OF, AW, UT, HH, SX, Y, AGE, OC, DSC, DTR) and p = Pr (Y=1 ‡ X) is the response probability to be modelled. The linear logistic model has the form:

$$\text{logit}\ (P) = \log\ (p / (1 - p)) = \alpha + \beta\ X$$

where :

α is the intercept parameter

ß is the vector of slope parameters.

X is vector of parameters

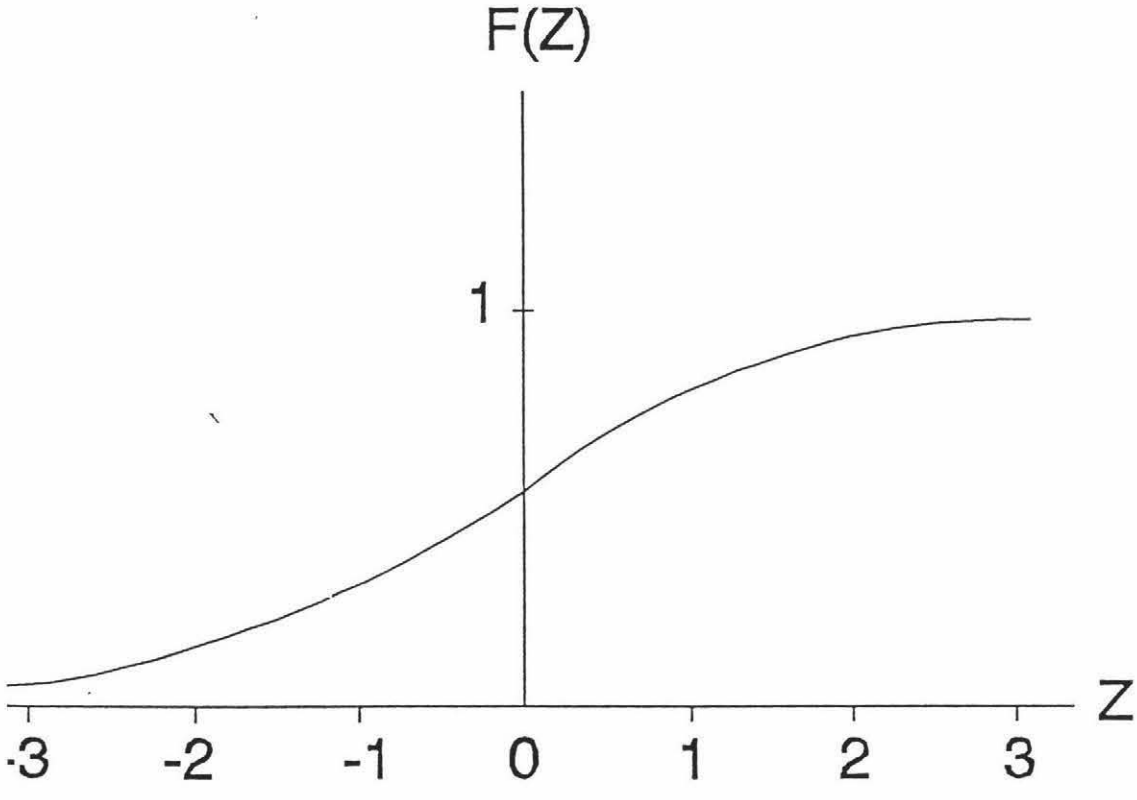


Figure 5.2. Logit Model

WTP2 = willingness to pay to have soil erosion control improvement (yes = 1, no =0)

OF = a bid offered, take some values: \$10,\$15,\$20,\$25,\$30 and \$50

HH = household member

SX = sex of respondent (female = 0, male=1)

AGE = age of respondent

OC = occupation (retired, unemployed = 1, employed = 2, farmer = 3)

Y = income, valued from 1- 6

DSC = distance to the nearest river

DTR = district where the respondent lives (Palmerston North=1, otherwise=0)

For the binary response question every individual was offered only one bid to which he/she had to respond to with a 'yes' or 'no' answer to pay the extra amount stated, to have more soil erosion measures put in place. The responses to each bid are summarised in Table 5.18

Table 5.18. Summary of Dichotomous Response

Bid (\$)	Number of questionnaire sent for each bid	The amount of sample back	Number of response toward the bid	
			'yes'	'no'
10	100	31	15 (48.39)	16 (51.61)
15	100	24	6 (25.00)	18 (75.00)
20	100	30	12 (40.00)	18 (60.00)
25	100	39	16 (41.03)	23 (58.97)
30	60	18	7 (38.89)	11 (61.11)
50	60	21	11 (52.38)	10 (47.62)
Total	520	163	67	96

The data is analyzed using the logistic procedure. To select the best model four statistical tests were exercised: Log likelihood chi-squared test; Akaike Information Criterion; Chi-squared score statistic and Percent Correct Prediction.

1. Log Likelihood Chi-squared Test

-2 Log Likelihood is expressed as :

$$-2 \text{ Log } L = -2 \Sigma_j W_j \log (P_j)$$

where:

P_j = the probability of the j^{th} observation

W_j = weight of the j^{th} observation

Let Y_j be the response value of the j^{th} observation, the estimate of $P_j = P(Y_j = y_j)$ is obtained by replacing the regression coefficients with their maximum likelihood estimates (MLEs) (SAS Institute Inc., ND).

The -2 Log Likelihood statistic indicates that the amount of variation explained by the models is significantly different from zero; the test follow Chi-square distribution with k degrees of freedom (Capps and Kramel, 1985).

2. Akaike Information Criterion

Where there are competing models which have different numbers of parameters, one should make adjustment for degrees of freedom. Akaike proposed the simple formula which is called Akaike Information Criterion (AIC), that is defined by :

$$AIC = -2 \text{ Log } L + 2 (k + s)$$

where k is the number of ordered values for the response, and s is the

number of explanatory variables (SAS Institute Inc., ND; Amemiya, 1981). The formula has to be used when comparing different models from the same data and a lower values of the statistic indicates a more desirable model (SAS Institute Inc., ND)

3. Chi-squared Score Statistic

The Chi-squared score statistic gives a test for the joint significance of the explanatory variables in the model. The test considers only the independent variables (SAS Institute Inc.,ND). The formula is defined by:

$$U'(\tau)\, I^{-1}(\tau)\, U(\tau)$$

where :

$U(\tau)$ = the vector of partial derivatives of the log likelihood with respect to the parameter vector τ

$I(\tau)$ = the matrix of the negative second partial derivatives of the log likelihood with respect to τ

$H_0 : \tau = \tau$

This formula has an asymptotic Chi-squared distribution with r degrees of freedom; r is the dimension of τ (SAS Institute Inc.,ND).

4. Percent of Correct Prediction

Another criterion that can be used is the correct prediction of whether or not an event will occur given a set of values for the explanatory variables. Based on this usage another summary measure to be reported is the percent of successful prediction within the given sample (Judge et al., 1982).

For the binary response model, the outcome is labelled as an EVENT if the ordered response is 1 and NO EVENT if the ordered response is 2. The

probability of an events is:

$$p = F(\alpha + \beta x)$$

The response is predicted to be an event if the estimated value of p is greater than or equal to 50 percent (SAS Institute Inc.,ND).

MODEL DEVELOPMENT OF DICHOTOMOUS CHOICE

The combination of test statistics were used to select the best model for the binary response question, which could represent the uncertainty benefit evaluation model for having increased level of soil erosion control. The result is depicted in Table 5.19.

According to the AIC test, the desirable model would have been model 3 since it has the smallest value of AIC test, meanwhile the -2 Log Likelihood and Chi-squared Score test showed a high confidence interval ($p < 0.005$). However, the percent correct prediction test is relatively poor (59.7 %).

The other model having adequate prediction is model 2 which has a 63.4 % level of correct prediction, it also has the highest level of correct prediction among the model options. The other two tests Chi-squared test and -2 Log Likelihood show that variables in model 2 combined significantly with $p < 0.005$.

To sum up the best model can be written as :

$$\text{Log}(\, p/\, 1\text{-}p) = 1.2523 - 0.0197\ OF - 0.9691\ AW + 0.4291\ SX - 0.7999\ OC + 0.0152\ AGE$$

where :

p = probability to answer 'yes'

OF = bid offered

Table 5.19 Dichotomous Choice Model Of Willingness To Pay For Soil Erosion Control Improvement

Variable	Model					
	1	2	3	4	5	6
INT	1.7457	1.2523	1.0858	2.2297	0.9233	1.8042
OF	-0.0195	-0.0197	-0.0171	-0.0193	-0.0159	-0.0155
AW	-1.0567	-0.9691	-0.9028	-0.9250	-0.9912	
UT	0.0157					
HH	0.0261					
Y	-0.0373					
SX	0.662	0.4291				
OC	-0.9773	-0.7999	-0.6651	-0.8210		-0.9128
AGE	0.0136	0.0152	0.0178			
DTR	-0.7419					
DSC	0.1464					
AIC	182.045	179.526	178.595	178.681	185.657	183.084
-2 LOG L	22.915 (*)	18.208 (**)	17.139 (**)	15.053 (**)	8.850 (*)	8.649 (*)
SCORE	21.294 (*)	17.251 (**)	16.300 (**)	14.458 (*)	8.705 (*)	8.485 (*)
CORRECT (%)	60.6	63.4	59.7	55.2	61.8	63.4

NOTE: (*) = significant with $0.01 < p < 0.05$
(**) = significant with $0.001 < p < 0.005$

AW = awareness

SX = sex

OC = occupation

AGE= age of respondent

Thus, let the value of AW = 1, SX = 1, OC = 2, OF =10 and age = 47 (as mean value), estimation of logit (P) is -0.3701, and the value of p can be calculated as:

$$P = e^{-0.3701}/(1+e^{-0.3701})$$

$$= 0.4085$$

By taking various value of bid offered, meanwhile keeping the values of the other variables constant (ceteris paribus), one can derive the graph of expected willingness to pay for increasing levels of soil erosion control as illustrated in Figure 5.3

AGGREGATION

1. Current Level of Soil Erosion Control

The model of willingness to pay for existing measurement of soil erosion is :

$$WTP1 = 0.4036\ HH + 0.9973\ AW + 0.0103\ AGE + 1.6951\ OC - 0.2429\ DSC$$

By putting the average value of variables into the model, where HH = 3; AW = 0.5; AGE = 47; OC = 2 and DSC = 2.45, the WTP1 value is estimated with a resultant value of 5.069. This value represents the WTP group which lay in the range $ 25 - $40 (Figure 5.16) . This range lies between the mean WTP of the sample that is $ 42.29 and the median WTP of sample that is $ 20. Therefore the median value can be taken as the lower bound of WTP and the mean WTP of the sample as an upper bound.

Concerning low level of response rate, assumptions should be made before doing any aggregation. The assumptions are :

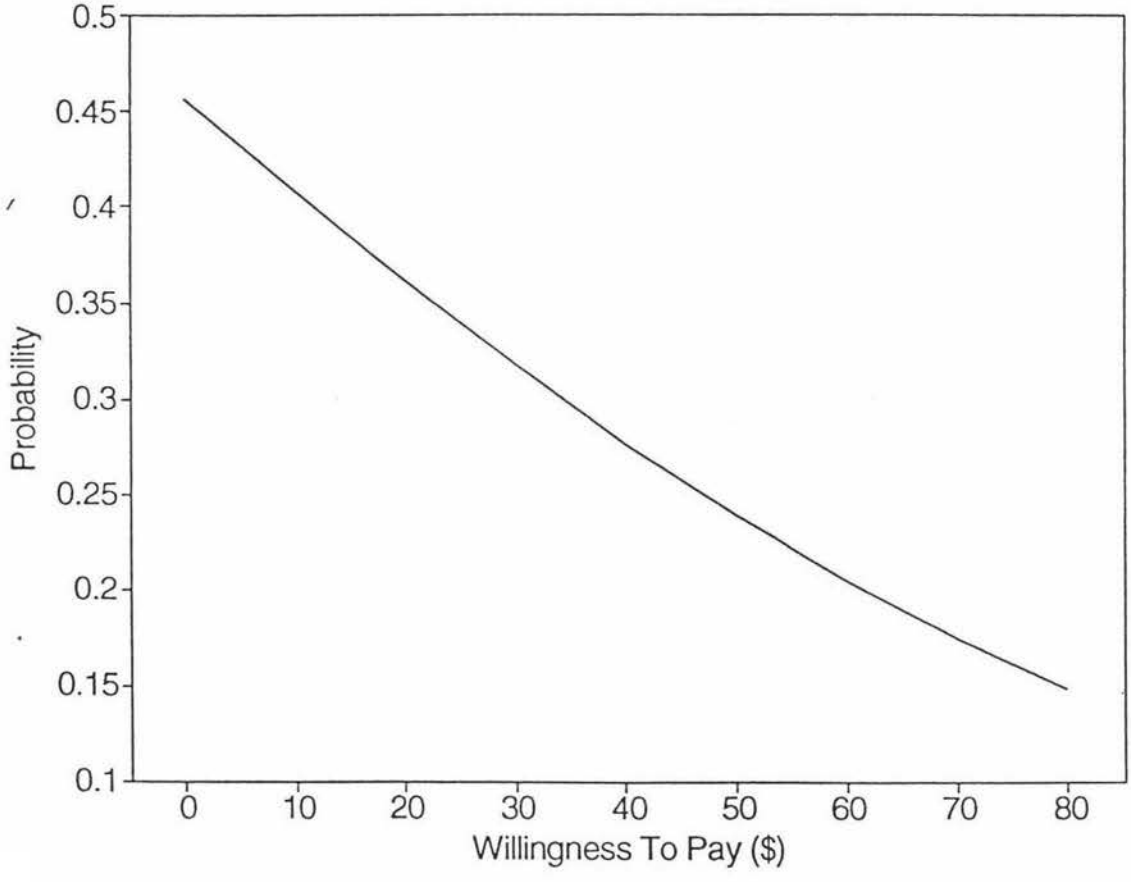


Figure 5.3. Expected Willingness To Pay For Soil Erosion Control Improvement.

1. That the non-responses are well represented by sample, which suggests they would behave in the same manner as the sample and this could be taken as an upper bound for willingness to pay of population.
2. The non-responses are not represented by the sample, which may indicate no value of soil erosion control, this is considered to be the lower bound for the population's benefit from having soil erosion control.

The total number of households in Palmerston North City and the Manawatu is 32,955 (Taranaki/Manawatu-Wanganui Statistics, 1991) and when this is multiplied by $ 42.29 and $ 20 respectively, the range for the upper bound of WTP for the region yields $ 659,100 < total WTP < $1, 393, 666.95 annually. For the lower bound the number of households was multiplied by 0.31 (from 31 % rate of response) before it was multiplied by the value of the mean and median WTP of the sample. This results in: $ 204,321 < total WTP < $ 432, 036. 75 per year.

To see how representative these results are for the region, one should compare the sample population and the actual population in terms of characteristics. The result are presented in Table 5.20.

Table 5.20 Representativeness of Sample Parameters

Parameters	Percentage in Sample	Percentage in Population (1)	Missing
Sex			
1. Male	65.0	48.5	
2. Female	35.0	51.5	
Occupation			
1. Unemployed	44.7	41.4	
2. Employed/non farmer	51.6	56.4	
3. Farmer	3.7	2.2	2
Income($,annually)			
1. < $ 10,000	8.7	34.5	
2. 10,001 - 20,000	21.7	24.6	
3. 20,001 - 30,000	19.9	17.3	
4. 30,001 - 40,000	18.0	8.4	
5. 40,001 - 50,000	14.3	3.9	
6. > 50,000	17.4	3.9	2
Household Composition			
1. One Person Household	20.9	19.7	
2. Family Household	65.7	62.5	
3. Non family Household (2)	13.4	10.3	
Age (years)			
20 - 29	11.7	20.6	
30 - 39	22.1	14.2	
40 - 49	21.5	11.2	
50 - 59	18.40	7.6	
60 +	26.4	13.7	
District			
Palmerston North City	75.3	72.2	
Outside PN City	24.7	27.8	1

Note:(1) Source Taranaki/Manawatu-Wanganui Statistics, 1991
(2) Household with member more than 5 in sample is assumed as non-family households

With reference to Table 5.20 there is a possibility over estimation. The percentage of respondents with an income of more than $ 30,000 are over represented. The Table shows an income group of $ 30,001 - $ 40,000 constituting 18 % of the sample whereas in the real population there is only 8.35 % in the same income group. The other two income groups ($ 40,001 - $ 50,000 and more than $ 50,000) have been represented by 14.3 % and 17.4 % of the sample whereas the same income groups in the population are 3.9 % and 3.9 % respectively.

One might consider the possibility of underestimation in valuing the public good. For erosion control cannot be made exclusive for the user only and the benefit yielded is enjoyed by everyone, so free rider behaviour would occur, inducing respondents to act strategically by lowering their valuation. However, empirical studies (Schulze, et.al, 1981; Hufschmidt et.al, 1983) indicate that this is not generally a major problem.

2. Increased Levels Of Soil Erosion Control

With regard to willingness to pay for having more soil erosion control, the analysis is conducted by plotting the probability of willingness to pay against the dollar amounts nominated (Kerr, 1986). This is illustrated in Figure 5.3. By integrating the probability curve which is the function of expected willingness to pay, one can calculate the area under the curve which represents the mean of expected willingness to pay. The result of the calculation is $ 30.9816.

The aggregation is carried out by multiplying the expected willingness to pay by the total number of households in Palmerston North City and Manawatu (32,995 households) which yields the amount of $1,020,998.63. By holding the same assumption of aggregation imposed to 'WTP for current level of soil erosion control model' the lower bound of willingness to pay for soil erosion control increment is estimated as $320,083.07.

The reasons respondents put forward for being willing to pay for having more soil erosion control are listed below :

- For the long term future security of the region
- Palmerston North is in a flood plain, currently there is not enough protection
- Erosion control is very important for erosion affecting farming production, scenic beauty and recreational areas
- We all benefit from soil erosion control
- Immediate action is required to begin a concentrated effort to establish control measurement
- Land loss is irreversible and it is time to put something back to balance nature
- Help keep the area beautiful, don't like seeing hillside scars

Other expression given by respondents are that they are willing to pay subject to :

- Everyone have to pay since everyone will benefit from having more soil erosion control
- The control should be effective
- The extra soil erosion control work have to be done in order to remove the cause and not just fix up the effects on a repeated basis

BENEFIT EVALUATION

For 1992/1993 the Council's total estimated funding from revenue and reserves was $17,101,327 (incl. GST) with 48.4 % or $8,273,900 from General Rates. This revenue was to be allocated to all services carried out by the Regional Council. The activities involving soil erosion control are carried out by the River and Drainage Engineering Department and Soil Conservation section.

The River Engineering Department encompasses operational activities over the whole region for river engineering, flood and erosion control works, and for land drainage works. It has responsibility for river and drainage schemes as well as non-scheme works. The overall objective of the Department is to prevent and or control flooding, erosion and provide land drainage at an acceptable cost-benefit level.

The Soil Conservation section provides advisory and extension services to land holders. These include soil conservation, afforestation, and other techniques pertaining to sustainable land management. The overall objectives are:

(a) to maintain and enhance the sustainable use and productivity of the soils of the Region

(b) to control and reduce the extent of soil erosion within the Region. (Manawatu-Wanganui Regional Council, 1992)

Indicative costs for 1992/1993 of River and Drainage Engineering were $4,195,801 (24.5 % of total service costs) and $1,573,858 (9.2 % of total services costs) for the Soil Conservation section (Manawatu-Wanganui Regional Council, 1992). Later, the aggregate of the service costs of respectives departments is taken as a comparative costs for soil erosion control which equals 33.7 % of the total general rate expenditure. Whereas, Palmerston North's general rate distribution of 1992/1993 is $2,976,176. If the contribution of rate devoted for soil erosion control cost is distributed proportionally according to the general rate expenditure by respective departments, the amount currently paid by residence of Palmerston North and surrounding areas can be estimated by multiplying 33.7 % with $2,976,176 that is $1,002,971.31.

Benefit evaluation is done by comparing the soil erosion control costs estimated earlier with the total WTP for soil erosion control, which yields

the range for the current level of the control as follows :

- the upper bound of WTP : 65.71 % - 138 % of current cost
- the lower bound of WTP : 20.37 % - 43.08 % of current cost

As to WTP for increased levels of soil erosion control, the range is 31.93 % - 101.80 %, which means the willingness to pay of 32 % - 102 % more than currently paid to have soil erosion control increased.

The lower bound of WTP current level of soil erosion control is relatively small with respect to current cost estimation. This can be due to :

- Society not having enough information to value the worth of soil erosion control, because support for soil conservation depends upon community understanding and acceptance that investment in soil conservation activities is desirable.
- Society may not be satisfied with the current level of soil erosion control which leads to undervaluation of its benefit.

However, the cost estimation for current level of soil erosion control is laid in the upper bound range of WTP, suggested that society is aware of soil erosion effect and the benefit of its control.

CHAPTER SIX

GENERAL DISCUSSION AND CONCLUSION

SUMMARY

Soil erosion is a major cause of land degradation in New Zealand. Sustainable land management implies that attempts are made to pass on a stock of natural resources to future generations that will give them similar opportunities for income generation as enjoyed by the present generation. Any passing on of all or at least a majority of the natural stock of land resources will require continued efforts in term of soil conservation.

Soil conservation measures cost money and it is important that scare money resources are spent efficiently.

In this thesis the above concerns were researched by finding out the benefits people derive from current conservation measures and by eliciting people's willingness to pay for additional conservation control expenditure to assure more of the land resource will be protected for the future. To discover answers to those questions a non-market valuation technique, the contingent valuation method, was used to elicit answers from a random sample of households living in Palmerston North city and the surrounding region.

The research results meet the objectives set, in that they :

Show the level of awareness that people have concerning the effects of soil erosion.

People's awareness of soil erosion was measured by asking them about the existence, form and severity of soil erosion in their area. Respondents engagement in outdoor activities was taken into account as one of the

factors influencing their awareness of soil erosion effects.

The results show that 54.6 % of respondents noticed and hence are aware of soil erosion in the area. Of respondents who noticed flooding as one of the effects, 35.8 % considered it a bad problem. As for landscape scaring, 33.8 % of respondents noted it as a bad problem. Of respondents who noticed a decline in land productivity, 48 % perceived it as a moderate problem. 30.2 % of respondents who noticed a decline in water recreation due to soil erosion, saw it as a moderate problem.

More than five types of outdoor activities were enjoyed by 41.72 % of respondents, 25.77 % of which are aware of the soil erosion effects compared with 15.95 % who are unaware. As the number of outdoor activities pursued, and the frequency at which they are pursued, increases, participants are more likely to be aware of the effects of soil erosion.

Identify the preferred policy for soil erosion control funding.

With regard to the options suggested for collecting money to finance soil erosion control, 66.05 % of respondents prefer soil erosion control to be financed from rates as is currently practised, whereas only 17.28 % of respondents wanted a special fund set up for soil erosion control. An increase in income tax is preferred by 12.35 % of respondents.

Discern public valuation toward soil erosion control including the valuation of the inter-generational issue.

In their valuation of soil erosion control, respondents rated bequest value highest, that is the desirability to endow future generations with sufficient environmental quality. In proportion to other factors, respondents weighted this as much as 37.40 %, whereas existence value is weighted as 25.40 % compared with present use value and future use value which are weighted as 18.13 % and 19.07 % respectively. So even though the benefit

of soil erosion control cannot be captured exclusively by off-site beneficiaries the value attached to its benefits were recognised and there appeared to be a clear desire to see further maintenance or even an increase in, the level of soil erosion control.

Identify the factors affecting peoples' willingness to pay for soil erosion control and the benefit of soil erosion control in Palmerston North and surrounding areas.

Analysis of the WTP answers for the current level of soil erosion control showed that, variables such as number of households members, awareness, occupation and distance of the house from the nearest river appear to be significant variables in explaining the willingness to pay levels.

In the logit model of willingness to pay for further increases in soil erosion control, factors of awareness, sex of respondents, occupation and age including the bid offered were the variables influencing the probability of saying 'yes' to the bid offered.

The aggregation of WTP for the region yielded as follows :

- WTP for current level of soil erosion control
  The upper bound : \$659,100 < total WTP < \$1,393,666.95
  The lower bound : \$204,321 < total WTP < \$432,036.75
- WTP for increased level of soil erosion control
  \$320,083.07 < total WTP < \$1,020,998.63

Compare the soil erosion control costs budgeted by the Regional Council with the aggregated WTP.

The aggregation of peoples' WTP for soil erosion control is compared with the 1992/1993 costs of soil erosion control for the Manawatu-Wanganui Regional Council. Since erosion control work is carried out by the River

Engineering Department, and soil conservation is performed by the Soil Conservation section, the aggregate budget of the respective departments was taken as a comparative cost for soil erosion control which amount to 33.7 % of the general rates expenditure. Residents of Palmerston North currently pay $2,976,176 in general rates. If it is assumed that the fund will be distributed in proportion of the general rate expenditure, then soil erosion control costs paid by people of Palmerston North can be estimated by multiplying 33.7 % with $2,976,176 which equals $1,002,971.31

The comparison of WTP for the current level of soil erosion control with the current costs shows that :

- the upper bound of WTP has a range from 65.71 % - 138 % of current cost.
- the lower bound of WTP has a range from 20.37 % - 43.08 % of current cost.

For WTP for an increased level of soil erosion control, the range is 31.93 % - 101.80 % of current cost.

This comparison suggests that people realize the value/benefit of having soil erosion control, even though the lower bound is relatively low. The latter may be due to a lack of information on the true worth of soil erosion control (i.e saving income foregone), and also a lack of information on the efforts that have been made by the Regional Council which may lead to an undervaluation of the benefits. On the other hand it could also be that people do not value soil erosion control highly. Nevertheless, the magnitude of WTP for increased level of soil erosion control indicates that people recognised the inter-generational benefits of passing on sufficient quality of soils to future generations.

METHOD EVALUATION

It is difficult to address the issue of soil erosion since its effect is not apparent in any particular recreational activity or at a specific location. And this could lead to non-respondents bias in mail return surveys. Becker et.al (1987) suggested that engagement in a specific recreation activity at a specific location may be a significant criterion for defining a population as homogeneous and a homogeneous population is less susceptible to non-respondents bias in mail return survey. A good deal of research in social psychology and marketing reveals that non-respondents often differ significantly from respondents on age, educational level, socio-economic status and, of particular concern to environmental economists, interest and participation in the subject of the survey (Edwards and Anderson, 1987). There are methodological improvements that will minimize and facilitate testing for non-response bias and possible selection bias due to self-censorship. A particularly promising approach advocated by Hochstim (1967) in Edwards and Anderson (1987) involves numerous follows-up and combinations of survey instruments. However, time and budget limitations dictated that these method could not be used.

There is a difficulty in stating a value in open ended questions by respondentsm, which may lead to respondents copying the value offered in dichotomous choice questions.

Lower response rates of the pilot survey led to limited improvement of the questionnaire for the main survey.

It might be worthwhile to differentiate the respondents according to geographical situation to discern the impact of soil erosion.

CONCLUSION

Society is aware of the effect of soil erosion and recognises the values attached to its control. The result of the survey, especially the comparison of lower bound WTP for soil erosion control with its costs budgeted by the Regional Council, supports the Review of Soil Conservation Activity (1991) by Regional Council which comprehended that there is a need for increased information production such as :

- promotion of the collection of information directed towards an adequate understanding of the soil and water resources
- informing the community of the problems associated with land degradation and the need for soil conservation activity
- pursuing the inclusion of soil conservation within relevant curricula taught at intermediate and secondary schools and tertiary institutions
- generally collating analysing and disseminating information pertinent to soil conservation

The review made by the Regional Council also discussed the necessity for improved targeting through distinguishing soil conservation activities which are more likely to have off-site benefits from those which clearly are of most benefit to the land owner.

The study indicated that the effects of soil erosion take place in noticeable forms, some of which are regarded as bad problems, i.e flooding and landscape scaring.

Respondents who pursued outdoor activities were more likely to be aware of the effects of soil erosion.

Use value and preservation value, comprising bequest and existence value, were taken into account in ascertaining the total value of soil erosion

control by respondents. This is supported by the fact that WTP for increasing levels of soil erosion control is large relative to the current soil erosion control estimates (30 % - 100 % more than currently paid).

Besides the awareness, social economics factors such as occupation, age, sex of respondents, number of households member, and distance of the house to the nearest river significantly affect the WTP for soil erosion control. Variables such as awareness and occupation appear to be significant in affecting both WTP, for current level of soil erosion control and for increasing levels of soil erosion control.

The comparison of the upper bound total WTP for soil erosion control and its costs showed that the present expenditure to control soil erosion is comprehended as the benefit received by the society and the policy preferred to finance the control is through the bill rate as currently practised.

Increasing levels of soil erosion control will depend on the rate payers being willing to pay increasing amounts of rates for this purpose. Information increases awareness and greater awareness will as shown by the results of this research, increase WTP. Further research may be necessary to assess the impact of dissemination of information about soil erosion and its control.

REFERENCES

Amemiya. T.
Qualitative response models : A survey. Journal of economics literature 19:1483 - 1536, 1981.

Becker, R. H. *et.al*
Research note : engagement as a criterion for defining homogeneous group - Implication for mail surveys. Leisure Sciences 9(2) : 135 - 140, 1987.

Bishop, R. C. and Heberlein, T. A.
The contingent valuation method. In valuing the environment : economic theory and applications. Edited by Kerr, G. N. and Sharp, BMH. Canterbury: Centre of resource management Lincoln College, 1987.

Blaschke, P. M. *et.al*
Ecosystem processes and sustainable land use in New Zealand steeplands. Agriculture, Ecosystem, and Environment 41 : 153 - 178, 1992.

Blyth, M. and McCallum, A.
On-site costs of land degradation in agriculture and forestry. In land degradation : problems and policies. Edited by Chisholm, A. and Dumsday, R. Centre for resource and environmental studies. Australian National University, 1987.

Boyle, K. J.
Commodity specification and the framing of contingent valuation questions. Land economics 65(1) : 57 - 63, 1989.

Boyle, K. J. *et.al*
Starting point bias in contingent valuation bidding games. Land Economics 61(2) : 188 - , 1985.

Bradfield, AGS.
Early history. In the geography of New Zealand, study no.1 : Introducing Manawatu. Edited by Saunders, B. R. and Warren, V. Palmerston North : Department of Geography, Massey University of Manawatu, 1964.

Brookshire, D. S. *et.al*
The valuation of aesthetic preferences. Journal of environmental economics and management 3 : 325 - 346, 1976.

Brookshire, D. S. *et.al*
Estimating option price and existence value for wildlife resource. Land economics 59(1) : 1 - 15, 1983.

Brown, T. L. *et.al*
Response to mail surveys on resource-bases recreation topics : a behavioral model and an empirical analysis. Leisure sciences 11(2) : 99 - 110, 1989.

Cameron, T. A.
A new paradigm for valuing non-market goods using referendum data : maximum likelihood estimation by censored logistic regression. Journal of environmental, economics and management 15 : 355 - 379, 1988.

Cameron, T. A. and Huppert, D. D.
OLS versus ML estimation of non-market resource values with payment and interval data. Journal of environmental economics and management 17 : 230 - 246, 1989.

Cameron, T. A.
Nonuser resource values. American journal of agricultural economics, December : 1133 - 1138, 1992.

Carson, R. T.
Constructed market. P 121 - 162. In measuring the demand for environmental quality : contribution to economic analysis. North Holland Elsevier Science Publisher B.V., 1991.

Central and Lower North Island Gravel Working (CALNIG)
Rocks from the rivers. A report on gravel extraction in NZ's lower North Island. The journal of the national water and soil conservation authority 22(4) : 8 - 12, 1987.

Cicchetti, C. J. and Wilde, L. L.
Uniqueness, irreversibility, and the theory of nonuse values. American journal of agricultural economics December : 1121 - 1125, 1992.

Cochrane, H. and Cutler, H.
The economics of sequential choice applied to quasi-option value. Journal of environmental economics and management 18 : 238 - 246, 1990.

Conrad, J. M.
Quasi-option value and the expected value of information. Quarterly journal of economics 94 : 813 - 820, 1980.

Cowie, J. D.
Soils. In the geography of New Zealand study no.1 : Introducing Manawatu. Edited by Saunders, B. R. and Warren, V. Palmerston North : Department of geography, Massey University of Manawatu, 1964.

Cowie, J. D. and Osborn, W. l.
Soil resources of the Manawatu and the expansion of Palmerston North City. Palmerston North : Advisory services division, Ministry of Agriculture and Fisheries, 1977.

Currie, J. M. *et.al*
The concept of economic surplus and its use in economic analysis. Economic journal 81(324) : 741 - 799, 1971.

Daubert, J. T. and Young, R. A.
Recreational demands for maintaining in-stream flows : A contingent valuation approach. American journal of agricultural economics, November : 666 - 675, 1981

Department Of Statistics New Zealand.
1991 Census of population and dwellings Taranaki/Wanganui-Manawatu regional report. Department of statistics New Zealand.

Devine, S.
The welfare theory basis for non-market valuation. In valuing the environment : Economic theory and applications. Edited by kerr, G. N. and Sharp, B. M. H. canterbury : Centre for resource management, Lincoln College, 1987.

Devousges, W. H. *et.al*
Option price estimates for water quality improvements : A contingent valuation study for Monongahela river. Journal of environmental economics and management 14 : 248 - 267, 1987.

Douglas, B.
Erosion control in agriculture (part 2) : An introductory handbook for students and field officers. Canterbury : department of agricultural engineering, Lincoln College, 1978.

Edwards, S. F. and Anderson, G. D.
Overlooked biases in contingent valuation surveys : Some considerations. Land economics 63(2) : 167 - 178, 1987.

Edwards, S. F.
Option prices for groundwater protection. Journal of environmental economics and management 15 : 475 - 487, 1988.

Ervin, C. A. and Ervin, D. E.
Factors affecting the use of soil conservation practices : hypotheses, evidence, and policy implications. Land economics 58(3) : 277 - 292.

Eyles, G. O.
The distribution and severity of present soil erosion in New Zealand. New Zealand geographer 39(1): 12 - 28, 1983.

Forbes, R. N.
The valuation of non-market costs and benefits in the New Zealand water and soil resources area. Ministry of Agriculture and Fisheries, 1984.

Foster, G. R. and Meyer, L. D. Soil erosion and sedimentation by water: An overview P1-13.
In Soil erosion and sedimentation. Proceedings of the national symposium on soil erosion and sedimentation by water. Michigan : American society of agricultural engineers, 1977.

Forster, B. A.
Valuing outdoor recreational activity : A methodological survey. Journal of leisure research 21(2) : 181 - 201, 1989.

Freeman III, A. M.
The benefits of environmental improvement : Theory and practice. Resource for the future. Baltimore London : John Hopkins University Press, 1979.

Freeman, J. R. and Daniel, H.
Applied categorical data analysis. Marcel Dekker Inc. USA, 1987.

Gibbs, H. S.
Management of land and water resources.P 170 - 184. In society and environment in New Zealand. Edited by Johnston, R. J. New Zealand Geographical society. Whitcombe and Tombs, 1974.

Greenley, D. A. *et.al*
Option value : Empirical evidence from a case study of recreation and water quality. Quarterly journal of economics 96 : 654 - 673, 1981.

Guest, P.
Who values our waterways ? Planning - A district responsibility. The journal of the national water and soil conservation authority 23(3): 8 - 12, 1987.

Gujarati, D. N.
Basic econometrics. McGraw-Hill Book Company, 1988.

Harris, B. S.
Contingent valuation of water pollution control. Journal of environmental management 19 : 199 - 208, 1984.

Harris, C. C. *et.al*
Improving the contingent valuation method : a psychological perspective. Journal of environmental economics and management 17 : 213 - 229, 1989.

Hawley, J.
Soil conservation-should the user pay ? The journal of the national water and soil conservation authority, Autumn : 4 - 7, 1986.

Hayward, J. A.
Competitive markets and conservation. The journal of the national water and soil conservation authority 22(3) : 2 - 4, 1986.

Heady, E. O. and Daines Jr, D. R.
Short-term and long-term implications of soil loss control on U.S agriculture. Journal of soil and water conservation, March-April : 109 - 113, 1982.

Heft, F. E. Political, social and economic aspects of soil erosion and sedimentation control programs. P 23 -30.
In soil erosion and sedimentation proceedings of the national symposium on soil erosion and sedimentation by water. Michigan : American society of agricultural engineers, 1977.

Holmes, J. M.
Soil erosion in Australia and New Zealand. Sydney : Angus and Roberston LTD, 1946.

Hovis, J. J.
Experiments in the valuation of non-market commodities valuation, auction. University of Microfilms Institute, 1985.

Hufschmidt *et.al*
Environment, natural system and development : An economic valuation guide. Baltimore London : The John Hopkins University Press, 1983.

Jakobsson, K. M. and Dragun, A. K.
Water and soil management in New Zealand. Journal of environmental management 33 : 1 - 16, 1991.

Jones, E. *et.al*
The impact of economic and socioeconomic factors on the demand for information : A case study of Ohio commercial farmers. Agribusiness 5(6):557 - 571, 1989.

Judge, G. G. *et.al*
Introduction to the theory and practice of econometrics. Canada: John Wiley & Sons, 1982.

Just, R. E. *et.al*
Applied welfare economics and public policy. Englewood Cliffs, new Zealand : Prentice-Hall, 1982

Kelman, E. H. H.
Soil conservation. In the geography of New Zealand study no.1 : Introducing Manawatu. Edited by Saunders, B. R. and Warren, V. Palmerston North : Department of geography, Massey University of Manawatu, 1964.

Kerr, G. N.
Introduction to non-market valuation : Theory and methods. Cantebury : Center for Resource Management Lincoln College, 1986.

Kirby, M. G. and Blyth, M. J.
Economic aspects of land degradation in australia. Australian journal of agricultural economics 31(2) : 154 - 174, 1987.

Kirkland, W. T.
Preserving the Whangamarino wetland. An application of the contingent valuation method. Thesis, Master of agricultural science, Massey University, 1992.

Kolstad, C. D. and Braden, J. B.
Environmental Demand theory. p17-39. In measuring the demand for environmental quality : contribution to economic analysis. North Holland Elsevier Science Publisher B. V., 1991.

Krutilla, J. V. and Fisher, A. C.
The economics of natural environments : studies in the valuation of commodity and amenity resources. Resources for the future John Hopkins University Press, 1975.

Lazo, J. K. *et.al*
Can contingent valuation measures nonuse values. American journal of agricultural economics, December : 1126 - 1132, 1992.

Lock, G. M.
The possum problem in the Manawatu-Wanganui Region. Thesis, Master of agricultural science, Massey University, 1992.

Loomis, J. B.
Comparative reliability of the dichotomous choice and open-ended contingent valuation techniques. Journal of environmental economics and management 18 : 78 - 85, 1990.

Loomis, J. B.
Contingent valuation using dichotomous choice models. Journal of leisure research 20(1) : 46 - 56, 1988.

Manawatu-Wanganui Regional Council
Soil conservation activities review. Edited by Cohey, A. *et.al* Manawatu-Wanganui Regional Council, 1991.

Manawatu-Wanganui Regional Council
Corporate Plan and Annual Plan 1992/1993. Manawatu-Wanganui Regional Plan, June, 1992.

Manawatu-Wanganui regional Council
Annual Report 1991-1992. Manawatu Wanganui Regional Council, 1992.

McConnell, K. E.
An economic model of soil conservation. American journal of agricultural economics, February:83-89, 1983.

McFadden, D.
Conditional logit analysis of qualitative choice behaviour.p105-139. In frontiers in econometrics. Edited by Zarembka, P. New York : Academic Press, 1974.

Meister, A. D.
New cost benefit analysis : useful aids in decision making or confidence tricks in economic analysis and soil conservation work. Discussion paper in natural resource economics no 10. Massey University, 1985.

Miller, J. R. and Hay, M. J.
Determinants of hunter participation : Duck hunting in the Mississipi flyway. American journal of agricultural economics 63 : 677 - 684, 1981.

Mitchell, R. C. and Carson, R. T.
Using surveys to value public goods : The contingent valuation method. Washington, D. C. : Resource for the future, 1989.

Molloy, L.
Soils in the New Zealand landscape. Mallinson Rendel Publishers, 1988.

Napier, T. L. *et.al*
Adoption of soil conservation practices by farmers in erosion-prone areas of Ohio : The application of logit modelling. Society and natural resources 1(2) : 109 - 129, 1988.

Napier, T. L. *et.al*
Willingness of land operators to participate in government-sponsored soil erosion control programs. Journal of rural studies 4(4) : 339 - 347, 1988.

National Water and Soil Conservation Organisation and New Zealand Forest Service.
The Ruahine Range. Edited by Cunningham, A. and Stribling, P. W. Water and soil technical publication no.13, 1978.

National Water and Soil Conservation Organisation
Catchment management for optimum use of land and water resources. Documents from an ESCAP seminar part 2. New Zealand contributions. Water and soil miscellaneous publication no. 46. Edited by Moore, D. J. Wellington, 1982.

Organisation for Economic Co-operation and Development.
Environmental policy benefits : Monetary valuation. Paris : Organisation for economic cooperation and development, 1989.

Page, K. J. and Heerdegen, R. G.
Channel change on the lower Manawatu River. New Zealand Geographer 41(1) : 35 - 38, 1985.

Pearce, D. W. and Turner, R. K.
Economics of natural resource and the environment. John Hopkins University Press, 1990.

Per-Olov, J.
The economic theory and measurement of environmental benefits. Cambridge University Press, 1987.

Pyndick, R. S. and Rubinfield, D. L.
Econometrics models and economic forecasts. McGraw-Hill Book Company, 1981. P 273 - 303.

Randall, A. *et.al*
Bidding games for valuation of aesthetic environmental improvements. Journal of environmental economics and management 1 : 132 - 149, 1982.

SAS Institute Inc.
SAS/STAT Software Calis and Logit procedures. SAS Technical Report P-200 Release 6.05. N.D.

SAS Institute Inc.
SAS/STAT User's guide release 6.03 Edition. Cary, NC USA :SAS Circle, 1988.

Sandrey, R. A.
Non-market valuation in New Zealand : An empirical analysis of vehicle bias. New Zealand economic papers December : 53 - 60, 1986.

Seitz, W. D. and Blyth, M. J.
Economics of soil conservation from the farmer's perspective. American journal of agricultural economics 62(4-5) : 1084 - 1088, 1980.

Sellar, C. *et.al*
Specification of the logit model : The case of valuation of non-market goods. Journal of environmental economics and management 13 : 382 - 390, 1986.

Seller, C. *et.al*
Validation of empirical measures of welfare change : A comparison of non-market techniques. Land economics 61(2) : 156 - 175, 1985.

Sinden, J. A. and Worrell, A. C.
Unpriced values : Decisions without market prices. A Wiley-Interscience Publication. John Wiley & Sons, 1979.

Sinden, J. A.
Estimation of consumer's surplus value for land policies. Australian journal of agricultural economics 22(3) : 175 - 193, 1978.

Sinden, J. A.
Empirical test of hypothetical bias in consumers' surplus surveys. Australian journal of agricultural economics 32(2-3) : 98 - 112, 1988.

Smith, V. K.
Uncertainty, benefit-cost analysis, and the treatment of option value. Journal of environmental economics and management 14 : 283 - 292, 1987.

Stone, A.
Valuing wetlands : A contingent valuation approach. Paper presented to the 35th Australian agricultural economic society conference. New South Wales : University of New England, Armidale, 1991.

Thayer, M.A.
Contingent valuation techniques for assessing environmental impacts : further evidence. Journal of environmental economics and management 8 : 27 - 44, 1981.

Turner, R. K.
Policy failures in managing wetlands. In market and government failures in environmental management wetlands and forests. Organisation for economics cooperation and development, 1992.

Universal Business Directories. Manawatu /Rangitikei.
Universal Business Directories Limited, 1993.

Upstill, G. and Yapp, T.
Off-site costs of land degradation. In land degradation problems and policies. Edited by Chisholm, A. and Dumsday, R. Centre for resource and environmental studies. Australian National University, 1987.

Walsh, R. G. *et.al*
Congestion and willingness to pay for expansion of skiing capacity. Land economics 59(2) : 193 - 210, 1982.

Walsh, R. G. *et.al*
Valuing option, existence, and bequest demands for wilderness. Land economics 60(1) : 14 - 29, 1984.

Weisbroad, B. A.
Collective consumption services of individual consumption goods. Quarterly journal of economics 78 :471 - 477, 1964.

Wibe, S.
Policy failures in managing forests. In market and government failures in environmental management wetlands and forests. Organisation for economics cooperation and development, 1992.

Willig, R. D.
Consumer's surplus without apology. American economic review 66:589 - 597, 1976.

Wills, I.
Resource degradation on agricultural land. Information problems, market failures and government intervention. Australian journal of agricultural economics 31(1) : 45 - 55, 1987.

Willman, E. A.
A note on supply side option value. Land economics 63(3) : 284 - 289, 1987.

APPENDIX 1(A)

PILOT SURVEY OF SOIL EROSION CONTROL

MASSEY
UNIVERSITY

Private Bag
Palmerston North
New Zealand
Telephone 0-6-356 9099
Facsimile 0-6-350 5642

FACULTY OF
AGRICULTURAL
AND
HORTICULTURAL
SCIENCES

DEPARTMENT OF
AGRICULTURAL
ECONOMICS
AND BUSINESS

2 December 1992

Dear Sir/Madam,

PILOT SURVEY OF SOIL EROSION CONTROL

I am undertaking a study to examine the benefit/value of soil erosion control. One aim of the study is to measure the value that people receive from soil erosion control in Palmerston North and surrounding areas.

The study is part of my thesis for the degree of Master of Agricultural Economics which is being supervised by Professor Anton Meister of the Department of Agricultural Economics and Business at Massey University.

All information given will be treated in the strictest of confidence and you and your responses will not be identifiable. The questionnaire has an identification number for mailing purposes only. This is so that we may check your name off of the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire.

Thank you for your assistance. I look forward to receiving your completed questionnaire as soon as possible.

Your sincerely,

Endang Rosawati

A.D. Meister
Professor, Resource and
Environmental Economics

QUESTIONNAIRE FOR PILOT SURVEY OF SOIL EROSION CONTROL

No._____

1. Are you aware of the effects that can be caused by soil erosion ?

Yes ☐ No ☐

If you answer 'No' , please go to question 3

2. If you answered 'yes' to question 1 , please state in what ways soil erosion can affect the landscape and how severe the effect can be ? (1=no problem, 2 = slight problem, 3 = moderate problem, 4 = bad problem , 5 = severe problem)

- flooding 1 2 3 4 5
- landscape scaring 1 2 3 4 5
- reduce soil stability affecting building foundations 1 2 3 4 5
- decline in land productivity 1 2 3 4 5
- decline in quality of water recreation due to polluted water and instream life (fish, aqua insect, etc) 1 2 3 4 5
- others (please specify what these are)
  _____ 1 2 3 4 5
  _____ 1 2 3 4 5

3. What kinds of outdoor recreation or enjoyment do you and your household member regularly or sometimes participate in, in Palmerston North and the surrounding area?

- fishing ☐ - boating ☐
- watersports ☐ - tramping ☐
- picnicking ☐ - just enjoying the scenery ☐
- others (please specify) _____

4. Could you please rank those outdoor recreation activities you or members of your household have participated in over this year ? (ranking : 1= most often, 5 = least participated)

- fishing ☐ - boating ☐

- watersports ☐ - tramping ☐

- picnicking ☐ - just enjoying the scenery ☐

- others (please specify) _____
_____

Rate payers in the Manawatu-Wanganui region currently pay up to 3/4 million dollars for soil conservation work (or more specifically each rate payer contributes $ 6.49 per $ 100,000 of equalized capital value in rates this year). For that amount of money they get the current amount of soil erosion control.

Palmerston North and the region surrounding it has scenic areas which are affected by soil erosion. The town and surrounding fertile land are susceptible to floods. Protection of our scenic environment, avoidance of loss of recreational areas, prevention of floods and the loss of land, all call for a continuation of soil erosion control in the region. The control is basically aimed at maintaining the situation as it is today.

If we now assume that from next year onward all soil erosion control work will be funded from a special fund set up for this region and to which all people in this region will be asked to contribute (which would mean that people no longer be charged for soil erosion control work in their rate bill), then

5. How much would you be willing to pay into such a fund on an annual basis? $_____

6. Other ways have been suggested to collect money to pay for soil erosion control, some of which are listed below. Which of these methods of collecting money do you prefer ?

- amount included in regional rates (the existing system) ☐

- amount added to income taxes ☐

- amount added to a special fund specified for soil erosion control ☐

- other (please specify) _____ ☐

This fund will keep the rate of erosion (and the wider impact on floods) much as it is today. This means that erosion will continue over time and that the region (and society as a whole) will continue to lose productive agricultural land.

How serious this continued loss of agricultural land will be is uncertain. For example we may find that at sometime in the future there simply is not enough productive land left in the region (or New Zealand) to produce food for local and export needs (or to produce it at reasonable cost). Hence at that time, society will regret not having stopped land loss through earlier soil erosion control. The land loss that has taken place cannot be reversed.

Alternatively however, the situation could be one in which erosion has been carefully controlled and we find that we have more than enough productive land to produce food and fibre for local and export needs. Hence, by then we may realise that we have spent a lot of money to preserve productivity which we don't really need. Some of that money could have been spent more profitably elsewhere.

It is in light of this uncertainty about the way things may be in the future, that I would now like you to consider the following question

7. Would you be willing to pay an additional amount (over and above the amount you stated earlier) to make sure that more erosion control will be put into place today ?

Yes ☐ No ☐

If you answer No, please go to question 9.

8. How much would you be willing to pay extra on an annual basis ?
$_____

9. Could you please give the reasons why you answered 'yes' or why you answered 'no' ?

_____
_____
_____
_____

10. How do you value the following impact of soil erosion control ?
(please rank from 1 - 4 where 1 = not important, 4 = very important)

- soil erosion decreases welfare of society now ☐

- soil erosion may decrease welfare of society in the future ☐

- I get satisfaction <u>from knowing</u> the land will exist in an improved state. ☐

- to know that future generation will be endowed with sufficient quality of environment ☐

11. To help us analyze the results we would like you to tell us about yourself and members of the household.

Household member	Sex	Age	Occupation
1.Yourself			
2			
3			
4			
5			

12. What is your approximate annual income (before tax)?

- Less than $ 10,000 ☐
- $ 10,001 - 20,000 ☐
- $ 20,001 - 30,000 ☐
- $ 30,001 - 40,000 ☐
- $ 40,001 - 50,000 ☐
- More than $ 50,000 ☐

13. How far is your house/place to the nearest river _____km.

Thank you for your time and cooperation. The information you have provided will be valuable towards understanding the benefit of soil erosion control. Please return the questionnaire as soon as possible in the envelope provided.

APPENDIX 1(B)
DICHOTOMOUS CHOICE OF PILOT SURVEY
(includes only pages which differ from the open ended survey)

7. Would you be willing to pay an additional amount (over and above the amount you stated earlier) to make sure that more erosion control will be put into place today ?

Yes ☐ No ☐

If you answer No, please go to question 9.

8. Would you be willing to pay $ 5 extra on an annual basis ?

Yes ☐ No ☐

9. Could you please give the reasons why you answered 'yes' or why you answered 'no' ?

_____

_____

_____

_____

10. How do you value the following impact of soil erosion control ?
(please rank from 1 - 4 where 1 = not important, 4 = very important)

- soil erosion decreases welfare of society now ☐

- soil erosion may decrease welfare of society in the future ☐

- I get satisfaction <u>from knowing</u> the land will exist in an improved state. ☐

- to know that future generation will be endowed with sufficient quality of environment ☐

7. Would you be willing to pay an additional amount (over and above the amount you stated earlier) to make sure that more erosion control will be put into place today ?

Yes ☐ No ☐

If you answer No, please go to question 9.

8. Would you be willing to pay $ 8 extra on an annual basis ?

Yes ☐ No ☐

9. Could you please give the reasons why you answered 'yes' or why you answered 'no' ?

_____
_____
_____
_____

10. How do you value the following impact of soil erosion control ?
(please rank from 1 - 4 where 1 = not important, 4 = very important)

- soil erosion decreases welfare of society now ☐

- soil erosion may decrease welfare of society in the future ☐

- I get satisfaction <u>from knowing</u> the land will exist in an improved state. ☐

- to know that future generation will be endowed with sufficient quality of environment ☐

7. Would you be willing to pay an additional amount (over and above the amount you stated earlier) to make sure that more erosion control will be put into place today ?

Yes ☐ No ☐

If you answer No, please go to question 9.

8. Would you be willing to pay $ 10 extra on an annual basis ?

Yes ☐ No ☐

9. Could you please give the reasons why you answered 'yes' or why you answered 'no' ?

_____

_____

_____

_____

10. How do you value the following impact of soil erosion control ?
(please rank from 1 - 4 where 1 = not important, 4 = very important)

- soil erosion decreases welfare of society now ☐

- soil erosion may decrease welfare of society in the future ☐

- I get satisfaction <u>from knowing</u> the land will exist in an improved state. ☐

- to know that future generation will be endowed with sufficient quality of environment ☐

7. Would you be willing to pay an additional amount (over and above the amount you stated earlier) to make sure that more erosion control will be put into place today ?

Yes ☐ No ☐

If you answer No, please go to question 9.

8. Would you be willing to pay $ 15 extra on an annual basis ?

Yes ☐ No ☐

9. Could you please give the reasons why you answered 'yes' or why you answered 'no' ?

_____

_____

_____

_____

10. How do you value the following impact of soil erosion control ?
(please rank from 1 - 4 where 1 = not important, 4 = very important)

- soil erosion decreases welfare of society now ☐

- soil erosion may decrease welfare of society in the future ☐

- I get satisfaction <u>from knowing</u> the land will exist in an improved state. ☐

- to know that future generation will be endowed with sufficient quality of environment ☐

7. Would you be willing to pay an additional amount (over and above the amount you stated earlier) to make sure that more erosion control will be put into place today ?

Yes ☐ No ☐

If you answer No, please go to question 9.

8. Would you be willing to pay $ 20 extra on an annual basis ?

Yes ☐ No ☐

9. Could you please give the reasons why you answered 'yes' or why you answered 'no' ?

_____

_____

_____

_____

10. How do you value the following impact of soil erosion control ?
(please rank from 1 - 4 where 1 = not important, 4 = very important)

- soil erosion decreases welfare of society now ☐

- soil erosion may decrease welfare of society in the future ☐

- I get satisfaction <u>from knowing</u> the land will exist in an improved state. ☐

- to know that future generation will be endowed with sufficient quality of environment ☐

APPENDIX 2 (A)

SURVEY OF SOIL EROSION CONTROL

135

MASSEY
UNIVERSITY

Private Bag
Palmerston North
New Zealand
Telephone 0-6-356 9099
Facsimile 0-6-350 5642

FACULTY OF
AGRICULTURAL
AND
HORTICULTURAL
SCIENCES

DEPARTMENT OF
AGRICULTURAL
ECONOMICS
AND BUSINESS

5 February 1992

Dear Sir/Madam,

SURVEY OF SOIL EROSION CONTROL

I am undertaking a study to examine the benefit/value of soil erosion control. One aim of the study is to measure the value that people receive from soil erosion control in Palmerston North and surrounding areas.

The study is part of my thesis for the degree of Master of Agricultural Economics which is being supervised by Professor Anton Meister of the Department of Agricultural Economics and Business at Massey University.

All information given will be treated in the strictest of confidence and you and your responses will not be identifiable. The questionnaire has an identification number for mailing purposes only. This is so that we may check your name off of the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire.

Thank you for your assistance. I look forward to receiving your completed questionnaire as soon as possible.

Your sincerely,

Endang Rosawati

A.D. Meister
Professor, Resource and
Environmental Economics

QUESTIONNAIRE FOR SURVEY OF SOIL EROSION CONTROL

No._____

A feature of some of the soil types in Manawatu region is that they are structurally unstable and erosion prone under cultivation. Also the coastal sands in the Manawatu region are extremely susceptible to wind erosion if their vegetation is disturbed. Some of the hill country in this region is part of Ruahine Range which has widespread erosion throughout the range. In 1978 it was estimated that the rate of erosion for the Ruahine range was 25 m^3 /ha/year, which is high by New Zealand and world standards.

The impacts of soil erosion not only affect the private land owners but also the region and appear in various forms, such as: landscape scars, accumulation of shingle in stream channels, floods, less soil aggregate stability, etc.

1. Have you noticed any of the effects of soil erosion in your area ?

Yes ☐ No ☐

If you answer 'No' , please go to question 3

2. If you answered 'yes' to question 1 , please state in what ways soil erosion affecting the landscape and how severe the effect is ?

(1=no problem, 2 = slight problem, 3 = moderate problem, 4 = bad problem , 5 = severe problem)

- flooding 1 2 3 4 5
- landscape scaring 1 2 3 4 5
- reduce soil stability affecting building foundations 1 2 3 4 5
- decline in land productivity 1 2 3 4 5
- decline in quality of water recreation due to polluted water and in-stream life (fish, aqua insect, etc) 1 2 3 4 5
- others (please specify what these are)
  _____ 1 2 3 4 5
  _____ 1 2 3 4 5

3. What kinds of outdoor recreation or enjoyment do you and your household member regularly or sometimes participate in, in Palmerston North and the surrounding area; and how often ?

(1 = very often; 2 = often; 3 = sporadic; 4 = seldom)

- fishing ☐ 1 2 3 4
- boating ☐ 1 2 3 4
- water sports ☐ 1 2 3 4
- tramping ☐ 1 2 3 4
- picnicking ☐ 1 2 3 4
- just enjoying the scenery ☐ 1 2 3 4
- others (please specify) _____

Soil erosion control is carried out by the Manawatu - Wanganui Regional Council and is partly paid/financed by rate payers in the regions. Their works includes operational activities over the whole region for river engineering, flood and erosion control works, land drainage works, advisory and extension services to landholders including soil conservation, afforestation and other techniques pertaining to sustainable land.

Palmerston North and the region surrounding it has scenic areas which are affected by soil erosion. The town and surrounding fertile land are susceptible to floods. Protection of our scenic environment, avoidance of loss of recreational areas, prevention of floods and the loss of land, all call for a continuation of soil erosion control in the region. The control is basically aimed at maintaining the situation as it is today.

If we now assume that from next year onward all soil erosion control work will be funded from a special fund set up for this region and to which all households in this region will be asked to contribute (which would mean that people no longer be charged for soil erosion control work in their rate bill), then

4. How much would you be willing to pay into such a fund on an annual basis? $_____

5. Other ways have been suggested to collect money to pay for soil erosion control, some of which are listed below. Which of these methods of collecting money do you prefer ?

- amount included in regional rates (the existing system) ☐

- amount added to income taxes ☐

- amount added to a special fund specified for soil erosion control (the proposed system) ☐

- other (please specify) _____ ☐

This fund will keep the rate of erosion and the wider impacts (floods, less recreations, landscape scaring) much as they are today. This means that erosion will continue over time and that the region (and society as a whole) will continue to lose productive agricultural land, and areas for recreational opportunities.

How serious this continued loss will be is uncertain. For example we may find that at sometime in the future there simply is not enough productive land left in the region (or New Zealand) to produce food for local and export needs (or to produce it at reasonable cost). Hence at that time, society will regret not having stopped land loss through earlier soil erosion control. The land loss that has taken place cannot be reversed.

However, it is possible to increase the level of soil erosion control through farm forestry, woodlot and shelter establishment, administering exotic forest, stream channel maintenance, etc; but these are subject to availability of funding.

It is in light of this uncertainty about the way things may be in the future, that I would now like you to consider the following question

6. Would you be willing to pay an additional amount (over and above the amount you stated earlier) to make sure that more erosion control will be put into place today ?

Yes ☐ No ☐

If you answer No, please go to question 8.

7. Would you be willing to pay $ 10 extra on an annual basis ?

Yes ☐ No ☐

8. Could you please give the reasons why you answered 'yes' or why you answered 'no' ?

_____
_____
_____
_____

9. How would you weight in terms of importance to you the various reasons of soil erosion control given below (the total = 100 %):

	% Weight of Importance
1. Soil erosion control will benefit my household and society now (at least within 1 - 10 years from now on).	_____ %
2. Soil erosion control will benefit my household and society in the future.	_____ %
3. To get satisfaction just from knowing the land will exist in an improved state (even though my household is not benefited directly).	_____ %
4. To know that future generation will be endowed with sufficient quality of environment.	_____ %
	100 %

10. To help us analyze the results we would like you to tell us about yourself and members of the household.

Household member	Sex	Age	Occupation
1.Yourself			
2			
3			
4			
5			

11. What is your household approximate annual income (before tax)?

- Less than $ 10,000 ☐
- $ 10,001 - 20,000 ☐
- $ 20,001 - 30,000 ☐
- $ 30,001 - 40,000 ☐
- $ 40,001 - 50,000 ☐
- More than $ 50,000 ☐

12. Are you a rate payers ? Yes ☐ No ☐

13. In what district are you living ? _____

14. How far is your house/place to the nearest river _____km.

Thank you for your time and cooperation. The information you have provided will be valuable towards understanding the benefit of soil erosion control. Please return the questionnaire as soon as possible in the envelope provided.

APPENDIX 2(B)
THE DIFFERENT BIDS OFFERED IN THE SURVEY OF SOIL EROSION CONTROL
(includes only pages which has different bids in the dichotomous question)

5. Other ways have been suggested to collect money to pay for soil erosion control, some of which are listed below. Which of these methods of collecting money do you prefer ?

- amount included in regional rates (the existing system) ☐

- amount added to income taxes ☐

- amount added to a special fund specified for soil erosion control (the proposed system) ☐

- other (please specify) _____ ☐

This fund will keep the rate of erosion and the wider impacts (floods, less recreations, landscape scaring) much as they are today. This means that erosion will continue over time and that the region (and society as a whole) will continue to lose productive agricultural land, and areas for recreational opportunities.

How serious this continued loss will be is uncertain. For example we may find that at sometime in the future there simply is not enough productive land left in the region (or New Zealand) to produce food for local and export needs (or to produce it at reasonable cost). Hence at that time, society will regret not having stopped land loss through earlier soil erosion control. The land loss that has taken place cannot be reversed.

However, it is possible to increase the level of soil erosion control through farm forestry, woodlot and shelter establishment, administering exotic forest, stream channel maintenance, etc; but these are subject to availability of funding.

It is in light of this uncertainty about the way things may be in the future, that I would now like you to consider the following question

6. Would you be willing to pay an additional amount (over and above the amount you stated earlier) to make sure that more erosion control will be put into place today ?

Yes ☐ No ☐

If you answer No, please go to question 8.

7. Would you be willing to pay $ 15 extra on an annual basis ?

Yes ☐ No ☐

5. Other ways have been suggested to collect money to pay for soil erosion control, some of which are listed below. Which of these methods of collecting money do you prefer ?

- amount included in regional rates (the existing system) ☐

- amount added to income taxes ☐

- amount added to a special fund specified for soil erosion control (the proposed system) ☐

- other (please specify) _____ ☐

This fund will keep the rate of erosion and the wider impacts (floods, less recreations, landscape scaring) much as they are today. This means that erosion will continue over time and that the region (and society as a whole) will continue to lose productive agricultural land, and areas for recreational opportunities.

How serious this continued loss will be is uncertain. For example we may find that at sometime in the future there simply is not enough productive land left in the region (or New Zealand) to produce food for local and export needs (or to produce it at reasonable cost). Hence at that time, society will regret not having stopped land loss through earlier soil erosion control. The land loss that has taken place cannot be reversed.

However, it is possible to increase the level of soil erosion control through farm forestry, woodlot and shelter establishment, administering exotic forest, stream channel maintenance, etc; but these are subject to availability of funding.

It is in light of this uncertainty about the way things may be in the future, that I would now like you to consider the following question

6. Would you be willing to pay an additional amount (over and above the amount you stated earlier) to make sure that more erosion control will be put into place today ?

Yes ☐ No ☐

If you answer No, please go to question 8.

7. Would you be willing to pay $ 20 extra on an annual basis ?

Yes ☐ No ☐

5. Other ways have been suggested to collect money to pay for soil erosion control, some of which are listed below. Which of these methods of collecting money do you prefer ?

- amount included in regional rates (the existing system) ☐

- amount added to income taxes ☐

- amount added to a special fund specified for soil erosion control (the proposed system) ☐

- other (please specify) _____ ☐

This fund will keep the rate of erosion and the wider impacts (floods, less recreations, landscape scaring) much as they are today. This means that erosion will continue over time and that the region (and society as a whole) will continue to lose productive agricultural land, and areas for recreational opportunities.

How serious this continued loss will be is uncertain. For example we may find that at sometime in the future there simply is not enough productive land left in the region (or New Zealand) to produce food for local and export needs (or to produce it at reasonable cost). Hence at that time, society will regret not having stopped land loss through earlier soil erosion control. The land loss that has taken place cannot be reversed.

However, it is possible to increase the level of soil erosion control through farm forestry, woodlot and shelter establishment, administering exotic forest, stream channel maintenance, etc; but these are subject to availability of funding.

It is in light of this uncertainty about the way things may be in the future, that I would now like you to consider the following question

6. Would you be willing to pay an additional amount (over and above the amount you stated earlier) to make sure that more erosion control will be put into place today ?

Yes ☐ No ☐

If you answer No, please go to question 8.

7. Would you be willing to pay $ 25 extra on an annual basis ?

Yes ☐ No ☐

5. Other ways have been suggested to collect money to pay for soil erosion control, some of which are listed below. Which of these methods of collecting money do you prefer ?

- amount included in regional rates (the existing system) ☐

- amount added to income taxes ☐

- amount added to a special fund specified for soil erosion control (the proposed system) ☐

- other (please specify) _____ ☐

This fund will keep the rate of erosion and the wider impacts (floods, less recreations, landscape scaring) much as they are today. This means that erosion will continue over time and that the region (and society as a whole) will continue to lose productive agricultural land, and areas for recreational opportunities.

How serious this continued loss will be is uncertain. For example we may find that at sometime in the future there simply is not enough productive land left in the region (or New Zealand) to produce food for local and export needs (or to produce it at reasonable cost). Hence at that time, society will regret not having stopped land loss through earlier soil erosion control. The land loss that has taken place cannot be reversed.

However, it is possible to increase the level of soil erosion control through farm forestry, woodlot and shelter establishment, administering exotic forest, stream channel maintenance, etc; but these are subject to availability of funding.

It is in light of this uncertainty about the way things may be in the future, that I would now like you to consider the following question

6. Would you be willing to pay an additional amount (over and above the amount you stated earlier) to make sure that more erosion control will be put into place today ?

Yes ☐ No ☐

If you answer No, please go to question 8.

7. Would you be willing to pay $ 30 extra on an annual basis ?

Yes ☐ No ☐

5. Other ways have been suggested to collect money to pay for soil erosion control, some of which are listed below. Which of these methods of collecting money do you prefer ?

- amount included in regional rates (the existing system) ☐

- amount added to income taxes ☐

- amount added to a special fund specified for soil erosion control (the proposed system) ☐

- other (please specify) _____ ☐

This fund will keep the rate of erosion and the wider impacts (floods, less recreations, landscape scaring) much as they are today. This means that erosion will continue over time and that the region (and society as a whole) will continue to lose productive agricultural land, and areas for recreational opportunities.

How serious this continued loss will be is uncertain. For example we may find that at sometime in the future there simply is not enough productive land left in the region (or New Zealand) to produce food for local and export needs (or to produce it at reasonable cost). Hence at that time, society will regret not having stopped land loss through earlier soil erosion control. The land loss that has taken place cannot be reversed.

However, it is possible to increase the level of soil erosion control through farm forestry, woodlot and shelter establishment, administering exotic forest, stream channel maintenance, etc; but these are subject to availability of funding.

It is in light of this uncertainty about the way things may be in the future, that I would now like you to consider the following question

6. Would you be willing to pay an additional amount (over and above the amount you stated earlier) to make sure that more erosion control will be put into place today ?

Yes ☐ No ☐

If you answer No, please go to question 8.

7. Would you be willing to pay $ 50 extra on an annual basis ?

Yes ☐ No ☐

APPENDIX 3(A)
REMINDER LETTERS FOR PILOT SURVEY

MASSEY
UNIVERSITY

Private Bag
Palmerston North
New Zealand
Telephone 0-6-356 9099
Facsimile 0-6-350 5642

FACULTY OF
AGRICULTURAL
AND
HORTICULTURAL
SCIENCES

DEPARTMENT OF
AGRICULTURAL
ECONOMICS
AND BUSINESS

16 December 1992

Dear Madam/Sir,

REMINDER LETTERS FOR PILOT SURVEY

Approximately two weeks ago you should have received a copy of a survey in regard to my study of erosion control. To date I have not received any reply from you. This letter is to urge you to fill in the survey and return it in the postage paid envelope as soon as possible.

Although you may consider that erosion have no direct effect on your household, you are indirectly involved in erosion control through rates. Rates have an effect on the price of rental accommodation.

Your response is very important to the success of my survey and degree. I am interested in responses from both people who value erosion control and people who do not value erosion control.

If you have already returned your survey, please ignore this letter.

Thank you

Your sincerely

Endang Rosawati

Anton D Meister
Professor, Resource and
Environmental Economics

APPENDIX 3(B)
REMINDER LETTERS FOR SURVEY OF SOIL EROSION CONTROL

MASSEY
UNIVERSITY

Private Bag
Palmerston North
New Zealand
Telephone 0-6-356 9099
Facsimile 0-6-350 5642

FACULTY OF
AGRICULTURAL
AND
HORTICULTURAL
SCIENCES

DEPARTMENT OF
AGRICULTURAL
ECONOMICS
AND BUSINESS

22 February 1993

Dear Sir/Madam,

REMINDER LETTER FOR SURVEY OF SOIL EROSION CONTROL

Approximately two weeks ago you should have received a copy of a survey in regard to my study of soil erosion control. To date I have not received any reply from you. This letter is to urge you to fill in the survey and return it in the postage paid envelope as soon as possible.

Although you may consider that soil erosion have no direct effect on your household, your response is worthwhile as information for this survey, as I am interested in responses from both people who value erosion control and people who do not value erosion control.
For this study is to estimate the benefit value of soil erosion control from people whom directly and indirectly affected by soil erosion.

If you have already returned your survey, please ignore this letter.

Thank you

Your sincerely,

Endang Rosawati

A.D. Meister
Professor, Resource and
Environmental Economics