

**Public perceptions of risk from the  
Waimakariri River**

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## PREFACE

This information paper is the result of a request from staff of the North Canterbury Catchment Board and Regional Water Board for research that would enable them to incorporate public opinion in the Waimakariri Floodplain Management Plan.

The Plan formulates policy for the mitigation of potential flood losses arising from the flood hazard posed by the Waimakariri River. Emphasis in the past has been on structural measures for modifying flooding such as stopbanks and river channel alteration.

Until recently such catchment works were funded by central government. Now regional authorities must adopt a 'user-pays' philosophy and invoke a more substantial charge against beneficiaries of catchment works than they did in the past.

In order to seek commitment to and understanding of flood mitigation policy amongst beneficiaries - residents of the Waimakariri floodplain - the Board wished to identify ways of incorporating public opinion into the Management Plan. Staff of the Board were also interested in assessing the public's perception of the risk it faces from flooding of the Waimakariri River, measures used to mitigate flood losses, willingness to pay for a stopbank option, knowledge of civil defence procedures, etc.

The author of this report accepted a contract in August 1988 to provide some information on these issues. A methodology on the role of public participation and how it could be effected in the management of the Waimakariri floodplain was developed. This report documents an application of the methodology. It details the findings of a survey of a sample of floodplain residents that was undertaken to assess their perceptions of risk, etc. Copies of the companion report prepared for the Catchment Board entitled Public participation: its role in the management of the Waimakariri floodplain can be purchased from the Centre for Resource Management, P.O. Box 56, Lincoln University, Canterbury, New Zealand.

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## SUMMARY

### 1 Setting the scene

Despite increasing investment in flood protection works over time in New Zealand the costs of flood damage have continued to rise. A new urban flood loss reduction policy was developed by the now defunct National Water and Soil Conservation Authority (NWASCA) to address this problem. The policy aims to keep people away from water as well as keeping water away from people.

In 1987 Budget changes resulted in a significant reduction in central Government funding for flood protection works. In the future, local communities will have to meet a much greater proportion of the costs of works than they have in the past. Those who benefit from floodplain management are expected to bear the costs in direct proportion to the benefits they obtain.

These economic and flood management policy changes mean the North Canterbury Catchment Board will now be required to incorporate the public perception of risk with statistical risk analysis into the new Waimakariri Floodplain Management Plan currently in preparation. Flood hazard managers will now need to know what risks the community is prepared to accept and what risks it wishes to pay to mitigate. Whereas in the past the design of flood protection schemes was a technical matter from which the public was largely excluded, present design demands that the process deal explicitly with both statistical risk and perceived risk.

The state of public awareness of the flood hazard posed by the Waimakariri River and floodplain occupants' attitudes towards risk were examined in this study. Insights were also sought into what the community is prepared to pay for flood protection. Information was sought on the public's familiarity with management options that keep water away from people and those that keep people away from water. These options had been previously identified in a pilot study carried out by Catchment Board staff.

An indication of the most appropriate medium for providing people with information on flooding and flood protection was also sought. This was required for any future flood awareness and preparedness programmes that might be offered by the Board.

A stratified random survey of 850 ratepayers was carried out using a mailed questionnaire. Of the surveys mailed, 490 eligible questionnaires were returned, representing a response rate of 58%.

### 2 Public perception of risk

Members of the public were asked directly whether they had felt safe from flooding from the Waimakariri River over the past five years, whether they felt safe from flooding over the next 10 years, and whether they believed the greater Christchurch urban area was at risk from major flooding over the next 30 years.

It was found that floodplain residents did perceive themselves to have been safe from flooding of the Waimakariri River over the past years. Floodplain residents also felt safe from flooding over the next 10 years. A greater number were less confident in the safety of the greater Christchurch urban area over a 30-year period.

Two methods were used to determine factors that influence people's perceptions of risk. The first method was to test influencing factors suggested by the literature. These were:

- (1) knowledge and past experience of the event;
- (2) interpretation of various physical characteristics of the hazard, including flood magnitude and frequency;
- (3) geographical situation of the floodplain occupant; and
- (4) personality traits.

It was found in this study that past experience of the event and geographical situation of the floodplain occupants did influence their perceptions. The other two factors did not appear to do so. This outcome could be attributed to the fact that major flooding of the Waimakariri River is a rare occurrence.

The second method was to ask participants directly the reasons for their responses. Responses indicated a faith in structural flood controls, and in the capacity of the river to contain floodwaters, and the fact that there had been no previous problems.

### **3 Flood management options**

Members of the public were questioned on their familiarity with structural and non-structural management options and their preferences for particular options to be used on the Waimakariri floodplain. These were identified in a pilot study carried out by the Board.

Floodplain residents were found to be more familiar with structural options than non-structural. Despite this, they appear to favour both categories being used on the Waimakariri. Stopbanks were greatly preferred to channel alteration. Order of preference for non-structural options were: floodwarnings and evacuation procedures, flood hazard maps (this option was not a specific component of the pilot study) and zoning. Floodproofing of buildings was seen to be desirable for property at high risk.

While a large percentage of respondents have insurance cover for buildings only half believe it would be sufficient to cover content losses in the event that flood waters reached half a metre above floor level.

### **4 Willingness to pay for flood protection**

A non-market valuation technique, namely, the contingent valuation method, was used to assess people's willingness to pay for enhanced flood protection. Those surveyed were presented with a hypothetical situation regarding the probability of their property being flooded in the next 30 years. They were also presented with a lower probability that could be achieved with improved flood protection works. Each respondent was randomly allocated a dollar amount to be paid as an annual rate for the

next 30 years to achieve this protection. They were then asked to indicate whether the hypothetical scheme should or should not proceed.

Findings indicated that people were willing to pay for flood management measures in proportion to the risks they perceived and the benefits received from protection from flooding. Those who expressed a neutral to extreme risk attitude towards flooding by the Waimakariri over the next 10 years were willing to pay significantly more for flood protection than those who feel safe or completely safe.

## **5 Floodwarnings and civil defence procedures**

Floodplain residents were familiar with flood disaster warnings. However it was not clear whether they would respond to sudden warnings if they had not been alerted to an emergency by the media.

Floodplain residents were not familiar with civil defence procedures. Many would be solely concerned with protecting personal property but relatively few appeared to be aware of personal safety measures recommended by the Civil Defence. While most seemed willing to report to the Civil Defence, only one third of respondents knew specifically where to report to Civil Defence in an emergency.

## **6 Information dissemination preferences**

Although the publication of flood hazard maps appears to be widely accepted by floodplain occupants, their lack of familiarity with maps of this type could result in unanticipated reaction if they were published. Most preferred localities for flood hazard maps were council offices and libraries.

Most preferred means of receiving information on flooding and flood protection were home-delivered pamphlets, television programmes and newspapers.

## **7 Conclusions**

It is difficult to make a clear statement as to the extent public perception of risk differs from that of technical experts. Although ratepayers do not feel they face a high risk of flooding from the Waimakariri, their willingness to pay for flood protection indicates that they do want to be protected from infrequent major events should they occur.

## **8 Recommendations**

Recommendations are given for any future public information dissemination exercise that might be carried out by the Board.

### **(i) Changing perceptions of risk**

A concentrated effort must be made to educate the public about the probabilities of long-term flood risk through indicators the public is able to understand. This must be related to an individual's personal situation.

(ii) Choosing adjustment options

NWASCA's 'Urban Flood Loss Reduction Policy' needs to be given a high profile. People should be made aware of the need to consider options that keep people away from water and not only those that keep water away from people. Structural options cannot be designed to offer protection from all floods as there is no way of anticipating the magnitude of the largest possible event.

An information dissemination programme should emphasise the advantages and disadvantages of non-structural options.

(iii) Floodwarnings and civil defence procedures

The Board needs to liaise with the Civil Defence in informing the public about what to expect in terms of flood warnings and an appropriate hierarchy of responses depending on the warning time given. People need to be made aware of the importance of knowing how and where to contact the Civil Defence in an emergency.

Formulation of a family/firm plan in the event of a disaster plus the setting up of and joining neighbourhood support groups are also recommended.

(iv) Information dissemination

Further research should be undertaken as to the likely reaction of flood-plain residents to the publication of flood hazard maps. Events in Australia suggest a possible adverse reaction.

Care should therefore be taken over the manner in which information is presented to the public. It should also be presented regularly.

(v) General comments

Any flood awareness/preparedness programme should be aimed more intensively at the Christchurch urban population than at the rural population which lives closer to the potential hazard.



## CHAPTER 1 Setting the scene

### 1.1 Introduction

Despite increasing investment in flood protection works over time in New Zealand the costs of flood damage have continued to rise (Fig. 1.1). Research into this phenomenon resulted in the National Water and Soil Conservation Authority's (NWASCA) 'Urban Flood Loss Reduction Policy' which was released in November 1984. Underlying the policy was the understanding that instead of solely 'keeping water away from people', as much attention should be paid to 'keeping people away from water'.

In the past, the approach to flood hazard planning had been to employ structural control options to mitigate flooding. Payment for stopbanks and channel alteration was subsidised by central Government \$3 for every \$1 of local contribution.

The 'Urban Flood Loss Reduction Policy', under which approvals are now granted, requires the consideration of three broad classes of adjustment options available for flood hazard response. These classes are:

- (i) **modification of the flood**, which includes stopbanks, channel improvements, catchment treatment and detention dams;
- (ii) **modification of damage susceptibility**, which can include land use management mechanisms such as zoning, building regulations, land acquisition, and floodplain development policies and plans; flood warnings and civil defence procedures;
- (iii) **modification of the flood loss burden**. Included in this class is insurance, relief funds, and rehabilitation services.

Class (i) is sometimes referred to as structural options; classes (ii) and (iii) as non-structural options.

In 1987 Budget changes resulted in a significant reduction in central Government funds that will be made available to catchment boards for structural protection works. In the future, local communities will be required to meet a much greater proportion of the costs of works than they have in the past. Those who benefit from floodplain management are expected to bear the costs in direct proportion to the benefits they obtain.

A fundamentally different approach to flood hazard management now has to be taken to reflect these changes in flood hazard planning policy and in central Government's economic policy. Flood hazard managers will now need to know what risks the community is prepared to accept and what risks it wishes to pay to mitigate. Whereas in the past the design of flood protection schemes was a technical matter from which the public was largely excluded, present design demands that the process deal explicitly with both **statistical risk** and **perceived risk**.

The Waimakariri River Improvement Scheme 1960 is scheduled for completion in 1989. The approach to the flood hazard posed by the Waimakariri for the next 30 years (1990-2020) is at present being considered by the North Canterbury Catchment Board (NCCB). The 1960 scheme was designed in accordance

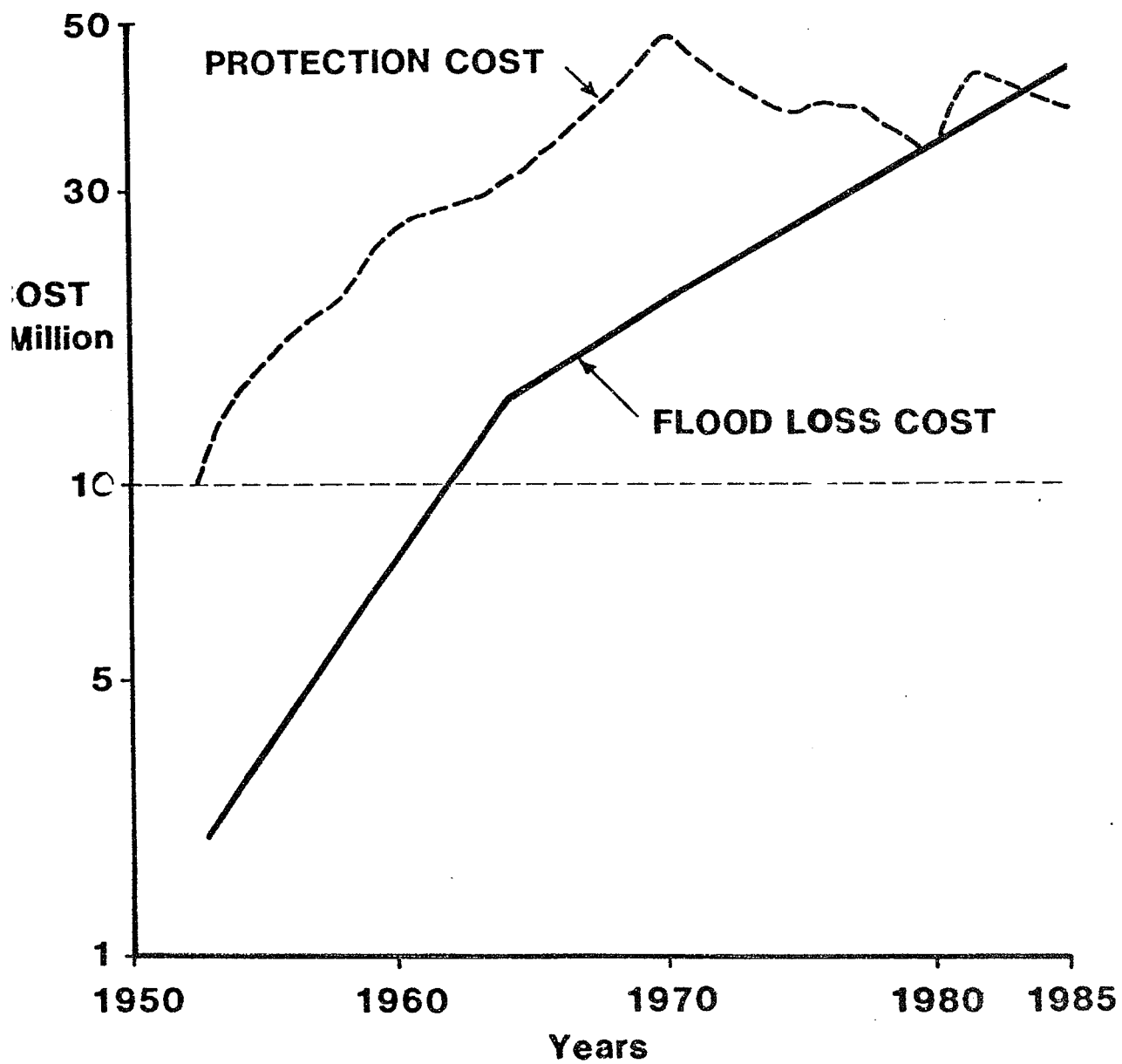


Figure 1.1 National flood losses and protection costs 1950-1985.  
 Source: Ericksen, 1984, p.204 (modified by NCCB).

with a specified statistical risk. The proposed scheme for the next 30 years requires the NCCB also to incorporate the perception of risk of the occupiers of the Waimakariri floodplain into the new Management Plan.

This report examines the state of public awareness concerning the flood hazard posed by the Waimakariri River and what the community is willing to pay for protection against risk imposed by that hazard. The considerations of who should participate, at what stage in the decision-making process, and by what methods, can be found in the companion report by the same author, Public participation: its role in the management of the Waimakariri River floodplain.

A random survey was one of the methods chosen to tap the public's perception of risk and its willingness to pay for protection against that risk. The Board asked that the survey be structured to form the basis for planning of any future programmes of public education/awareness/flood preparedness. For this reason, sections were included on flood warnings and civil defence procedures, and the availability of information relevant to the flood hazard.

## 1.2 Objectives

The survey was designed to meet the following basic objectives.

1. To determine the public perception of the flood hazard posed by the Waimakariri River. As major flooding is a rare event experienced by relatively few people, community perceptions of the hazard and their attitudes towards risk were to be identified.

This information:

- a) provides a data base against which the Board can compare their approaches to designs based on the probabilities of floods of certain magnitudes with the community's view of the flood risks they are prepared to accept,
  - b) indicates the level of information that should be directed at the public through future programmes aimed at increasing flood awareness and preparedness,
  - c) forms the basis of a concentrated package directed at the community representatives who are to participate formally in a consultative capacity (see Blackford, 1989, Chapter 6).
2. To determine the public's familiarity with:
    - (i) structural measures designed to decrease flooding, and
    - (ii) non-structural options aimed at flood damage mitigation.
  3. To gain insights into what the community is prepared to pay for flood protection.
  4. To ascertain the public's familiarity with civil defence procedures and the possible effectiveness of present public warning systems.
  5. To determine the most appropriate media for presenting information to the public.

### 1.3 Methods

#### Survey population

Figure 1.2 shows the entire Waimakariri-Eyre-Cust Rating District. Properties within this area are rated on a graduated scale for direct or indirect benefit received from the construction and maintenance of works designed to protect land and property from flooding. "All property within the area was classified into one of six classes (A-F) on the basis of the benefits which the property was deemed to receive from the works. The classification, which was carried out in the mid-1950's by registered valuers, is the base from which rates are struck, and sets a relativity between each classification in terms of the benefits afforded. Hence properties within the 'A' classification receive a much greater degree of benefit than do properties within the 'D' classification and therefore are rated more highly. The relative classification weightings are:

A = 0.3	B = 0.2	C = 0.08
D = 0.06	E = 0.04	F = 0.02."

(North Canterbury Catchment Board, 1982, Appendix II, 15-16). However, this requirement to levy on a graduated scale has been repealed (Soil Conservation and Rivers Control Amendment, 1987, p.2).

Class A is most likely to be affected by any major riverine flooding while Class F is least likely.

The survey population was defined to be ratepayers living on the Waimakariri floodplain. Ratepayers were chosen because they would be paying directly for any increased flood protection works. The physical boundary of the population that was sampled, that is, the Waimakariri River floodplain, is marked on Figure 1.2. This boundary was derived from topographic photographs which indicate present and former courses of the river. It is apparent from the map that there is an area to the north-east of Lake Ellesmere that faces a degree of risk from overflow of the Waimakariri into the Halswell River at times of major flooding. Properties in this area are not included in the Waimakariri-Eyre-Cust Rating District.

As there is no separate list of Waimakariri floodplain ratepayers, individual properties on that floodplain had to be identified from Valuation New Zealand maps, and roll numbers recorded. The approximate size of this population is 110,000.

#### Sample selection process

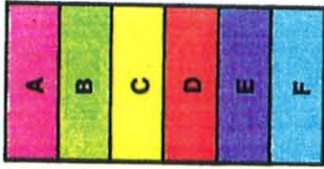
A random sample of 850 ratepayers was selected from ratepayer property valuation rolls. This sample was "a compromise between cost, accuracy and ensuring sufficient numbers for meaningful subgroup analysis." (de Vaus, 1985, p.65). Previous studies (Miller, 1983, pp.102-107) suggested that an expected 40-60% return rate on a sample of that size would give a large enough response to allow useful subsequent analysis.

There were relatively low numbers of ratepayers in all classes apart from Class D. Therefore classes were combined into three groups (Table 1.1). This was to provide groups large enough to analyse while allowing for differences in risk perception to be expressed by groups facing different levels of risk.

Figure 1.2 Waimakariri Eyre-Cust Classification  
 Source: NCCB, 1982

**WAIMAKARIRI  
 EYRE - CUST  
 CLASSIFICATION**

**LEGEND - CLASS**



Scale 1:250000

Approximate  
 boundary  
 Waimakariri  
 floodplain

-----



**Table 1.1 Survey population and survey response rates.**

Risk classes	Ratepayer population <sup>1</sup>	Sample size	%age of popn	No. responses	Response as %age of sample	Class response as %age of total
A & B	3,370	350	10.4	217	62.0	44.0
C & D	106,000	400	0.4	218	54.5	45.0
E, F and others at risk	1,240	100	8.1	53	53.0	11.0
No indication of class <sup>2</sup>				2	0.5	
<b>Total</b>	<b>111,000</b>	<b>850</b>	<b>0.8</b>	<b>490</b>	<b>100.0</b>	<b>57.7</b>

<sup>1</sup> Obtained from ratepayer rolls

<sup>2</sup> Occurred at coding stage

<sup>3</sup> Sum of percentages in each class

The random selection was weighted towards those facing the greatest risk. This was to gain more detailed information from those facing a higher risk than would have been derived from an even allocation over a large urban population facing a lower level of risk. Three hundred and fifty names were randomly chosen from an aggregation of ratepayers in Classes A and B of the Waimakariri Rating District (referred to as risk class 1 in the survey findings). This represented 10.4% of the ratepayer population in that group. Four hundred were chosen from an aggregation of Classes C and D (referred to as risk class 2). This number represented only 0.8% of the large Christchurch urban population.

One hundred were selected from an aggregation of Classes E and F plus those not in the District referred to above (referred to as risk class 3). A greater weighting (8.1%) appears to have been given to those facing a lower level of risk than was given to those in Classes C and D. However, with an anticipated response rate of around 50%, any fewer than 50 questionnaires would have provided too few cases for meaningful sub-group analysis.

The process of random selection involved summing the total number of ratepayers in each group referred to above, and a random number generating programme was used to identify which valuation roll numbers would be selected. After the list of numbers had been prepared, Valuation New Zealand provided names and addresses of the ratepaying property owners. Names of ratepayers living overseas were discarded (because of the time factor involved in their receiving and returning questionnaires) and the next property on the computer printout was chosen. The same process was followed if a randomly selected property was owned by a Government Department.

### Questionnaire design

The survey used a structured questionnaire (see Appendix I) that was mailed out to the sample population. A reply-paid envelope was enclosed with each

questionnaire to encourage those surveyed to respond. A follow-up letter, and copy of the questionnaire were sent out two weeks after the initial mailing to those who had not responded. Questionnaires were coded according to risk class and a dollar value that represented a hypothetical annual rate increase for an improvement in flood protection (see Chapter 4.2 for elaboration).

The questionnaire was divided into 10 sections. Sections A to D were designed to assess respondents' perception of risk from flooding of the Waimakariri River. They covered attitudes towards causes of flooding, knowledge of the flood phenomenon, past flood experience and geographical situation of the floodplain occupant. The literature (Kates, 1970, and Ericksen, 1986) suggested that these factors influence risk perception.

Section E investigated familiarity with and preference for specific structural and non-structural flood management options. The options included stopbanks, channel alteration, floodwarning and evacuation procedures, flood hazard maps, zoning, and floodproofing. Apart from flood hazard maps, these options had been previously identified in a pilot study carried out by Board staff to receive consideration in the Waimakariri Floodplain Management Plan.

Section F aimed to gauge respondents' willingness to pay for enhanced flood protection. This was relevant in view of the Government's 'user pays' policy towards those benefitting from structural flood protection.

Section G investigated knowledge of and anticipated response to flood warnings and civil defence procedures. It was intended to gain more specific information than that derived in Section E.

Section H sought information dissemination preferences in the event that the Board carries out flood awareness and preparedness programmes in the future.

Sections I and J were to provide a general description of the sample population.

In some cases respondents were asked to rank their preferences; in others they were given a choice of two or three responses. Sections A-F included open-ended questions where reasons for preferences could be stated.

Four hundred and ninety eligible questionnaires were returned, representing a response rate of 58%. Ineligible returns (28) amounted to 3%. These applied to addresses outside the floodplain, or were returned by or on behalf of people who were deceased, infirm or too elderly to complete the questionnaire, or had left the address.

### Data analysis

The data was analysed using the SPSSX statistical package on the University of Canterbury Prime computer.

Frequency distribution tables were initially used to describe the number of responses to questions with an ordinal answering scale (for example, see Questions D.2 and D.4 in Appendix I). This provided information on ratepayers' perceptions of past and future risk of flooding with regard to the Waimakariri, attitudes towards adjustment options identified in a pilot study, and knowledge of flood warnings and civil defence procedures.

Cross-tabulation was used to investigate sets of relationships between variables. Factors identified in the literature as contributing to risk perceptions were tested

against perceptions of past and future risk.

The chi-square test was used to determine whether or not the variables were statistically independent, that is, whether a systematic relationship exists between two variables. This test indicates whether a relationship is statistically significant but does not measure the strength of the relationship. Chi-square can be used to make inferences from the sample data to conditions existing in the larger population. It is conventional in social science to accept relationships that have a probability of occurring 95% of the time or more, that is, in 95 out of 100 samples, as statistically significant (Nie *et al.*, 1975, pp. 218-224).

Logit regression procedures were used to analyse respondents' willingness to pay for enhanced flood protection measures. This was to accommodate the dichotomous dependent variable (see Chapter 4.2 for elaboration).

#### 1.4 Characteristics of the sample

The following tables provide a description of the sample obtained in the survey. They show the number of cases responding to each question plus a percentage of those who responded. Most totals do not add up to 490. The discrepancies are accounted for by non-response to individual questions.

**Table 1.2 Sample - gender.**

Gender	No.	%
Male	304	65
Female	124	27
Combined response	40	8

**Table 1.3 Sample - age.**

Age	No.	%
Under 20 years	1	0.2
20 - 29 years	47	10
30 - 39 years	106	23
40 - 49 years	115	24
50 - 59 years	70	15
60 - 69 years	77	16
70 years and over	54	11

**Table 1.4 Sample - floodplain property description.**

Property description	No.	%
Residential (own home)	349	75
Residential (landlord)	25	5
Business	31	7
Farming	58	12
Other (includes land only)	6	1

**Table 1.5 Breakdown of businesses according to type.**

Type of business	No.	%
Retail	9	29
Service (medical, bank, educ.,)	9	29
Social service	1	3
Secondary industry (including manufacturing, engineering)	6	19
Real estate/commercial	3	10
Recreation	2	6
Not indicated	1	3

**Table 1.6 Breakdown of farming according to type.**

Type of farming	No.	%
Mixed	18	31
Dairy	6	10
Horticulture	6	10
Sheep	7	12
Other, e.g. deer, pig, racehorses, beef stock, orcharding, grain, non-specific such as grazing	21	36

## CHAPTER 2 Perception of risk

### 2.1 Risk

Risks can be described as the "quantitative measure of hazard consequences" (Gough, 1988, p.8). Four different evaluations of future risk can be identified (Starr et al., 1976, p.629).

- (1) **Real risk** is determined by future circumstances when they eventually occur or develop fully.
- (2) **Statistical risk** is determined by currently available historical data, typically measured actuarially (for insurance purposes). It is based on observed frequencies which can be evaluated by normal statistical means.
- (3) **Predicted risk** is predicted analytically from systems models structured from historical data.
- (4) **Perceived risk** is seen intuitively by individuals.

Technical interpretations use statistical measures of risk and formal methods of risk evaluation. Flood magnitude and flood frequency are of particular importance in determining the future probabilities of flood risk. However, public perceptions of risk (covers beliefs regarding likelihood of occurrence and causality, as well as evaluations of risk) often diverge from these 'technical frameworks'.

Burton and Kates (1964, p.417) identify this "hiatus between popular perception of hazard and the technical-scientific perception. To many flood-plain users, floods are preventable, i.e. flood control can completely eliminate the hazard. Yet the technical expert knows that except for very small drainage areas no flood control works known can effectively prevent the flood-inducing concentration of precipitation, nor can they effectively control extremely large floods of very rare occurrence."

### 2.2 Influences on risk perception

Perception, or social perception specifically, is "the process by which a person gives meaning to what they see ... (It) is the filter through which the external environment is given meaning by a person" (Ericksen, 1986, p.39). Factors that influence the process include past experiences; existing attitudes, values and motivation; personality; and future expectations. These are shaped by social and cultural conditions such as family, education, occupation, religion, and age (Ibid.).

Ericksen (Ibid., p.40) suggests that, based on the findings of past research, four main factors can influence lay perception of hazards (in this case flooding):

- (1) **knowledge and past experience** of the event;
- (2) **interpretation of various physical characteristics** of the hazard, including **flood magnitude and frequency**;

- (3) **geographical situation of the floodplain occupant; i.e. urban or rural;**
- (4) **personality traits.**

Interviews carried out by the East Cape Catchment Board (1987, p.3) with residents of Opotiki found a general lack of knowledge of the statistical meaning of the so-called 100-year flood; only 15% of those interviewed appeared to understand. The Board is working on an initiative to describe flood risk in terms of the 50% probability concept and not that of 'return periods'.

Residents of Paeroa also demonstrated an erroneous or inadequate understanding of the 'return period' concept used by technical experts. Over 42% of those interviewed implied that it meant a regular cycle" (Ericksen, 1986, p.44).

Research indicates that there is a dominant relationship between past experience and expectation of future flood events; a greater past experience is more likely to yield more accurate views of the probabilities of past and future flood distributions. The town of Opotiki has experienced extensive flooding on a number of occasions (Ericksen, 1986, p.42). A recent study (East Cape Catchment Board, 1988) showed that 78% of those interviewed considered the flood risk of Opotiki to be medium to high, and 74% consider it is likely Opotiki will be flooded within the next 50 years.

However there are important exceptions to this rule. Ericksen (Ibid., p.44) discusses interviews carried out in Paeroa after a recent flood experience. Forty-four percent did not expect flooding to occur again; most of these people implied it was a 'freak' experience yet a scientist's estimate was that there was a 14% chance of recurrence in a 10-year period.

Factors such as the magnitude and frequency of past flooding and how that affected the individual in a temporal and spatial manner can influence and distort a person's perception of past events (Ibid., p.40). Ericksen reports on risk perception of two flood-prone communities; Greymouth and Opotiki. It appears that people who are exposed to relatively frequent flood experiences have reduced expectations of larger future events (Ibid., pp.41-42).

Research into the 1974 Brisbane floods found that after 14 months the usual fading of memory and the development of consensus interpretations of the disaster distorted victims' views (Luketina, 1985, p.31).

Ericksen (1986, p.42) refers to the notion of 'gambler's fallacy' that affects lay perception of flooding. It assumes the reduced likelihood of an event happening in any one year if it has happened the previous year. In contrast, scientists view floods as random events that have the same probability of happening in one year as the next. Ericksen suggests that this fallacy might be more prevalent in areas of infrequent flooding.

Where the event is infrequent, failure to perceive a significant hazard is widely shared (Burton and Kates, 1964, p.429).

Studies by Burton and Kates (1964, p.428) suggest that urban and rural floodplain users display different perceptions of the flood hazard. Agricultural land users exhibit a greater hazard sensitivity in terms of awareness. Ericksen compares perceptions of rural and urban floodplain occupants. He has found

that closeness to nature tends to align farmers more closely to scientists in their views of flooding (Ericksen 1986, p.40).

The fourth factor, that is, personality traits, affects the attitudes people have towards natural events. These include "attitudes towards fate (ranging from 'disasters are acts of God' to 'individuals create disasters'); belief in the efficacy of Government acting (ranging from 'the catchment board will solve the flooding' to the need for personal action); views of people-nature relationships (including dominance, harmony, and subjugation); and risk-taking behaviour" (Ibid., p.9).

### **2.3 Technological solutions**

Public perceptions may contain contradictions and inconsistencies. Burton and Kates (1964, p.432) point to the widespread belief in the technical engineering solutions to problems of hazards. Optimism about the recurrence of future floods may correlate with knowledge and familiarity with flood protection works. People are lulled into a false sense of security without realising that structures are built to withhold a specific flood capacity. Problems occur when the design capacity is exceeded by an infrequent event.

Ericksen (1986, pp.43-44) refers to studies carried out on flood-prone communities in New Zealand. In Otorohanga, a small community on the floodplain of the Waipa River, it was found that 13 years after a major flood, no-one expected a future flood. Half of those interviewed held this view because of confidence in stop bank protection completed in response to the previous major flood.

Luketina (1985, p.11) reviews studies of flood hazard perceptions. Research indicates that even when people are informed of the hazard-prone nature of their locality they appear to deny the danger. Responses indicate an "it won't happen here" attitude. In cases of denial it cannot be assumed that attempts to raise the hazard consciousness of the general public will have the desired effect.

### **2.4 Perceptions of past and future risk**

The main factors that can influence flood risk perception tested in the survey were: knowledge and past experience of the event, geographical situation of the floodplain, and personality traits.

The order of the results and discussion relating to this section differs from the questionnaire format; it was suggested at the questionnaire design stage that a less demanding section at the beginning could encourage people to respond more readily.

All tables marked with an \* indicate respondents' first choice where they were asked to rank options. Some gave more than one first choice; this accounts for why some percentage totals exceed 100 slightly.

#### 2.4.1 Perceptions of past and future risk - findings

These questions investigate the public perception of risk from flooding of the Waimakariri River as a past and future problem, and possible influences upon that perception.

Question D.2. When asked to indicate how safe respondents felt from the risk of flooding from the Waimakariri over the last five years, they were given a scale of discrete categories from 'completely safe' to 'at extreme risk'.

**Table 2.1 Perception of past risk.**

Risk perception of past	No.	%
5. Completely safe	219	46
4.	127	26
3.	84	18
2.	18	4
1. At extreme risk	14	3
Don't know	17	3

Weighted mean = 4.1

D.3. The most frequent reasons given by those who felt completely safe or safe included -

**Table 2.2 Why safe in past?**

Reasons	Times mentioned	%
No previous problems in past	94	35
Positive characteristics/capacity of river	94	35
Faith in structural controls	80	30

Those who felt at risk or at extreme risk did so because -

**Table 2.3 Why at risk in past?**

Reasons	Times mentioned	%
Negative characteristics/capacity of river	36	68
Lack of faith in structural controls	10	19
Influence of climatic factors	7	13

D.4. "How safe do you think your property is from the risk of flooding from the Waimakariri over the next 10 years?"

**Table 2.4 Perception of future risk.**

Risk perception of future	No.	%
5. Completely safe	138	28
4.	144	30
3.	109	23
2.	27	6
1. At extreme risk	13	3
Don't know	50	10

Weighted mean = 3.9

D.5. Reasons given for feelings of safety or complete safety were -

**Table 2.5 Why safe in future?**

Reasons	Times mentioned	%
Positive characteristics/capacity of river	86	42
Faith in structural controls	68	34
No previous problems	48	24

Those who felt at risk or at extreme risk did so because -

**Table 2.6 Why at risk in future?**

Reasons	Times mentioned	%
Negative characteristics/capacity of river	37	47
Negative influence of climatic factors	25	32
Always a risk	17	21

D.6. "In your opinion, how likely is it that a major flood by the Waimakariri will cause significant damage to the greater Christchurch urban area within the next 30 years?"

**Table 2.7 Perception of future risk to greater Christchurch urban area.**

Risk perception	No.	%
1. Improbable	75	16
2.	120	25
3.	115	24
4.	68	14
5. Very probable	49	10
Don't know	53	11

Weighted mean = 2.8

#### **2.4.2 Perceptions of past and future risk - discussion**

Seventy-two per cent of ratepayers surveyed have felt safe or completely safe from flooding of the Waimakariri over the past five years. Only 7% perceived themselves to be at moderate or extreme risk in the past.

Comments from those who perceived themselves to have been safe in the past included reference to large upper basins combined with stopbanks, the capacity of the river to cope with large volumes of water, protection received from stopbanks, faith in engineers and no previous problems. Those on the north side believed they were favoured by height above sea level.

Those who felt they were at risk believed that high water levels had been reached at times, a build up of shingle exacerbated flooding problems, there were limitations on the height of stopbanks, a 100-year flood would overtop the stopbanks, and that the 'greenhouse effect' and depletion of the ozone layer were causing increased rainfall.

Perceptions changed with regard to personal risk of flooding over the next 10 years. Fifty-eight per cent felt they were safe or completely safe while 9% believed they faced moderate to extreme risk in the future. Thirty-three per cent took a neutral position or did not know whether they faced a personal risk of flooding. Reasons given for these perceptions were similar to those given by respondents when offering their perceptions of whether or not they perceived that they had faced a past risk. Those who were optimistic believed that measures had already been taken, they were well out of the flood path, providence would prevail, and that there had been no major flooding of the Waimakariri during the past 75 years.

Those who perceived a future risk offered reasons such as increasing rainfall attributable to the 'greenhouse effect' and depletion of the ozone layer, few measures (preventative presumably) were being taken, we are unable to predict future happenings/events, that is, the unpredictability of nature, and the fact that the river has been very close to breaking its banks every year.

Forty-one percent perceived that flooding of the greater Christchurch Urban Area is an improbability or highly improbable during the next 30 years. Twenty-four percent believed that it was probable or very probable, 24% took a neutral position while 11% did not know. Reasons for these views were not solicited.

The weighted mean value falls over time from 4.1 for past risk to 3.9 for future risk (see Tables 2.1 and 2.4). Although the weighted mean value for risk to the greater Christchurch urban area during the next 30 years is 2.8 (Table 2.7), it would actually equate with 3.3 if the options ranged from 5 to 1. and not 1 to 5. In other words, while the weighted mean tends towards the 'safe' end of the scales in these three tables, people appear to feel less confident towards future risk than this result suggests. A greater degree of uncertainty is also expressed over time: 21% indicated a neutral (indicated by the number 3 on the scale) or 'don't know' position regarding past risk, as did 33% regarding safety over the next 10 years, and 35% over the next 30 years.

## **2.5 Factors influencing risk perception**

The next sections explore the relationships underlying the responses to questions on perceived risk.

### **2.5.1 Past experience of flooding**

Question C.1 investigated how long the respondents had lived at their present site on the floodplain.

**Table 2.8 Length of occupancy on floodplain.**

Years	No.	%
1 - 5 years	153	33
6 - 10 years	81	17
11 - 20 years	105	23
21 - 30 years	54	12
31 - 90 years	72	15

Questions C.2 and C.3 enquired whether respondents had experienced flooding of the Waimakariri River at their present site and/or whether they had personal experience of their property being flooded elsewhere in New Zealand.

**Table 2.9 Past riverine flooding experience.**

Flood experience	No.	% of total respondents
Waimakariri	26	5
Elsewhere	72	15

C.4. When inquiring about the number of years since the respondent had last experienced flooding the following results were obtained.

**Table 2.10 Years since past flooding experience.**

Years	No.	% of total respondents
1 - 5 years	6	1.2
6 - 10 years	3	.6
11 - 20 years	8	1.6
21 - 30 years	14	2.9
31 - 90 years	26	5.3

**Table 2.11 <sup>1</sup>Perceived risk in past by Waimakariri flood experience.**

Waimak. flood experience	Perceived risk in past (%)					Total nos
	1. At extreme risk	2.	3.	4.	5. Completely safe	
Yes	8	21	8	25	38	24
No	3	3	19	27	48	435

(Significant at 95% level)

<sup>1</sup> Perceived risk in past equates with the question "How safe have you felt from the risk of flooding from the Waimakariri over the last five years?"

**Table 2.12 <sup>1</sup>Perceived risk in future by Waimakariri flood experience.**

Waimak. flood experience	Perceived risk in future (%)					Total nos
	1. At extreme risk	2.	3.	4.	5. Completely safe	
Yes	14	10	24	33	19	21
No	2	6	26	33	33	405

(Significant at 95% level)

<sup>1</sup> Perceived risk equates with the question "How safe do you think your property is from the risk of flooding from the Waimakariri over the next 10 years?"

### 2.5.2 Past experience of flooding - discussion

It was found that floodplain residents who have experienced flood damage are more likely to view flooding as a past and future problem than floodplain residents who have not experienced damaged by flooding.

Only 15% of respondents have lived on the Waimakariri floodplain for more than 30 years (the river last flooded in 1957). One third have owned property there for five years or fewer. Five per cent of respondents claimed to have been flooded by the Waimakariri River in the past.

A check of some of the respondents' locality and length of occupation on the floodplain showed a lack of correlation. This could be attributable to occupation of a different property previously, or there could have been an erroneous understanding of causes of previous flooding. The figure of 5% is therefore slightly higher than is probably the actual situation.

Past experience of flooding of the Waimakariri influenced respondents' perceptions of both past and future risk (see Tables 2.11 and 2.12). Nearly 30% of those who had experienced flooding in the past felt at risk or at extreme risk over the past five years whereas only 6% of those with no past experience of flooding of the Waimakariri felt at risk.

Twenty-four per cent of those with previous Waimakariri experience believe they are at risk or at extreme risk from flooding over the next 10 years while only 8% of those with no past experience share the same fears.

Fifteen per cent have had experience of flooding elsewhere in New Zealand. No statistical relationship was found between this past experience and their perceptions of risk from the Waimakariri. For most of those who had experienced flooding elsewhere, approximately only one-sixth indicated this had occurred within the past 10 years (see Table 2.10).

### 2.5.3 Geographical situation (i.e. risk class) on floodplain - findings

Table 2.13 <sup>1</sup>Perceived risk in past by <sup>2</sup>risk class.

Risk class	Perceived risk in past (%)					Total nos
	1. At extreme risk	2.	3.	4.	5. Completely safe	
1	4	8	22	31	35	202
2	2	1	15	24	58	209
3	4		14	27	55	49

(Significant at 95% level)

<sup>1</sup> Perceived risk equates with the question "How safe have you felt from the risk of flooding from the Waimakariri over the last five years?"

<sup>2</sup> Risk class represents proximity to the hazard (see Fig. 1.2 and Table 1.1)

**Table 2.14** <sup>1</sup>Perceived risk in future by <sup>2</sup>risk class.

Risk class	Perceived risk in future (%)					Total nos
	1. At extreme risk	2.	3.	4.	5. Completely safe	
1	4	10	33	29	25	189
2	2	5	18	35	41	192
3	2		25	46	27	48

(Significant at 95% level)

1 Perceived risk equates with the question "How safe do you think your property is from the risk of flooding from the Waimakariri over the next 10 years?"

2 Risk class represents proximity to the hazard (see Fig. 1.2 and Table 1.1).

Question D.1. "Did you realise that your property is situated on a floodplain?"

**Table 2.15** Realisation that property on floodplain

Realise on floodplain	No.	%
Yes	342	71
No	139	29

**Table 2.16** Risk class by realisation on floodplain.

Risk class	Realise on floodplain (%)		Total nos
	Yes	No	
1.	78	22	213
2.	63	37	215
3.	78	22	51

(Significant at 95% level)

**Table 2.17 Realise on floodplain by safe in past.**

Realise on floodplain	Safe in past (%)					Total nos.
	1. At extreme risk	2.	3.	4.	5. Completely safe	
Yes	3	4	22	30	41	329
No	3	3	9	22	63	130

(Significant at 95% level)

**Table 2.18 Realise on floodplain by safe in future.**

Realise on floodplain	Perception of future risk (%)					Total nos
	1. At extreme risk	2.	3.	4.	5. Completely safe	
Yes	2	8	29	35	26	313
No	4	3	15	30	48	114

(Significant at 95% level)

**2.5.4 Geographical situation on the floodplain - discussion**

**Geographical situation (rural/urban)** on the floodplain did influence perception to a limited extent; a weak relationship was found between risk class and feelings of safety both in the past and in the future. A greater number of those who live closest to the river perceived a past risk (12%) than those who face a lesser degree or risk (3% and 4% respectively) (see Table 2.13). Conversely, greater numbers in risk classes 2 and 3 felt safe or completely safe than did those in class 1. A similar picture emerged with regard to future risk (see Table 2.14).

One interesting observation arose when questionnaire returns were compared between risk classes. Sixty-one per cent of Classes A and B participated in the survey, as did 55% of Classes C and D, and 53% of Classes E and F and others (see Table 1.1). One of the reasons for a lower comparative return from at risk Classes C to F could be attributed to an absence of perceived risk.

Nearly one-third of respondents were unaware that their property was situated on a floodplain (Table 2.13). These were not confined solely to any one risk class (see Table 2.14). A surprising revelation was that nearly 40% of those in

risk class 2 (which equates with Classes C and D in Fig. 1.2) are not aware they own property on a floodplain yet those who face a lower level of risk (risk class 3) have an increased awareness.

A weak relationship was found to exist between an awareness that the property one owns is located on the floodplain and a feeling of safety both in the past and in the future (Tables 2.17 and 2.18). Fewer of those who realise they live on a floodplain felt safe or completely safe in the past than those who were not aware. A difference in past and future perceptions of risk was also manifest in this sub-group.

### 2.5.5 Personality traits - findings

(Tables marked with an \* indicate respondents' first choice where they were asked to rank options.)

A.1 "Some people believe floods are caused by the way we use our land close to rivers, some believe that floods are 'an act of God' or a natural event. Others believe that floods are caused by a combination of these things." Respondents were asked to rank a number of options to indicate what they felt were the main causes of floods.

**\*Table 2.19 Attribution of flood causation.**

Flood cause	No.	%
1. Upper catchment land use	138	26
2. Floodplain land use	57	11
3. Nature	280	54
4. God/Gods	34	7
5. Don't know	13	2

A.2 "Who do you think is most responsible for making preparations so that a major flood does as little damage as possible to your home and family?"

**\*Table 2.20 Responsibility for mitigating flood damage.**

Who is responsible?	No.	%
Your Catchment Board	300	58
Government	99	19
You and your household/firm/organisation	22	4
Combination of these	98	19

### 2.5.6 Personality traits - discussion

Fifty-four per cent attributed causation of flooding to nature. Twenty-six per cent blamed upper catchment land use while 11% saw floodplain land use as a major factor although the word "exacerbate" in the question rather than "cause" might have produced a different response. Nonetheless 37% are aware of the role of human activities and land use in hazard situations.

Although 54% of respondents indicated that Nature was the major 'cause' of flooding, this could not be demonstrated statistically to have influenced their perception of past and future risk. Nor did their views on the culpability of upper catchment and floodplain land use. **Personality traits** did not appear to influence flood perception.

Only 4% saw a role for the individual in the prevention of flood damage. Responsibility was seen to lie with the Catchment Board by almost two-thirds of respondents. This could indicate a belief that structural controls are the only way flood damage can be mitigated. Only approximately one-fifth of respondents were amenable to the concept underlying the 'Urban Flood Loss Reduction Policy', namely that a combination of structural and non-structural measures can reduce flood damage.

### 2.5.7 Knowledge of event - findings

B.1. "What do you think the term '100-year flood' means?"

- a. A flood of a certain size that occurs once every one hundred years.
- b. A flood of a certain size that has a 1% chance of occurring in any one year."

**Table 2.21 Understanding of flood return periods.**

Flood knowledge	No.	%
Choice a. (incorrect)	226	47
b. (correct)	231	49
c. Don't know	19	4

### 2.5.8 Knowledge of event - discussion

There was an almost even split between those who appeared to understand the technical term '100-year flood' and those who did not. However, it is not possible to determine whether those who answered correctly actually do understand or whether a guess was attempted.

When the survey was designed it was intended to test whether floodplain occupants understand probabilities of risk expressed as a percentage over a period of time better than they understand statistical notions of risk that refer to return

periods. Catchment Board staff believed the questions posed were too difficult for most people to answer so the author chose a simpler 'either/or' option.

Other studies suggest that the term '100-year flood' is not well understood by the general public. The implications of this finding are that specific probabilities of risk around which flood management options are designed should be described in terms that the public are able to understand.

Statistical analysis did not reveal any relationship between respondents' flood knowledge and their perceptions of risk, both past and future.

## 2.6 Summary

Occupants of the Waimakariri River floodplain have felt safe from flooding over the past five years. Their own reasons indicated that they had faith in structural controls, a lack of awareness of risk and a belief that the characteristics of the river such as large upper basins and the capacity of the river bed to cope with large quantities of water could reduce the likelihood of flooding.

Of the factors suggested by the literature as influencing risk perception, a weak relationship was found between perception and past flooding experience of the Waimakariri. However, as only a very few people had had this experience this finding should be viewed with caution. A weak relationship appeared between perception and geographical situation on the floodplain (risk class). No relationship was found between perception and flood knowledge, and perception and personality traits.

People thought that they were moderately safe against future risk over the next 10 years; a change in perception appeared from that towards risk in the past. A higher proportion believed they were facing a degree of risk in the future (10% v. 7%) and a lower proportion indicated feelings of safety (58% v. 72%). Faith in structural controls, the fact that there were perceived to be no previous problems, positive river capacity, plus distance from the river were cited as reasons for feeling safe. Reasons for feeling unsafe in the future included the effects of climatic changes attributable to the 'greenhouse effect' and depletion of the ozone layer, the unpredictability of nature, and a belief in being unable to predict future events.

Factors predicted in the literature to influence perception of past risk also influenced perception of future risk.

The above outcomes could be attributed to the fact that flooding of the Waimakariri River is an infrequent occurrence. Few of those who live on the floodplain at present were there at the time of the last major flood in 1957. The fact that weak or very weak relationships were found between risk perception and past flood experience could be attributable to the fading of long-term memory. However, even if the Waimakariri had flooded, say, within the past five years, it is difficult to know whether these outcomes might have been considerably different.

It is also not possible to say what effect this survey may have had in alerting people to potential future risk.

## CHAPTER 3 Flood management options

### 3.1 Introduction

Underlying the Urban Flood Loss Reduction Policy was the understanding that instead of solely 'keeping water away from people', as much attention should be paid to 'keeping people away from water'. The policy requires the consideration of three broad classes of adjustment options available for flood hazard response. These classes are:

1. **modification of the flood**, which includes stopbanks, channel improvements, catchment treatment and detention dams;
2. **modification of damage susceptibility**, which can include land use management mechanisms such as zoning, building regulations, land acquisition, and floodplain development policies and plans;
3. **modification of the flood loss burden**; included in this class is insurance, relief funds, and rehabilitation services.

Class 1 is also referred to as structural options while Classes 2 and 3 are referred to as non-structural options.

"One aim of a unified natural hazards management policy is to enable individuals to make land use choices that are sensitive to the problem of natural events and hazards." (Ministry for the Environment, 1988, p.11) Individuals have a number of responsibilities; they should:

- \* consult with regional and district agencies regarding possible hazards before investing in property or development;
- \* take out relevant natural hazard insurance;
- \* install hazard reduction measures (e.g. flood proofing);
- \* maintain awareness of hazards;
- \* maintain survival kits in readiness for disaster, as indicated by the Civil Defence.
- \* know what to do in the event of a disaster, as indicated by the Civil Defence (Ibid.).

It is apparent from policy statements such as this that both catchment boards and individuals have important roles to play in policy implementation.

In March 1988, a pilot study (see Appendix II) was carried out by staff of the North Canterbury Catchment Board "to determine the scale of the project by forecasting key components of a floodplain management plan for the Waimakariri River. This was achieved by examining and analysing a list of options previously considered to merit study for possible inclusion as a policy or a strategy in the (Waimakariri Floodplain Management Plan) WRFMP. Feasibility was judged on the basis of economic, environmental, social and technical considerations." The key components build on the Waimakariri River Improve-

ment Scheme 1960 with options from both classes 1 and 2 of the Urban Flood Loss Reduction Policy being considered.

These components are:

1. **Maintenance and refinement** of the structural system of the existing protection scheme. Grass stopbanks and plant trees and brush.
2. **Structural extensions**, that is, extend the stopbank system on the south side of the river.
3. **Floodwarning and communications**. Develop a quantitative flood forecasting system. Review flood communications with the New Zealand Meteorological Service, Police and the Civil Defence.
4. **Flood hazard zoning** of the highest risk area of the floodplain. Restrict development where necessary and enforce flood proofing standards in new construction.
5. **Technical assistance programme** to enable floodplain occupiers to determine the risk of flooding at their location and obtain advice about appropriate damage reduction measures.
6. **Community awareness programme** for floodplain occupiers through the co-ordination and maintenance of the technical assistance programme and the floodwarning system.

Components 2, 3, 4 and 5 were addressed in the survey. Flood warning and communications will be dealt with separately in Chapter 5; the Community Awareness Programme in Chapter 6. The formulation and publication of flood hazard maps was not identified as a key component of the Waimakariri Floodplain Management Plan. However it is a measure that can be used to inform and educate individuals about the flood hazard and was included in this section of the survey. The concept is more fully addressed in Chapter 6.

Various aspects relating to components 4 and 5 are outlined below.

#### Flood hazard zoning

One of the critical steps in floodplain management planning is the selection of a base flood, that is, the size of flood to be used for planning purposes. This determines the area of land that would be subject to building controls and restrictions on land development. Controls include zoning, building permit restrictions, floor level criteria, etc. (Bewick, 1988, Section 1, pp.1-2).

Councils have a duty of care in their choice of flood size for planning purposes. If the adopted specified flood size is too low, then property above that flood level will be inundated when that size is exceeded. On the other hand, if a very high flood size is adopted, long term economic losses will occur where land that is infrequently flooded is subject to unnecessary controls. Councils therefore need to be very explicit about the basis of their decision (Ibid. Section 7, pp.1-5).

#### Technical assistance programme - floodproofing

Floodproofing can be defined as "adjustments to structures and contents which are designed or adapted primarily to reduce flood damages" (Sheaffer,

1960, p.3). Sheaffer identifies three main classes of measures; permanent, contingent, and emergency. In the pilot study (see Appendix II) carried out by the North Canterbury Catchment Board, permanent measures were considered.

Permanent measures include structural design; new structures can be designed to accommodate the garage at ground level and activities that are extremely susceptible to flood damage could be located above the potential flood level where possible (Ibid., p.19).

Floodproofing of doors and windows is another permanent measure. Doors and window frames can be reinforced, replacing glass windows with sealed, unbreakable panes (Ibid., p.6)

### 3.2 Flood management options - findings

Questions in this section investigated residents' familiarity with measures available to reduce impacts of flooding, and their preferences for individual options to be used on the Waimakariri.

E.1. "Have you heard of stopbanks before now?"

**Table 3.1 Heard of stopbanks.**

Heard of stopbanks	No.	%
Yes	483	99.8
No	1	0.2

E.2 "How would you feel about stopbanks being used to manage major flood flows in the Waimakariri River?"

**Table 3.2 Preference for stopbanks.**

Preference	No.	%
5. Strongly in favour	347	75
4.	65	14
3.	38	8
2.	11	2
1. Strongly opposed	5	1

Weighted mean = 4.6

E.3. Those who were in favour or strongly in favour of stopbanks were so because -

**Table 3.3 Why favour stopbanks?**

Reasons	Times mentioned	%
Effective control of river	277	76
No alternative, best flood prevention good idea, commonsense	70	19
Economic benefits	16	4

Those who were opposed or strongly opposed gave the following reasons -

**Table 3.4 Why opposed to stopbanks?**

Reasons	Times mentioned	%
Ineffective control of river	21	68
Negative environmental impacts	7	22
Negative economic factors	3	10

E.4. "Have you heard of channel alteration before now?"

**Table 3.5 Heard of channel alteration?**

Heard of channel alteration	No.	%
Yes	426	89
No	52	11

E.5. "How do you feel about channel alteration being used to help reduce the possibility of flooding of the Waimakariri?"

**Table 3.6 Preference for channel alteration.**

Preference	No.	%
5. Strongly in favour	185	45
4.	56	13
3.	102	25
2.	44	11
1. Strongly opposed	25	6

Weighted mean = 3.8

E.6 Reasons for being in favour or strongly in favour were -

**Table 3.7 Why favour channel alteration?**

Reasons	Times mentioned	%
Positive structural control/complementary to other options	128	84
Economic benefits	12	8
Positive effects on river capacity	12	8

Reasons for being opposed or strongly opposed were -

**Table 3.8 Why opposed to channel alteration?**

Reasons	Times mentioned	%
Negative effects on river capacity/characteristics	44	40
Negative structural control	43	39
Adverse environmental effects	23	21

E.7. "Have you heard about floodwarning and evacuation procedures before now?"

**Table 3.9 Heard of floodwarning and evacuation procedures.**

Heard of floodwarning and evacuation procedures	No.	%
Yes	406	85
No	70	15

E.8. "How do you feel about these kind of procedures which would be used in the greater Christchurch urban area in the event of a flood?"

**Table 3.10 Preference for floodwarning and evacuation procedures.**

Preference	No.	%
5. Strongly in favour	326	75
4.	63	15
3.	34	8
2.	8	2
1. Strongly opposed	1	

Weighted mean = 4.6

E.9. Reasons for being in favour or strongly in favour were -

**Table 3.11 Why favour floodwarning and evacuation procedures?**

Reasons	Times mentioned	%
Positive communication/organisation	129	41
Prevent loss of life, personal safety	106	34
Protect property	76	24

Reasons for being opposed or strongly opposed were -

**Table 3.12 Why opposed to floodwarning and evacuation procedures?**

Reasons	Times mentioned	%
Various negative factors	13	68
Negative communication/organisation	6	32

E.10. "Have you heard of flood hazard maps before now?"

**Table 3.13 Heard of flood hazard maps?**

Heard of flood hazard maps	No.	%
Yes	133	28
No	345	72

E.11. "How would you feel about the greater Christchurch urban area being mapped for flood hazards?"

**Table 3.14 Preference for flood hazard maps.**

Preference	No.	%
5. Strongly in favour	292	68
4.	62	14
3.	50	11
2.	16	4
1. Strongly opposed	11	3

Weighted mean = 4.4

E.12. Reasons given for those in favour or strongly in favour were -

**Table 3.15 Why favour flood hazard maps?**

Reasons	Times mentioned	%
Positive information/planning	225	76
Good idea, commonsense, logical, etc.	43	15
Positive economic benefits	26	9

Reasons given for those opposed or strongly opposed were -

**Table 3.16 Why opposed to flood hazard maps?**

Reasons	Times mentioned	%
Negative information aspects	16	52
Negative economic factors	15	48

E.13. "Have you heard about zoning of land at risk from flooding before now?"

**Table 3.17 Heard of zoning?**

Heard of zoning	No.	%
Yes	204	43
No	267	57

E.14. "How do you feel about floodplain zoning being used in the greater Christchurch urban area to help lessen flood damage to buildings?"

**Table 3.18 Preference for zoning.**

Preference	No.	%
5. Strongly in favour	223	52
4.	45	10
3.	128	30
2.	29	7
1. Strongly opposed	5	1

Weighted mean = 4.1

E.15. Reasons given by those in favour or strongly in favour were -

**Table 3.19 Why favour zoning?**

Reasons	Times mentioned	%
Positive information/planning	151	60
Good idea, commonsense, logical, etc.	63	25
Positive economic benefits	37	15

Reasons given by those opposed or strongly opposed were -

**Table 3.20 Why opposed to zoning?**

Reasons	Times mentioned	%
Negative economic impacts	10	48
Negative information/planning	7	33
Always some risk	4	19

E.16. "Have you heard of floodproofing before now?"

**Table 3.21 Heard of floodproofing?**

Heard of floodproofing	No.	%
Yes	214	45
No	261	55

E.17. "If your house/building was severely flooded do you think the Council should grant you a building permit to rebuild it in exactly the same way as it was before the flood?"

**Table 3.22 Council should grant permit to rebuild.**

Council should give a permit to rebuild	No.	%
Yes	141	30
No	243	52
Don't know	81	18

E.18. "If your house/building was severely flooded, would you be willing to raise the floor level?"

**Table 3.23 Willing to raise the floor?**

Willing to raise floor	No.	%
Yes	260	56
No	127	28
Don't know	74	16

E.19. "If your house/building was severely flooded, would you be willing to fit water-tight doors and windows?"

**Table 3.24 Willingness to fit water-tight doors and windows.**

Willing to fit water-tight doors and windows	No.	%
Yes	165	35
No	198	43
Don't know	104	22

E.20 "Is your home/business on the floodplain insured for losses due to flood damage?"

**Table 3.25 Home/business covered by insurance.**

Covered by insurance	No.	%
Yes	354	76
No	27	6
Don't know	87	18

E.21. "Are the contents of the above and/or farm equipment also insured for such losses?"

**Table 3.26 Contents/farm equipment covered by insurance.**

Contents covered by insurance	No.	%
Yes (house/business)	244	54
No (house/business)	33	7
Yes (farm equipment)	5	1
No (farm equipment)	3	1
Yes (unqualified whether house/business/ farm equipment)	63	14
No (unqualified whether house/business/ farm equipment)	13	3
Don't know	93	20

E.22. "If you answered 'YES' to E.20. would this insurance cover be sufficient to cover likely losses in the event that water came up, say, half a metre above floor level?"

**Table 3.27 Sufficient insurance.**

Sufficient insurance	No.	%
Yes	210	54
No	75	19
Don't know	107	27

### 3.3 Flood management options - discussion

#### 3.3.1 Familiarity with available flood management measures

Floodplain residents are more familiar with structural adjustment options than non-structural. Only one (0.2%) respondent had not heard of stopbanks while 11% were not aware of channel alteration as an option.

Flood warning and evacuation procedures were well known; 85% had heard of them before. However, the other non-structural options were less familiar. Twenty-eight per cent had heard of hazard maps, 43% of floodplain zoning, and 45% of flood proofing measures.

#### 3.3.2 Preference for available flood management options

Eighty-nine per cent of ratepayers were in favour or strongly in favour of stopbanks. Only 3% were opposed or strongly opposed. Channel alteration was favoured or strongly favoured by 58% of the sample while 17% were opposed or strongly opposed.

Preferences for stopbanks included the belief that they would stop major flooding, it is a cheaper option than moving the city, they contain the flood sufficiently to allow warnings, they control upper catchment water, they have been effective in the past, they provide economic benefits by stopping the loss of productive land from erosion, and they are better than 'doing nothing'.

Those who did not think stopbanks should be used on the Waimakariri believed that a reliance on stopbanks leads to the development of areas that should be left to wilderness, that stopbanks lead to the raising of the river bed which subsequently exacerbates the hazard, that they were only a temporary measure, and could not stop a major flood. Only two respondents referred to negative economic aspects of stopbanks.

There were numerous references to the possibilities for irrigation that channel alteration would afford. Reasons for preferring channel alteration were: it would stop major floods, it would ease pressure on stopbanks, it is a natural option that facilitates water flow, it would divert more water than stopbanks hold back (previous 'successes' such as Wright's Cut were cited).

Those who did not prefer channel alteration as an option felt it was not a permanent solution because nature takes its own course, it is costly, it is possibly not effective in a major flood, natural courses should not be changed, and it will not work because shingle needs to be removed constantly.

Floodwarnings and evacuation procedures were favoured or strongly favoured by 90%, hazard maps by 82%, and zoning by 62%. Fifty-six per cent indicated they would be prepared to raise the floor level of their building if it were severely flooded. Thirty-five per cent were prepared to fit water-tight doors and windows in similar circumstances. Thirty per cent believed that the Council should grant a building permit to rebuild in exactly the same way it was prior to being severely flooded; 52% did not.

Preferences for flood warnings and evacuation procedures were dominated by the perceived benefits of organisation and communication (prevention of loss of life and property). Others expressed sentiments such as 'good idea, logical', etc. Those who did not prefer this option suggested that civil defence information available for citizens on how to prepare for a disaster was inadequate, they were wary of instilling panic where there was no risk, or there was a desire to make an individual decision when to evacuate.

People preferred flood hazard maps because of the information aspect associated with saving lives and property, evacuation priorities could be established and they serve to raise the general public's awareness of risk. This was considered important for those buying properties. It was also considered an useful counter to property developers' 'misinformation'. Negative aspects of this option were seen to be a depreciation of property values, the huge economic and political costs associated with publication of maps, a waste of money for areas already built on.

Zoning of land was also seen to have a positive information and planning function as well as being a logical, commonsense option. Forward planning was commended as was the promotion of risk awareness. Others believe it was too late to be of value, people should be allowed to live where they wish, it is difficult to zone for a 100-year flood, and would be a strain on home values.

Preferences for flood proofing options were not sought.

A comparison of the weighted means for each flood-management option ranks floodwarning and evacuation procedures (4.6), stopbanks (4.6), flood hazard maps (4.4), zoning (4.1) and channel alteration (3.8) in order of overall preference.

One of the initiatives that can be taken by individuals to mitigate the flood loss burden is to take out insurance. Seventy-two per cent of respondents have insurance cover for their homes or businesses. Eighteen per cent did not know, while 6% have no cover. Fifty-four per cent of those with cover stated it would be sufficient to cover losses in the event that water reached half a metre above floor level. Twenty-seven per cent were uncertain, while 19% stated their cover would not be sufficient. Sixty-nine per cent indicated that the contents of their house/business or farm equipment were covered by insurance.

### 3.4 Summary

Stopbanks were the most favoured option for flood management, followed closely by flood warning and evacuation procedures. This correlates closely with familiarity with these particular options.

Only one-third of respondents had heard of hazard maps yet nearly two-thirds strongly favoured their use. This lack of familiarity may mean many people are unaware of perceived negative aspects of this measure and how they might be personally affected. This observation is discussed in Chapter 6.

It is anticipated that insurance premiums would rise for property in high risk areas if hazard maps were published. Property values would also be affected. For this reason, floodplain occupants may finally prefer structural options such as stopbanks where the cost to the individual could be low compared to the cost of these other effects.

## CHAPTER 4 Willingness-to-pay for flood protection

[This chapter was contributed by Geoff Kerr, Research Officer, Centre for Resource Management].

### 4.1 Introduction

In a recent survey of residents of Opotiki, the East Cape Catchment Board (1987) was interested to learn whether ratepayers were willing to pay higher rates for a greater level of flood protection than they now have. Just over 40% responded in the affirmative.

However, this method of assessing people's willingness-to-pay for increased flood protection gives no indication of how much they are willing to pay, nor what level of protection in terms of flood frequency respondents had in mind when answering the question.

To understand people's responses in situations such as this, basic economic principles assist. Many of our everyday transactions involve an exchange of goods and services. The seller only relinquishes rights to a good if offered something of at least as much value to him or her - this may take the form of goods, services, or money. The exchange price, in effect, reflects the relative 'worth' of the good. It is a short-hand way of describing what an individual is willing to forego to obtain a particular good. A market price can be said to guide private decision making on a buyer's willingness-to-pay (Sharp, 1987, p.13).

However, there are many 'goods' or "types of value which are not measured in markets, including: recreational use, aesthetics, existence, bequest, maintenance of options, intrinsic worth, and changes in risks." (Kerr, 1988, p.4). Decision makers may require estimates of the values that people place on these things.

Non-market valuation encourages a range of techniques that assist decision makers in the allocation of scarce resources to their most valued uses (Ibid.). Non-market valuation is a set of procedures for valuing things like natural environments, as well as other non-priced inputs and outputs (or costs and benefits) in a common metric (usually dollars), to provide information to the decision-making process (Ibid., pp.4-6).

The benefits of further flood protection works may be measured in terms of floodplain residents' willingness-to-pay to obtain an enhanced level of flood protection. Since flood protection is not commonly traded in markets, its value cannot be imputed from behavioural observations. This study therefore adopted the contingent valuation method of non-market valuation to determine floodplain ratepayers' willingness-to-pay for enhanced flood protection.

The contingent valuation method employs survey techniques "to ask people about the values they would place on non-market commodities if markets did exist or other means of payment such as taxes were in effect. That is to say, study subjects are asked the values they would place on environmental assets contingent on the creation of a market or other means of payment" (Bishop and Heberlein, 1987, p.99). The focus is on people's willingness-to-pay values, that is, the maximum amount an individual would be prepared to pay to gain access to a natural resource or environmental commodity (Ibid., p.100).

Description and discussion of contingent valuation approaches to non-market valuation may be found in Bishop and Heberlein (1987), Cummings *et al.* (1986), and Peterson *et al.* (1988).

Five different approaches to asking contingent valuation questions have been distinguished: bidding games, open-ended questions, payment-card formats, dichotomous-choice questions, and contingent-ranking techniques (Bishop and Heberlein, 1987, p.102).

The dichotomous-choice approach was chosen for this study. The other techniques referred to above (apart from contingent-ranking) require study subjects to express their maximum willingness-to-pay. This is a complicated task that many people have difficulty with for commonly traded goods, but is likely to be more difficult for environmental goods that have never been traded. The dichotomous choice approach asks subjects whether they would be willing to pay a specific dollar amount. It is easily incorporated into mail surveys and is very similar to everyday market transactions. The main difficulty with this approach is that "analysis of the data to estimate maximum willingness-to-pay is more difficult than for previously mentioned techniques problem and the dichotomous choice approach is becoming widely used because of its simplicity and realism.

#### 4.2 Willingness-to-pay - methods

A dichotomous choice format was employed to enhance the realism of the hypothetical situation for survey respondents. Each respondent was presented with information regarding: the probability of their property being flooded in the next 30 years, a (lower) probability of flooding that could be achieved with improved flood protection works, and a nominated cost to that person of obtaining the improved flood protection. The cost nominated for each questionnaire was randomly chosen from six amounts (\$10, \$30, \$50, \$100, \$200, \$300) to be paid as an annual rate for the next 30 years. Respondents were asked to indicate whether they thought the scheme should or should not proceed given the circumstances outlined to that individual (Question F2).

A pre-test indicated that people were able to place themselves in the hypothetical market and were comfortable providing a response to this question. The pre-test indicated an extremely low probability of willingness-to-pay greater than \$200, resulting in a decision to limit the upper end of the nominated costs to \$300.

Logit regression procedures allow estimation of the probability of any respondent being willing to pay any nominated dollar cost of building a flood protection scheme. Respondents were divided into three groups according to pre- and post-scheme risk categories. The categories are identified in Table 4.2. Respondents were allocated to a pre-scheme risk category according to the existing probability of their property being flooded, as identified by North Canterbury Catchment Board staff. The post-scheme risk categories were also chosen with Catchment Board guidance, according to their needs for information (Griffiths, 1988, pers. comm.).

### 4.3 Findings

The questions in this section address the willingness of floodplain residents to pay for increased flood protection through stopbanks. They relate to Section F of the survey.

F.2. "Assume that engineers estimate your property currently faces a \_\_\_\_\_% chance of being flooded by the Waimakariri River in the next 30 years. For your area this would mean water covering the ground to a depth of up to one metre.

It is possible to undertake further flood protection work which would reduce the chance of flooding. This work would have to be paid for mainly by ratepayers.

Catchment engineers are able to build a flood protection scheme that would reduce the probability of the Waimakariri River flooding your area in the next 30 years from \_\_\_\_\_% to \_\_\_\_\_%. Do you think such a scheme should be built if your rates were increased by \$\_\_\_\_\_ per year to pay for it?"

Tables 4.1 and 4.2 represent the responses received according to the different scenarios presented to groups of floodplain residents. Those living in risk classes A, B, C, and D are believed to face a 30% chance of being flooded by the Waimakariri River in the next 30 years. Those in risk classes E, F, and others at risk face a 10% chance (Table 4.1).

Table 4.2 shows a number of values representing hypothetical annual rate increases that were assigned to the survey population on a random basis within Groups 1, 2 and 3.

Table 4.1 Reduction in probability of being flooded.

Group <sup>1</sup>	Pre-scheme probability of flood in next 30 years	Post-scheme probability of flood in next 30 years	Number of responses analysed	% of total
1	30%	2%	188	39
2	30%	10%	246	50
3	10%	5%	52	11

<sup>1</sup> Groups 1 and 2 are a combination of risk classes A to D, and Group 3 represents risk classes E and F and others likely to be affected by flooding.

**Table 4.2 Hypothetical annual increase in rates.**

Annual rate increase over 30 years <sup>1</sup>	No.	%
\$10	83	17
\$30	81	17
\$50	89	18
\$100	85	17
\$200	78	16
\$300	74	15

<sup>1</sup> Years of scheme review (1990-2020).

**Table 4.3 Should the scheme be built?**

Should the scheme be built?	No.	%
Yes	277	70
No	114	29
Don't know	3	1

**Table 4.4 Preference for building the scheme by perception of future risk.**

Scheme built (%)	Perception of future risk				
	1. At extreme risk	2.	3.	4.	5. Completely safe
Yes	88	74	85	72	53
No	12	26	15	28	47
Total nos	8	23	94	115	109

(Significant at 95% level)

F.1. "Flood protection from the Waimakariri should be paid for by -

**Table 4.5 Payment for flood protection.**

Who should pay	No.	%
Central government	246	52
People directly at risk from flooding	36	7
Everybody protected from flooding	193	41

#### **4.4 Willingness-to-pay - discussion**

Table 4.4 indicates that a large proportion of those who believe they are at risk or extreme risk of flooding by the Waimakariri River support the building of a flood protection scheme that would increase the present level of protection. Support for increased protection is lower for those who feel safe from flooding.

People are willing to pay for flood management measures in proportion to the risks they perceive and the benefits received from protection from flooding. Those who expressed a neutral to extreme risk attitude towards flooding by the Waimakariri over the next 10 years were willing to pay significantly more for flood protection than those who felt safe or completely safe.

A range of other independent variables was tested for Groups 1 and 2. These included: risk classification of the property, respondent's sex, respondent's age, type of property, attitude toward stopbanks (Question E2), respondent's experience of flooding (Questions C2 and C3), and respondent perceptions of flood risk (Questions D2 and D4). Only respondent perception of flood risk over the next 10 years was a significant determinant of willingness-to-pay. Those who responded 1, 2, or 3 to Question D4, indicating moderate to strong perceptions of future flood risk, were willing to pay significantly more for flood protection than those responding 4 or 5 (that is, those who felt safe or completely safe). This result may indicate that respondents had difficulty incorporating the 30% probability of pre-scheme flooding in their analyses of the benefits of flood protection works, preferring to use some prior notion of the risk of flooding.

That perceptions of flooding risk vary widely and influence willingness to support further flood control measures has important implications for flood management. Those people who feel very safe will not support flood management schemes, while those who feel very threatened will encourage substantial effort to be spent on flood protection. Education of floodplain residents is important to clarify the messages provided to catchment managers. While many people face identical risks, their perceptions of those risks vary widely. We have shown that support for flood protection schemes depends closely upon perceived risks. By reducing the discrepancies in perception, floodplain managers will obtain a narrower (and therefore more useful) range of preferences for flood protection.

Table 4.6 presents estimates of median and expected consumers' surplus<sup>1</sup> for each group of respondents. Contrary to pre-test indications, many respondents were willing to pay \$300 additional rates per annum for the next 30 years to obtain enhanced flood protection. However, since the maximum dollar amount nominated in the questionnaire was \$300 (\$200 for Group 3) it is not appropriate to extrapolate results far beyond this amount. The estimates of consumers' surplus must therefore be regarded as approximations only. The estimates of medians are not affected by this difficulty. More accurate estimates of consumers' surplus could be obtained by administering additional questionnaires with nominated costs in the \$500-\$1200 range.

**Table 4.6 Estimates of flood protection enhancement benefits.**

	Group 1	Group 2	Group 3
Median	\$ 220	\$ 297	\$ 109
- lower 95% limit	\$ 180	\$ 220	\$ 47
- upper 95% limit	\$ 278	\$ 527	\$ 406
Expected consumers surplus	\$ 225	\$ 332	\$ 121
Expected per capita benefits <sup>1</sup>	\$2155	\$3179	\$1159

<sup>1</sup>Derived by summing expected consumers' surplus over 30 years, discounting at 10%.

The equations estimated for the simple case which does not account for differing perceptions of flood risk are:

$$\begin{aligned} \text{Group 1. Logit} &= 2.54 - 0.01156 \text{ Dollars} & t &= 12.7 \\ \text{Group 2. Logit} &= 1.56 - 0.00524 \text{ Dollars} & t &= 4.8 \\ \text{Group 3. Logit} &= 1.70 - 0.01540 \text{ Dollars} & t &= 5.5 \end{aligned}$$

where  $\text{Logit} = \ln[p/(1-p)]$  and  $p$  is the expected probability of any individual being willing to pay "Dollars" for enhanced flood protection.

#### 4.4.1 Interpretation of results

The median is the dollar amount half of the ratepayers would be willing to pay to obtain the relevant scheme. For example, if a vote was held to determine whether the scheme in Group 1 should be built, with ratepayers paying a flat rate of \$220 per year for the next 30 years to pay for the scheme, about 50% of ratepayers would vote for the scheme. Schemes with costs above the median are not likely to be politically feasible, however financed. As the cost of scheme implementation to individuals decreases, more people are willing to support scheme implementation. Table 4.7 and Figures 4.1 to 4.3 present expected probabilities for each group.

<sup>1</sup>Consumers' surplus is a measure of the benefits floodplain residents would obtain from increased flood protection assuming they did not have to pay for it (see Just *et al.* (1982) for elaboration on this concept).

Figure 4.1 Case 1: Willingness to pay for reduction of flood risk from 30% to 2%.

Median = \$220  
Lower 95% = \$180  
Upper 95% = \$278  
Expected  
consumer  
surplus  $\approx$  \$225

The interior solid curve shows  
expected probability of an  
individual being willing to pay  
any dollar amount.

The shaded area indicates  
95% confidence interval.

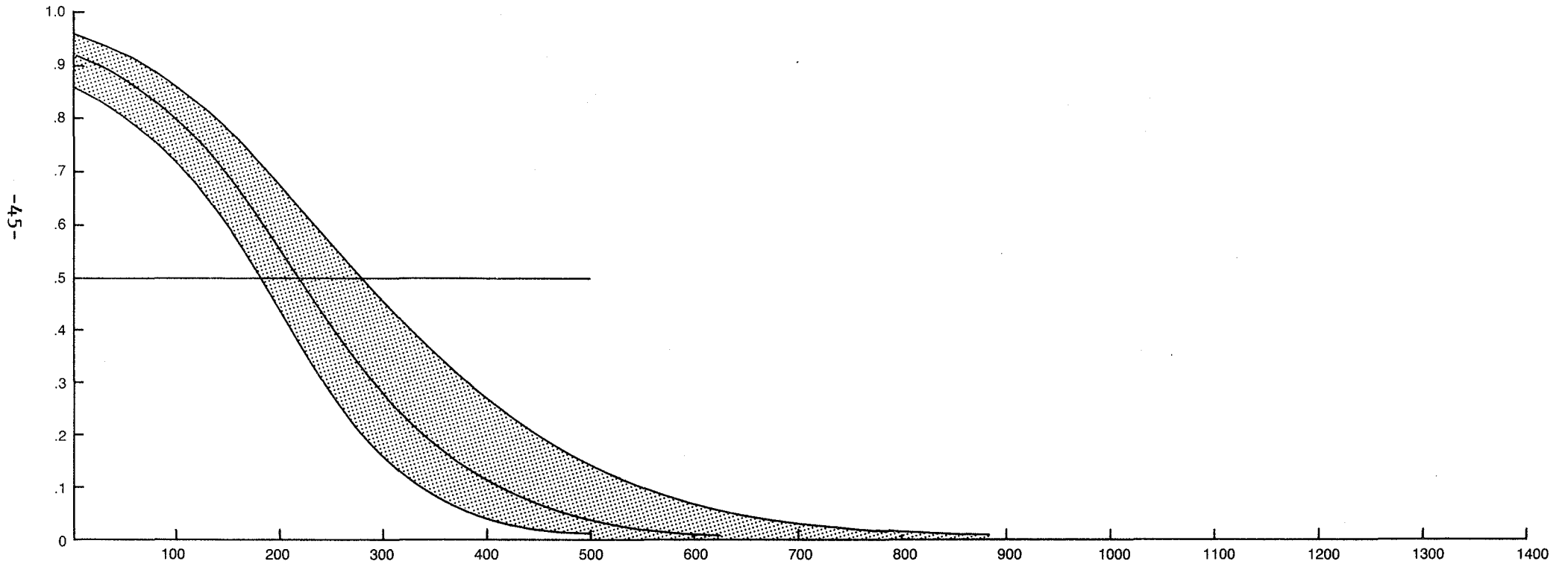


Figure 4.2 Case 2: Willingness to pay for reduction of flood risk from 30% to 10%.

Median = \$297  
Lower 95% = \$220  
Upper 95% = \$527  
Expected  
consumer  
surplus  $\approx$  \$332

The interior solid curve shows  
expected probability of an  
individual being willing to pay  
any dollar amount.

The shaded area indicates  
95% confidence interval.

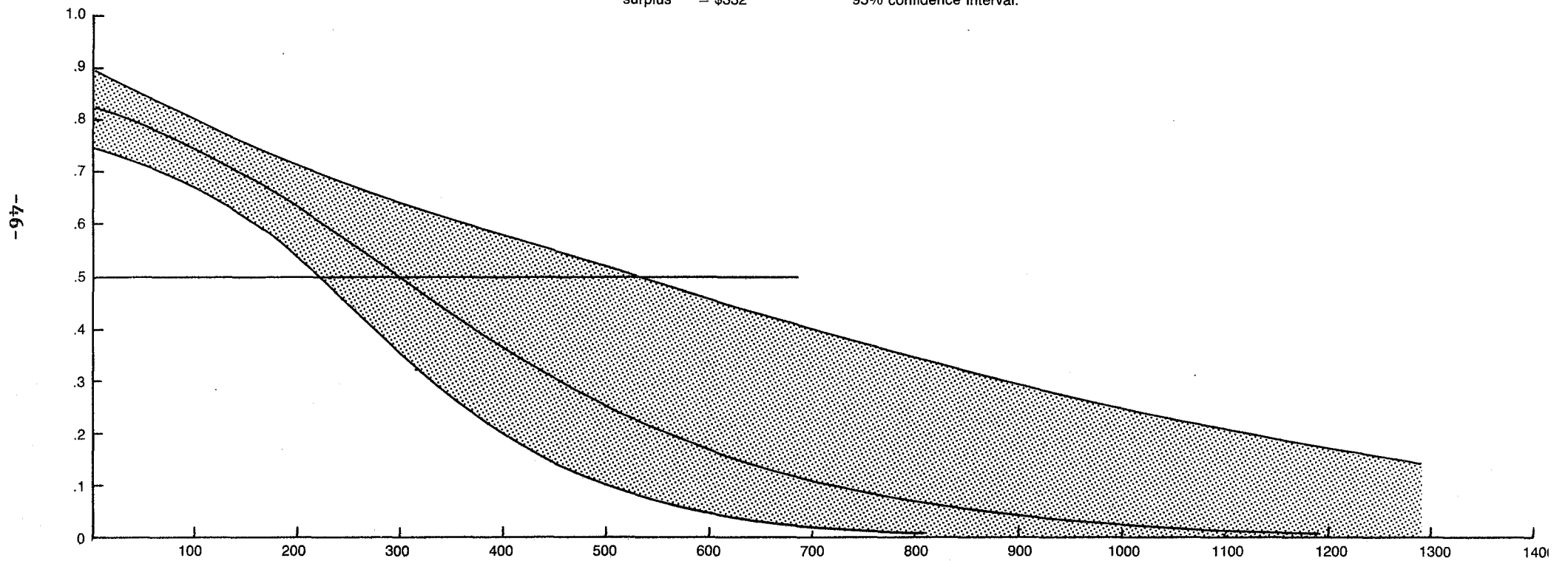
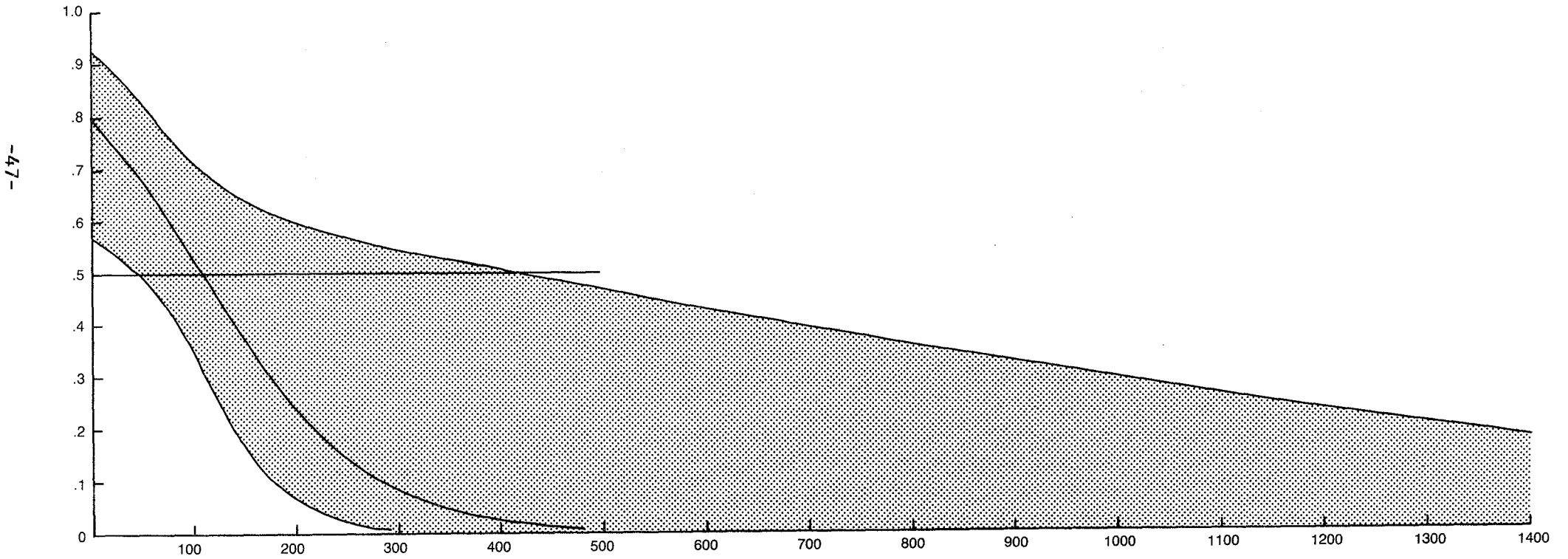


Figure 4.3 Case 3: Willingness to pay for reduction of flood risk from 10% to 5%.

Median = \$109.49  
Lower 95% = \$46.76  
Upper 95% = \$405.81  
Expected consumer surplus  $\approx$  \$121

The interior solid curve shows expected probability of an individual being willing to pay any dollar amount.  
The shaded area indicates 95% confidence interval.



Because these results are derived from small samples of a large population there is uncertainty over the outcomes that would occur in practice. This explains why the median and consumer surplus estimates presented here for Group 1 are less than those for Group 2. This result occurs even though Group 1 represents a greater increment in benefits to floodplain ratepayers. This result, while unexpected, is easily explained by the margin of error attributable to the estimates in each group.

**Table 4.7 Scheme costs necessary to obtain given levels of support for flood protection enhancement works.**

Probability of voting for scheme implementation	Group 1	Group 2	Group 3
0.10	\$410	\$717	\$283
0.20	340	562	219
0.30	293	459	176
0.40	255	375	142
0.50	220	297	109
0.60	185	220	77
0.70	146	135	43
0.80	100	32	
0.90	30		

Expected consumers' surplus is an estimate of the mean consumer surplus accruing to ratepayers in the relevant group if the scheme was built without charge to ratepayers. It is the appropriate measure of benefits to be incorporated in cost-benefit analyses of flood protection works. Because of the aforementioned extrapolation difficulties, the consumers' surplus estimates presented here are not precise. For this reason, no confidence interval is provided, since this would provide a false sense of accuracy.

#### 4.4.2 Application of results to a hypothetical situation

Approximately 110,000 ratepayers (Classes A, B, C and D) face a 30% probability of their properties being flooded by the Waimakariri River in the next 30 years. About 1200 ratepayers (Classes E and F plus others likely to be affected) face a 10% chance of flooding in the same period. Suppose a scheme could be built to lower these probabilities to 10% and 5% respectively, and that such a scheme would cost \$270 million.

##### a) Net benefits of scheme

The total benefit of the scheme (assuming no benefits to people who are not ratepayers on the Waimakariri floodplain) is the sum of the average present value of benefits to each ratepayer in each risk area multiplied by the number of ratepayers in the risk area, i.e.

$$\begin{aligned} \text{Total benefit} &= \$3179 \times 110,000 + \$1159 \times 1200 \\ &= \$351 \text{ million (approx.)} \end{aligned}$$

Subtracting total cost from total benefits yields an estimate of net benefits of about \$82 million. The benefit-cost ratio is about 1.30. Using the potential Pareto improvement criterion, society will be better off by implementing this flood protection scheme.

b) Support for scheme

To finance such a scheme the capital sum could be borrowed, with equal repayments to be made at the beginning of each of the 30 years of the additional rate. If this money could be borrowed at (or has an opportunity cost of) 10% the annual repayment would be \$26.0 million. Spread evenly over all ratepayers this amounts to \$234 per ratepayer per year for the 30-year period. Reference to Table 4.7 indicates that about 50-60% of ratepayers in the 30% risk area, and only about 10% in the 10% risk area, would support such a scheme if it was to be funded solely by affected ratepayers. On this basis it is probably safe to conclude that this project is unlikely to proceed if it was reliant solely on affected ratepayer funding. While the scheme is efficient in terms of the benefits being greater than the costs, it would not be wholeheartedly endorsed because many people earn less than the average benefit. However, if the scheme only cost \$30 million dollars to build it is apparent that it would receive resounding support.

The preceding example is totally fictitious, but serves to illustrate how even the limited information supplied in this section of the study may provide useful information to decision makers. Discount and finance rates, costs of flood protection schemes, ratepayers numbers, and distribution of the funding burden can be substituted for the figures used here to provide guidance on specific schemes.

#### 4.5 Payment for flood protection - discussion

Table 4.5 indicates attitudes towards payment for flood protection. Fifty-two percent believed the Government should be responsible while 41% thought that everybody receiving protection from flooding should pay. Only 7% wanted to see the burden of flood protection costs fall on individuals whose property is directly at risk from flooding.

These results are interesting for two reasons.

First, an awareness of the effect of the incumbent Government's 'user-pays' philosophy which underlies the reduction in subsidy referred to in Chapter 1 is not strongly apparent in these responses. Alternatively, people may be aware of the philosophy but do not support it. Despite considerable benefits being derived locally from flood protection works, 52% of respondents believe the costs should be spread nationally. However, this is not surprising given the historical role central Government has played in flood protection in the past. To capture a national contribution towards these costs the community will need to demonstrate the national benefits derived from flood protection.

Second, a significant proportion of respondents indicated a preference for costs to be shared by all who would be protected from flooding. Until 1987, rates were levied on a graduated scale according to the classification of lands that received benefit from flood protection works (Soil Conservation and Rivers Control Act 1941, s.101(1)). The Soil Conservation and Rivers Control Amendment Act 1987 s.5 removed the requirements for rates to be levied on a graduated scale; the Board may now levy on a uniform scale.

It could be argued that not burdening only those at direct risk means possible acceptance of a uniform rating across much of the floodplain.

#### 4.6 Summary

People's willingness-to-pay for further flood protection works was measured using a non-market valuation technique, the contingent valuation method.

Those who perceived themselves to be at risk from flooding in the future were willing to pay significantly more for flood protection than those who felt safe.

Any scheme that required ratepayers to pay \$220 per year would be supported by around 50% of ratepayers.

In order to extrapolate estimates of consumers' surplus, additional questionnaires would need to be administered with nominated costs above \$300.

Group 1 represents a greater reduction in flood risk than Group 2, implying that members of Group 1 should have been willing to pay more for the proposed improvement in flood protection than members of Group 2. This did not occur in practice, but could be explained by the margins of error in our estimates. The estimates of willingness-to-pay obtained here for the two groups are not significantly different.

Directly related to the issue of willingness-to-pay is the question 'who should be paying?' Floodplain residents need to understand the implications of the Government's 'user pays' policy for floodplain management and how it will affect them personally in practice. Alternatively, lack of support for the underlying philosophy can be expressed when voting in the general election.

## CHAPTER 5 Floodwarnings and civil defence procedures

### 5.1 Introduction

The community can be warned of impending flooding that is likely to affect them but success in modifying flood damage susceptibility depends on a) the community's willingness to respond to warnings, and b) its awareness of what is appropriate action to reduce loss of life and damage to property.

There are a number of important components to a floodwarning exercise. These are:

1. warning method,
2. time of day or night,
3. who gives the warning,
4. specificity of warning,
5. length of warning time.

The community must be aware of the kind of warning to expect. This can depend on the time of day or night and whether the river is rising slowly or suddenly.

In the event of a slow rise, river users, contractors, and farmers close to the river are advised to take precautions by local authorities or the Catchment Board. Newspapers and commercial radio are also informed (Elder, 1988, pers. comm.).

If the river continues to rise, the Catchment Board and local authorities inform the Civil Defence as to whether flood protection systems appear to be holding. If there is any doubt, the police and the civil defence will be asked to declare an emergency under the Civil Defence Act 1983 and to order an evacuation. The Act is designed to protect people, not property (Ibid.).

Under this scenario it is expected that many people will be aware of rising water levels. The mass media will keep viewers/listeners/readers informed.

However, should a flash flood occur there may be insufficient time to warn people through the media. This is particularly so if it is late at night when people are sleeping or when they may be at their place of work with no access to a radio or television set.

While farmers have an informal system of communication, the difficulties of warning a large urban or semi-urban population of the need to evacuate is apparent. Depending on the urgency, one could expect to hear police vehicles, ambulances, fire engines, and loud hailers (Ibid.).

The next important aspect is the source of the warning, the public figure who announces the decision to evacuate. In rural areas the mayor is seen to be a credible figure and people are likely to take heed of warnings. However, in a large urban area an official such as the town clerk or commercial radio announcers might be seen to be sufficiently removed from the political process to persuade the community to respond (Ibid.).

It can be expected that people would wish to have some indication of the extent that their property might be affected by flooding. Those living near the river or in low-lying areas particularly need to know the official river height that may result in flooding of their property. According to Catchment Board sources, however, such information would not be available at such short notice.

Finally, a crucial factor in responding to a warning is the length of warning time given. The community must be aware of the hierarchy of actions to be taken in the event of an emergency and what can be reasonably undertaken within a specific timeframe. If the warning time is extremely short people may wish to protect personal memorabilia that cannot be replaced rather than consumer items or furnishings that have less personal value.

Views vary on the advisability of warning people at an early stage of a catastrophic event; some in authority believe that early warning generates panic. According to Luketina (1985, p.12) this view is completely rejected by all disaster researchers although some stress that it is difficult to prompt action before the disaster reaches the impact stage.

Research carried out after the 1984 Southland floods indicated that many people who were later flooded did not hear the Civil Defence sirens. Of those who heard them, some did not realise they indicated a civil defence emergency (Luketina, 1986, 40). There is evidence however that official warnings appear to have been received with widespread disbelief (Ibid., 41).

The second aspect of modification of flood damage susceptibility is awareness of appropriate action to prevent loss of life and damage to property.

There are four distinct facets to a flood warning response. They are:

1. emergency procedures recommended by the Civil Defence,
2. care of personal household/business effects,
3. registration with Civil Defence before leaving the area,
4. knowledge of a safe area of high ground.

The Civil Defence publishes pamphlets advising of appropriate actions but funds do not permit these to be widely circulated. (The local council rates each person approximately \$1 per annum for civil defence purposes (Elder, 1988).) However, very useful information appears in the yellow pages of the telephone directory for pre- and post-disaster action. Emergency procedures include listening to the radio for information, securing supplies of drinking water and tinned food, checking the survival kit, switching off electricity and gas; and moving chemicals such as weedkillers and flysprays where they cannot mix with floodwaters.

After these basic precautions have been taken, valuable possessions, clothing and food should be stored in a safe place. Family documents should be taken if there is time. Carpets can be lifted and appliances raised. Pets and elderly neighbours may need help.

It is of utmost importance that people know where their nearest civil defence post is. Help and advice can be obtained if needed. The Civil Defence urges those evacuating to register with them so that people who appear to be missing can be accounted for. In those areas with Neighbourhood Support Groups, co-ordinators are expected to present Civil Defence headquarters with a list of evacuees and their destination. People could expect to be advised by

the radio or by loud hailer of the need to register with the Civil Defence before leaving the area (Elder, 1988).

Finally, people are advised in advance to ascertain where the nearest high ground lies that would be out of the flood path.

During the the Southland floods some people had trouble initially in accepting the situation. They were therefore unprepared to protect their property when water started entering their homes (Ibid, 42).

Many people were not aware they were required to register with Civil Defence or did not bother to go to evacuation centres to do so. These problems were particularly acute in the city where insufficient flood relief personnel were available to keep track of people or to instruct them what to do after leaving their homes. Failure of the registration system meant that very inaccurate estimates of people displaced by the floods were available. (Ibid., 48).

A survey carried out in the Wellington region in 1987 (Ministry of Civil Defence, 1987, p.7) on household awareness and preparedness for a major earthquake recommended that it was **not** necessary to unduly promote an understanding of shutting down utilities, first aid kits, etc. However, it was recommended that the following areas need promoting:

1. the formulation of a family plan,
2. joining a neighbourhood support group,
3. location of nearest civil defence post.

Schools were found to be the best places to provide accurate information on the Civil Defence, disasters and preparedness (Ibid., p.10).

## 5.2 Floodwarnings and civil defence procedures - findings

This section addressed the familiarity floodplain residents have with flood-warning systems and civil defence procedures.

G.1. "How would you expect to be warned of an impending flood or other natural disaster in your area?"

**Table 5.1 Anticipated floodwarning methods.**

Warning method	Times mentioned	%
Radio	385	53
Loud hailer/siren	102	14
Civil Defence/organised official effort	64	9
Television	38	5
Word of mouth	35	5
Phone	35	5
General media	22	3
No response	43	6

G.2. "Have you ever heard or seen a flood warning relating to the Waimakariri River?"

**Table 5.2 Past Waimakariri floodwarnings.**

Heard floodwarning	No.	%
Yes	233	49
No	239	51

G.3. "In the event of a major flood, what is the minimum warning time you think you would need to be able to take effective action to reduce damage to your property?"

**Table 5.3 Minimum warning time for effective action.**

How many hours needed	No.	%
24 hours	90	20
12 hours	101	22
6 hours	146	32
3 hours	87	19
Don't know	33	7

G.4. "What actions would you take given eight hours' warning that floodwaters would reach your property?"

(As most people suggested more than one action, the findings in the table indicate the number of times the options was mentioned. Most of those who gave an evacuation procedure suggested only one.)

**Table 5.4 Hypothetical response to floodwarnings.**

What actions	Times mentioned	%
Raise furniture, appliances, valuables	290	35
Evacuation procedures recommended by the Civil Defence in telephone directory	197	24
Shift/evacuate valuables and family	113	14
Go to higher ground	66	8
Lift carpets	65	8
Seal/sandbag doors, windows	50	6
Move livestock, pets	50	6

G.5. "Would you advise Civil Defence evacuation personnel if you had vacated your house or property unassisted?"

**Table 5.5 Advice of evacuation to the Civil Defence.**

Advise Civil Defence	No.	%
Yes	381	82
No	22	5
Don't know	59	13

G.6. "If you answered 'YES' to G.5. how would you do this?"

**Table 5.6 How the Civil Defence would be advised.**

How advise Civil Defence	No.	%
Telephone	111	24
Report in person to the Civil Defence	59	12
Notice on house, gate, etc.	28	6
Telephone and report in person	73	16
Various other	79	17
No response	115	25

G.7. "If you were directed to evacuate your property and proceed to the nearest Civil Defence point, where would you go?"

**Table 5.7 Knowledge of Civil Defence centres.**

Know where to go	No.	%
Yes (specifically)	140	31
No	168	37
Vague knowledge	77	17
No response	71	15

G.8. "Has your household or firm or organisation a plan for what you would do in the event of a flood?"

**Table 5.8 Family/organisation flood plan.**

Has a plan	No.	%
Yes	94	21
No	360	79

G.10. "Do you know what it requires you to do in the event of a flood?"

**Table 5.9 Role in flood plan.**

Know your role	No.	%
Yes	114	26
No	322	74

### 5.3 Floodwarnings and civil defence procedures - discussion

Floodplain residents are familiar with flood disaster warnings. They are not familiar with civil defence procedures.

Most people are aware of the different methods of flood warning that they would be likely to receive. Six per cent gave no response. Many expected to be warned by the media of impending flooding. This response would not have anticipated flash flooding or rapid rising of water at night. Only 14% expected to hear a siren or loud hailer.

Forty-nine per cent had seen or heard floodwarnings relating to the Waimakariri. Yet many stated they expected to be warned by the media.

Around 50% of respondents would require at least six hour's warning of flooding in order to taken effective precautions while another 20% would need at least 12 hours.

When questioned on the actions they would take given eight hours' warning that floodwaters would reach their properties, only 24% listed one or possibly two civil emergency procedures recommended by the Civil Defence in the telephone book. A large number of people expected to be concerned with protecting valuables, furnishings, and appliances. Two novel approaches were to make large drains through the property, and to build a stopbank round the house.

Luketina (1985, p.12) mentioned that it may be difficult to prompt action before disaster reaches the impact stage. For this reason it is advisable not to attach too much confidence to what people say they would do in an emergency. A study that was to be carried out by the Otago Catchment Board in association with the University of Otago in 1988 hoped to document actions actually taken by individuals in localities affected by flooding in New Zealand in the last two to three years (Otago Catchment Board, 1988, p.1). The results of that study could be usefully compared with this study.

Most stated they would advise Civil Defence they had evacuated their property while 5% stated categorically they would not. There was a significant degree of uncertainty as to how they could advise authorities. An appreciation of the breakdown in services (for example, telephone) that can occur during an emergency was obviously not apparent to some.

Only 31% knew specifically where to report to Civil Defence in an emergency while 17% had a general idea.

21% of households/firms/organisations indicated they had a plan of action in the event of flooding. The wording of Question G.10. may have confused some respondents. Only 19% indicated having a plan of action yet 26% claimed to know their role in 'the plan'.

#### **5.4 Summary**

Floodplain residents are generally aware of floodwarning measures but might not respond at night or while at work. Only 14% would expect to hear a siren or loud hailer; the rest might not perceive an emergency.

People appear ready to respond to floodwarnings to protect their property but relatively few would take personal safety precautions. However, there could be a divergence between what people claim they would do and what they might actually do in the event of a major flood.

Response to floodwarnings could depend quite heavily on the perceived credibility of the person giving the order to evacuate.

Residents are not very familiar with civil defence procedures, in particular, where and how to advise the Civil Defence of their intentions. Less than one quarter of respondents have a plan of action if threatened by a major flood.

## CHAPTER 6 Information dissemination preferences

### 6.1 Flood hazard maps

The formulation and publication of flood hazard maps was not identified as a key component of the Waimakariri Floodplain Management Plan. However, it is a measure that can be used to inform and educate individuals about the flood hazard both in the Technical Assistance Programme and the Community Awareness Programme identified in the pilot study (refer Chapter 3.1).

Section 4 of the pilot study (Appendix II) refers to the zoning of a high risk area that runs parallel to the Waimakariri at about a three to four kilometre width from the Eyre Diversion/Halkett to the coast. Kaiapoi and parts of north Christchurch would fall within this zone. The extent of this zone would be apparent in any flood hazard maps that were prepared.

If hazard mapping of high risk zones is restricted to undeveloped areas there may not be significant reaction from property owners. However, if developed urban areas of the floodplain are to be zoned it is possible that a reaction not dissimilar to that that occurred in New South Wales could be expected.

The State (New South Wales) was forced to abandon its Flood Prone Land Policy. Flood prone land had been defined as areas inundated by a 100-year flood. Concern over possible adverse effects on property values led to massive protests following the release of hazard maps for a particular Sydney suburb (Handmer, 1986, p.83). The designation was finally deleted; it was considered "too restrictive and the cause of unnecessary hardships to affected property owners and occupiers" (Flood Policy Advisory Committee, undated, p.51).

There is quite an extensive literature on the arguments against the use of flood hazard maps for providing information on flood risk. Examples include (Handmer (1980); McDonald, *et al.* (1982); Lees and McGlynn (1985); Handmer (1985); and Handmer (1988)). The study by McDonald, *et al.* (1982) documented an attempt by the Public Works Department, New South Wales to involve the public in flood map preparation. The measures taken to ensure maximum public involvement were seen as only partially successful. The general public did not finally participate in the process (Ibid., p.3). It was concluded that the delineation of flood hazard areas on maps is not an effective form of communication (Ibid., p.4).

It is beyond the brief of this study, however, to examine in detail the usefulness of flood hazard maps as a means of communicating information about flooding and the potential reaction to their being made public.

### 6.2 Pamphlets and newsletters

The Sydney Metropolitan Water, Sewerage and Drainage Board has established a public relations group that liaises closely with consultants employed to assist in consultations with the public over a flood protection project that is being undertaken for the Warragamba Dam. Form letters and glossy coloured pamphlets are sent out in response to enquiries. They are also available at the Board's offices. The pamphlets outline the aims of the flood protection programme, the need for such a programme, options being considered, information on flood prediction and flood damage studies, and details on opportunities for

the public to influence the final form of the programme. Six-monthly community participation newsletters are also distributed by the consultants. (Heath, 1988, pers. comm., Metropolitan Water, Sewerage and Drainage Board, Sydney).

Pamphlets and newsletters provide information to those known to be interested and can indicate what opportunities for involvement are coming up. They encourage and stimulate public awareness and involvement in planning but may afford only a one-way flow of communication unless letters, etc. are solicited. This can be a costly means of communication in terms of staff to produce newsletters, printing and mailing expenses (Working Party, Undated, p.45)

### 6.3 Public meetings

There are dangers that public meetings may be unrepresentative. Those who feel strongly about an issue may seek to make that issue the subject of discussion and preclude the opportunity for other views on other issues to be heard (Ministry of Housing and Local Government, 1970, p.29).

The Sydney Metropolitan Water, Sewerage and Drainage Board employs consultants who assist in consultations with the public over a dam project that is being undertaken at present. The consultants have compiled an extensive list of groups and individuals who are invited to planning focus meetings (Heath, 1988, pers. comm.).

### 6.4 Newspapers

McDonald, *et al.* (1982, p.4) concluded that of the methods tried in their study, the insertion of a centre leaf in the local newspaper, seemed to be the most cost-efficient way of reaching a large number of people. "The traditional approach of notifying the public of Governmental action or policies solely via (Public Notice) advertisements placed in the newspapers is not recommended if the objective of the mapping programme is to provide information to the public" (Ibid.).

### 6.5 Information dissemination preferences - findings

These questions address information dissemination preferences.

H.1. "Do you think special maps showing the extent of expected flooding according to different sized floods should be publicly available?"

**Table 6.1 Availability of flood hazard maps.**

Special maps should be available	No.	%
Yes	412	87
No	32	7
Don't know	28	6

H.2. "If 'YES', where do you think they could be viewed by the greatest number of people?"

(As most people suggested more than one location, the findings in the table below represent the number of times the option was mentioned.)

**Table 6.2 Preferred location of flood hazard maps.**

Map location	Times mentioned	%
Council offices	172	29
Library	131	22
Telephone directory	89	15
Public agencies, e.g. post offices, banks	79	13
Shops, supermarkets, community centres, halls	53	9
Newspapers	36	6
Mailed out/purchased	38	6

H.3. "Where/how would you like to find out more information about flooding and flood protection?"

**Table 6.3 Flood information source.**

Information source	Times mentioned	%
Pamphlets	205	30
Television	190	28
Newspapers	138	20
Radio	72	11
Contact Catchment Board	38	6
Public meetings	20	3
Other suggestions	11	2
Not interested	4	

## 6.6 Discussion

Most respondents think that hazard maps showing the extent of expected flooding according to different sized floods should be publicly available. Most preferred localities were council offices and libraries. The impression gained during coding of responses was that some indicated where they believed they could be viewed by the greatest number of people, while it appeared that others were suggesting places most convenient to themselves.

Findings in Chapter 3 indicated that only 28% of respondents had heard of flood hazard maps while 68% were strongly in favour of their use in the greater Christchurch urban area.

While the results in this Chapter (6) give the impression of substantial support for the introduction of flood hazard maps, lack of prior knowledge and therefore of the potential effects that it might have on property values suggests caution. This is particularly so when the reactions elsewhere are examined.

When questioned on where or how people would like to be informed about flooding or flood protection, home-delivered pamphlets were mentioned as first preference 30% of the time, television programmes 28% of the time, and newspapers 20%.

## 6.7 Summary

Although the publication of flood hazard maps appears to be widely accepted by respondents, in practice a public outcry might be expected. This study was not able to examine the usefulness of hazard maps as a means of informing floodplain occupants of the risk they face and as a means of modifying flood damage susceptibility.

Home-delivered pamphlets was the first choice of floodplain residents as a means of gaining information about flooding and flood protection measures.

## CHAPTER 7 Conclusions and recommendations

### 7.1 Summary of findings

The aim of the survey was to ascertain the public's perception of risk with regard to the Waimakariri River and to determine the floodplain community's willingness to pay for protection against that risk. This information is to provide a data base against which the Board can assess statistical risk. It also forms the basis for any future Board programmes aimed at increasing flood awareness and preparedness.

The first objective was to determine the state of public awareness of the flood hazard posed by the Waimakariri River. A number of propositions were designed to address the public perception of flooding as a past and future problem, and possible influences upon these perceptions. Possible influences suggested by the literature were: knowledge and past experience of the flood event; interpretation of various physical characteristics of the hazard, including flood magnitude and frequency; geographical situation of the floodplain occupant; and personality traits. Those surveyed were given the opportunity to rank their preferences and state reasons for those preferences.

Floodplain occupants did perceive themselves to have been safe from flooding from the Waimakariri over the past five years. A heightened perception of risk in the future was apparent but nonetheless people felt moderately safe from flooding over the next 10 years. However, over a much longer time period, that is, 30 years, nearly one-quarter of respondents believed it was probable that the greater Christchurch urban area would experience flooding.

The influences on flood hazard perception were tested against stated perceptions of risk. It was found that flood knowledge did not show any correlation with perception of risk whereas past experience of the hazard under study, the Waimakariri did. Experience of hazards elsewhere did not correlate with the perception of the Waimakariri flooding. As the last major flood of the River was over 30 years ago, memories of magnitude and frequency would have faded considerably and were therefore not tested. There was a correlation between proximity to the potential hazard (risk class) and both past and future perceptions of risk. Although more than half the sample stated that nature was the main cause of flooding, this 'personality trait' did not influence risk perception.

Reasons respondents themselves gave as to why they felt safe in the past or in the future included a belief in stopbanks, the capacity of the river to cope with large volumes of water, no previous problems, no perception of any risk, or that their location precluded them from flooding.

The second objective was to determine the public's familiarity with structural and non-structural flood management options. Floodplain residents are more familiar with structural options generally, although floodwarnings and evacuation procedures were also well known.

Strong preferences appeared for stopbanks but not for channel alteration. All non-structural options apart from zoning were strongly favoured by over 50% of the population. Lack of knowledge of these options could partly explain a lesser overall preference for options that modify flood damage loss. However, those who showed strong preferences for structural options tended to show

strong preferences for non-structural options too. It appears that people are willing to consider a range of options to complement each other.

The **third objective** was to gain insights into what the community is prepared to pay for flood protection. Use of a non-market valuation technique showed that people are willing to pay for flood management measures in proportion to the risks they perceive and the benefits received from protection from flooding. Those people who feel very safe will not support flood management schemes, while those who feel very much at risk will encourage a lot of effort to be invested in flood protection.

More accurate estimates of consumer surplus could be gained by administering additional questionnaires with nominated costs in the \$500-\$1200 range. It was found that any scheme requiring ratepayers to pay \$220 per annum would be supported by around 50% of ratepayers.

Half the respondents believed the Government should pay for flood protection. This view is not consistent with the incumbent Government's 'user pays' philosophy which intends that those who benefit from flood protection should bear the costs in proportion to the benefits gained.

The **fourth objective** was to ascertain the public's familiarity with civil defence procedures and the possible effectiveness of present public warning systems. People appeared to be aware of the different methods of flood warning they would be likely to receive. However, in the event of a flash flood with no prior warnings possible from the media, a significant number might not recognise the implications of siren warnings.

At least six hours' warning would be required by half the respondents to take effective precautions but many might not take the actions recommended by the Civil Defence. Floodplain residents are not very familiar with civil defence procedures.

The **fifth objective** was to determine the most appropriate media for presenting flood information to the public. Mixed messages were given on the public availability of flood hazard maps. Nearly two-thirds of respondents strongly favoured their use in management of the Waimakariri floodplain and more than four fifths agreed they should be publicly available. Yet less than one third of respondents had not heard of flood hazard maps previously. If the public were made more familiar with the costs and benefits to them as individuals of flood hazard maps, a different response might be expected.

The questionnaire suggested a number of means whereby information about flooding and flood protection could be made available. Home-delivered pamphlets, television programmes and newspapers were their first, second and third choices respectively.

## **7.2 General conclusions**

The use of Ericksen's model did not provide significant insights into influences on risk perception. This should not be attributed to shortcomings in the model but to the fact that flooding of the Waimakariri is an infrequent event; over 30 years have passed since major flooding was experienced. Very few now living on the floodplain were living there in 1957 so few are aware of the flooding potential.

Stopbank protection has also been increased with the Waimakariri River Improvement Scheme 1960 and floodplain occupants appear confident that their future safety is assured.

It is difficult to make a clear statement as to the extent public perception of risk differs from that of technical experts. Approximately 40% of respondents believe that the greater Christchurch urban area is not at risk from flooding over the next 30 years. However, when ratepayers are presented with similar probabilities in the section that investigates their willingness-to-pay for a greater level of protection than they currently enjoy, they express a different perception.

It can be assumed that the risk scenario was accepted by many considering the high level of participation in the willingness-to-pay section. It appears that while many do not believe themselves to be at risk, they do want to be protected from such events should they occur.

### 7.3 Recommendations

#### Public information dissemination exercise

##### (i) Changing perceptions of risk

A significantly high proportion of respondents believe that the greater Christchurch urban area will not be at risk from flooding over the next thirty years (the period being addressed by the Waimakariri Floodplain Management Plan). A concentrated effort must be made to educate the public about the probabilities of long-term flood risk.

It is essential that this is done using terms the public are able to understand. When questioned on the meaning of the '100-year flood' less than half answered correctly. It is not possible to ascertain how many of these responses were guesses. Other research suggests that probabilities of risk expressed as a percentage over a period is more readily understood than statistical notions of risk that refer to 'return periods'.

The second aspect of this problem is how such factors relate to an individual's personal situation. While the community may need to plan for a 100-year flood, an individual's planning horizon may span only 10 years or so. There is a need to convince people to be prepared for a rare event that could occur in any one year. Obviously people should be made aware of the fact that they live on a floodplain and the implications of this.

A number of respondents indicated a faith in structural controls. There is an urgent need to inform the public of the limited protection stopbanks can offer; that they are designed to contain floods of a certain magnitude but not rare, infrequent events.

##### (ii) Choosing adjustment options

Although stopbanks were seen to be the most preferred adjustment option for the Waimakariri, the public needs to be made aware of the Urban Flood Reduction Policy which proposes non-structural options that complement the use of stopbanks against extreme hazard events. Awareness of other options should assist them in deciding what they will be prepared to pay towards the cost of structural controls.

Fifty per cent of respondents thought the Government should pay for flood protection. Floodplain residents should therefore be informed of the reduction in central Government subsidies toward structural control options; that those receiving protection are expected to pay for it themselves. However, those people not in favour of the incumbent government's 'user pays' policy have an opportunity to express disfavour at the general election.

If channel alteration is to be a preferred option, special efforts will have to be made to demonstrate its advantages. The reasons why irrigation cannot be a feature of this option need to be clearly explained to the public.

The public appears willing to consider a complementary range of options. Although a large number of respondents had heard of flood warning and evacuation procedures they were less familiar with hazard maps, zoning and floodproofing. These options need to be clearly described in a way that addresses both their advantages and disadvantages. This could avoid adverse public reaction at a later date.

The floodplain community needs to be aware of how floodplain land use exacerbates vulnerability to flood loss and flood damage before they can consider planning options such as hazard maps and zoning. Results from the survey show that only 11% of respondents believed floodplain land use exacerbates flooding, although the use of the word 'cause' in the question could have been misleading.

Floodplain residents also need to know what magnitude of flood they are at risk from personally. They will need to know how they will be affected individually if non-structural measures are implemented. The Board should have officers who are available to explain the impacts if required. Information should be available on any subsidies available for floodproofing measures or the likely beneficial effect they could have on insurance premiums in the future.

### (iii) Floodwarnings and civil defence procedures

The Board, in liaison with the Civil Defence, should inform the public as to how and where to expect to see/hear early flood warnings.

Around 50% of respondents indicated a need of at least six hours' warning in the event of a major flood. A flood preparedness programme should indicate the actual warning times people could expect under different scenarios, and a hierarchy of precautions to be taken depending on the length of warning time. Relatively few people indicated that they would follow any of the emergency procedures recommended by the Civil Defence, such as assembling survival kits, turning off electricity.

People are not sufficiently aware of where or how to report to the Civil Defence if they evacuate or need help. Many did not contemplate the prospect of a breakdown in essential services such as telephone and/or electricity in the event of a disaster. The importance of knowing where their nearest civil defence post is located should be stressed. They also need to understand the importance of reporting before they move out of the area.

The idea of having a family/firm 'plan' in event of a disaster needs to be emphasised to encourage people to take a degree of responsibility as individuals. All should be aware of their role should the 'plan' be effected. Although people were not asked about membership of neighbourhood support

groups, recommendations from the Wellington survey (Ministry of Civil Defence, 1987) would suggest a further advantage of forming such groups, especially in high risk areas.

(iv) Information dissemination

Further research should be undertaken as to the likely reaction of floodplain residents to the publication of flood hazard maps. Events in New South Wales suggest that a similar reaction might be expected here unless the public is heavily involved in the selection of the base flood size for planning purposes. Research should investigate how this can successfully occur, particularly for an area where major flooding is an infrequent event and risk perception is consequently low.

Findings in an Australian study relevant to this issue are:

"Despite the widespread use of maps in planning displays and for public information there has been little research on map comprehension by the ordinary person or for that matter anyone else.... Surveys undertaken as part of the present study show that people have some ability with maps in that they can locate their own houses, but that they did not understand terms used to describe the flood risk. Additional research both from this study and by others, strongly suggests that a conventional line map may not be the best way to present spatial data. Even though topographic maps present height data of direct relevance to flooding many people have difficulty using them. Oblique aerial photographs appear to be superior as vehicles of public information... (t)he authors contend that a written description and accompanying photographs is often more effective than a map at conveying flood hazard information." (McDonald, *et al.* 1982, p.5).

In this study pamphlets, television, and newspapers were the three most preferred methods of information dissemination. Obviously cost is an important aspect of choice but a combination of the three, used over the long term could be very effective.

"For the information programme to be effective in the long term, the public needs to be reminded. Hence the dissemination procedures should be repeated regularly. The time between repeats should depend on the occurrence of local flooding and the population turnover. Flooding serves to increase awareness of the risk and thus decrease the need for information. Conversely a high turnover may mean a high proportion of people new to the area and unfamiliar with the local flood hazard" (Ibid.).

Information is publicly available on preferred television channels, viewing times, and newspapers (Lamb, 1988, pers. comm.).

(v) General comments

Any flood awareness/preparedness programme should be aimed intensively at the Christchurch urban population rather than the rural and semi-urban populations close to the Waimakariri River. However, as only a weak relationship was found between risk perception and risk class there is also a need for a general campaign directed at all residents of the floodplain.

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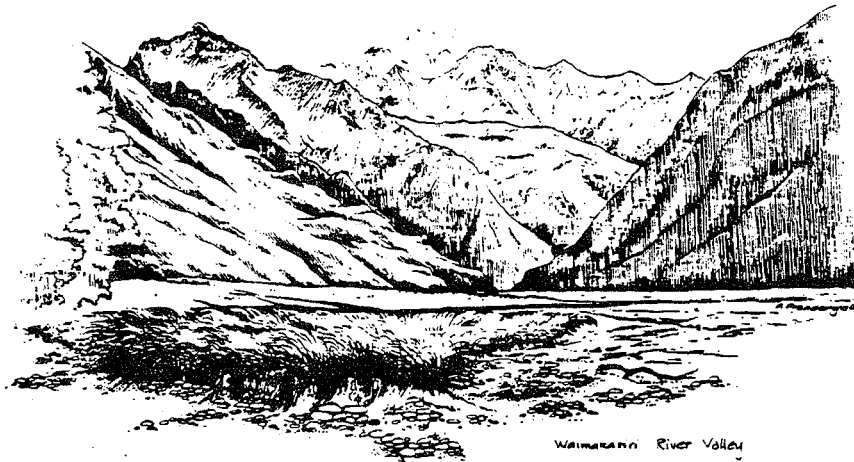
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APPENDIX 1. WAIMAKARIRI FLOODPLAIN QUESTIONNAIRE



\*\*\*\*\*  
 The Waimakariri River floodplain is an area that has been formed by river action during a long period in the past (see map on page 8).

In this questionnaire flooding refers to flood flow of the Waimakariri River that results from the overtopping or breaking through of its banks - not to water lying after heavy rainfall or blocked drainage.

Where you are asked to RANK boxes, please number them in order of your preference. You should write '1' in the box of the choice you prefer most, 2 in the box of your second choice, etc. Number as many or as few boxes as you wish. Place a tick in the 'Don't know' box if you are not able to answer the question.

\*\*\*\*\*

A. FLOOD CAUSES AND RESPONSIBILITY

1. Some people believe floods are caused by the way we use our land close to rivers, some believe that floods are "an act of God" or a natural event. Others believe that floods are caused by a combination of these things. Please RANK these boxes to show what you feel are the main causes of floods.

Upper catchment land use

Floodplain land use

Nature

God/s

Don't know

2. Who do you think is most responsible for making preparations so that a major flood does as little damage as possible to your home and family? Please RANK these boxes.

Your Catchment Board

Government

You and your household/  
firm/organisation

Combination of these

Don't know

**B. FLOOD KNOWLEDGE**

1. What do you think the term "one hundred year flood" means?   
(Tick ONE box.)
- a. A flood of a certain size that occurs once every one hundred years.
- b. A flood of a certain size that has a 1% chance of occurring in any one year.
- c. Don't know

**C. FLOOD EXPERIENCE**

1. How long have you occupied your present site on the floodplain?   
Years
2. Have you ever personally experienced flooding of the Waimakariri River at your present site? Yes  No
3. Have you had personal experience of your property being flooded elsewhere in New Zealand? Yes  No
4. If you answered 'YES' to C.3. what was the name of the town, city or district you were living in at the time?

\_\_\_\_\_  
Year/s 19 .....  
19 .....

**D. FLOOD RISK**

1. Did you realise that your property is situated on a floodplain? Yes  No
2. How safe have you felt from the risk of flooding from the Waimakariri over the last five years? (Circle the number of your choice.)
- 5 \_\_\_\_\_ 4 \_\_\_\_\_ 3 \_\_\_\_\_ 2 \_\_\_\_\_ 1 \_\_\_\_\_  
Completely safe At extreme risk Don't know
3. Why did you feel this way? \_\_\_\_\_  
\_\_\_\_\_
4. How safe do you think your property is from the risk of flooding from the Waimakariri over the next ten years? (Circle your choice)

5 \_\_\_\_\_ 4 \_\_\_\_\_ 3 \_\_\_\_\_ 2 \_\_\_\_\_ 1 \_\_\_\_\_  
Completely safe At extreme risk Don't know

5. Why do you feel this way? \_\_\_\_\_

6. In your opinion, how likely is it that a major flood by the Waimakariri will cause significant damage to the greater Christchurch urban area within the next thirty years? (Circle your choice)

5 \_\_\_\_\_ 4 \_\_\_\_\_ 3 \_\_\_\_\_ 2 \_\_\_\_\_ 1  
Very Improbable Don't  
probable know

### E. FLOOD CONTROL OPTIONS

There are several kinds of actions that can be taken to reduce and manage damage from flooding. Although they are often used in combinations, we will discuss each one separately. The North Canterbury Catchment Board is interested in what people think about different ways of controlling the flood hazard and reducing flood damage.

Stopbanks are built along river banks. They are designed to keep floods below a certain size in the main river channel.

1. Have you heard of stopbanks before now? Yes  No

2. How do you feel about stopbanks being used to manage major flood flows in the Waimakariri River? (Circle your choice)

5 \_\_\_\_\_ 4 \_\_\_\_\_ 3 \_\_\_\_\_ 2 \_\_\_\_\_ 1  
Strongly Strongly Don't  
in favour opposed know

3. Why do you feel this way? \_\_\_\_\_

River channels can be altered to help reduce the possibility of flooding. A channel can be artificially widened, deepened, straightened, or the river's course changed.

4. Have you heard of channel alteration before now? Yes  No

5. How do you feel about channel alteration being used to help reduce the possibility of flooding of the Waimakariri?

5 \_\_\_\_\_ 4 \_\_\_\_\_ 3 \_\_\_\_\_ 2 \_\_\_\_\_ 1  
Strongly Strongly Don't  
in favour opposed know

6. Why do you feel this way? \_\_\_\_\_

Flood warnings Rainfall and river flow records are used in providing warnings that flood conditions might occur. This is to allow people and organisations to move themselves and some of their belongings to decrease the risk of flood damage. Emergency centres are also made available for people who need personal assistance.

7. Have you heard about warning and evacuation procedures before now?  
Yes  No

8. How do you feel about these kind of procedures which would be used in the greater Christchurch urban area in the event of a flood?  
(Circle your choice)

5 \_\_\_\_\_ 4 \_\_\_\_\_ 3 \_\_\_\_\_ 2 \_\_\_\_\_ 1 \_\_\_\_\_  
Strongly in favour Strongly opposed Don't know

9. Why do you feel this way? \_\_\_\_\_  
\_\_\_\_\_

Flood hazard maps are sometimes drawn up so that people can see how likely different areas are to be flooded. A range of levels are shown from high risk areas to low risk areas. These maps can be looked at by anyone intending to buy a property to see which areas are most at risk from flooding. People can also obtain advice about measures they might need to take to reduce damage from flooding.

10. Have you heard of flood hazard maps before now?  
Yes  No

11. How would you feel about the greater Christchurch urban area being mapped for flood hazards?

5 \_\_\_\_\_ 4 \_\_\_\_\_ 3 \_\_\_\_\_ 2 \_\_\_\_\_ 1 \_\_\_\_\_  
Strongly in favour Strongly opposed Don't know

12. Why do you feel this way? \_\_\_\_\_  
\_\_\_\_\_

Zoning of land is used by some towns and cities to restrict building in places on the floodplain which are most likely to be seriously flooded or to ensure that new construction meets appropriate flood proofing standards.

13. Have you heard about zoning of land at risk from flooding before now?  
Yes  No

14. How do you feel about floodplain zoning being used in the greater Christchurch urban area to help lessen flood damage to buildings? (Circle your choice)

5 \_\_\_\_\_ 4 \_\_\_\_\_ 3 \_\_\_\_\_ 2 \_\_\_\_\_ 1 \_\_\_\_\_  
Strongly in favour Reasonable action Strongly opposed Don't know

15. Why do you feel this way? \_\_\_\_\_  
\_\_\_\_\_





10. Do you know what it requires you to do in the event of a flood?

Yes  No

**H. OBTAINING INFORMATION ABOUT FLOODING.**

We are interested to know what you think would be the best ways of informing the public about future flood risk, methods of protecting themselves and their property, flood warnings, etc.

1. Do you think special maps showing the extent of expected flooding according to different sized floods should be publicly available?

Yes  No  Don't know

2. If 'YES', where do you think they could be viewed by the greatest number of people?

3. Where/how would you like to find out more information about flooding and flood protection? (Please RANK the boxes)

Watch programmes  
on television

Read newspaper  
articles

Listen to radio  
programmes

Attend public  
meetings

Pamphlets delivered  
to your home

Other  
suggestions

Visit or telephone  
Catchment Board

Not interested

Don't know

**I. PERSONAL DETAILS**

1. Male  Female

2. How old are you?    under 20     20-29     30-39   
   40-49     50-59     60-69     70 or over

**J. DESCRIPTION OF YOUR PROPERTY ON THE FLOODPLAIN**

1. Residential (own home) \_\_\_\_\_
2. Residential (landlord) \_\_\_\_\_
3. Business (please state type) \_\_\_\_\_
4. Holiday bach or cottage \_\_\_\_\_
5. Farming (please state type/s of farming) \_\_\_\_\_
6. Other \_\_\_\_\_

Thank you very much for your participation - it is greatly appreciated.



Approximate Boundary of Waimakariri Floodplain

Pegasus Bay

SCALE 1:250,000



CHRISTCHURCH

Waimakariri River

## PILOT STUDY

The purpose of the pilot study was to determine the scale of the project by forecasting key components of a floodplain management plan for the Waimakariri River. This was achieved by examining and analysing a list of options previously considered to merit study for possible inclusion as a policy or a strategy in the WRFMP. Feasibility was judged on the basis of economic, environmental, social and technical considerations. The outcome is six distinct components. These are detailed broadly below, without combinations and sub-options, and represent optimal responses at this stage. The components, which are evolutionary rather than revolutionary, build on the Waimakariri River Improvement Scheme 1960, largely in the non-structural arena.

## KEY COMPONENTS

### 1. MAINTENANCE AND REFINEMENT

Maintain and locally refine the structural system of the existing protection scheme. Grass the stopbanks to improve their resistance to scour. Further reduce the possibility of stopbank erosion in the reach between Old Crossbank and Halkett by brush and tree planting on the berm.

Local refinement might include, for example, removing McLeans Crossbank to improve floodway capacity and flow alignment. River behaviour in the Crossbank-Halkett reach poses the greatest threat to Christchurch.

### 2. STRUCTURAL EXTENSIONS

- (a) Extend the stopbank system from Halkett Groyne upstream as far as the natural terrace near Intake Road. This action would provide continuous structural protection on the south side and match present conditions on the north bank.
- (b) Construct a secondary stopbank from Old Crossbank downstream to the Christchurch Northern Motorway.

This action, which provides a secondary flow path and detention area, would increase structural protection of northern Christchurch, Belfast and Kaiapoi to a level similar to that already enjoyed by northwest Christchurch.

A suggested line for the secondary bank is from the southern extent of Old Crossbank along the right bank of the Old South Branch taking advantage of an existing stopbank north of McLeans Island Road and a natural terrace north of Johns Road. The presumption underlying the secondary bank proposal is that degree of structural protection should be proportional to potential for flood damage.

### 3. FLOODWARNING AND COMMUNICATIONS

Complete installation of the AQUITEL telemetry system for floodwarning and develop a quantitative flood forecasting system. Review the operation of the Board's flood control and monitoring station. Review the nature, means and effectiveness of flood related communications with the New Zealand Meteorological Service, Police and Civil Defence.

The review of the Board's flood station would include staffing requirements and care of staff families during emergencies.

### 4. FLOOD HAZARD ZONING

Zone the highest risk area of the floodplain as a flood hazard zone. Allow development within the zone if it is unable to be located elsewhere; but ensure that new construction meets appropriate flood proofing standards.

The high risk area parallels the river, at about a 3 to 4 kilometre width, from Eyre Diversion to the coastline on the north bank, and from Halkett to the coastline on the south. The proposed zone would reinforce greenbelt provisions of the Canterbury United Council Regional Scheme and groundwater protection provisions of the Christchurch Groundwater Management Plan.

## **TECHNICAL ASSISTANCE PROGRAM**

**Develop a technical assistance program to enable floodplain occupiers to determine the risk of flooding at their location and obtain advice about appropriate damage reduction measures.**

The variable nature of risk over the floodplain would need to be mapped. Examples of damage reduction measures are sealing of doors and windows on ground floors, raising floor levels and installing capital intensive equipment above predicted flood levels.

## **COMMUNITY AWARENESS PROGRAM**

**Establish an ongoing flood preparedness program for floodplain occupiers. This would co-ordinate and maintain the effectiveness of the Technical Assistance Program and the floodwarning system.**

The program would be structured to meet the needs of differing occupier groups - industry, local government, residents etc. It would educate people about the likelihood and dangers of flooding, and would advise them of what to do both in anticipation of flooding and should flood warnings be issued.