THE INFLUENCE OF FLOOD PROTECTION ON PERCEPTION OF FLOOD HAZARD AND CHOICE OF ADJUSTMENT BY RESIDENTS OF OTOROHANGA BOROUGH, NEW ZEALAND

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CHAPTER I

GEOGRAPHIC RESEARCH INTO PERCEPTION OF NATURAL HAZARDS

INTRODUCTION

Man and the results of his work are distributed according to the decisions he makes. In endeavouring to interpret and explain the spatial distribution of any particular phenomena reflecting man's actions over a part of the earth's surface, the geographer should, of necessity, take account of human behaviour and, in particular, individual decision making. This may not be an easy task since decision making is a complex process involving many variables. Nevertheless, geographers are devoting increasing attention to behavioural variables in their analyses of the man-land relationship. To this end the theme of environmental perception is a significant one in geographic research since it is concerned with analysing human behaviour in terms of man's reaction to his environment.

This study embraces the theme of environmental perception. Its particular concern is with man's view or awareness of flood hazard, and his attitude towards the adoption of measures for reducing flood damage.

A single urban community with a history of flooding was chosen in order to examine the behaviour of residential managers (i.e. householders) towards flooding. In the chosen study area, Otorohanga, an evaluation of flood hazard perception by individual managers[1] was made and their adjustments to this hazard analysed.

The purpose of this chapter is to place this study in its geographical research perspective. It is thus necessary to outline the nature of environmental perception with particular reference to natural hazard perception and choice of adjustment to hazard. Previous literature is reviewed, particularly that relating to human occupance of flood plains.

ENVIRONMENTAL PERCEPTION AND BEHAVIOUR

The lives and affairs of men constantly interact with the natural world in a man-land system. Geographers have long been interested in this system, as evidenced by the man-environment tradition in geography. This tradition is represented by a range of man-milieu hypotheses, including cognitive behaviourism, environmental determinism, environmental possibilism, and probabilism, (Saarinen, 1966, 26; Sprout and Sprout, 1956; 1965). The last three of these hypotheses have inherent disadvantages. Determinism, for example, incorporates the notion that non-human environmental factors are all-powerful, man having little choice in determining what happens in the total environment.

This implies that a given set of environmental factors is sufficient to explain a given human situation. Probabilism sought to explain and predict man's reaction to a given milieu on the basis of a generalised model stating the average person's behaviour in this particular environmental situation. It was generally assumed that, in making decisions with regard to the use of his environment, man was aware of all the alternatives and acted in a rational manner, therefore his actions always had optimal results (i.e. the notion of 'economic man'). In an attempt to overcome the disadvantages, an increasing number of man-land studies in recent years have pursued the theme of environmental perception which embraces the man-milieu hypothesis of cognitive behaviourism. This, Saarinen (1966, 26) states, assumes that 'a person reacts to his milieu as he perceives and interprets it in the light of his previous experience.' It rejects the notion of 'economic man', and the idea that man's economic behaviour is determined by his physical environment. Rather, his economic behaviour is seen as the result of his perception of the environment, or, in other words, the images and ideas he has about the world. These, Lowenthal (1961,260) suggests, are 'compounded of personal experience, learning, imagination, and memory' to which can be added individual and group values. Each individual manager therefore has what McDaniel and Eliot Hurst (1968, 15) call a 'behavioural

or perceived environment'[2] within which their decision making and consequent behaviour in respect of economic activities takes place. It is highly unlikely that any individual manager will perceive the total environment within which economic activities occur. This consists of both the physical environment and the operational milieu of the society to which the manager belongs (Figure 1). The latter milieu comprises the economic, political and value systems and the perceptions and attitudes of the society as a whole. The individual manager is therefore only aware of a selection of the theoretically possible alternatives for action open to him. How he perceives the environment is thus a very important element in his decision making with regard to natural resource use.

In any decision making situation affecting the use of natural resources, managers are faced with a variety of uncertainties. There are, for example, economic uncertainties such as fluctuations in price and demand. Equally important are the vagaries of nature itself, these being commonly referred to as natural hazards.

In many situations of natural resource use, managers are faced with the possibility of a natural hazard occurrence, although they are not necessarily aware of it. A flood plain manager, for example, may be ignorant of any risk to his own person or property. In areas of hazard one can expect that decision making in respect of resource use will

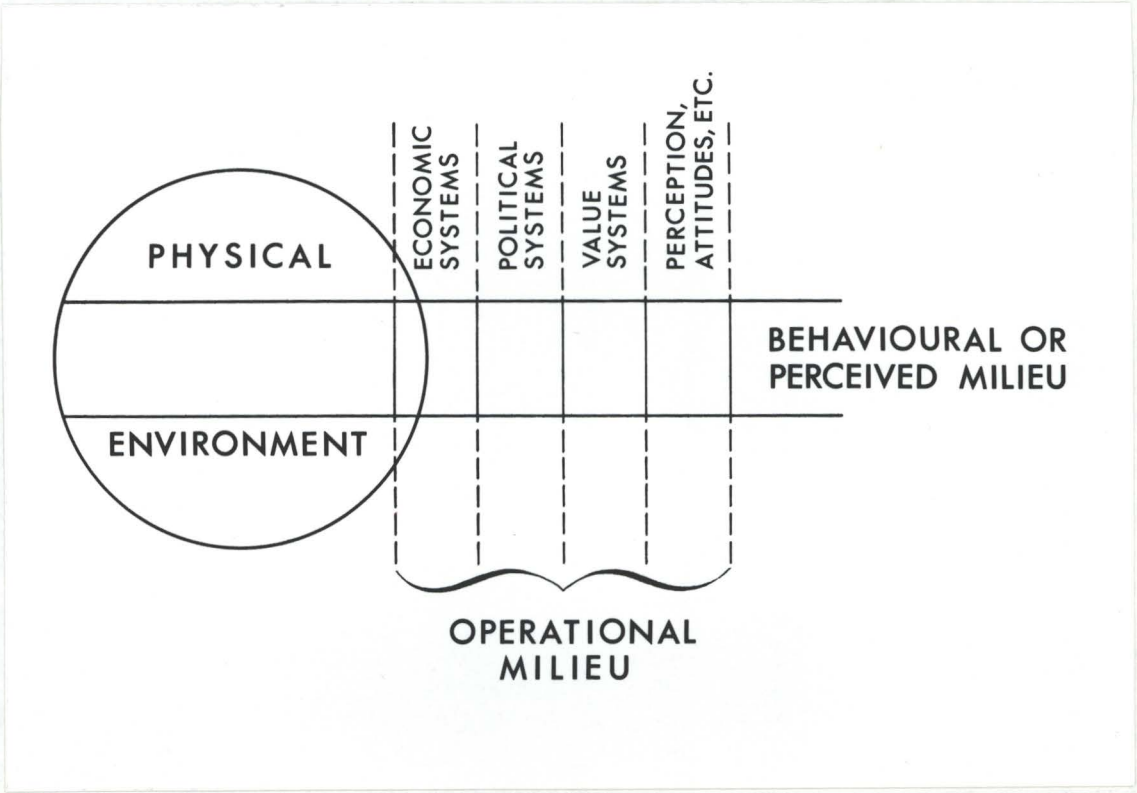

FIGURE 1. The Milieu within which Economic Activities Occur.

Source: R. McDaniel and M.E. Eliot Hurst, A Systems Analytic Approach to Economic Geography, 1968, 16.

reflect the manager's perception, or lack of perception, of the hazard. Natural hazards are clearly a significant variable in the man-land system, and they must be seen in this perspective.

NATURAL HAZARDS IN HUMAN ECOLOGICAL PERSPECTIVE

It is in the man-land system that man endeavours to utilise and manage natural resources. By employing elaborate or simple technical and social mechanisms he endeavours to seek in nature that which is useful and to buffer that which is harmful to himself. To cope with the harmful effects of nature, complex sets of human adjustments are found in all human resource use systems. In view of these relationships Kates (1970) discusses natural hazards in a human ecological perspective. In this he is consistent with a strain of geographic research first outlined by Barrows (1923) who saw geography as human ecology or the study of the adjustment of man to his environment. Hazards are taken to be those events in nature which do not recur regularly at the same magnitude and which have such variance that they may cause dislocations in societal activity. A continuous process of adjustment is necessary if man is to survive and indeed benefit from the natural world. While this is possible even in areas of frequent and recurrent natural hazard, there is always the possibility that the adjustments will prove insufficient to cope with a given set of natural events. Serious and detrimental

effects may ensue. It is therefore in the interests of all hazard zone managers to collectively and/or individually adjust to the hazard in the most efficient manner. The success of their adjustment is very likely to be dependent upon their perception and choice of adjustment to the hazard.

NATURAL HAZARD PERCEPTION

The process of adjustment is subject to managers first perceiving that there is a hazard sufficient for them to take action to minimise its threat and mitigate its effects. Among resource managers, including those of the same social group, there is likely to be variation in hazard perception since each manager has an individual 'perceived environment'. Empirical studies show that among those who occupy and use a flood plain, there may be those who perceive no hazard; those who are aware of a definite hazard; and those who are uncertain as to the risk of flooding faced (Burton, 1961 a; Ericksen, 1967 b; Kates, 1962; Roder, 1961). Furthermore, the risk perceived by many flood plain managers may well differ from the probability of flooding as known to the professional hydrologist. Among the principal hypotheses being investigated in natural hazard research are those which account for variation in hazard perception by a combination of the following :

1) The way in which characteristics of the natural event (e.g. magnitude, duration, frequency) are perceived.

2) The nature of personal experience of the hazard (e.g. recency, frequency and intensity of experience).
3) The importance of the hazard to income or locational interests.
4) Personality factors such as risk taking propensity, fate control, and views of nature (Kates, 1970, 6; White, Kates and Burton, 1970, 4-5).

Empirical evidence suggests that variation in hazard perception is not related to socio-economic class or age (Burton, 1961 a; Roder, 1961).

Managers who perceive a hazard may feel the risk warrants action to reduce the potential danger. They must therefore evaluate and choose which adjustments they will adopt.

CHOICE OF ADJUSTMENT TO HAZARD

Decision making with regard to choice of adjustment to hazard may best be described by adopting the approach developed by White (1961 a, 1964 a) for analysing and explaining decisions in resource use and management. White envisages a decision making framework compounded of a trichotomous set of choices: the theoretical range of choice open to any manager; a practical range of choice which lies within the theoretical range; and the actual choices selected from within the limits of the practical range. The actual selection depends upon the way in which the manager analyses the different elements in the

decision. White illustrated his approach by developing the model outlined in Figure 2. This incorporates six elements which he suggests may enter decisions as to flood plain use and management.

First, there is the manager's perception of the theoretical range of choice open to him in making adjustments to the flood hazard. It is likely that few, if any, managers will be aware of the full range of possible adjustments open to them. Burton, Kates and White (1968, 11) record that they have found few instances in which all the theoretical possibilities are canvassed. Kates (1970, 7, 17-18) suggests that variation in awareness of the number and type of adjustments, and the quality of knowledge thereof, might be accounted for by factors controlling access to information, or surrogates thereof such as education, income, travel, and role related responsibility and training.

The second element entering decision making is the manager's perception of hazard in terms of personal vulnerability during possible future flooding.

Third, is a manager's perception and assessment of the logical feasibility of an adjustment in terms of its efficacy and the availability of skills, tools and materials.

Fourth, is the manager's perception of the relative economic efficiency of alternative adjustments. This

Adjustment	Perception by Manager of:					
	Theoretical Choice	Flood Hazard	Technology	Economic efficiency	Spatial Linkage	Practical Choice
Loss bearing	1	1	1	1	1	1
Flood protection works	1	1	1	1	1	1
Emergency action	1	1	1	0	0	0
Structural change	1	1	0	0	0	0
Insurance	1	1	0	0	0	0
Public relief	0	0	0	0	0	0
Change in land use	0	0	0	0	0	0

0 Not perceived

1 Perceived

FIGURE 2. Choice of Adjustment to Floods by a Hypothetical Flood Plain Manager.

Source: G.F. White, Choice of Adjustment to Floods, 1964 a, 9.

involves estimating the anticipated costs and benefits of an adjustment in light of the manager's perceived time horizon, and the degree to which the adjustment is required.

Fifth, is the manager's perception of spatial linkage between action in the flood plain and resource use in other areas. For example, stopbanking may promote use of land in one place whilst hindering it in another.

The final element is the complex of social constraints (e.g. social values, traditions and laws) which may affect a manager's perception of any of the other elements and result in his being limited to a practical range of choice. For example, the absence of periodic dissemination of information by bodies qualified to do so (e.g. Regional Water Boards) may affect managerial perception of both the hazard and the theoretical range of adjustments. Even if a theoretical choice is perceived, it may not be adopted because it seems to the manager to be unwise in the light of social constraints which prohibit or discourage the choice.

In the example used in Figure 2, the manager, a merchant occupying a building on a flood plain, is aware of all but two of the theoretical choices open to him: public relief and change in land use. He perceives the flood hazard as sufficient for him to consider adjustment. However, he does not have command of the technique of effecting structural changes to his business premises (e.g. raising the floor

level), nor does he know how to go about obtaining insurance cover. He considers the cost of emergency action, such as protecting his stock with plastic sheeting, to be too great. Thus, he is left with the practical choice of either bearing the loss or relying upon flood protection works, neither of which he regards as objectionable to others in the town in terms of the effects on land use.

White's model is descriptive rather than normative and obviously the elements could be arranged in different combinations. Several empirical studies provide applications of it. They show that both perception of the various alternative adjustments and the frequency of adoption thereof vary according to the frequency and severity of flooding, especially the perceived frequency and severity (Ericksen, 1967 b, 102-111; Kates, 1962, 83-88). There also appears to be a relationship between adoption of adjustments and previous experience of the hazard, this being most evident in areas where very heavy damage has been sustained. Thus, occupants who have a high level of knowledge and experience of flooding are the ones most likely to adopt adjustments other than loss bearing. For example, White (1964 a) found a strong association between those who perceive and adopt structural measures and their length of tenure on the flood plain, and between the perception and adoption of emergency measures and their location within reach of the latest major flood. The

frequency of adoption does not appear to be related to socio-economic status except where the cost is high (Burton, Kates, Mather and Snead, 1965; Kates, 1962).

Having outlined the nature of environmental perception with particular reference to natural hazard perception and choice of adjustment to hazard, it is pertinent to indicate the extent of geographical research embracing the theme of environmental perception, especially that relating to natural hazards and, more particularly, flood risk.

SCOPE OF PREVIOUS LITERATURE

As a research theme in geography, environmental perception has wide application. For example, studies incorporating an awareness of the importance of perception have contributed to an understanding of wilderness use (Lucas, 1964; 1966), English criteria for scenic beauty (Lowenthal and Prince, 1964; 1965), industrial water demands (Wong, 1969), appraisal of pastoral resources (Heathcote, 1963), multiple recreational demands (O'Riordan, 1969), adaptation to the East African environment (Porter, 1965), space preference in Tanzania (Gould, 1969), and have brought to light the discord that can arise between resource users and the technical experts who propose how a resource should be managed (Fomaroff, 1963; Macinko, 1963). Within its broad scope, environmental perception has its oldest research tradition in studies of natural hazards. In more recent years it has found increasing application in

urban geography through studies of human spatial behaviour. It has been applied, for example, in studies of intra-urban migration (Adams, 1969; Brown and Holmes, 1970; Johnston, 1969). The extent and nature of this new development is well outlined by Golledge (1970) and Saarinen (1969).

NATURAL HAZARD RESEARCH

Research into perception and adjustment to natural hazards has to date been concentrated on relatively few of the wide range of hazards outlined by Burton and Kates (1964 b, 414-417). Beginning with investigations into flood plain occupance, research has been extended to include blizzards and snow (Sonnenfeld, 1967; Rooney, 1965; 1967; 1969), coastal storms (Burton, Kates, Mather and Snead, 1965; Burton, Kates and Snead, 1969; Kates, 1967), drought (Heathcote, 1969; Parkhill, 1970; Saarinen, 1966), soil erosion (Blaut, et al, 1959), tsunami (Havighurst, 1967), and the quasi-natural hazards of air pollution (Auliciems and Burton, 1970) and water pollution (Hewings, 1968). All these varied studies may be seen as part of the research paradigm outlined by Kates (1970, 2). This seeks to:

1) Assess the extent of human occupance in hazard zones.
2) Identify the full range of possible human adjustment to the hazard.
3) Study how men perceive and estimate the occurrence of the hazard.
4) Describe the process of adoption of damage-reducing

adjustments in their social context.

5) Estimate the optimal set of adjustments in terms of anticipated social consequences.

This research framework emphasises the idea that natural hazards should be viewed in an ecological perspective. The emphasis in the present study is on the third and fourth aspects of this paradigm.

Since this study is concerned with managerial perception and response to flood hazard, it is necessary to confine the remainder of this review to literature relating to flood plain occupance.

Research into Flood Plain Occupance

Geographical research into human occupance of flood plains has largely been the province of American geographers, notably those associated with the University of Chicago. The Chicago research programme arose out of concern at mounting American flood losses which continued to rise despite increasing expenditure on conventional flood control schemes (Holmes, 1961; Renshaw, 1961). This paradoxical situation was accounted for in part by limitations on the choice of adjustment to flooding. Research was thus directed at investigating the factors which tend to limit the range of choice, and in so doing it was hoped to offer some solution to the flood loss-protection cost problem.

The literature may be reviewed in three closely related groups, the first of which consists of several studies that assess the ways in which social, economic and behavioural variables have interacted to produce the observable patterns of rural and urban flood plain occupance. Burton (1962) has developed a typology of agricultural occupance of flood plains, and White, et al, (1958) have studied changes in flood plain occupance in 17 United States cities. The latter research showed that, in general, frequent flooding fails to inhibit the growth of urban flood plain settlement, and that the rising toll of flood losses is being caused primarily by increasing encroachment of urban settlement on to flood plains without sufficient adjustments being made. Furthermore, expensive flood control schemes were found to increase the potential for flood losses since they encouraged confidence in the protected area as a place for human occupance (White, et al, 1958; White, 1960).

The second group of studies are those which have investigated flood plain managers' perceptions of hazard and their attitudes towards alternative adjustments for reducing possible flood losses. The present study comes within this context. The two most detailed works in this group are the companion volumes of Kates (1962) and White (1964 a). Both are based on studies in six United States towns with flood problems ranging from minor to severe. Kates concentrated on the perception of flood hazard and

the range of choice of adjustment, while White examined the circumstances in which private and public managers choose among several possible adjustments. Kates illustrated the variation in managerial perception of the nature and magnitude of the flood problem. He found that many managers perceived the hazard and range of choice of adjustment rather imperfectly and hence their adjustment, if any, was not the most efficient for the situation. Both researchers found experience to be a significant factor in managerial perception and response to hazard. Action to reduce the damage of possible future flooding was found to be most likely when several floods had been experienced and when the losses had been severe.

Two smaller studies have investigated the effects that knowledge of flood protection has on hazard perception. Both Burton (1961 a) in his study of the communities of Hammond and Munster on the flood plain of the Little Calumet River in northern Indiana, and Roder (1961) in his investigations at Topeka, Kansas, were unable to discern a direct relationship between residents' knowledge of protective structures and their expectation of future floods. Instead, Burton found that it was the type of past flood experience which tended to have a significant role to play in appraisals of flood hazard.

Other studies have assessed the attitudes of flood plain managers to flood insurance (Czamanske, 1966), and have

compared the hazard perception of flood plain and sea shore inhabitants (Burton and Kates, 1964 a; Burton, Kates, Mather and Snead, 1965). In the latter study it was found that managers of coastal properties had a greater awareness of the hazards of storms than did urban flood plain dwellers.

The final group of studies are those concerned with the range and nature of alternative adjustments to flood hazard. As a possible counter to the rising toll of flood losses, these studies were aimed at broadening the basis of choice by encouraging full consideration of the whole range of theoretically possible adjustments. The extent of this range as seen by the Tennessee Valley Authority (1963) is outlined in Figure 3. This chart also shows an assessment made by Ericksen (1967 b, 16) of the degree to which the various adjustments have been adopted in New Zealand. The range of adjustments is considered by Sewell (1969) and White (1945; 1964 b), while Jackson (1965) limits his discussion to non-structural measures for flood control. Several adjustments have been considered in detail, for example, regulation of land use (Murphy, 1958; Perry, 1956), flood proofing (Sheaffer, 1960), and flood insurance (Clawson, 1966; Foster, 1954; Grossman, 1958; Langbein, 1953; Overman, 1957). Other works have investigated the potential effectiveness and economic efficiency of various adjustments using

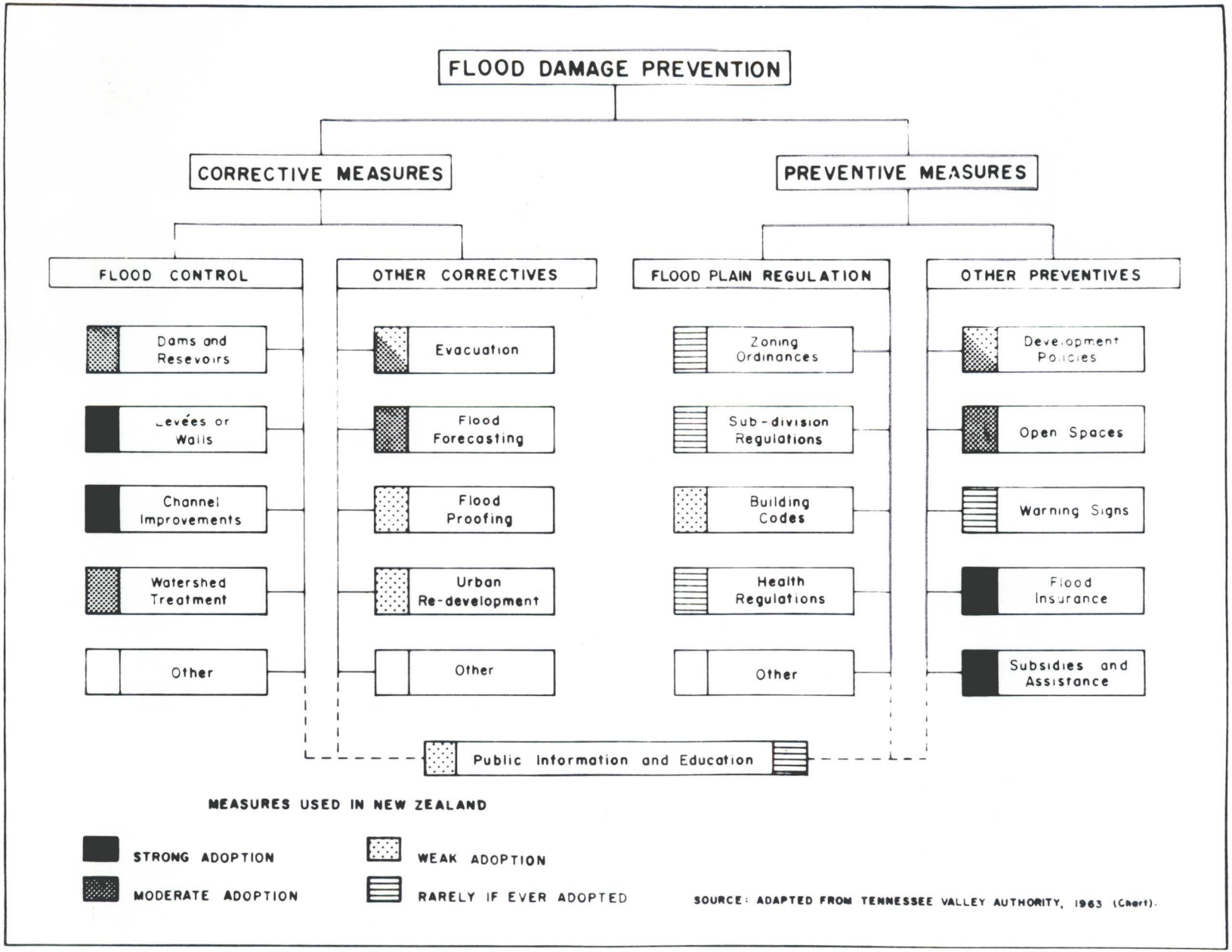

Figure 3. Possible Flood Damage Prevention Measures and their adoption in New Zealand. Source: adapted from Tennessee Valley Authority chart (1963) by N.J. Ericksen (1967 b, 16)

techniques such as cost-benefit analysis (Burton, 1965 b; Kates, 1965; Sewell, 1964; White, 1964 a).

A tangible result of the Chicago and related studies has been a change in United States government policy relating to adjustment to flooding. The approach has been broadened so that as well as flood control, emergency action, and flood relief, consideration is now being given to other measures such as structural change, flood insurance, flood proofing and flood plain zoning.

Outside of the United States comparatively little research has been undertaken into flood plain occupance. Apart from the in-depth interviews conducted by Burton (1965 b) in Belleville, Ontario and Sewell (1965) in the Fraser River Basin, British Columbia, Canada, little attention has been devoted to identifying the attitudes of flood plain managers. Studies of flood loss reduction in England and Wales (Burton, 1961 b), and Canada (Burton, 1965 a), showed that there was a need in these countries for consideration of a wider range of adjustments. Too much reliance was placed on conventional engineering approaches to flood problems, although in England and Wales some local planning authorities have attempted to regulate flood plain development. In Australia, the Hunter Valley Research Foundation has an information programme to warn the public of the dangers of flood hazard and to suggest measures that can reduce the damaging consequences of

flooding (Hunter Valley Research Foundation, 1963).

Apart from the recent work by Bricksen, the New Zealand literature relating to flooding shows little awareness of both the significance of perception in flood plain management and the benefits of a wider range of adjustment to flooding. Most of the literature is devoted to the more conventional aspects of the problem such as collection of hydrological data, soil conservation, and river control activity. This emphasis is borne out by the references cited in the detailed work of Acheson (1968). Aside from this type of work, Johnston (1969) has discussed perception, choice and adoption of adjustments to flooding with reference to the field work done in Opotiki by Bricksen (1967 b). Caddie (1967) gives a passing reference to the research undertaken by the University of Chicago and Pullar (1967) briefly queries the wisdom of encouraging further urban development on flood plains through the implementation of flood control schemes.

The sole researcher in New Zealand to devote attention to identifying the attitudes of flood plain occupants has been Bricksen (1967 b; no date b). In investigating the way in which Opotiki residents perceive flood hazard, he found that expectation of flooding does not correspond closely to either knowledge or past experience of flooding, thus somewhat contradicting the findings of Burton (1961 a) and Kates (1962). The relatively low expectancy of future

flooding was attributed to the presence of large-scale protective works of which every respondent showed awareness. The effect of confidence in these protective works has been an encouragement to flood plain settlement; a reduction in the range and frequency of adoption of adjustments; and an increase in the potential losses from any future flooding.

Ericksen (1968; 1971; no date a) is also the only researcher to have examined critically the range and frequency of adoption of adjustments to flooding in New Zealand. In particular he has shown the need for regulation of flood plain development in this country (Ericksen, 1967 a; 1970).

In commencing the present study the author was aware of the paucity of empirical studies into human occupance of flood plains in New Zealand. It was hoped that research in Otorohanga would complement and extend the work of Ericksen and contribute to a better understanding of man's utilisation of the flood plain resource in New Zealand.

THE PRESENT STUDY IN ITS RESEARCH CONTEXT

The present work is an attitude study embracing the theme of environmental perception. It is an endeavour to establish as accurately as possible how the members of a particular community actually perceive and respond to the hazard presented by their particular environmental situation.

As a small urban community with a history of flooding, Otorohanga Borough was chosen in order to examine the behaviour of residential managers towards the flood hazard. This involved identifying the perceptions of flood hazard by individual managers, and establishing their attitudes towards measures for reducing flood damage. The present work is thus essentially replicate of some of the American attitude studies (Burton, 1961 a; Kates,1962; Roder, 1961) and the Opotiki study of Ericksen (1967 b). In contrast with the American study sites, Otorohanga has made a large-scale community adjustment to the flood hazard in the form of an expensive flood protection scheme. In this, Otorohanga presents a somewhat similar situation to that found in Opotiki. However, in the latter town the protective structures were little more than two years old when Ericksen made his study, and at the time his interviews were made the risk of flooding was sufficient to cause many to evacuate the town in response to a flood warning. In Otorohanga, on the other hand, nearly 13 years had elapsed since the last major flood and the protective works had been in existence nearly five years when the present study was undertaken. Obviously, in Otorohanga there has been a longer period for confidence to have been restored in the flood plain as a place for human occupance. The findings of the present study will therefore warrant comparison with the pertinent results

obtained in the American and Opotiki studies.

In summary, the purpose of the present research is to:

a) Establish how individual residential managers in Otorohanga perceive and interpret the flood hazard in light of the existence of a large-scale flood protection scheme.

b) Determine what have been the consequences of this perception in terms of their decision making with regard to choice of adjustment to hazard, including those decisions relating to choice of home location.

c) Compare the results of this study with those obtained by other empirical studies of a similar nature.

It is to be hoped that from this, more will be learnt of the variables that enter into the decision making of managers in an area of flood risk, and of the conditions of knowledge under which these decisions are made. The results may contribute to a better understanding of why people locate on flood plains. This in turn may assist planning for the more efficient utilisation of flood plain resources in New Zealand.

In the remaining chapters the focus is on Otorohanga. In Chapter II the geographic problems and the research hypotheses investigated, and methods used, are outlined against a background description of the study area. Analysis begins in Chapter III where the influence of the flood protection scheme on flood hazard perception is examined. Chapter IV investigates the influence of

hazard perception on the adoption of alternative adjustments to the hazard, including choice of home location. Finally, in Chapter V, comparisons are made with other studies and some conclusions are presented.

CHAPTER II

STUDY AREA, RESEARCH HYPOTHESES AND METHODS

In the preceding chapter an attempt was made to place the present study within its geographical research context. From the general discussion of human perception and adjustment to natural hazard, this chapter moves to an outline of the specific geographic problems that were investigated. Since this study is primarily one of flood plain occupance and human perception and adjustment to flood hazard, it is necessary to consider the main elements of land and flood that have influenced the occupance of Otorohanga. This involves describing Otorohanga's physical setting and development; its history of flooding; and the chosen solution to its flood problem - a large-scale flood protection scheme. It is also pertinent to make some evaluation of the hazard in light of the protective measures. Against this background will be outlined the geographic problems investigated in this study together with the research hypotheses and methods used in the attempted solution of these problems.

STUDY AREA

Physical Setting and Development of Otorohanga

Otorohanga (population 1,961 in 1971 census)[1] is the northernmost borough of the King Country region in the central North Island of New Zealand (Inset, Figure 4). The present town originated as a permanent camp set up in the late 1880's for construction workers engaged in the extension southwards of the North Island Main Trunk Railway line. In the vicinity of Otorohanga this line traverses the Waipa River flood plain and it was around the railway station that the town grew and prospered.

Otorohanga today is a servicing and community centre for a predominantly dairy farming district. Some sawmilling is also undertaken close to the town. Industrial activity in the town includes caravan assembly; the manufacture of concrete products, clothing and furniture; and the production of butter, lime and other fertilizers, and sawn and dressed timber.

A large portion of the residential and industrial areas, and the entire commercial area of the borough have been developed on a narrow flood plain. Composed of alluvial silt, sand, gravel and pumice, this flood plain has been built up through sedimentation by the upper Waipa and Mangapu Rivers, and the Mangawhero and Orahiri Streams which join the Waipa as it flows round the southern boundary of the borough (Figure 5). The remaining

residential development has occurred on low hill land in the northern portion of the town.

The catchment of the rivers and streams that have their confluence at Otorohanga has an area of 350 square miles and is generally described as the upper Waipa catchment (Figure 4). In its lower northern reaches the catchment is undulating country, but this soon rises to hill land in the west and a more mountainous belt in the east where the Rangitoto Range rises to 3,000 feet. To the south there is a generally low divide between the Waipa and Mokau catchments.

The flood plains of the river system and/the lower northern reaches of the catchment are principally devoted to dairying. On the steeper slopes of the perimeter hills and mountains indigenous forest cover is still common and includes State Forest. Where the native cover has been cleared breeding and store stock are raised. In some of these areas slump, slip and gully erosion is evident but to date there has been little adoption of soil conservation measures. However, the Waikato Valley Authority is hopeful of establishing a 13,000 acre exotic forest in the middle Mangaokewa sub-catchment to help reduce the flood threat to Te Kuiti (Figure 4).

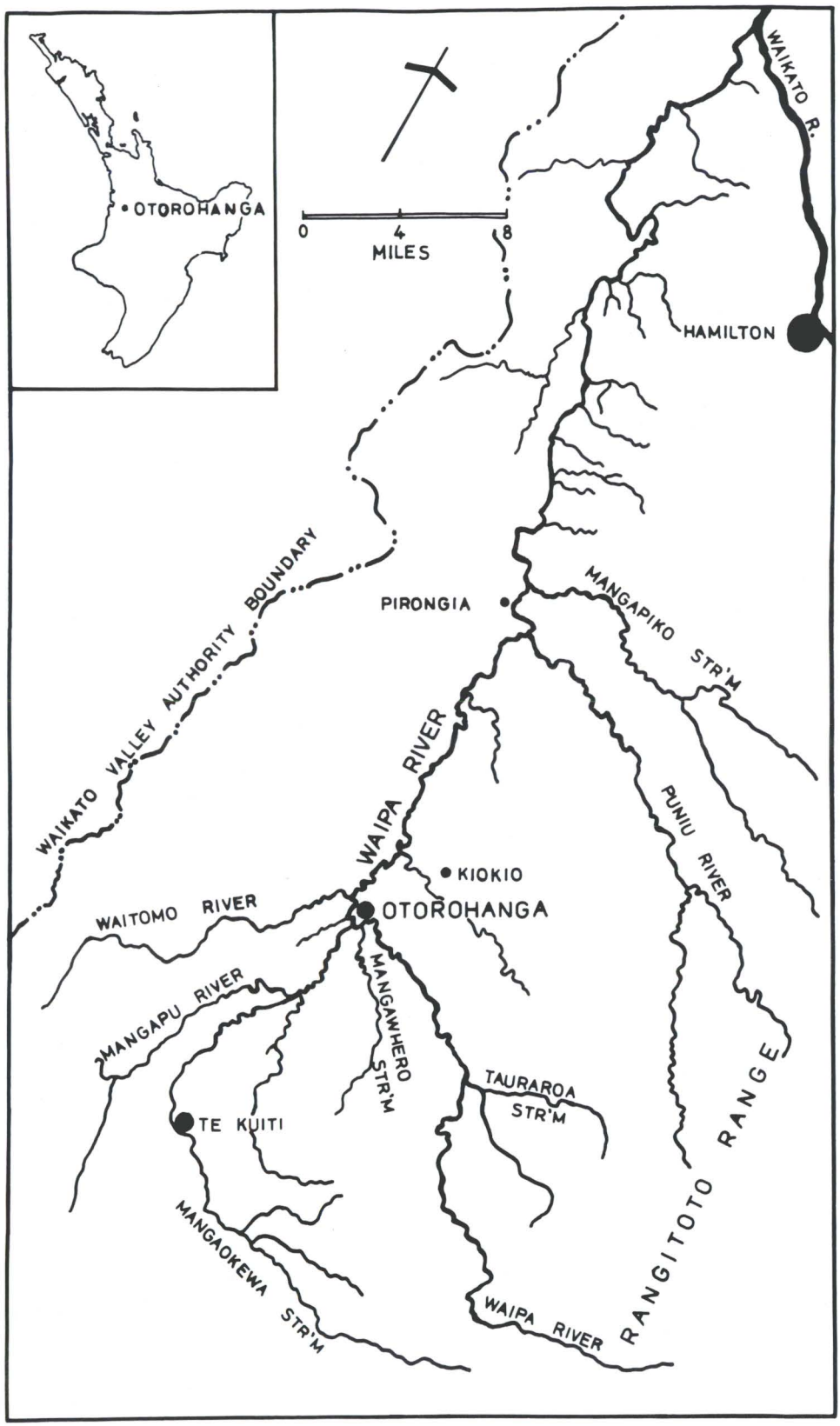

Figure 4. The Waipa River System

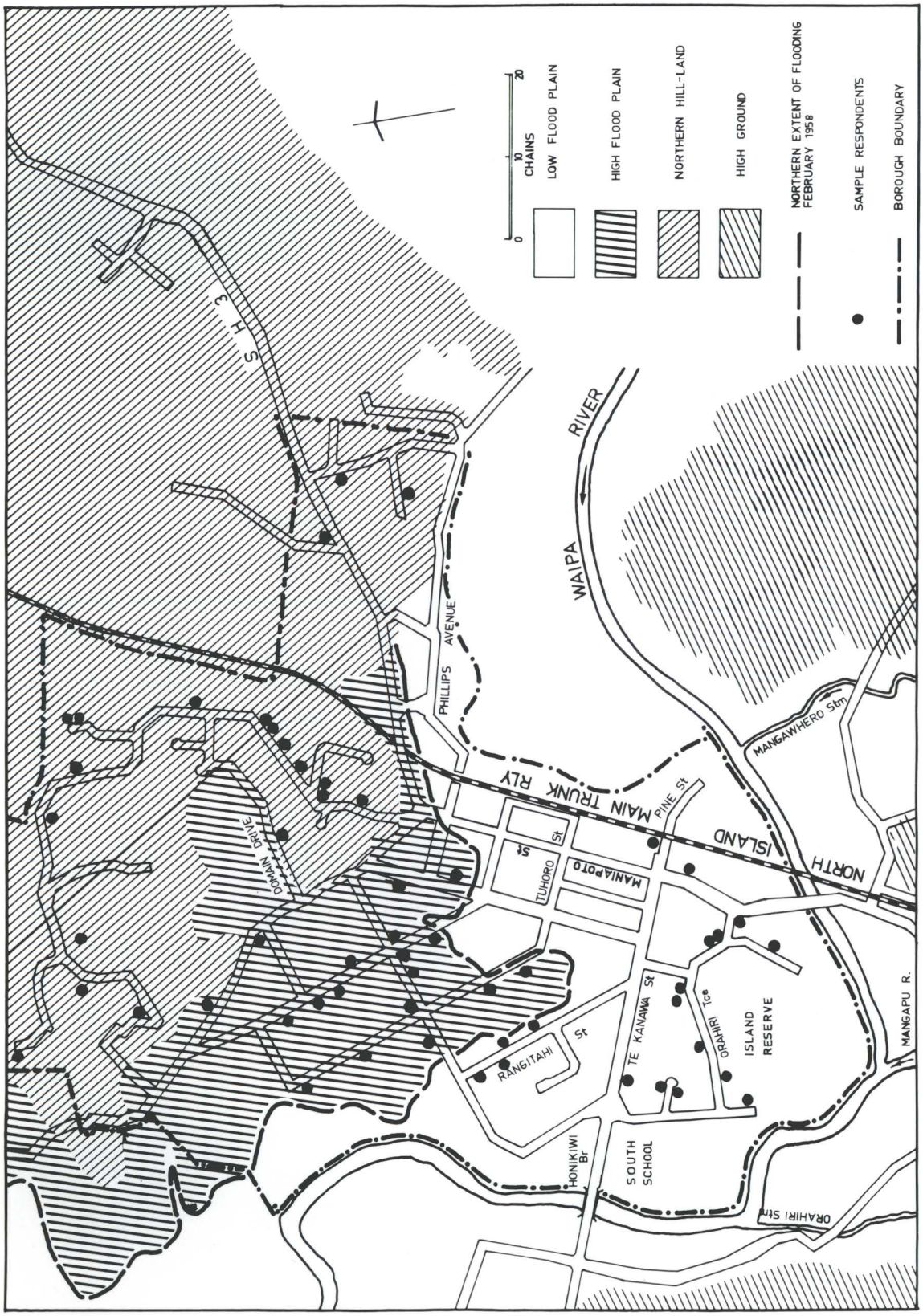

Figure 5. Otorohanga Borough: Geophysical Areas and Sample of Respondents

Flooding in Otorohanga

Since the flood event is a major variable in the flood plain resource base, the history of flooding is basic to a study of flood plain occupance. However, the flood record at Otorohanga prior to the formation of the Waikato Valley Authority in 1956 has not been well recorded. One valuable source of information was lost during the major flood of February, 1958, when flood waters destroyed the files and back copies of the local weekly newspaper, The Otorohanga Times. This loss is partly compensated for by the existence of two other sources of information: data compiled by Cowie (1957) for floods in New Zealand between 1920 and 1953; and readings taken by the Ministry of Works from a staff gauge installed on the Honikiwi Bridge which is just below the confluence of the Waipa and Mangapu Rivers (Figure 5). Daily water levels were recorded at Honikiwi between 1924 and 1934, but these readings were not supported by discharge measurements. Flows which probably constituted minor floods during this period are shown in Table 1. Continuous readings were begun again at Honikiwi Bridge following the establishment of the Waikato Valley Authority. The peak heights and discharges recorded for floods occurring since 1956 are also set out in Table 1. A discharge of approximately 8,000 cusecs corresponds to the bank-full capacity of the Waipa at Honikiwi Bridge. If the river level rose to a height of 108 feet on the Honikiwi

gauge then flood water began to inundate sections in the lowest lying parts of the town, that is in the vicinity of Pine Street, Orahiri Terrace, South School, and Phillips Avenue (Figure 5). If the gauge read 110 feet then flood waters would be above the floor level of some of the houses in this part of town, would be blocking streets in the vicinity of the Honikiwi Bridge, and would have reached the doorsteps of houses in Rangitahi Street.

The first recorded flood after the inception of European settlement was one of major proportions in mid-January, 1907. Fortunately the township was then small and thus the losses, though heavy to the individual, were not, in aggregate, very large. The only indication that can be given of the size of this flood relative to that of the major flood of February, 1958, is by comparing the water level heights recorded at the Whatiwhatihoe Bridge, Pirongia (Figure 4) which supported the only gauge on the Waipa in 1907. In January of that year a height of 89 feet 5 inches was recorded compared with 94 feet 1 inch in February, 1958, the approximate normal water level being 55 feet.

Between these two major floods, there were minor floods which caused concern from time to time. Some of the larger ones caused houses to be evacuated, For example, in June, 1920, all the railway staff were forced to leave their homes (Cowie, 1957, 25). The year by day gauge

TABLE 1

PEAK HEIGHTS AND DISCHARGES RECORDED AT HONIKIWI BRIDGE, OTOROHANGA, FOR SOME HISTORICAL FLOODS IN THE WAIPA RIVER.

Date	May 1925	Oct. 1926	July 1956	Feb. 1958	Dec. 1958	Sept. 1960	July 1961
Height (ft.)	109.0	109.5	108.2	117.0	111.0	109.8	110.65
Rise above normal (ft.)	14.0	14.5	13.2	22.0	16.0	14.8	15.65
Discharge (cusecs)	-	-	7,200	22,000	10,000	9,200	12,300
Date	June 1962	July 1962	March 1964	Jul.-Aug. 1964	Feb. 1967	June 1968	Sept.-Oct. 1970
Height (ft.)	108.9	108.7	108.8	108.2	107.8	107.4	108.7
Rise above normal (ft.)	13.9	13.7	13.8	13.2	12.8	12.4	13.7
Discharge (cusecs)	8,400	8,200	8,300	7,100	6,600	6,100	8,000

Notes:

1) Approximate normal water level is 95 feet. At normal summer flow the Waipa discharges 250 cusecs at Honikiwi Bridge.
2) February, 1958 - flood waters entered 170 residential and 100 commercial properties.
3) December, 1958 - 50 residential sections flooded; 17 houses from 2-24 in. above floor level.
4) September, 1960 - 7 houses evacuated.
5) July, 1961 - 16 houses evacuated; 14 flooded to depths from 1-17 in. above floor level.

Source: Unpublished information supplied by the Waikato Valley Authority.

records for Honikiwi Bridge between 1924 and 1934 indicate that water probably covered the lowest lying parts of the town in May, 1925, and October, 1926. Cowie (1957, 27,28, 31) records other minor floods in August 1945, September, 1948, and May and July, 1953. It is possible that other minor floods occurred in this period. Some older residents claim that prior to the implementation of the flood protection scheme, minor floods occurred every year or two.

It was not, however, until February, 1958, that the precarious and highly dangerous situation of the borough was fully realised. Following very heavy rainfall in the catchment (5.44 inches were recorded in Otorohanga for the 24 hours ending 9 a.m., 24 February, 1958), the upper Waipa and its tributaries rose very quickly. Flood waters overtopped the North Island Main Trunk Railway embankment, which had protected the commercial area of Otorohanga during minor floods, and the fall in level induced cataract conditions resulting in considerable damage to 100 properties in the main and secondary streets of the commercial area (Figures 8 and 9). Elsewhere in the borough 170 residential properties were damaged, the water rising in many houses to depths greater than three feet above floor level (Figures 6 and 7). The extent of the spread of water in this flood can be seen in Figures 5 and 10. For a town the size of Otorohanga the flood losses were immense (Table 2). The average cost of house repair alone was $900,

TABLE 2

FEBRUARY, 1958 FLOOD LOSSES IN OTOROHANGA BOROUGH

ITEM	$
PROPERTY LOSSES:	
Residential	153,000
Chattels	257,000
Commercial	44,000
Stock and Floor Coverings	200,000
Total Property Losses:	$ 654,000
OTHER LOSSES:	
General Borough Damage	26,600
Rescue Relief and Immediate Assistance	12,000
Post and Telegraph Buildings and Communications	2,000
Railways - Assessed Damage	60,000
Transport - Assessed Damage	4,000
Total Other Losses:	$ 104,600
TOTAL FLOOD LOSSES:	$ 758,600

Source: Waikato Valley Authority,
Lower Waikato-Waipa Control Scheme:
Economic Report - Boroughs of Otorohanga, Huntly and Te Kuiti, 1960, Appendix 1.

FIGURE 6. Flooding in Te Kanawa Street (February, 1958)

Photo: B.J. Baigent

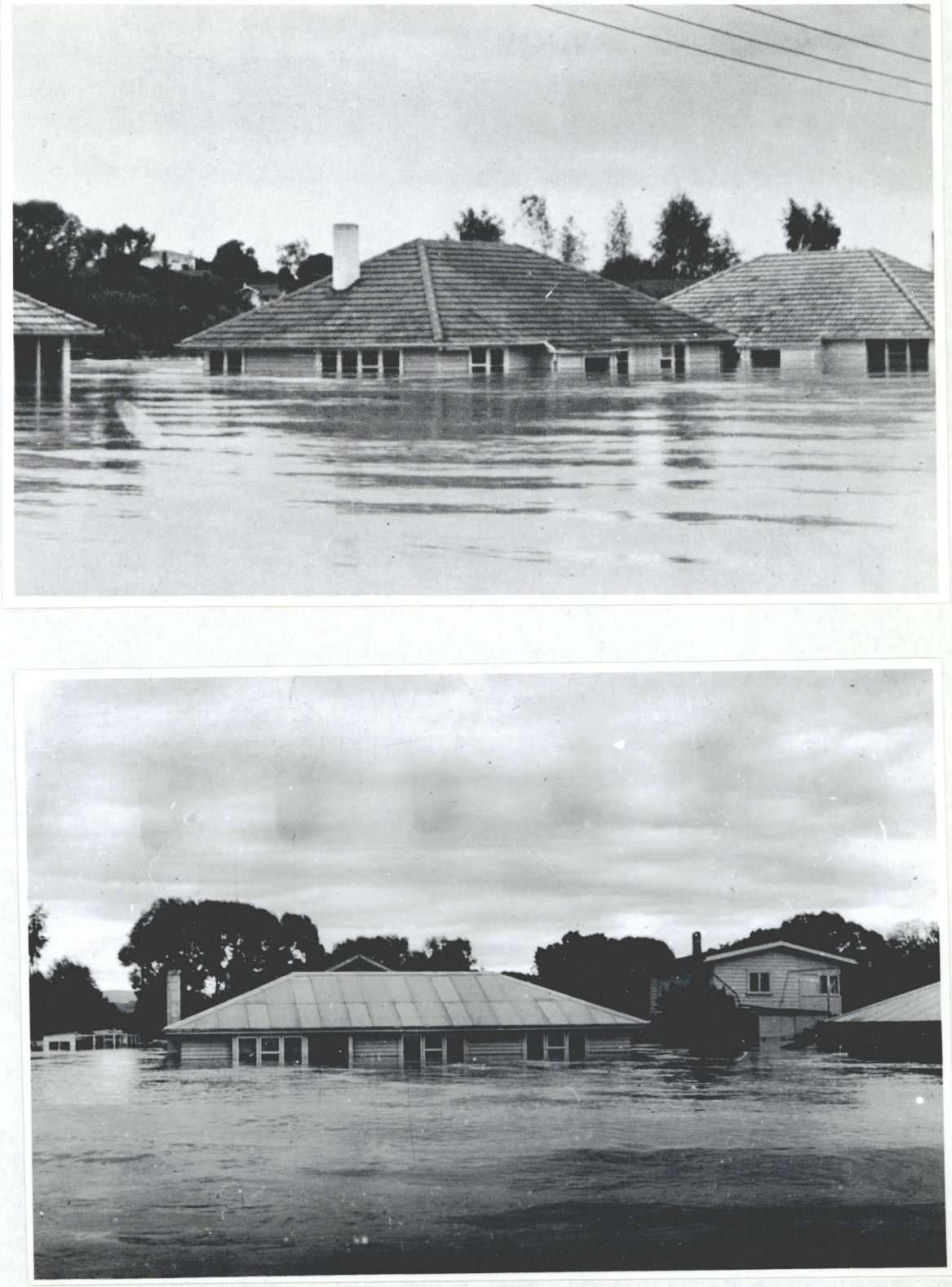

FIGURE 7. Residential Flooding in Orahiri Terrace (February, 1958)

Photo: B.J. Baigent

FIGURE 8. Flooding in the Commercial Zone - Tuhoro Street (February, 1958)

Photo: B.J. Baigent

FIGURE 9. Flooding in the Commercial Zone - northern end of Maniapoto Street (Feb., 1958)

Photo: B.J. Baigent

FIGURE 10. Flooding in the southern section of Otorohanga Borough (February, 1958)

Photo: Photo Flight, Cambridge.

and on top of this residential managers were faced with the replacement cost of furniture, drapes, floor coverings, home appliances, personal possessions, etc. In addition to the assessable losses there was considerable human suffering and dislocation of economic activity. At its peak this flood reached a height of 22 feet above normal at the Honikiwi Bridge, the discharge being 22,000 cusecs.

After this major flood the pattern of minor flooding continued to cause concern for some years. Several minor floods were of sufficient magnitude to inundate homes in the lowest lying parts of the town (Table 1). However, in more recent years minor floods in the river system have presented no danger because of the implementation of a large-scale flood protection scheme.

Otorohanga Borough Flood Protection Scheme

One of the effects of the disastrous flood of February, 1958, was to shock the residents and authorities of Otorohanga into an awareness of the need to collectively adjust to the flood hazard. Since Otorohanga lay within the catchment area administered by the Waikato Valley Authority it was the Authority's responsibility to assess the hazard, to design flood protection works and to negotiate their finance with the Government. The resulting flood protection scheme was officially opened on March 12, 1966.

The scheme, as designed by the Authority in 1959 as part

of the comprehensive lower Waikato-Waipa flood control scheme, provided for the protection of Otorohanga Borough primarily by stopbank defences with extensive channel realignment, channel clearing and appurtenant works. Two principal stopbanks were erected; one on the right bank of the Waipa around the borough boundary, and the other around the area between the Mangapu River and the Mangawhero Stream on the left bank of the Waipa (Figure 11). The channel realignment included major diversions to cut off the more prominent meanders of the Waipa above its confluence with the Mangapu (Figure 11). A smaller diversion for the same reason was necessary on the Mangapu just before it enters the Waipa. Channel clearing involved removing willows and other growth from berms and cut-off meanders as well as the bed of the channel, and modified clearing of the channel banks, principally on the downstream side of the borough. The provision of a sufficiently wide and clear floodway around the borough necessitated cuts being made for berm widening, and also that bridges be raised and lengthened. The latter meant new bridges over the Waipa (the Honikiwi Bridge) and the lower Mangapu diversion; the extension of the State Highway bridge over the Waipa; the relocation and raising of the North Island Main Trunk Railway line; and the construction of a new railway bridge and two subways. In addition, pumping stations were provided for the disposal

TABLE 3

OTOROHANGA BOROUGH FLOOD PROTECTION SCHEME

PROTECTION AND ANCILLARY WORKS DATA

Nature of Works	Length	Earth Moved (cu.yds)
FLOOD PROTECTION WORKS:		
Willow Clearing	480 chns	
Diversions: Waipa River	95 "	455,000
Mangapu River	25 "	122,000
Edge Protection	220 "	
Stopbanking: Waipa River	214 "	690,000
Mangapu River	16 "	72,000
Pumping Stations (four)		
RAILWAY WORKS:		
Railway Embankment	60 chns	50,000
Main Line Track Relaying	60 "	
Railway Bridge	440 feet	
Subways (two)	154 "	
HIGHWAY WORKS:		
Highway Embankments	47 chns	62,000
Waipa Bridge Lengthening	210 feet	
Mangapu Bridge	360 "	
Honikiwi Bridge	480 "	
TOTAL EARTH WORK QUANTITY:		1,451,000

Source: Waikato Valley Authority, Otorohanga Borough Flood Protection Scheme; 1966, 4.

TABLE 4

OTOROHANGA BOROUGH FLOOD PROTECTION SCHEME

COSTS OF PROTECTION AND ANCILLARY WORKS

ITEM	$
FLOOD PROTECTION WORKS:	
Land Purchase and Compensation	255,200
Willow Clearing	41,200
Earthworks	443,600
Pumping Stations and Drainage Alterations	50,400
Miscellaneous Items	42,400
Cost of Protection Works:	$ 832,800
RAILWAY WORKS:	453,200
HIGHWAY WORKS:	
State Highway Realignment and Bridging	480,000
TOTAL COST:	$ 1,766,000

Source: Waikato Valley Authority, Otorohanga Borough Flood Protection Scheme: 1966, 4.

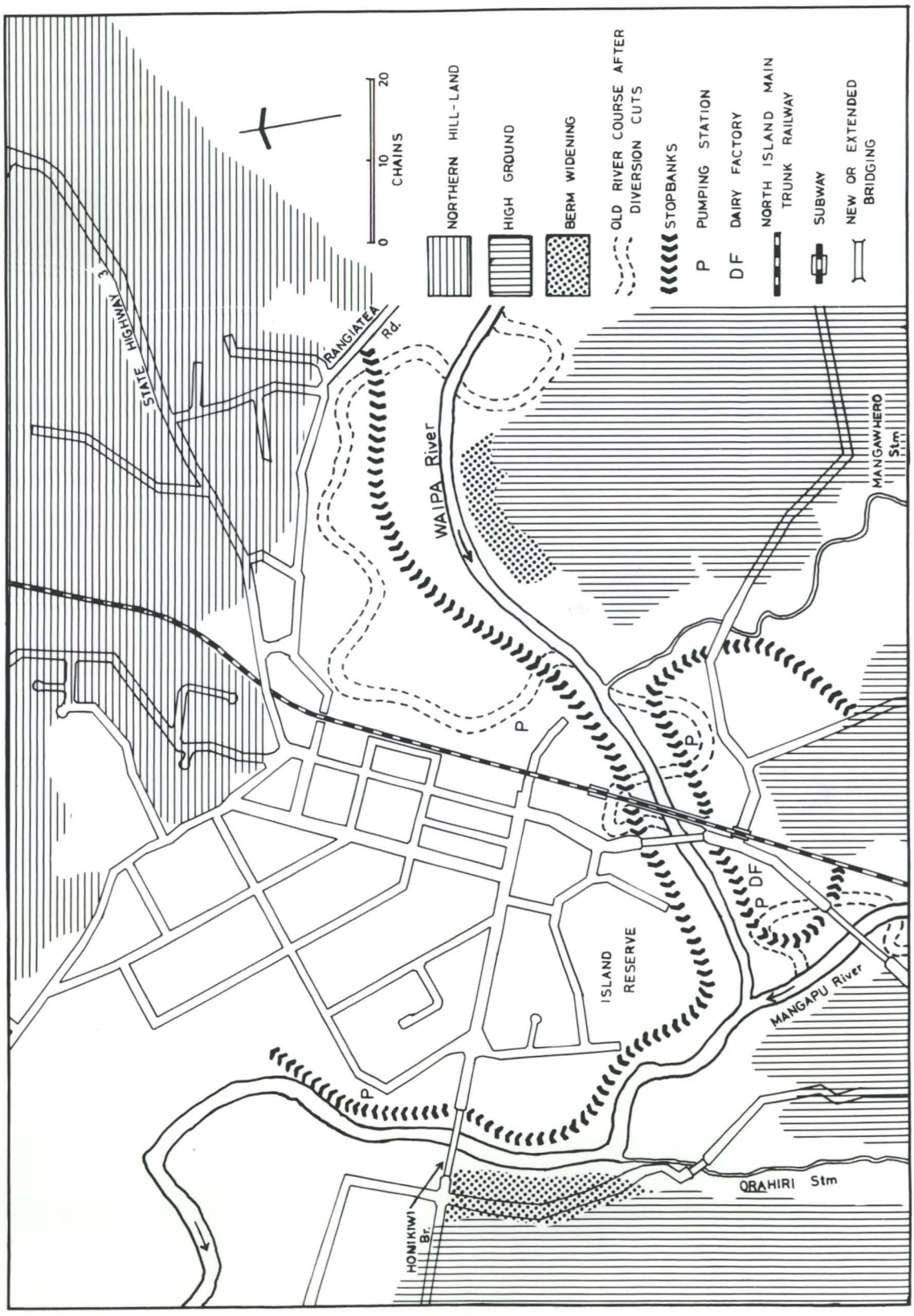

Figure 11. Otorohanga Borough Flood Protection Scheme
Source: Waikato Valley Authority (1966, 6)

FIGURE 12. Stopbanking in the vicinity of the Island Reserve, Otorohanga.

Photo: N.J. Ericksen

FIGURE 13. Stopbank protecting N.Z. Co-operative Dairy Company's factory, Otorohanga.

Photo: N.J. Ericksen

FIGURE 14. Flood Protection Works in Progress.

The lines of trees in the lower foreground and the centre right indicate meanders of the Waipa River that have been removed by diversion cuts. The nearly completed right bank stopbank extends from the bottom right around the southern boundary of the borough. In the upper left is the extended State Highway bridge and the new railway bridge. The new Honikiwi Bridge can be seen in the upper right. Areas of berm widening are evident in the middle centre.

Photo: R. Wallace

of internal stormwater. The scale of the scheme can be seen from Table 3 and Figures 11, 12, 13 and 14. The protection works made a considerable impact on the landscape of Otorohanga, even to the extent of the resiting or demolishing of 21 residential properties which were located on land required for scheme works.

The implementation of this large-scale flood protection scheme was naturally an expensive undertaking (Table 4). Without Government assistance the borough could never have underwritten the work. Even with the highest rate of subsidy awarded for flood control works, $3 for $1, the borough would still have been under a crippling burden which would have stifled development and the provision of amenities necessary to its growth. Accordingly, it was agreed by all parties concerned that the borough should limit its rating for flood protection purposes to one-quarter of the maximum general rate which was estimated to finance a loan of $250,000, as well as the maintenance cost estimated to be $1,560 per annum. To further spread the financial burden the cost of State highway realignment and bridging was met by the National Roads Board, and New Zealand Railways contributed $121,000 towards the cost of railway works.

Hazard Evaluation

In calculating the design flood used to determine the required standard of flood protection works for Otorohanga,

the Waikato Valley Authority (1959, 17-26) adopted a statistical rainstorm of three-day duration and approximately one in a hundred year proportions. The calculation of the design flood on this basis was necessary because of the paucity of data on Waipa River flood discharges. The predicted recurrence interval of the design flood is 100 years. In other words, it has a probability of occurring once in 100 years and therefore a one percent chance of recurring in any one year. The peak discharge of the design flood is calculated to be 33,000 cusecs at Honikiwi Bridge. This may be compared with the February, 1958, peak discharge of 22,000 cusecs at this point.

Although the engineering works are designed to protect Otorohanga from a flood that is greater by half that which occurred in February, 1958, the possibility of future flooding in the borough can never be completely discounted. In their initial report on the comprehensive scheme to provide flood control for the lower Waikato and Waipa Rivers, the Waikato Valley Authority (1959, 26) warn that 'the possibility of the occurrence of a flood of greater size than the design flood is real and must be squarely faced by all concerned in the proposed flood control'. Since many areas of the upper Waipa catchment are undeveloped or underutilised there is a possibility of future increases in the size and frequency of flood discharges. The effect of upstream land development and

an intensification of farming generally, would be to reduce infiltration rates and hence increase flood discharge for the same rainfall. For example, it has been estimated that the additional development of the Mangaokewa sub-catchment (Figure 4) from 48 to 90 percent grassland could increase the peak flood discharge of the Mangaokewa Stream by 140 percent in the event of a rainstorm of February, 1958, magnitude.[2]

Otorohanga has always had a history of flooding. Yet despite this experience it required the disastrous event of February, 1958, to bring home to the people and authorities the dangerous situation of the borough and the need for community adjustment to the hazard. The result has been the implementation of an expensive and large-scale flood protection scheme and the neglect of other methods of adjustment to flood hazard. Though the protective works have reduced the hazard, they have not eliminated it completely. It is against this background that the geographical problems under investigation arose.

THE GEOGRAPHIC PROBLEMS

The geographic problems investigated in this study may be viewed in two related groups, both of which focus on the history of flooding in Otorohanga and the flood protection scheme that the town now has.

It seems reasonable to assume that an event of the

magnitude and disastrous consequences of the February, 1958 flood would make a lasting impression on the community as a whole. Silt under floor boards and water level marks on the walls of some houses are reminders of the event even 13 years after. The implementation of the flood protection scheme has doubtless made a similar impression. The presence of 13 to 16 feet high stopbanks, for example, is most noticeable round the southern boundary of the borough (Figure 12). From this situation two sets of questions arise.

The first set concerns the hazard perception of the residential managers of Otorohanga. How do they perceive and interpret the flood hazard today? Was their expectation of flooding greater in the past? What influence has the implementation of the flood protection scheme had on their perception of hazard? How much confidence do they have in the protective works? Has confidence in the protection scheme been reflected in growth and development within the borough? Is there any variation in the perception of hazard among residential managers? If there is variation, can it be accounted for? It is these questions which constitute the first group of geographic problems.

The second group of problems concerns the response of residential managers to the hazard. Have they perceived and adopted alternative individual adjustments to the hazard?

Do they feel additional damage reducing adjustments are necessary, either to be made by the individual or by the community as a whole? Has their attitude towards the flood protection scheme influenced their perception and adoption of adjustments? To what extent are they content to rely merely on the community choice of adjustment in the form of flood protection works? Have some managers adjusted to the hazard through their choice of home location?

The topographical nature of Otorohanga is such that the last question warrants particular attention. Residential development in the borough has taken place in three geophysical areas:

1) On the low portion of the Waipa flood plain subject to flooding since the inception of European settlement in Otorohanga. This area is bounded by the extent of the flood spread in February, 1958, and hereafter it is termed 'low flood plain'.
2) On the high portion of the Waipa flood plain that lies above the maximum recorded flood level (February, 1958). Hereafter this area is designated 'high flood plain'.
3) On hill land which provides flood free sites in the northern portion of the borough. This area is hereafter called 'the northern hill-land'.

The extent of these geophysical areas is shown in Figure 5. In selecting their home location, residential managers in Otorohanga knowingly or unknowingly make a choice between

these three areas. Obviously many variables will enter into the decision making of managers with regard to their choice of home location. It is pertinent to ask, however, whether or not perception of flood hazard has been a significant influence in managerial choice of home location. Is a manager's choice related to the degree of confidence he has in the flood protection scheme? Has his decision to relocate elsewhere in the borough been influenced by a desire to escape the possibility of being flooded?

Investigation of these geographic problems requires a set of hypotheses on which to base the research.

RESEARCH HYPOTHESES

The first group of geographic problems were those concerned with managerial perception of flood hazard. Empirical evidence (Burton, 1961 a; Kates, 1962; Roder, 1961) indicates that a manager's perception of hazard (i.e. his expectancy of future flooding) will reflect the information he has on that hazard. According to Kates (1962,45):

> The flood hazard information of each manager is compounded of experience and knowledge, and such information, or the lack of it, is known to be related to some perceived probability distribution of flood hazard.

Burton (1961a, 89-90) and Kates (1962,45-103) showed that if flood protection measures are non-existent or unreliable then information of past flooding increases a manager's

expectation of future flooding. In Otorohanga, however, the reverse is likely to apply since a large-scale flood protection scheme has been implemented by the community. It is therefore generally hypothesised for Otorohanga that:

1) A residential manager's perception of flood hazard reflects the degree of confidence he has in the flood protection scheme.

2) Knowledge of the physical presence of protective measures decreases, or even eliminates completely, managerial expectation of future flooding, thus overriding the significance of knowledge and experience of past flooding in hazard perception.

3) Awareness of protective measures increases confidence in the protected area as a place for human occupance.

Empirical evidence (Burton, 1961a; Ericksen, 1967b; Kates, 1962; Roder, 1961) has shown that perception of flood hazard varies among managers as to the expected magnitude and frequency of flooding. It has been hypothesised above that managerial perception of hazard reflects the degree of confidence a manager has in the protection scheme. One therefore has to explain variation in levels of confidence. In attempting such an explanation the following research hypotheses are advanced for investigation:

1) That the degree of confidence a residential manager has in the flood protection scheme is related to his experience of flooding.

2) That the level of confidence is related to the knowledge that the manager has of the frequency and magnitude of past flooding.

3) That the level of confidence is related to the knowledge that the manager has of the flood protection scheme.

4) That the level of confidence is related to the manager's age.

5) That the level of confidence is related to the manager's length of residence in or near Otorohanga.

6) That the level of confidence is related to the manager's socio-economic status.

The second group of geographic problems were those concerned with the response of managers to the flood hazard. Empirical studies (Ericksen, 1967 b; Kates, 1962) have shown that perception of flood hazard influences managerial response or lack of response to the hazard. The present study therefore seeks to establish the consequences of this perception in terms of managerial decision-making with regard to choice of adjustment to hazard. Of particular concern is the influence of perception of hazard on managerial choice of home location. In an endeavour to answer the questions raised in this group of problems,

the following hypotheses are advanced:

1) That confidence in flood protection measures narrows the perceived range of both community and individual adjustments and results in managers adopting few, if any, alternative adjustments to the hazard.

2) That perception of flood hazard, as reflected in the degree of confidence in flood protection, is a significant variable in the choice of home location made by residential managers in Otorohanga.

The second hypothesis can be stated more explicitly through an alternative series of hypotheses as follows:

a) That residential managers who perceive some degree of risk adjust to the hazard by choosing to locate their homes away from what they perceive is the hazard zone.

b) That residential managers who perceive no hazard are content to reside in the area of low flood plain, knowing that this area has been flooded in the past.

c) That managerial perception of hazard is a significant variable in decisions to relocate within the borough.

d) That free choice of relocation by a manager if all socio-economic constraints are removed is related to the degree of confidence that the manager has in the flood protection scheme.

THE STUDY METHOD

All the foregoing research hypotheses required a method of testing. The most suitable means of obtaining the information necessary for such testing was deemed to be the construction of intensive interview schedules which would be personally administered to a sample of residential managers in Otorohanga.

The Interview Schedules

The interview schedules contained eight sets of basic questions. The first set concerned the manager's length of residence and changes of home location in Otorohanga. The second sought to establish his opinions as to the advantages and disadvantages of living in Otorohanga. The third set was to determine his experience of flooding and his knowledge of the frequency and magnitude of past flooding in Otorohanga. The fourth and fifth sets of questions sought to assess his knowledge of the flood protection scheme and his expectancy of future flooding in light of the scheme. Sets six and seven were aimed at establishing his reasons for both choice of present home location, and preferred choice of location if all socio-economic constraints were removed. Finally, a group of questions were asked concerning personal items such as age, occupation, education and income.

Three interview schedules were constructed and used for data collection. All three were basically similar in

form. The first was used in interviews with residential managers living in the area designated low flood plain. In addition to the sets of basic questions these managers were asked questions to determine their expectancy of future flooding in their own home; to find out whether or not they had adopted any individual measures to reduce the possibility of flood loss; and to discover how they would bear a loss should flooding occur. Separate schedules were used for managers resident on the area of high flood plain and the northern hill land. The only differences in these schedules was the manner in which the questions relating to experience of flooding and motives for choice of present home location were asked. The complete form of the interview schedules appear as Appendices A(I), A(II) and A(III).

The Sample of Respondents

The sample for each of the three interview schedules was drawn in the following way. The locations of all houses within the borough boundaries were mapped in the field using a base map which showed the boundaries of individual sections. The houses in each of the three geophysical areas were then numbered from one upwards. To facilitate the order of numbering a ruler was laid in a north-south position on the base map and moved across the map from east to west as numbering proceeded. The total number of houses on the low flood plain was found to be 178; on the high

flood plain 175; and on the northern hill land 198. This made a total of 551 houses in the borough. In each of the three areas a random sample of 10 percent of households was drawn using tables of random numbers. This meant that 18 interviews were conducted with residential managers on the low flood plain, 18 on the high flood plain, and 20 on the northern hill land, making a total of 56 interviews. The location of the sample respondents is shown in Figure 5.

Administering the Interview Schedules

Before interviewing proper began, interviews were conducted with six managers whose homes were picked at random from those in the area designated as low flood plain. This group did not include any of those managers in the actual study sample. This pilot study was undertaken to judge the suitability and offensiveness, if any, of the questions used. It resulted in some modifications and additions being made to the original schedules.

All of the 56 interviews were conducted personally by the author. The period spent in the field for data collection was seven days between December 13 and 23, 1970. The duration of the interviews ranged from 15 minutes to three hours depending on the interest and knowledge of the respondent. A hundred percent response was obtained for the samples drawn in each of the geophysical areas. It was hoped that the majority of respondents would be the

head of the household. In fact this was the case with all but 11 respondents.

Utilising the Data

The data collected was recorded and analysed by hand. The interview schedules were designed so that the responses to many of the questions could be abstracted for recording in contingency tables. The latter facilitated the testing of most of the research hypotheses since they enabled the application of the Chi-squared Test (see Appendix B). This was used to test whether the observed frequencies obtained through the interview schedules differed significantly from the frequencies which could be expected according to the research hypotheses. In the calculation of the various Chi-squares the University of Waikato's Olivetti Programma 101 was used.

From the information obtained on the occupation, education and income of respondents, a simple socio-economic index was constructed. Criteria for assigning respondents to socio-economic classes are summarised in Table 5. These criteria refer to the characteristics of the head of the household who was not in every case the interviewee. Four of the heads of households in the sample exhibited characteristics distributed into all three classes; they were classified as middle class. All others were classified into the class in which two of their characteristics coincided.

TABLE 5

SOCIO-ECONOMIC CLASS INDEX

Characteristic	Socio-Economic Class		
	Lower	Middle	Upper
Occupation	Unskilled Semi-skilled Unemployed	Skilled Clerical	Professionals Managers Proprietors Officials
Annual Income	Less than $2,199	$2,200 to $3,199	More than $3,200
Education	Does not have School Certificate	School Certificate or University Entrance	University, Teachers' College, etc.

NOTE: 1) Characteristics refer to head of household.

2) Respondents were classified in the class into which at least two of their characteristics coincided.

The author recognises the drawbacks of using data that is largely qualitative. The accuracy of the responses to some questions in the interview schedules is clearly dependent on the memory of respondents. Furthermore, there are difficulties in generalising from data that amounts to expression of opinions, perceptions and attitudes. However, the nature of the study was such that it was this type of information that was appropriate.

This chapter has outlined the geographic problems and research hypotheses investigated, and the methods of study used. The results of the investigation are presented in the next two chapters. In Chapter III the influence of the flood protection scheme on flood hazard perception is examined, while Chapter IV investigates the influence of flood protection on perception and adoption of alternative adjustments to the hazard, including choice of home location.

CHAPTER III

THE INFLUENCE OF THE FLOOD PROTECTION SCHEME ON FLOOD HAZARD PERCEPTION

In the preceding chapter the geographic problems investigated in the present study were outlined in two groups. This chapter analyses the first group which were those problems concerned with managerial perception of flood hazard. A set of research hypotheses were advanced as a basis for the analysis of these problems. These hypotheses incorporate the notion that the community choice of an engineering solution to Otorohanga's flood problem has profoundly influenced managerial expectation of future flooding. It was therefore hypothesised that managerial perception of flood hazard reflects the degree of confidence a manager has in the flood protection scheme, and that knowledge of the existence of protective measures:

a) Overrides the significance of information on past flooding in hazard perception.

b) Increases confidence in the protected area as a place for human occupance.

The general purpose of this chapter is to establish how individual residential managers in Otorohanga perceive and

interpret the flood hazard in light of the existence of a large-scale flood protection scheme. The analysis will examine in turn, managerial information on past flooding, knowledge of flood protection, and confidence in the protection scheme. With this background the influence of the protection scheme on hazard perception can be analysed, and an attempt made to explain variation in levels of confidence in the scheme.

INFORMATION ON PAST FLOODING

According to Kates (1962, 45) the flood hazard information of each manager is compounded of two elements - experience and knowledge. Both the quality and quantity of the information will vary from person to person. A similar level of information does not mean that there will be similar perception of the flood risk. Indeed, for Otorohanga, it is hypothesised that knowledge of the existence of protective measures overrides the significance of information on past flooding in hazard perception. In order to investigate this hypothesis, it is first necessary to examine the elements of flood hazard information held by the residential managers of Otorohanga.

Experience of Flooding

Since the last major flood in Otorohanga occurred nearly 13 years before the present study, and the last significant minor flood nearly seven years ago, it was to be expected that many managers would have no experience of flooding in

TABLE 6

EXPERIENCE OF FLOODING BY SAMPLE RESPONDENTS

Number of Respondents with Flood Experience		
Major flood of January, 1907	Major flood of February, 1958	Also experienced minor flooding
1	9	6
Water Level in Home During Major Flood		
Basement flooded	Water up to 2 feet above floor level	Between 2 and 5 feet above floor level
1	1	8
Estimated Loss Suffered During Major Flood		
Less than $199	$200 to $999	More than $1000
1	3	6

terms of flood waters entering their home. In fact only 10 respondents (17.9 percent) had experience of a major flood in Otorohanga. During this experience they had all suffered moderate to heavy losses (Table 6), the highest individual loss being $2,300. In addition to a major flood, six of these 10 respondents had also experienced minor flooding.

Knowledge of Past Flooding

Knowledge of flood hazard entails an awareness of the frequency and magnitude of past flooding. Respondents were judged to have little knowledge if they were aware only of the major flood of February, 1958. If, in addition to this flood, they were also aware of the occurrence of some of the minor floods, they were classified as having some knowledge. To qualify for the group with most knowledge a respondent had to be aware of both major floods (i.e. January, 1907, and February, 1958) and able to comment on the frequency and extent of minor flooding. Statistical analysis shows that there is a significant relationship between knowledge of past flooding and a manager's length of residence in or near Otorohanga (Table 7).

No respondent was completely ignorant of the fact that Otorohanga had a flood problem, all being aware of the February, 1958 flood. Thirty-three of those interviewed

TABLE 7

KNOWLEDGE OF PAST FLOODING BY LENGTH OF RESIDENCE IN OR NEAR OTOROHANGA

Level of Knowledge of Past Flooding	Length of Residence			Totals	% of Total
	12 yrs or less	13-24 years	25 yrs or more		
Little knowledge	16	2	0	18	32.1
Some knowledge	7	8	9	24	42.9
Most knowledge	0	5	9	14	25.0
Totals:	23	15	18	56	100.0

Research Hypothesis: that there is a significant relationship between level of knowledge of past flooding and the length of a manager's residence in or near Otorohanga.

Chi-square = 29.55. With 4 degrees of freedom the probability value is less than 0.1 percent; highly significant.

(58.9 percent) were living either in the borough or the surrounding district at the time of this flood, the remainder having learnt of the event through the news media of the time or through conversation with other residents.

Aside from the February, 1958 flood, there was variation in awareness of other events in the flood history of the town. Only 14 respondents (25 percent) were aware of the major flood of January, 1907. Although 33 of the managers interviewed were living in or near Otorohanga at the time, only 19 (33.9 percent) could recall the minor flood of December, 1958 when approximately 50 residential sections in the borough were flooded, including 17 houses to depths from 2 to 24 inches above floor level. No respondent named a minor flood in 1960, yet, in September of that year, seven homes were evacuated. Only one respondent (1.8 percent) could remember the flood of July, 1961 when 16 houses were evacuated, including 14 that were inundated to depths ranging from 1 to 17 inches above floor level. One would expect such events to have been significant in a town the size of Otorohanga. It can only be concluded that either some respondents were unaware of such events occurring in their town, or that such floods were not significant events to them personally, and were, therefore, not memorable. It would seem that disastrous events of the magnitude of that of February, 1958 are significant to those who witness them, but who are not actually affected

by them, or even to those who learn of them some time after they have occurred. On the other hand, events of a much lesser magnitude appear to be significant mainly to those personally affected by them. Variation in ability to remember, and the nature of what constitutes a memorable event to the individual, would appear to be important factors in the flood hazard information that a manager possesses.

Before considering whether or not flood hazard information has any influence on hazard perception, it is necessary to examine managerial knowledge of, and confidence in, the flood protection scheme since it has been hypothesised that knowledge of the physical presence of protective works overrides the significance of knowledge and experience of past flooding in hazard perception.

KNOWLEDGE OF FLOOD PROTECTION

Levels of Knowledge

To provide some measure of managerial knowledge of the flood protection scheme respondents were asked to name:

1) The measures that have been taken to protect Otorohanga from flooding.
2) The organisation which was responsible for planning the protection scheme.
3) The sources of finance for the scheme.
4) The size of flood the scheme is designed to protect the borough from.

Those who could name only one or two protective measures and not answer any of the last three questions were judged to have little knowledge of the scheme. Those respondents who could answer one of the last three questions and who were aware of three protective measures were classified as having some knowledge. Those designated as being well-informed were aware of four or more of the protective measures and could answer two or all of the last three questions.

Awareness of much of this information is likely to be largely a function of access to communication networks (i.e. newspapers, technical reports, public meetings, etc.). Variation in levels of knowledge may well be accounted for by factors controlling access to such information, or surrogates thereof, such as socio-economic class or, more specifically, education. Roder's investigation at Topeka, Kansas, supports this. He found a clear difference between socio-economic classes in their knowledge of the protective measures taken against recurrent flood damage (Roder, 1961, 74-75). In Otorohanga, however, no such relationship was found to exist (Table 8). This result may reflect inadequacies in the socio-economic index (Table 5) used for assigning respondents to socio-economic classes. The significance of educational attainment was therefore examined and a statistically significant relationship was found to exist between it and knowledge of flood protection

TABLE 8

KNOWLEDGE OF FLOOD PROTECTION BY SOCIO-ECONOMIC CLASS

Level of Knowledge	Socio-Economic Class			Totals	% of Total
	Lower	Middle	Upper		
Little Knowledge	9	10	15	34	60.7
Some Knowledge	4	4	6	14	25.0
Well-informed	1	2	5	8	14.3
Totals:	14	16	26	56	100.0

Research Hypothesis: that there is a significant difference between socio-economic classes in their knowledge of the flood protection scheme.

Chi-square = 1.17. With 4 degrees of freedom the probability value is greater than 10 percent; not significant.

TABLE 9

KNOWLEDGE OF FLOOD PROTECTION BY EDUCATION

Level of Knowledge	Level of Education			Totals
	Doesn't have Sc.Cert.	Sc. Cert / Univ.Ent.	Tertiary	
Little knowledge	20	10	4	34
Some knowledge	12	0	2	14
Well-informed	3	0	5	8
Totals:	35	10	11	56

Research Hypothesis: that there is a significant relationship between level of knowledge of flood protection and level of education.

Chi-square = 17.31 With 4 degrees of freedom the probability value is between 0.1 and 1.0 percent; significant.

(Table 9). Of those respondents with little knowledge, 88.2 percent have never attended an institution such as a University, Teachers' College or Pharmacy School. On the other hand, 62.5 percent of those judged to be well-informed have the benefit of a tertiary education and now occupy professional positions (e.g. lawyer, engineer, teacher, minister, and chemist). They have therefore perhaps been better able to obtain and retain information on the flood protection scheme.

Knowledge of Scheme Details

Responses to the questions used to assess managerial knowledge of flood protection indicate that variation exists in the knowledge which managers have of individual aspects of the protection scheme (Table 10). All respondents have knowledge of stopbanking. This is not surprising since the stopbanks are quite a prominent feature of the landscape, particularly round the southern boundary of the borough (Figure 12). Channel diversion and channel improvements (e.g. willow clearing) are not as well perceived as stopbanking, probably because their use in reducing flood overflows is a less obvious flood protection measure. In Opotiki, Ericksen (1967 b, 87-88) found a similar difference between managerial knowledge of stopbanking and awareness of channel clearance and related measures. The other measures taken in Otorohanga as part of the protection scheme are poorly perceived. Many of the managers

TABLE 10

KNOWLEDGE OF THE FLOOD PROTECTION SCHEME HELD BY SAMPLE RESPONDENTS

Knowledge of:	Respondents with Knowledge	
	Number	Percentage
Stopbanking	56	100.0
Channel diversion	37	66.1
Channel improvements (e.g. willow clearing)	33	58.9
State Highway and Main Trunk Railway realignment and raising	22	39.3
Pumping Stations	9	16.1
Flood warning system	2	3.6
Berm widening	0	0.0
Sources of Finance:		
1) National Roads Board	3	5.4
2) New Zealand Railways	6	10.7
3) Rating by Borough for flood protection	28	50.0
4) Government subsidy	29	51.8
Role of Waikato Valley Authority	26	46.4
Size of 'design flood'	3	5.4

interviewed, clearly did not associate flood protection with the realignment and raising of bridges and sections of State highway and the North Island Main Trunk Railway line. Yet these changes were necessary in order to provide a sufficiently wide and clear floodway round the borough. No respondent expressed knowledge of the berm widening done for the same purpose. It would seem likely that some, at least, had seen the cuts being made, but again did not associate them with flood protection. The low awareness of the existence of a flood warning system and pumping stations may possibly be accounted for by the fact that these measures are not conspicuous features of the landscape.

Many of the managers interviewed had no knowledge of some or all of the four sources of finance for the scheme (Table 10). Somewhat surprisingly, only 50.0 percent were aware that rating is being used for flood protection purposes. A quarter of the general rate struck uniformly over the whole borough goes towards this end. As 66.1 percent of respondents owned their home, it is clear that some are not fully aware of what they are paying rates for.

Only three of those interviewed (5.4 percent) were able to name the size of flood the scheme is designed to protect the town from. This is an interesting reversal of the situation in Opotiki where Ericksen (no date b, 18) found that many respondents possessed this information. A large number of his respondents were, however, commercial managers

and may, therefore, have been better informed on the flood protection works. The three Otorohanga managers knew that the protective measures were designed to protect the borough from a hundred year flood. However, they wrongly assumed that this meant that such a flood would occur only once every hundred years. This conforms to what Burton, Kates and White (1968, 16) term 'a non-professional penchant for making events knowable and cyclical.' This is a mistake, since the water resource engineer or the hydrologist uses the term 'hundred year flood' to mean that such a flood has a probability of occurring once in a hundred years and therefore a one percent chance of recurring in any one year. It does not mean, as the three managers in Otorohanga believed, that the flood having occurred once, will not do so again for another hundred years.

Sources of Knowledge

The extent and quality of knowledge is dependent to a large degree on how such knowledge is gained. In Otorohanga knowledge of the flood protection scheme seems to have reached respondents in three ways:

1) Through written information on the scheme.
2) By personal observation.
3) Via word of mouth.

Probably the most important agent in disseminating written information on the scheme has been the town's local weekly

newspaper, The Otorohanga Times. This paper recorded the planning, financing and development of the scheme from its inception. A full review of the history, cost and nature of the scheme, including its expected degree of protection, was undertaken for the official opening of the scheme on March 12, 1966. Up to this point The Otorohanga Times played an important role in informing residents of the views held by the technical experts on the town's flood problem and measures to combat this problem. Since the opening of the scheme, however, flooding and flood protection have been accorded little space apart from the occasional brief reference in reports on the proceedings of Borough Council meetings. Events such as the high flow in the Waipa River in early October, 1970 were not considered worthy of mention.

Full technical and other information on the Otorohanga scheme is contained in the Waikato Valley Authority's master scheme report on flood control for the lower Waikato and Waipa Rivers (Waikato Valley Authority, 1959). However, only two respondents had access to this report, one as a foundation member of the Authority, and the other as engineer for the Otorohanga County Council. For the official opening of the scheme, the Authority issued an information booklet (Waikato Valley Authority, 1966), but this only had limited distribution to the public.

The Otorohanga Borough Council has recently had prepared a district planning scheme (North, et al, 1970), but this

contains no reference to flood protection, nor to regulating land use in terms of the flood hazard, even though the Town and Country Planning Act of 1953 allows for such planning.[1]

As almost all the written information on the scheme was printed in 1966 or earlier, it was obvious that the majority of those interviewed had not recently read anything pertaining to the scheme. Thirty-four managers (60.7 percent) remembered having seen newspaper articles on the scheme at some time in the past, but few of them could recall the content of these articles. Only 10 respondents (17.9 percent) had seen the booklet put out by the Waikato Valley Authority (1966) for the official opening of the scheme. It is therefore hardly surprising that as few as eight managers (14.3 percent) were judged to be well-informed. It would seem likely that many respondents have gained much of their information via word of mouth, or through personal observation of scheme works, rather than from reading written information. This may help explain the large group (85.7 percent) who were assessed as having little or some knowledge of flood protection. Thirteen respondents (23.3 percent) had taken up residence in Otorohanga after the completion of the protective works and therefore are not likely to have had access to the written information published on the scheme. They are aware of the stopbanks since they are an obvious feature of the Otorohanga landscape, but any additional information

they possess is likely to have been gained during conversation with longer term residents.

Explanation of variation in levels of knowledge of flood protection is thus a complex problem. Among those factors that seem significant are the degree and recency of access to written information, educational attainment, powers of observation, the ability to remember, and whether or not the manager lived in Otorohanga during the planning and construction of the scheme works.

The paucity of knowledge among many managers suggests that there may be a need for periodic dissemination of information to make the public more aware of the hazard and the expected degree of protection provided by the scheme. Further credence to this idea is suggested by the hypothesis that knowledge of the existence of protective structures decreases, or even eliminates completely, managerial expectation of future flooding. The analysis, therefore, now moves to an examination of managerial confidence in the protection scheme.

CONFIDENCE IN THE FLOOD PROTECTION SCHEME

Levels of Confidence

In order to assess managerial confidence in the flood protection scheme respondents were asked how much protection they thought the scheme gave Otorohanga from flooding, and how many future floods they expected in light of the

protective works. Did they expect no future floods in Otorohanga, or would the number be more, less or about the same as that experienced before the scheme was completed? Those who felt that the borough was now protected from all floods regardless of size were designated as having complete confidence in the scheme (i.e. they expected no future floods). Those who were of the opinion that Otorohanga was protected from most floods, but were not sure about all, and who expected less flooding than had been experienced before the completion of the scheme, were judged to be reasonably confident, but with an element of doubt as to the complete effectiveness of the scheme. A respondent who was certain that Otorohanga would be flooded again, and who expected there would be more or about the same number of floods as that experienced in the past, would have been classified as completely lacking confidence in the scheme.

Exactly half of those interviewed had complete confidence in the scheme; the other half being reasonably confident, but with an element of doubt. No one was found to be completely lacking in confidence.

Before examining the influence of confidence in the scheme on perception of flood hazard, and before endeavouring to explain the variation in levels of confidence, it is pertinent to investigate the hypothesis that awareness of the physical presence of stopbanking increases confidence in the protected area as a place for human occupance.

This involves consideration of some of the consequences of confidence in the flood protection scheme.

Consequences of Confidence

The disastrous flood of February, 1958, naturally affected the confidence and morale of the people of Otorohanga. It was not easy to face the future with silted up houses and business premises, flood damaged stocks, and ruined furniture, floor coverings, personal possessions, etc. For many, it meant a new start in life. During the next six years there were minor floods which kept residents aware of the hazard (Table 1). Many lived in fear of flooding until 1966 by which time the stopbanks were nearing completion. Initially, there was some loss of confidence in the future of the borough. To some residents a stagnant and deteriorating town was a possibility.

The loss of confidence was most marked in the area flooded in February, 1958 (i.e. the area designated low flood plain). The decline in the rate of home building in this area was such that only one house was built between March, 1958, and December, 1961 (Figure 15). The same period, however, saw a total of 48 new houses erected on the northern hill-land. It seems likely that some residential managers chose to live on the hill-land in order to escape the possibility of being flooded. This hypothesis will be examined in the next chapter. In the five years up to the completion of the flood protection scheme in 1966, the situation on the

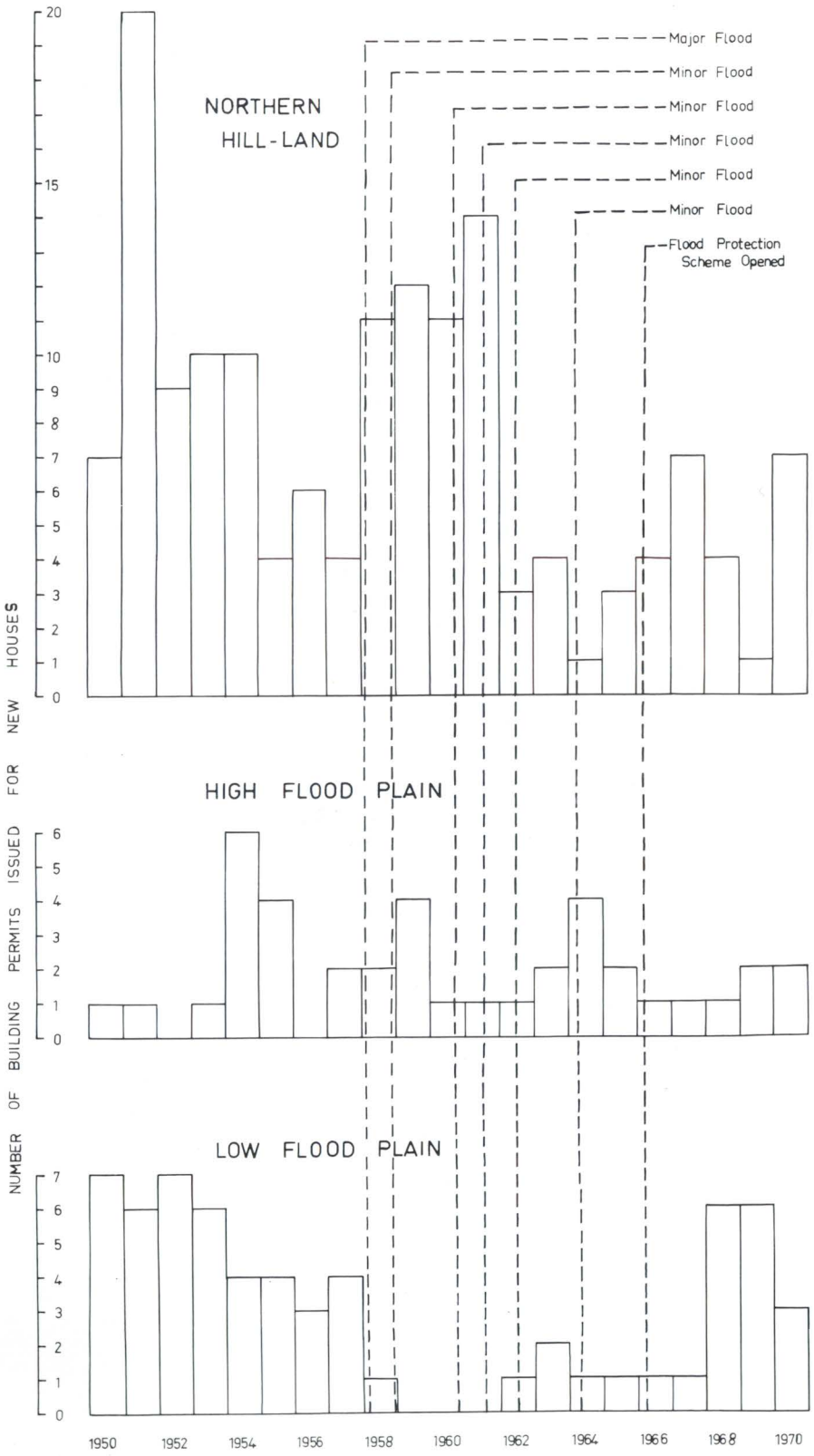

Figure 15. Residential Building Trends Related to Flooding in Otorohanga Borough, 1950 to 1970
Source: Building Permit Records of the Otorohanga Borough Council

low flood plain improved slightly with a total of six houses being built (Figure 15). Undoubtedly the low rate of home building on the low flood plain was influenced by the policy of the State Advances Corporation which, after the flood of February, 1958, was no longer prepared to supply mortgage finance for building in this area. This policy was maintained until the completion of the flood protection scheme. The regulation of flood plain development through building finance is not unique to Otorohanga. It has also been used, for example, in Opotiki (Ericksen, 1970, 15).

The implementation of the flood protection scheme helped to restore confidence in the town. When asked to name and rank what they considered were the advantages of living in Otorohanga, 47 of those interviewed (83.9 percent) gave protection from flooding as one of their answers. Fourteen of these (25 percent of all respondents) ranked flood protection as the main advantage (Table 11). Some of those interviewed were of the opinion that Otorohanga would have become a 'ghost town' without the construction of the flood protection works. Others credited the scheme with having 'put a new face on the town'. They saw the flood of February, 1958, as 'a blessing in disguise' since it forced the authorities to provide flood protection measures for the borough.

The restoration of confidence in the town has manifested

TABLE 11

RANKINGS BY SAMPLE RESPONDENTS
OF ADVANTAGES OF LIVING IN OTOROHANGA

Advantages	Rankings						No Response
	1	2	3	4	5	6	
	Number making each ranking						
Social advantages (e.g. easy to make friends)	20	15	7	5	1	-	8
Protection from flooding	14	9	9	10	4	1	9
Educational facilities	9	8	10	9	1	-	19
Small town atmosphere	8	22	14	4	-	-	8
Central location	2	-	1	1	1	-	51
Employment opportunities	1	1	2	2	3	-	47
Other advantages	2	3	1	-	1	2	-

itself in several ways. Industrial activity has increased with the establishment of a clothing factory, which employs 27 females, and the rapid expansion of caravan manufacturing by a company which now employs up to 100 workers and commands sizable export orders to Australia. Many commercial premises have been modernised and redecorated. The general spirit of the community is indicated by the scope and nature of projects undertaken by service organisations such as the Junior Chamber of Commerce. To attract tourists, a deer park and aviary have been developed and a kiwi house is under construction. The establishment of a botanical reserve and the construction of a replica of a Maori pa are planned for the future.

Confidence in the low flood plain is such that residential building in this area has increased in the last three years (Figure 15) and the first new subdivisions for many years have been opened up. All but one of the 13 sections in the Mace Street subdivision (Figure 16) have been built on since mid 1968. There are also two more recent subdivisions which as yet are not built on. One consists of 19 sections in Glendon Place and the other of 10 sections offered for sale in Rangitahi Street (Figure 16) by the Borough Council. These sections are selling quite well despite the fact that they were flooded to depths from six to eight feet in February, 1958.

The confidence in the protected area as a place for human

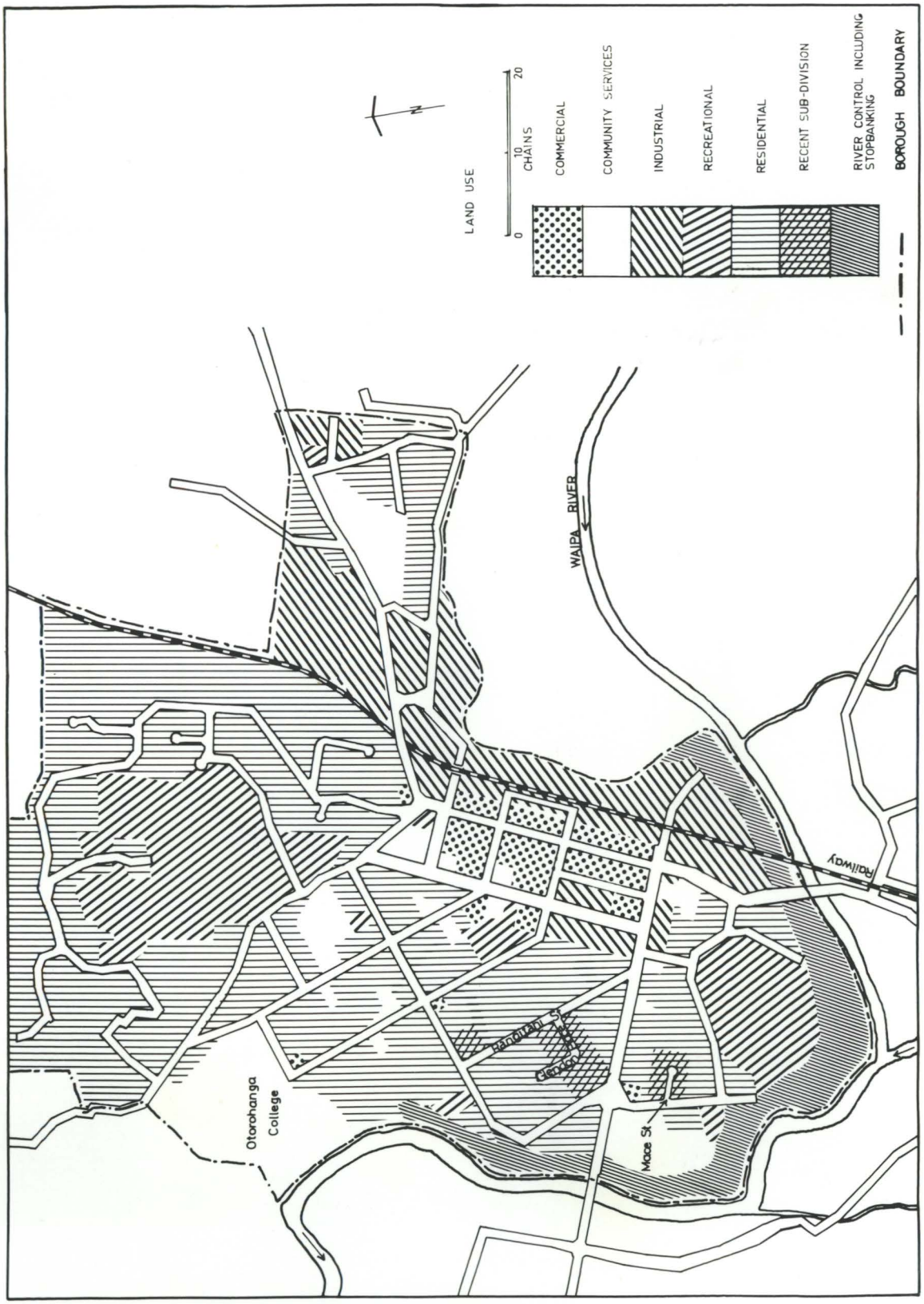

Figure 16. Otorohanga Borough: Land Use Zoning
Source: Borough of Otorohanga District Planning Scheme (1970, Map 1)

occupance is reflected in the recently completed district planning scheme prepared for the Otorohanga Borough Council (North, et al, 1970). This scheme provides for the future development of those areas of low flood plain that are not utilised at present, but which are within the area protected by the stopbanks. Thus the area between the railway line and the old course of the Waipa along the eastern boundary of the borough is zoned for heavy industrial development, while the low lying area inside the stopbanking along the western boundary is designated as residential (Figure 16).

The increase in property values within the borough may also be an indication of the restoration of confidence in the town. The ratable value of property within the borough has shown a marked increase over the past decade. The total unimproved value has more than doubled from $772,690 at March 31, 1960, to $1,816,000 at March 31, 1970. In the same period the total capital value almost doubled from $3,598,030 to $6,966,400.[2]

The implementation of a large-scale flood protection scheme appears to have played a very significant role in the restoration of confidence in Otorohanga following the disastrous flood of February, 1958. All of the managers interviewed were aware of the physical presence of stopbanking and such knowledge clearly increases confidence in the protected area as a place for human occupance. This

is leading to an increase in settlement within the hazard zone and has also contributed to the rise in property values within the borough. The result is clearly an increased loss potential should flooding ever occur again. This paradoxical situation, whereby the large expenditure on flood protection is increasing the potential flood damage cost, is far from a unique one. There are many similar situations in New Zealand (Bricksen, 1967 b; 1970; 1971) and elsewhere. The cost of this situation has been demonstrated in the United States where flood losses continue to rise despite the expenditure of large sums of Federal money on large-scale flood control schemes (Holmes, 1961; Renshaw, 1961; White, et al, 1958; White, 1960).

Having examined the levels of managerial confidence in the protection scheme and considered some of the consequences of this confidence, the next step in the analysis is to establish the influence of the implementation of the scheme on hazard perception.

INFLUENCE OF PROTECTION ON FLOOD HAZARD PERCEPTION

Empirical studies in the United States by Burton (1961 a, 89-90) and Kates (1962, 45-103) indicate that if flood protection measures are non-existent or unreliable then information of past flooding increases a manager's expectation of future flooding. It was suggested in Chapter II that the reverse is likely to apply in Otorohanga since the community has chosen to adjust to the hazard

through the implementation of large-scale protective works which to date have been effective. It was hypothesised that awareness of the existence of protective measures decreases managerial perception of flood hazard, regardless of the knowledge and experience that a manager possesses of past flooding.

In examining this hypothesis it is pertinent to note that all of the managers interviewed were of the opinion that Otorohanga would have been flooded again at some time in the future if flood protection measures had not been taken. In support of this response, managers were asked to assume that channel improvements and the erection of stopbanks had not been undertaken, and, with this in mind, to indicate by drawing a line on a base map what they thought the spread of flood water would be in the event of the largest flood they thought likely to occur. The resulting isopercepts (Figure 17, a, b, c) show that in the absence of protective works all respondents perceive some portion of the borough to be a hazard zone. However, the impact of the flood protection scheme has been such that half of those interviewed expect no future floods in Otorohanga; the other half expecting that there would at least be less flooding than had been experienced before the completion of the protective works. In other words, whatever level of flood expectation may previously have been held by managers, knowledge of the existence of protective measures had

lessened or even eliminated that expectancy. It is thus apparent that managerial perception of flood hazard in Otorohanga reflects the degree of confidence a manager has in the protection scheme.

No respondent had complete lack of confidence in the scheme (i.e. was certain that Otorohanga would be flooded again) and hence no one could be said to have a pessimistic attitude towards future flooding. Half of all respondents were reasonably confident, but had an element of doubt as to the complete effectiveness of the protective works. Their attitude towards future flooding was thus one of uncertainty. Nevertheless they perceived that the hazard had been reduced by the presence of stopbanking. Eight of these managers (14.3 percent of all respondents) even went so far as to estimate how effective the scheme would be by making statements such as: 'The stopbanks will provide protection from 80 to 90 percent of floods.' The other half of those interviewed had complete confidence in the scheme and may therefore be considered to have an optimistic attitude towards future flooding. They perceived that the hazard had been completely eliminated by the adoption of flood protection measures.

Those respondents living in the area flooded in February, 1958, were questioned in more detail as to their expectancy of future flooding. The majority (88.9 percent) did not

expect future flooding on their section or inside their home; the remaining 11.1 percent being uncertain as to this prospect. As all but one respondent were aware of the flood problem when they decided to take up their present residence on the flood plain, it is obvious that the presence of flood protection works has had a profound influence on their perception of hazard. In fact, knowledge of the presence of stopbanking was the sole reason given by respondents in explanation of their perceived certainty that their home and section would not be flooded in the future.

In summary, the community choice of a large-scale engineering solution to Otorohanga's flood problem has clearly reduced managerial perception of the flood hazard which in physical terms still exists. Knowledge of the physical presence of protective measures has decreased or even completely eliminated expectation of future flooding. Ericksen (1967 b) found that flood protection works had influenced the hazard perception of Opotiki residents in a somewhat similar, but not quite so marked manner. Of the managers he interviewed 19.1 percent expected a future flood; 38.2 percent expressed uncertainty as to the future; while 42.7 percent revealed their optimism of the future flood situation by firmly denying the possibility of a future flood.

As managerial perception of flood hazard reflects the degree of confidence a manager has in the protection scheme,

an explanation of variation in hazard perception is of necessity an explanation of variation in levels of confidence in flood protection.

EXPLAINING VARIATION IN CONFIDENCE IN FLOOD PROTECTION

The simple variation in levels of confidence (i.e. between complete confidence and reasonable confidence, but with an element of doubt) proved difficult to explain. It might seem reasonable to assume that managers with severe experience and detailed knowledge of past flooding would not have complete confidence in the protective measures because they would be aware of the magnitude and damaging consequences of flooding in the past. However, statistical analysis shows that the level of managerial confidence in flood protection does not correspond to either experience of flooding (Table 12) or knowledge of past flooding (Table 13).

This lack of correspondence lends further support to the hypothesis that knowledge of the physical presence of protective measures decreases managerial expectation of future flooding. Confidence in the protection scheme clearly overrides the significance of both knowledge and experience of past flooding as factors in hazard perception.

Ericksen's findings in Opotiki suggest that those who possess a greater amount of knowledge about protection works are more optimistic about the future occurrence of flooding

TABLE 12

CONFIDENCE IN FLOOD PROTECTION BY EXPERIENCE OF FLOODING

Level of Confidence	Level of Experience		Totals
	No Experience	Moderate to Severe	
Reasonably confident but element of doubt	23	5	28
Complete confidence	23	5	28
Totals:	46	10	56

Research Hypothesis: that there is a significant relationship between level of confidence in the flood protection scheme and experience of flooding.

Chi-square = 0. There is therefore no probability value; not significant.

Coefficient of Contingency (C) = 0

TABLE 13

CONFIDENCE IN FLOOD PROTECTION
BY KNOWLEDGE OF PAST FLOODING

Level of Confidence	Level of Knowledge of past Flooding			Totals
	Little knowledge	Some knowledge	Most knowledge	
Reasonably confident but element of doubt	7	11	10	28
Complete confidence	11	13	4	28
Totals:	18	24	14	56

Research Hypothesis: that there is a significant relationship between level of confidence in the flood protection scheme and knowledge of past flooding.

Chi-square = 3.63. With 2 degrees of freedom the probability value is greater than 10 percent; not significant.

Coefficient of Contingency (C) = 0.2466

(Ericksen, no date b, 20). However, six of the eight respondents in Otorohanga who were judged to be well informed on the protection scheme were among those who admitted to an element of doubt as to the complete effectiveness of the protective measures. When knowledge of the protection scheme was related to level of confidence, no statistically significant difference could be found between them (Table 14). At first sight this result might appear to reflect the inadequacy of the measures used for defining levels of knowledge. Only one of the questions used as a measure related to the expected degree of protection as estimated by the technical experts (i.e. the Waikato Valley Authority). As only three of those interviewed (5.4 percent) knew the size of the design flood, it appears that the majority of respondents are not basing their confidence on detailed and accurate knowledge of the scheme. That there is no relationship between levels of confidence and knowledge of the protective measures is therefore to be expected.

Statistical analysis also shows that there is no significant relationship between levels of confidence and the following variables: age (Table 15); length of residence in or near Otorohanga (Table 16); and socio-economic class (Table 17).

This section of the analysis has been unable to discern any variables that are statistically related to levels of confidence in flood protection. It seems likely that the

TABLE 14

CONFIDENCE IN FLOOD PROTECTION
BY KNOWLEDGE OF THE SCHEME

Level of Confidence	Level of Knowledge of the Scheme			Totals
	Little knowledge	Some knowledge	Well-informed	
Reasonably confident but element of doubt:	14	8	6	28
Complete confidence	20	6	2	28
Totals:	34	14	8	56

Research Hypothesis: that there is a significant relationship between level of confidence in the flood protection scheme and knowledge of the scheme.

Chi-square = 3.34. With 2 degrees of freedom the probability value is greater than 10 percent; not significant.

Coefficient of Contingency (C) = 0.2374

TABLE 15

CONFIDENCE IN FLOOD PROTECTION BY AGE

Level of Confidence	Age					Totals
	20-29	30-39	40-49	50-59	Over 60	
Reasonably confident but element of doubt	1	9	7	5	6	28
Complete confidence	3	7	3	9	6	28
Totals:	4	16	10	14	12	56

Research Hypothesis: that there is a significant relationship between level of confidence in flood protection and age.

Chi-square = 3.99. With 4 degrees of freedom the probability value is greater than 10 percent; not significant.

Coefficient of Contingency (C) = 0.2580

TABLE 16

CONFIDENCE IN FLOOD PROTECTION
BY LENGTH OF RESIDENCE IN OR NEAR OTOROHANGA

Level of Confidence	Length of Residence			Totals
	12 years or less	13-24 years	25 years or more	
Reasonably confident but element of doubt	8	9	11	28
Complete confidence	15	6	7	28
Totals:	23	15	18	56

Research Hypothesis: that there is a significant relationship between level of confidence in the flood protection scheme and the length of a manager's residence in or near Otorohanga.

Chi-square = 3.62. With 2 degrees of freedom the probability value is greater than 10 percent; not significant.

Coefficient of Contingency (C) = 0.2464.

TABLE 17

CONFIDENCE IN FLOOD PROTECTION
BY SOCIO-ECONOMIC CLASS

Level of Confidence	Socio-Economic Class			Totals
	Lower	Middle	Upper	
Reasonably confident but element of doubt	4	9	15	28
Complete confidence	10	7	11	28
Totals:	14	16	26	56

Research Hypothesis: that there is a significant difference between socio-economic classes in their confidence in the flood protection scheme.

Chi-square = 3.44. With 2 degrees of freedom the probability value is greater than 10 percent; not significant.

Coefficient of Contingency = 0.2405.

degree of confidence a manager has is simply a subjective opinion that bears little relationship to his experience and knowledge of past flooding. It is interesting to note that Roder (1961) in his study at Topeka, Kansas, found no significant relationship between attitude towards future flooding and knowledge of protection. He suggested that the attitude of an individual resident was 'derived from basic factors in his personality, and may be relatively little influenced by what he hears and reads' (Roder, 1961, 71).

Examination of the reasons given by managers in explanation of their degree of confidence shows that in some cases their opinion is based on little or faulty information. All of the respondents with complete confidence could offer no reason why they felt Otorohanga would not be flooded again other than the existence of the protective measures. They are simply satisfied that the stopbanks will prevent flooding. Five of these respondents even claimed that the banks had been well tested. This is incorrect as the peak discharge at Honikiwi Bridge since the opening of the scheme in 1966 has only been 8,000 cusecs (Table 1). This occurred during the high flow of early October, 1970. Since the water only covered the floodway to lap the base of the stopbanks, this can hardly be considered a good test of their effectiveness.

The majority (71.4 percent) of respondents who have reasonable confidence, but possess an element of doubt as to the complete effectiveness of the protective measures, gave, in explanation of this attitude, statements to the effect that floods can occur regardless of what man does to prevent them. Fifteen of these managers (53.6 percent) did not discount the possibility of a breach occurring in the stopbanks. In explanation they gave one or more of the following reasons:

1) Stopbanks are not infallible and have been breached elsewhere, for example at Kaitangata in 1945 (one respondent), Paeroa in 1956 (one respondent) and Rangiriri in October, 1970 (three respondents).
2) Floods much larger than those experienced in the past are always a possibility, for example the catastrophic floods in Florence in 1966 (one respondent) and the Esk Valley in 1938 (one respondent).
3) There has not yet been a large enough flood in the Waipa to really test the stopbanks (five respondents).
4) The stopbanks could have weak spots in them (two respondents).
5) The stopbanks have not yet had time to consolidate (one respondent).
6) The stopbanks could be breached in the event of a very rapid rise in the river level such as occurred in February, 1958 (one respondent).

7) The stopbanks are sitting on river shingle and therefore the foundations could be unstable in parts (one respondent).

8) During a high flow the water could work its way round the Rangiatea Road (Figure 11) end of the stopbank (one respondent).

9) During high flows (e.g. that of October, 1970) there is a build up of timber and other debris between the piles of the Railway Bridge (Figure 7). This forces the current against the stopbank and this could result in a breach (two respondents).

Some of these reasons are clearly more feasible than others. In fact all but the first three were discounted by technical experts associated with the planning and implementation of the scheme.[3] They considered the stopbanks to be as sound as modern engineering methods could make them and that the banks would provide effective protection from a 33,000 cusec flood and still have two feet of free-board.

Other reasons were also advanced in support of doubt as to the complete effectiveness of the scheme. One manager interviewed felt the possibility of flooding would become greater as time went by because of land development in the catchment areas. Another felt the possibility of a flood still existed because of the need for afforestation and other soil conservation measures that would reduce run-off

in the catchment areas. A third respondent claimed the river bed had risen since the completion of the scheme and hence the same amount of rain would produce a higher flood level. This is incorrect, as recent measurements taken by the Waikato Valley Authority show that the Waipa is degrading in the vicinity of Otorohanga.

SUMMARY

The community choice of a large-scale engineering solution to Otorohanga's flood problem has influenced managerial expectation of future flooding to the extent that a manager's perception of hazard reflects the degree of confidence he has in the flood protection scheme. Knowledge of the physical presence of the protective measures has reduced, or even eliminated completely, managerial expectation of future flooding, thus overriding the significance of knowledge and experience of past flooding in hazard perception.

The implementation of the protection scheme has played a very significant role in the restoration of confidence in Otorohanga following the disastrous flood of February, 1958. All respondents were aware of the existence of stopbanking and such knowledge has clearly increased confidence in the protected area as a place for human occupance. This is leading to an increase in settlement within the hazard zone and has contributed to the rise in

property values within the borough. The result is an increased loss potential should flooding ever occur again.

Explanation of variation in managerial confidence in the protection scheme proved a complex problem. A statistically satisfactory explanation was not possible. The analysis showed, however, that the following variables are not significant: experience of flooding; knowledge of past flooding; knowledge of the protection scheme; age; length of residence in or near Otorohanga; and socio-economic class. It appears that the degree of confidence a manager has is simply a subjective opinion.

This chapter has investigated the first group of geographic problems outlined in Chapter II, that is those problems concerned with managerial perception of hazard. The next chapter will examine the second group of problems, which were those concerned with the response of managers to the hazard.

CHAPTER IV

THE INFLUENCE OF FLOOD PROTECTION ON PERCEPTION AND ADOPTION OF ALTERNATIVE ADJUSTMENTS TO HAZARD

In the previous chapter an examination was made of managerial perception of flood hazard in light of knowledge of the existence of flood protection measures. Since the protective works have profoundly influenced hazard perception it is pertinent to examine whether or not the implementation of the protection scheme has also influenced the response of managers to the hazard in terms of:

a) Their perception and adoption, or non adoption, of alternative individual adjustments to the hazard.

b) Their attitudes towards the community adoption of additional measures for reducing possible flood damage.

Empirical studies (Ericksen, 1967 b; Kates, 1962) have shown that perception of flood hazard influences managerial response or lack of response to the hazard. As indicated in White's model (Figure 2) of managerial decision making with regard to choice of adjustment to hazard, a manager before considering adjustment must first perceive the hazard as sufficient to warrant action to reduce the possibility of flood losses. Since managerial perception

of hazard in Otorohanga reflects the degree of confidence a manager has in the flood protection scheme, it is hypothesised that confidence in the protective measures narrows the perceived range of both community and individual adjustments and results in managers adopting few, if any, alternative adjustments to the hazard.

The topographic nature of Otorohanga Borough provides the opportunity for a manager to adjust to the hazard by choosing to locate his home away from what he perceives to be the hazard zone. It is therefore hypothesised that perception of flood hazard, as reflected in the degree of confidence in flood protection, is a significant variable in the choice of home location made by residential managers in Otorohanga.

The two hypotheses advanced above suggest that some managers place great reliance on the community choice of an engineering solution to Otorohanga's flood problem. The analysis in this chapter will thus begin by considering how residential managers view the scale and scope of the flood protection scheme, and whether or not they perceive the need for additional community adjustments to the hazard, either in the form of an extension of existing protection works or the adoption of alternative non-engineering forms of adjustment. The remainder of the chapter examines choice of home location as an adjustment to hazard.

COMMUNITY ADJUSTMENTS

The community choice of a large-scale engineering scheme is generally regarded as a satisfactory solution to Otorohanga's flood problem. Almost all (92.8 percent) of the managers interviewed were of the opinion that the existing scale and scope of the protective measures was necessary, even though this placed a considerable financial burden on the borough. Three of the four dissenters felt that if the Waipa channel between Otorohanga and Pirongia (Figure 4) had been straightened and cleared of willows, etc., so as to increase the velocity of the flow downstream of the borough, then either no stopbanks would have been necessary (two respondents) or the banks could have been made lower by 10 feet (one respondent). The final dissenter had a long-term view of the situation in suggesting that a better alternative to the existing scheme would have been to resite the town on high ground away from the river. His choice of site was near Kiokio (Figure 4). Although he thought that this was probably not considered practical because of the enormous short-term cost, he suggested that it may have proved a cheaper solution in the long run.

In addition to forcing the authorities to take action to combat the flood problem, the disastrous flood of February, 1958, stimulated the formation, in 1962, of a Civil Defence organisation[1] to plan for the execution of emergency actions in time of flood, especially through temporary evacuation.

Although this organisation operated during the minor floods of 1962 and 1964 by keeping residents in the lower-lying parts of the town informed of water levels, only two respondents were aware of the existence of such a flood warning system (Table 10).

Although almost all respondents agreed that the existing scale of the protection works was necessary, this does not imply that they think the adjustments made as part of the protection scheme are the only ones required. In fact 12 respondents (21.4 percent) perceive a need for additional community adjustments to the hazard, either in the form of an extension of existing protective measures or the adoption of alternative adjustments not previously made. The additional measures suggested as necessary are:

1) Willow clearing and channel straightening downstream of Otorohanga (six respondents).[2]
2) Improved internal drainage within the area protected by the stopbanks so as to assist the outflow of water in the event of a breach in the banks (two respondents).
3) Higher stopbanks (one respondent).
4) Reshaping of the Railway Bridge (Figure 11) piles so that timber, etc. carried during high flows is deflected off rather than collecting behind the piles thereby impeding the flow (one respondent).
5) Afforestation and other soil conservation measures that will reduce the runoff in the catchment areas (three respondents).

The need for watershed management in the catchment areas is supported by the Waikato Valley Authority. The Authority's concern is indicated by its proposal for the establishment of a 13,000 acre exotic forest in the middle Mangaokewa sub-catchment (Figure 4). It is estimated that without this forest, the additional development of the sub-catchment from 48 to 90 percent grassland could increase the peak flood discharge of the Mangaokewa Stream by 140 percent in the event of a rainstorm of February, 1958 magnitude.[3]

Apart from the need for watershed management, the other additional measures suggested as necessary by respondents are all related to aspects of the flood protection scheme. It appears that the implementation of the scheme has narrowed the perceived range of community adjustments to the hazard as the residential managers interviewed were aware only of engineering and soil conservation measures. The perception of the borough authorities has been similarly affected. For example, regulation of land use in terms of the flood hazard is neglected, even though the Town and Country Planning Act of 1953 allows for such planning (Bricksen, 1970, 4-6). The recently completed district planning scheme prepared for the Otorohanga Borough Council (North, et al, 1970) makes no provision for zoning ordinances which outline the type of land use and level of development appropriate to the flood hazard, or

for building codes that specify the type and level of construction of building on the flood plain. Such measures would be an insurance against much of the damage that will occur if the stopbanks are ever breached or overtopped. The need for such additional adjustments is made more apparent by the fact that the protection scheme has clearly increased confidence in the flood plain as a place for human occupance, thereby increasing the potential loss should flooding ever occur again.

The flood protection scheme may succeed in what it is designed to do, but it does not completely remove the flood risk from the area. Kates (1962, 4) writes that 'Almost all flood control works provide only partial flood protection, there being few known works protecting against the maximum probable flood.' This emphasises the need for other alternative adjustments that might be combined with engineering works to provide a more comprehensive programme of flood damage reduction. A wide range of theoretically possible adjustments exists (Figure 3). Having examined managerial perception of those adjustments which might be adopted by the community at large, the analysis moves to a consideration of those which are open for adoption by individual residential managers.

INDIVIDUAL ADJUSTMENTS

The topography of Otorohanga is such that perhaps the most obvious form of individual adjustment that can be

made by residential managers in the borough is to locate their homes away from what they perceive to be the hazard zone. Before considering choice of home location as an adjustment to hazard, an examination will be made of the response to the hazard by managers who have chosen to live in the area inundated in February, 1958.

Respondents living in the area designated as low flood plain have poor perception of the range in choice of adjustment to flooding. The majority (72.2 percent) could name only one or two measures which individual home owners could take to reduce the possibility of loss from flooding. The adjustments perceived in almost all cases were structural alterations (e.g. raising house above known flood level) and emergency actions that required no prior preparation (e.g. elevating possessions). However, as White's model (Figure 2) suggests, perception of an adjustment does not mean it will be adopted. In fact none of the managers interviewed on the low flood plain has, up to the present time, taken any action to reduce the possibility of flood loss, although one was aware that the previous owner of his home had placed boards above the ceiling in order that goods might be elevated in the event of a flood. The non-adoption of direct adjustments (i.e. those made primarily to reduce the possibility of flood loss) is related to managerial hazard perception, as reflected in confidence in the flood protection scheme.

The majority of respondents (88.9) resident on the low flood plain failed to perceive any risk to their own property because they possessed complete confidence in the protective works. They therefore do not see any need to make any individual adjustment to the hazard. For example, one respondent had contemplated raising his basement house by two feet after being flooded in February, 1958, but abandoned this proposal after learning that the protection scheme was to be implemented. It is apparent that complete confidence in the protective works has considerably narrowed the perceived range of direct individual adjustments and resulted in their non-adoption by managers resident on the low flood plain. In other words, where the perceived frequency of hazard is equated with negative certainty (i.e. flooding will not occur) no response is made by individual managers to the hazard.

Respondents on the low flood plain were also asked how they would recover their losses should flooding ever occur in Otorohanga again. Many (77.8 percent) thought that flooding was a contingency covered under their comprehensive houseowner/householder insurance policies. This form of insurance may be considered an indirect adjustment since this type of policy is not taken out primarily to cover the possibility of flood loss. A third of the managers interviewed were aware of the Earthquake and War Damage Commission, but had the false impression that the Commission

made handouts to all flood victims. In fact such victims can only turn to the Commission for relief as holders of a fire insurance policy, and then only after they have exhausted their other insurance policies.[4] Only one respondent admitted to simply having to accept the loss if he ever was flooded.

The non-adoption of direct individual adjustments by managers resident on the low flood plain suggests that they are today unconcerned about the flood problem. This is understandable since they have placed great faith in the community choice of an engineering solution to the flood problem. Furthermore, for any flood plain occupant anywhere, flooding will be only one of many problems that concern him in his daily life and as a result he devotes only a very small part of his time, if any, to dealing with it.

Having examined the lack of response to the hazard by managers who are resident in the area flooded in February, 1958, the analysis moves to a wider perspective to consider whether or not residential managers elsewhere in the borough have adjusted to the hazard through their choice of home location.

CHOICE OF HOME LOCATION AS AN ADJUSTMENT TO HAZARD

The Spatial Problem

Consideration of choice of home location as an adjustment

to hazard is only part of a more complex problem concerning human spatial behaviour. The spatial pattern of any human phenomena is the aggregate result of the decisions made by individual managers. Obviously many variables will enter into the decision making of residential managers with regard to their choice of home location. These variables may be grouped into two sets:

1) Those that constitute the manager's particular socio-economic circumstances.
2) Those that constitute his perception of the advantages and disadvantages, risks and opportunities of the various alternative locations available to him.

It is not a purpose of the present study to consider in detail all the variables that may be significant in an explanation of the spatial pattern of home location in Otorohanga. It is merely intended to establish whether or not perception of flood hazard has been a significant influence in managerial choice of home location. Is, for example, a manager's choice related to the degree of confidence he has in the flood protection scheme? Has his decision to relocate elsewhere in the borough been influenced by a desire to escape the possibility of being flooded? Has he adjusted to the hazard through his choice of home location? Before examining these questions it is necessary to outline the choice of home location open to residential managers in Otorohanga.

Range of Choice for Home Location

In selecting their home location, residential managers in Otorohanga knowingly or unknowingly make a choice between three geophysical areas:

1) The low portion of the Waipa flood plain subject to flooding since the inception of European settlement in the town. This is the area designated low flood plain. It is bounded by the extent of the flood spread in February, 1958.
2) The high portion of the Waipa flood plain that lies above the maximum recorded flood level (February, 1958). This area is termed high flood plain.
3) Hill-land which provides flood free sites in the northern portion of the borough. For the purposes of the present study this area is called the northern hill-land. Residents here might be considered escapees from the flood hazard.

The extent of these geophysical areas is shown in Figure 5. In each area is located approximately one-third of the residential dwellings in the borough: 178 houses on the low flood plain; 175 on the high flood plain; and 198 on the northern hill-land.

The majority of houses on the northern hill-land are of more recent construction and above average quality for the town, although some lower quality homes exist in Domain Drive and along State Highway Three (Figure 5). The houses

on the low flood plain tend to be smaller and older than those on the hill-land, but there are many exceptions including the modern homes built in the Mace Street subdivision (Figure 16). Most of the homes on the high flood plain are also older, but they tend to be larger than many of those on the low flood plain. Again, there are exceptions, and, recently established, well appointed homes exist in this area. Overall, however, more houses of below average quality are evident on the flood plain than on the northern hill-land.

Present Home Location

The lack of response to hazard by managers resident in the area inundated in February, 1958 (i.e. the low flood plain) has previously been examined. Their complete confidence in the flood protection scheme has resulted in their non-adoption of individual adjustments to the hazard. The topography of Otorohanga is such that residential managers elsewhere in the borough (i.e. on the high flood plain or northern hill-land) could have adjusted to the flood risk through their choice of home location. It is therefore hypothesised that managers who perceive some degree of risk adjust by choosing to locate their homes away from what they perceive to be the hazard zone, and, conversely, that managers who perceive no hazard are content to reside in the area designated as low flood plain.

In support of this hypothesis, statistical analysis shows that a relationship of quite moderate strength (Coefficient of Contingency = 0.4724) exists between the present home location of respondents and their degree of confidence in flood protection (Table 18). The majority of respondents resident on the northern hill-land (70.0 percent) and in the area designated as high flood plain (66.6 percent) possess an element of doubt as to the complete effectiveness of the protective measures. On the other hand, the majority of managers interviewed on the low flood plain (88.9 percent) expressed complete confidence in the protection works. They thus deny the flood risk and this suggests an 'indeterministic perception of the state of nature' (Kates, 1962, 67).

In the previous chapter it was shown that knowledge of the physical presence of protective measures decreases managerial expectation of future flooding thus overriding the significance of information on past flooding in hazard perception. It was therefore to be expected that no significant relationship would be found between present home location and both experience (Table 19) and knowledge of past flooding (Table 20).

Since the implementation of the protection scheme has reduced managerial perception of hazard, it seems likely that managers who took up residence in their present home prior to the completion of the protection works, would have

TABLE 18

PRESENT HOME LOCATION BY CONFIDENCE IN FLOOD PROTECTION

Present Home Location	Level of Confidence		Totals
	Reasonably confident but element of doubt	Complete Confidence	
Low flood plain	2	16	18
High flood plain	12	6	18
Northern hill-land	14	6	20
Totals	28	28	56

Research Hypothesis: that there is a significant relationship between present home location and level of confidence in the flood protection scheme.

Chi-square = 16.09. With 2 degrees of freedom the probability value is less than 0.1 percent; highly significant.

Coefficient of Contingency (C) = 0.4724

TABLE 19

PRESENT HOME LOCATION BY EXPERIENCE OF FLOODING

Present Home Location	Degree of Experience		Totals
	No Experience	Moderate to Severe	
Low flood plain	13	5	18
High flood plain	15	3	18
Northern hill-land	18	2	20
Totals	46	10	56

Research Hypothesis: that there is a significant relationship between present home location and the degree of experience of flooding a manager has.

Chi-square = 2.07. With 2 degrees of freedom the probability value is greater than 10 percent; not significant.

Coefficient of Contingency (C) = 0.1887

TABLE 20

PRESENT HOME LOCATION BY KNOWLEDGE OF PAST FLOODING

Present Home Location	Level of Knowledge of Past Flooding			Totals
	Little knowledge	Some knowledge	Most knowledge	
Low flood plain	7	9	2	18
High flood plain	6	7	5	18
Northern hill-land	5	8	7	20
Totals	18	24	14	56

Research Hypothesis: that there is a significant relationship between present home location and level of knowledge of past flooding.

Chi-square = 3.14. With 4 degrees of freedom the probability value is greater than 10 percent; not significant.

possessed a greater expectation of flooding at the time of choosing their present home location. In fact, 29 respondents (51.8 percent) had occupied their present home before 1966. Because managerial perception of hazard was probably greater prior to the adoption of protective measures, respondents were asked to assume that channel improvements and the erection of stopbanks had not been undertaken. With this in mind they indicated, by drawing a line on a base map, what they considered the spread of flood water would be in the event of the largest flood they thought likely to occur. The isopercepts drawn by respondents have been superimposed on top of one another to produce a composite map for each of the three geophysical areas (Figure 17 a, b, c). Comparison of these maps appears to lend further support to the hypothesis that managers who perceive some degree of risk adjust by choosing to locate their homes away from what they perceive to be the hazard zone, and, conversely, that managers who perceive no hazard are content to reside in the area flooded in February, 1958. The maps indicate that respondents resident on the northern hill-land (Figure 17 a) and high flood plain (Figure 17 b) perceive the area of risk to be larger, and are more consistent in what they consider the extent of the flood spread would be, than those respondents living in the area designated low flood plain (Figure 17 c). This result can be compared with the distribution of levels

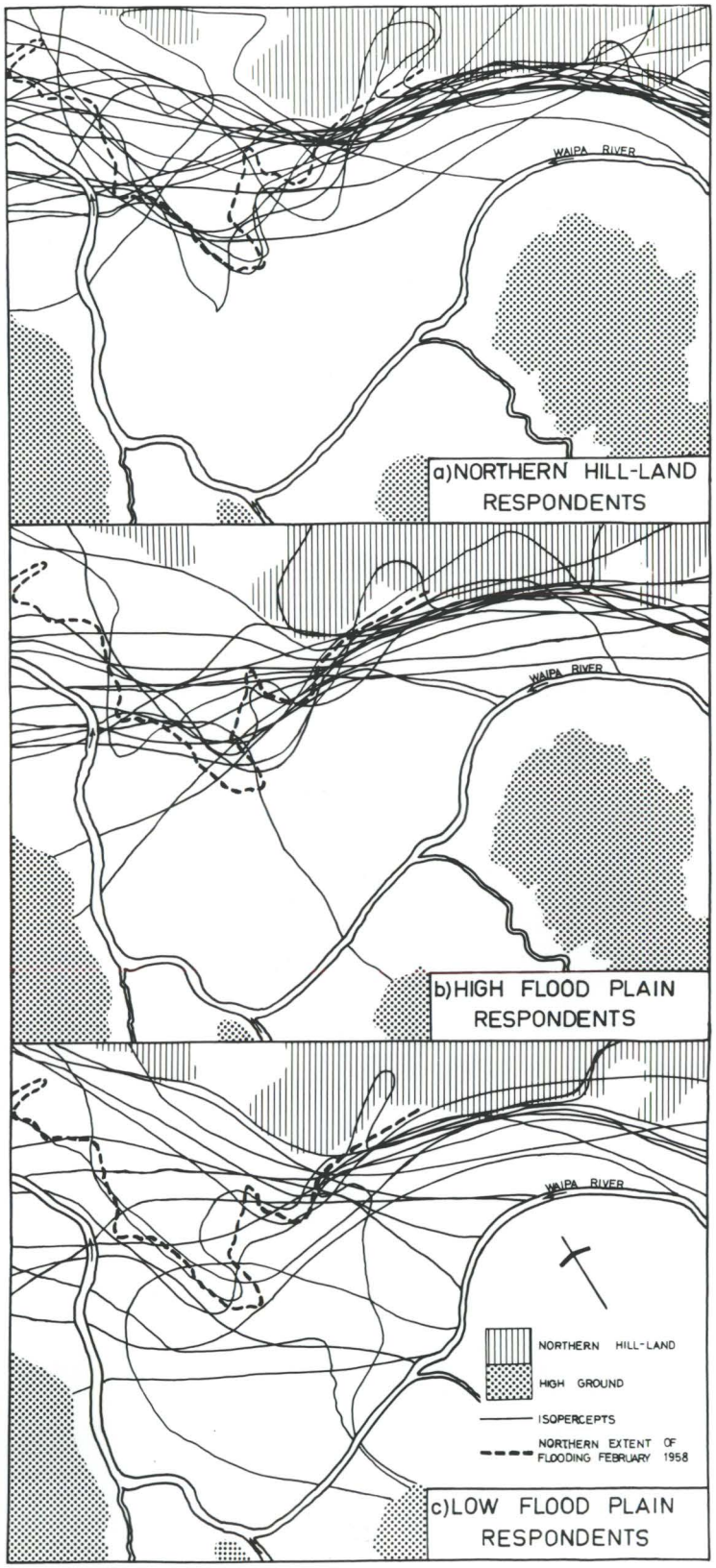

Figure 17. Perception of Flood Spread by Sample Respondents in the absence of Flood Protection Measures

of confidence in flood protection (Table 18). While the majority of respondents resident on the northern hill-land and high flood plain do not deny the possibility of future flooding, almost all of those managers interviewed on the low flood plain show in their complete confidence in the protective measures a denegation of the flood risk. It is interesting to note that although all respondents were aware of the February, 1958 flood, several managers on the low flood plain showed, in drawing their isopercepts, that they did not perceive their own home to be in a hazard zone. Thus, without the presence of protective structures, these respondents would still deny the flood risk to their own house and property, even though they are living in the area inundated in February, 1958.

The managers interviewed on the northern hill-land and high flood plain were asked to recall what factors had entered their decision making when choosing their present home location. Of the 38 respondents, 16 (42.1 percent) ranked being in a flood free area as a significant factor (Table 21). When asked whether they had considered that there were disadvantages to living in the lower lying parts of the borough, 42.1 percent indicated that they perceived a flood risk in this part of the town at the time of choosing their present home location (Table 22). Finally, respondents were asked to what extent escaping the possibility of being flooded entered their decision

TABLE 21

RANKINGS OF MOTIVES FOR CHOICE OF HOME LOCATION GIVEN BY RESPONDENTS RESIDENT ON THE HIGH FLOOD PLAIN AND NORTHERN HILL-LAND

Motives for Choice of Home Location	Rankings					Total responses
	1	2	3	4	5	
	Number making each ranking					
Better view	6	7	2	2	-	17
Flood free area	5	3	3	4	1	16
Handy to amenities (shops, schools, etc.)	5	6	3	1	-	15
Liked the section/house	5	1	3	-	-	9
More rural atmosphere (e.g. not surrounded by neighbours)	2	3	1	1	-	7
House goes with job	5	1	-	-	-	6
Property values in this area higher - therefore better resale prospect	3	-	2	1	-	6
Climatic advantages (e.g. more sunshine and no fog on hills)	1	3	2	1	-	7
House price/rent suited respondent's financial circumstances	5	1	-	-	-	6
Social reasons (e.g. close to family or friends)	1	2	-	-	-	3

TABLE 22

RANKINGS OF DISADVANTAGES OF LOCATING ON THE LOW FLOOD PLAIN AS SEEN BY RESPONDENTS LIVING ON THE NORTHERN HILL-LAND AND HIGH FLOOD PLAIN

Disadvantages of locating on Low Flood Plain	Rankings			Total Responses
	1	2	3	
	Number making each ranking			
Flood risk	9	7	-	16
Suitable house/section not available	11	2	-	13
Climatic disadvantages (e.g. fog, less sunshine, more frost)	4	-	2	6
Resale value of property not so good	1	1	-	2
No view	1	1	-	2
Some of houses still musty and damp because flooded in the past	-	1	-	1

Note: 12 respondents saw no disadvantages.

making. For six managers (15.8 percent) this was a major reason for their choice of home location; for ten (26.3 percent) it was a minor reason. In other words, 42.1 percent of respondents resident on the northern hill-land and high flood plain were influenced in their choice of home location by their perception of flood hazard.

Managers interviewed on the low flood plain were also questioned as to their motives for choice of home location. Of the five respondents who had experienced the February, 1958 flood, only one had been unaware that Otorohanga had a flood problem when he decided to locate in this area. Although these five managers had experienced heavy losses, only one had considered, but not very seriously, leaving the area after this flood. The implementation of protective measures had been a significant factor in these five managers remaining in the area inundated in the past (Table 23). The remaining 13 of those interviewed on the low flood plain had taken up residence here since the flood of February, 1958. At the time of choosing to locate in this area all 13 were aware of both the flood problem and some of the measures taken or planned to alleviate it. For seven of these 13 managers, knowledge of protective measures was a significant factor in their choosing to locate in this area, even though it had been flooded in the past (Table 24).

Responses to the questions concerning managerial motives

TABLE 23

RANKINGS OF MOTIVES FOR REMAINING ON THE LOW FLOOD PLAIN GIVEN BY RESPONDENTS WHO EXPERIENCED THE FLOOD OF FEBRUARY, 1958.

Reasons for remaining on Low Flood Plain	Rankings		
	1	2	3
	Number making each ranking		
Learnt that the flood protection scheme was to be implemented	-	2	3
Handy to amenities (shops, schools, etc.) and place of work	1	1	1
Like this house and section	1	1	1
Would have cost too much to move	2	-	-
House goes with job	1	-	-
Will never get another flood like 1958	-	1	-

TABLE 24

RANKINGS OF MOTIVES FOR CHOICE OF HOME LOCATION GIVEN BY RESPONDENTS WHO ARRIVED IN OTOROHANGA AFTER 1958 AND WHO ARE RESIDENT ON THE LOW FLOOD PLAIN

Motives for Choice of Home Location	Rankings		
	1	2	3
	Number making each ranking		
Knew of the existence of flood protection measures	1	4	2
Only house available for renting at time of looking for a house to rent	4	-	-
Price of house suited respondent's financial ci cumstances	4	-	-
Liked the house/section	1	2	-
Handy to amenities (shops, schools, etc.) and place of work	1	3	-
House goes with job	2	-	-

Note: All of these respondents claimed to have some knowledge of Otorohanga's past flood problem at the time when they made their choice of home location.

for choice of home location (Tables 21-24) clearly lend additional support to the hypothesis relating to the influence of hazard perception on choice of home location (i.e. managers who perceive some degree of risk adjust through their choice of home location, and, conversely, that managers who perceive no hazard are happy to reside in the area flooded in the past). Obviously other variables not related to flooding are also significant in managerial decision making with regard to home location. Tables 21-24 indicate the wide range of motives that were considered by the managers interviewed. Although one would expect socio-economic class, or surrogates thereof, to be significant in an explanation of the spatial pattern of home location in Otorohanga, this proved not to be the case. Statistical analysis shows that there is no significant relationship between present home location and both socio-economic class (Table 25) and income (Table 26). This suggests that economic considerations are not the dominant factor in managerial choice of home location in Otorohanga.

Relocation

In order to assess the significance of hazard perception in managerial decisions to relocate within Otorohanga, respondents were required to give details, if any, of the length and location of previous residences in the borough. Half of the managers interviewed had relocated at some time in the past; 11 (19.7 percent) having resided in three or

TABLE 25

PRESENT HOME LOCATION BY SOCIO-ECONOMIC CLASS

Present Home Location	Socio-Economic Class			Totals
	Lower	Middle	Upper	
Low flood plain	7	7	4	18
High flood plain	4	5	9	18
Northern hill-land	3	4	13	20
Totals	14	16	26	56
% of Total:	25.0	28.6	46.4	100.0

Research Hypothesis: that there is a significant difference between socio-economic classes in their choice of home location.

Chi-square = 7.24. With 4 degrees of freedom the probability value is greater than 10 percent; not significant .

TABLE 26

PRESENT HOME LOCATION BY INCOME

Present Home Location	Annual Income Group			Totals
	Less than $2,199	$2,200 - $3,199	More than $3,200	
Low flood plain	3	8	7	18
High flood plain	3	5	10	18
Northern hill-land	3	3	14	20
Totals	9	16	31	56
% of Totals	16.1	28.6	55.3	100.0

Research Hypothesis: that there is a significant relationship between present home location and the annual income of residential managers in Otorohanga.

Chi-square = 4.56. With 4 degrees of freedom the probability value is greater than 10 percent; not significant.

more different houses in the borough. The over-all pattern of relocation is shown in Figure 18, while Table 27 gives the number of moves made in various directions. It can be seen that half of the moves made were to houses that were at a higher elevation than the one previously occupied, for example, from the low flood plain to the northern hill-land. For 11 respondents (39.3 percent of those who have relocated) escaping the possibility of being flooded was either a major or minor reason for moving to a house at a higher elevation (Figure 18). The three respondents for whom this was a major reason had all suffered heavy losses during the February, 1958 flood. It is thus evident that perception of hazard has been a significant variable in the decisions made by some managers to relocate within the borough.

Free Choice for Relocation

Tables 21, 23 and 24 suggest that some of the managers interviewed were restricted in their choice of home location by various socio-economic constraints (e.g. family ties, and the capital available for home purchase). All respondents were therefore asked where in Otorohanga they would prefer to live if all socio-economic constraints were magically removed. In these circumstances, 40 of the managers interviewed (71.4 percent) would prefer to remain in their present home. Of the 11 flood plain (high and low) respondents who would move given free choice for

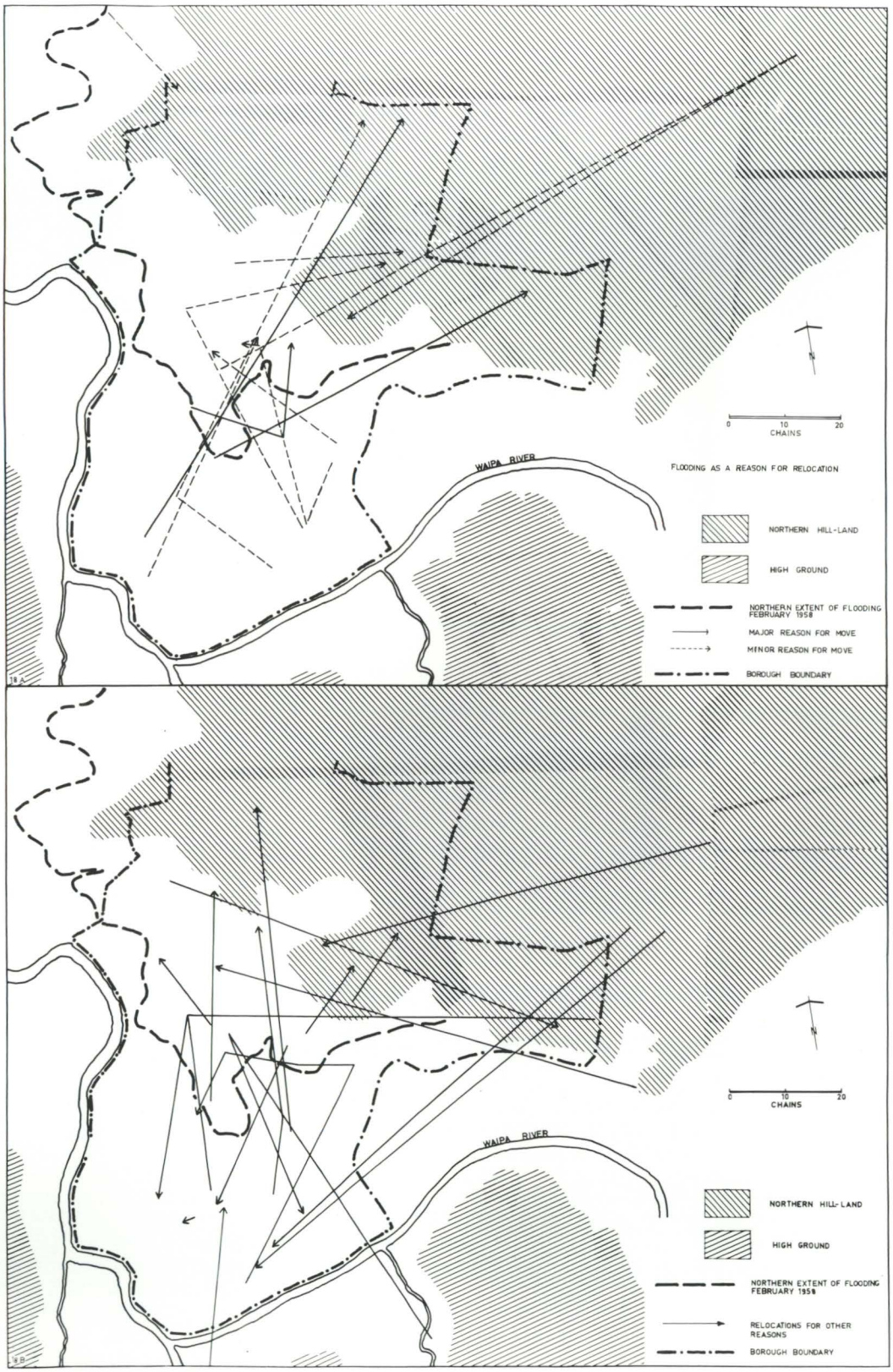

Figure 18. Relocation by Sample Respondents

TABLE 27

DIRECTIONS OF MOVES MADE BY RESPONDENTS WHO HAVE RELOCATED WITHIN OTOROHANGA

Direction of Relocation	Number who have Relocated
A. Respondents now resident on Low Flood Plain:	
elsewhere on low flood plain before 1958	1
high flood plain to low flood plain	5
northern hill-land to low flood plain	2
B. Respondents now resident on the High Flood Plain:	
elsewhere on high flood plain before 1958	1
elsewhere on high flood plain after 1958	2
low flood plain to high flood plain	5
C. Respondents now resident on Northern Hill-land:	
elsewhere on northern hill-land	3
low flood plain to northern hill-land	4
high flood plain to northern hill-land	5
Total	28

Note: If respondents have relocated more than once, only their last move is shown in the above table.

relocation, nine indicated that they would prefer to reside on the northern hill-land. Four of the nine preferred this part of Otorohanga for reasons that included being in a flood free area (Table 28). Significantly, these four respondents all possessed an element of doubt as to the complete effectiveness of the flood protection measures. The other five managers preferred the northern hill-land for reasons other than escaping the possibility of flood loss. (Table 28). These managers were among those who had expressed complete confidence in the protection works. When free choice for relocation was related to levels of confidence in the flood protection scheme, a relationship of quite moderate strength (Coefficient of Contingency = 0.4486) was found to exist. (Table 29). All of the managers who possessed reasonable confidence, but did not completely deny the possibility of future flooding, would prefer that their homes were outside the area flooded in February, 1958. In contrast, those respondents who, given a free choice, would still choose to reside on the low flood plain, showed in their complete confidence in the scheme that they deny the flood risk. It appears likely, therefore, that if all socio-economic constraints could be removed, then managers would be influenced in their choice for relocation by their perception of flood hazard. This situation is somewhat similar to that Ericksen (no date b, 22-26) found in Opotiki where almost

TABLE 28

RANKINGS OF REASONS FOR PREFERRING NORTHERN HILL-LAND GIVEN BY RESPONDENTS WHO WOULD LEAVE THE FLOOD PLAIN GIVEN A FREE CHOICE FOR RELOCATION

Reasons for preferring Northern Hill-land	Rankings		
	1	2	3
	Number making each ranking		
Better view	3	2	-
Climatic advantages (e.g. more sunshine, no fog or dampness)	2	1	1
Flood free area	2	2	-
Property values higher therefore better resale prospect	1	-	-
More rural atmosphere	1	1	-
Sloping section allows basement and more effective landscaping	-	2	-

TABLE 29

FREE CHOICE FOR RELOCATION BY CONFIDENCE IN FLOOD PROTECTION

Preferred Choice of Home Location	Level of Confidence			% of Total
	Reasonably confident but element of doubt	Complete confidence	Totals	
Low flood plain	0	11	11	19.6
High flood plain	11	5	16	28.6
Northern hill-land	17	12	29	51.8
Totals	28	28	56	100.0

Research Hypothesis: that there is a significant relationship between preferred choice of home location if all socio-economic constraints could be removed and level of confidence in the flood protection scheme.

Chi-square = 14.11. With 2 degrees of freedom the probability value is less than 0.1 percent; highly significant.

Coefficient of Contingency (C) = 0.4486

75 percent of those with a pessimistic attitude towards future flooding would prefer homes outside the flood plain, mostly because they do not wish to experience the flooding they believe could still occur. While 45 percent of the optimists in Opotiki also favoured relocation beyond the hazard area, they did so for reasons other than flooding.

When the free choice for relocation was widened so that respondents could leave Otorohanga altogether if they so desired, 23 managers (41.1 percent) indicated that they would do so, 18 of these because they would prefer a coastal location. None wanted to leave because of the flood hazard. This is again similar to the situation in Opotiki where Ericksen (no date b, 24) found that no one desired to leave the district for flood reasons.

SUMMARY

The implementation of Otorohanga's flood protection scheme has had a profound influence on managerial response to the flood hazard. Confidence in the protective measures has narrowed the perceived range of both community and individual adjustments and resulted in managers adopting few, if any, alternative adjustments to the hazard. The majority of managers (88.9 percent) resident on the low flood plain have complete confidence in the protection works. Their perceived frequency of hazard, in light of knowledge of the presence of stopbanking, is equated with negative certainty (i.e. flooding will not occur again) and hence

they see no necessity for making any direct individual adjustments to further reduce the possibility of flood loss. Perceiving no hazard they are content to reside in the area inundated in February, 1958. Although the non-adoption of individual adjustments is characteristic of managers on the low flood plain, elsewhere in the borough some managers have adjusted to the hazard through their choice of home location, or, in some cases, relocation. Of the respondents resident on the high flood plain and northern hill-land, 42.1 percent had been influenced in their choice of present home location by their perception of flood hazard. Having perceived a risk, these managers have chosen to escape the possibility of being flooded by locating their home away from what they perceive is the hazard zone. The evidence suggests, therefore, that perception of flood hazard, which today is reflected in degree of confidence in the flood protection measures, is a significant variable in an explanation of the spatial pattern of home location in Otorohanga.

CHAPTER V

COMPARISONS AND CONCLUSIONS

Persons who wish to settle or continue settlement in the Borough of Otorohanga must knowingly or unknowingly locate in one of three geophysical areas: an area of low flood plain which has been inundated since the inception of European settlement in the town; an area of high flood plain above the maximum recorded flood level (February, 1958); and hill-land which provides flood free sites in the northern portion of the borough. The present study shows that, in general, the use of these areas by the residential managers of Otorohanga reflects their perception of flood hazard and their confidence in community adjustments to the hazard.

The chosen community solution to the town's flood problem is an expensive flood protection scheme based on large-scale engineering works. Analysis of the perceptions and attitudes of residential managers towards the flood hazard and the flood protection measures shows that implementation of the scheme has profoundly influenced managerial perception of flood hazard. All respondents were sure that Otorohanga would have been subject to future flooding if the

protection works had not been undertaken. Knowledge of the existence of stopbanking has, however, decreased their expectation of future flooding to the extent that no respondent was certain that the borough would be flooded again. Half of the managers interviewed possessed so much confidence in the protective measures that they completely denied the flood risk. The other half, although satisfied that the hazard had been reduced by the presence of stopbanking, were not so confident as to completely denegate the possibility of future flooding. Their attitude was one of uncertainty.

The influence of protection measures on flood hazard perception is much more pronounced in Otorohanga than in the towns studied in America by Kates (1962). The experience in the only other New Zealand study site, Opotiki, is however somewhat similar. Table 30 compares several characteristics of the Otorohanga flood situation with those of the towns studied by Bricksen (1967 b) and Kates (1962). Otorohanga, with eight floods in the 10 years prior to 1966, has the third greatest frequency of flooding behind Darlington and Opotiki, although only four of these floods inundated homes above floor level. All of the respondents in Otorohanga had knowledge of past flooding, although only 17.9 percent had actual experience. Nevertheless, none of the managers interviewed was so lacking confidence in stopbanking that they expressed

TABLE 30

COMPARISON OF OTOROHANGA WITH SITES STUDIED BY KATES AND ERICKSEN

Characteristic	Study Site							
	Darlington, Wisconsin	Aurora, Indiana	El Cerrito-Richmond, California	La Follette, Tennessee	Desert Hot Springs, California	Opotiki, New Zealand	Watkins Glen, New York	Otorohanga, New Zealand
Floods per ten years	24.00	5.80	*	1.90	1.20	13.37	0.35	8.00
Rank	1	4		5	6	2	7	3
Expectation of future flooding:								
% of respondents	100	87	45	43	25	19	10	0
Rank	1	2	3	4	5	6	7	8
Knowledge of past flooding:								
% of respondents	100	100	91	93	31	100	100	100
Rank	1=	1=	3	2	4	1=	1=	1=
Experience of past flooding:								
% of respondents	92	93	73	49	12	81	40	18
Rank	2	1	4	5	8	3	6	7
Knowledge of protective works:								
% of respondents	92	13	82	60	56	100	80	100
Rank	2	7	3	5	6	1=	4	1=

Note: * Flood frequency data was unavailable for El Cerrito-Richmond.

Source: Adapted from R.W. Kates, Hazard and Choice Perception in Flood Plain Management, 1962, 82 and 87 : N.J. Ericksen, Perception and Adoption of Alternative Measures for Reducing Flood Damages in Opotiki, 1967, 62 and 104 (Otorohanga data additional).

certainty as to the future occurrence of flooding in Otorohanga. Even Watkins Glen, a town which has had only one flood experience in 35 years, ranks higher in managerial expectation of future flooding with 10 percent of managers being certain that flooding would occur again. The situation in Otorohanga has much in common with that in Opotiki, although Bricksen's respondents had much greater experience of flooding than those in Otorohanga. It should be remembered, however, that although only 17.9 percent of those interviewed in Otorohanga experienced the major flood of February, 1958, 58.9 percent were living either in the borough or the surrounding district at the time and doubtless saw the disastrous consequences of this flood. In explaining the differences between the American and New Zealand results it is pertinent to note the differences in community adjustments to the hazard. Both Otorohanga and Opotiki have complete stopbank protection, channel clearance, and channel diversions. None of the American study sites, however, has such large-scale flood control works. Darlington has a watershed protection project; Aurora, a flood channel; El Cerrito-Richmond, some channel clearance; La Follette, some channel clearance, but not on a community scale; Desert Hot Springs, no measures taken; and Watkins Glen, an inadequate overflow channel. The low ranking of Otorohanga and Opotiki in expectation of future flooding may thus be attributed to the existence of the large-scale

protective works. Significantly, the two New Zealand sites were the only ones where all respondents had some knowledge of the works undertaken to protect the respective towns.

The Otorohanga and Opotiki studies show other differences with the findings of American research. Both Burton (1961 a) and Roder (1961) were unable to discern a relationship between levels of knowledge of flood protection works and expectation of future flooding. In Opotiki, however, Bricksen found that knowledge of the physical presence of flood protection measures decreases managerial expectation of future flooding, and hence increases confidence in the protected area as a place for human occupance. This relationship is even more marked in Otorohanga where such knowledge has not only decreased hazard perception, but, in the case of half the respondents, has completely eliminated their expectation of future flooding. The more pronounced result in Otorohanga may well be accounted for by the fact that in Opotiki the protective structures were little more than two years old when Bricksen (1967 b) made his survey and this may have been insufficient time for confidence to have been restored to many of the people living within the area flooded in the past. In Otorohanga, however, nearly five years had elapsed since the official opening of the protection scheme in March, 1966 and it is today apparent that considerable confidence has been restored

in the area inundated by flood waters in the past.

The studies of Burton (1961 a), Kates (1962) and White (1964 a) show that the type of past flood experience is a significant factor in managerial perception of hazard. Both Otorohanga and Opotiki have suffered severe flooding in the past. In Opotiki, however, Ericksen (1967 b) found that although 80.7 percent of respondents had experienced at least one flood, managerial expectation of future flooding did not correspond closely to either actual experience or knowledge of past flooding. The Otorohanga results support this. It would seem, therefore, that the presence of large-scale protective works overrides the significance of knowledge and experience of past flooding in hazard perception.

An American finding that the Otorohanga study does support is the conclusion of Burton (1961 a) and Roder (1961) that there is no association between attitudes towards future flooding and socio-economic class.

Since the choice of an engineering solution to Otorohanga's flood problem has decreased managerial awareness of the hazard, it was hardly surprising to find that the range of alternative adjustments perceived and adopted is a very narrow one. The response to hazard of a typical manager resident on the low flood plain is illustrated in Figure 19. This is an adaptation of the decision making model developed

Adjustment	Perception by Manager of:					
	Theoretical Choice	Flood hazard	Technology	Economic Efficiency	Spatial linkage	Practical Choice
Flood protection works	1	1	1	1	1	1
Emergency action	1	0	0	0	0	0
Structural alterations	1	0	0	0	0	0
Loss bearing	0	0	0	0	0	0
Locate home away from perceived hazard zone	0	0	0	0	0	0
Public relief	0	0	0	0	0	0
Regulation of land use	0	0	0	0	0	0
Watershed management	0	0	0	0	0	0

0 Not perceived

1 Perceived

Note: Insurance is not included as an adjustment since in New Zealand flooding is a contingency covered under comprehensive houseowner/householder policies and therefore is not likely to be taken out primarily to reduce the possibility of flood loss.

Figure 19. Choice of Adjustment to Floods by a Typical Manager Resident on the Low Flood Plain of Otorohanga. Source: Adapted from G.F. White, Choice of Adjustment to Floods, 1964a, 9.

by White (1961 a, 1964 a) and outlined in Chapter I (Figure 2). The residential manager is aware that he could effect structural alterations (e.g. raise house above known flood level) or take emergency action (e.g. elevate possessions) to reduce the possibility of flood losses. However, he has placed such great faith in the flood protection measures adopted by the community that he has removed the threat of floods from his mind and therefore sees no need for either individual or additional community actions (e.g. regulation of land use, and watershed management) to further reduce the possibility of flood damage. He is so confident that he denies the possibility of having to bear a loss. Furthermore, he is unaware that he might be eligible for flood relief through the Earthquake and War Damage Commission should he ever suffer losses due to flooding. Though he remains on the low flood plain because of various socio-economic constraints, he would not, given a free choice for relocation, choose to live on either the high flood plain or the northern hill-land for reasons that include escaping the possibility of being flooded.

Although the non-adoption of direct individual adjustments (e.g. flood proofing, and structural change) is characteristic of managers resident on the low flood plain, elsewhere in the borough many managers (42.1 percent of those interviewed on the high flood plain and northern hill-land) have adjusted to the hazard by locating their homes in an

area where they feel there is no danger of flooding. The evidence suggests that managerial perception of flood hazard has been a significant influence on the spatial pattern of home location in Otorohanga.

The perception and choice of adjustment by a typical manager resident on the northern hill-land is illustrated in Figure 20. Although reasonably confident that the flood protection measures have reduced the flood hazard, the manager is not so confident that he completely rejects the possibility of the stopbanks being over-topped or breached. His choice of home location is therefore his form of individual adjustment to the hazard. Having located in a flood free area he is naturally not concerned with other forms of individual adjustment such as emergency action, structural alterations and loss bearing.

While flood protection schemes, like that in Otorohanga, may succeed in what they are designed to do, they do not completely remove the flood risk from an area. It is pertinent to note the statement of Craik (1970, 64):

> Flood control works provide protection from floods of a certain range of magnitude, which seldom, if ever, includes the ... catastrophic, maximum possible flood. Thus, while such installations encourage increased occupance of flood plains and induce relaxation of emergency preparations, the protective works do not

Adjustment	Perception by Manager of:					
	Theoretical Choice	Flood Hazard	Technology	Economic efficiency	Spatial linkage	Practical Choice
Flood protection works	1	1	1	1	1	1
Locate home away from perceived hazard zone	1	1	1	1	1	1
Emergency action	0	0	0	0	0	0
Structural alterations	0	0	0	0	0	0
Loss bearing	0	0	0	0	0	0
Public relief	0	0	0	0	0	0
Regulation of land use	0	0	0	0	0	0
Watershed management	0	0	0	0	0	0

0 Not perceived
1 perceived

Figure 20. Choice of Adjustment to Floods by a Typical Manager Resident on the Northern Hill-land of Otorohanga.

Source: Adapted from G.F. White, Choice of Adjustment to Floods, 1964 a, 9.

offer security from catastrophic floods.

Despite the fact that a hazard, in physical terms, still exists, the implementation of the flood protection scheme in Otorohanga has encouraged confidence in the protected area as a place for human occupance. Such confidence is in turn discouraging managers from moving off the flood plain and promoting further development of the hazard zone. Clearly, if a flood larger than the design magnitude does occur then the losses are likely to be considerably increased. If this does transpire, the majority of flood plain managers will have to rely on emergency actions, which they have not prepared for, or compensation obtained through their comprehensive houseowner or householder insurance policies or through the Storm and Flood Disaster Fund of the Earthquake and War Damage Commission.

Having run its course of interviews, analysis of data, and interpretation of the findings, it is pertinent to state explicitly where the contribution of the present study lies. In Chapter I (page 14) a natural hazard research paradigm was outlined. This paradigm emphasises the idea that natural hazards should be viewed in a human ecological perspective. Thus, as White (1961 a; 1966) has persuasively argued, a society's management of natural resources such as a flood plain can only be fully understood by treating all individuals as natural resource managers

occupying certain environmentally relevant positions within the social structure and by investigating the influence of their environmental dispositions upon policy and action regarding natural resources (Craik, 1970, 46). This approach implies taking account of human behaviour and, in particular, individual decision making. It is, therefore, of considerable significance to the geographer, since man and the results of his work are distributed according to the decisions man makes in his capacity as a natural resource manager. The spatial distribution of any particular phenomena reflecting man's use of natural resources is the aggregate result of all the individual decisions made by managers with regard to resource use. In endeavouring to explain and interpret spatial patterns of resource use geographers should, of necessity, consider individual decision making. This has been the approach of the Otorohanga study. Individual householders in the borough were taken to be managers of residential properties either on the Waipa flood plain or the hill-land in the northern portion of the town. The purpose of the present research, as outlined in the opening chapter, was therefore to:

a) Establish how residential managers perceive and interpret the flood hazard in light of the existence of the flood protection scheme.

b) Determine what have been the consequences of this perception in terms of their decision making with regard to choice of adjustment to hazard, including those decisions relating to choice of home location.

The emphasis of the study has thus been on two aspects of the natural hazard research paradigm, namely those which seek to:

a) Study how men perceive and estimate the occurrence of the hazard.

b) Describe the process of adoption of damage-reducing adjustments in their social context (Kates, 1970, 2).

The flood hazard in Otorohanga had caused concern from time to time for many years, but it required the disastrous flood of February, 1958, to trigger action to buffer the harmful effects of the hazard. Following the heavy losses during this flood the call was for some form of protection. This was provided by the community and the Government through the agency of the Waikato Valley Authority. The choice of action was in line with the prevailing Government and public approach to flood problems, and resulted in an expensive flood protection scheme. It is pertinent to ask how efficient this form of adjustment has been.

The Otorohanga findings clearly indicate that where the community as a whole adjusts to a hazard through measures easily recognisable by its individual members, and which

require a minimum of effort on their part, then the presence of these measures profoundly influences the perception and responses of managers whose establishments are located in the area of risk. In the face of flood hazard, individual managers prefer to rely on public actions such as stop-banking and insurance relief rather than expend time and money on alternative individual measures for reducing flood losses. This is only human, however, and it is well to remember that flooding is only one of many problems that concern flood plain occupants in their daily lives. They are, therefore, only too willing to see the responsibilities of flood loss reduction pass to public agencies such as Regional Water Boards (formerly Catchment Boards) and the Earthquake and War Damage Commission. The Otorohanga experience, like that of Opotiki (Ericksen, 1967 b), suggests that the implementation of large-scale flood protection schemes may not always provide the most efficient means of adjustment since the presence of such a scheme decreases the range of alternative adjustments perceived and adopted, and increases occupance of the flood plain. This point may be expanded within the context of New Zealand's flood problems, bearing in mind that the present study has provided empirical evidence as to the decrease in perception and response to flood hazard resulting from the adoption of protective measures. This is significant since the national policy on flood damage

reduction appears to rely upon certain types of community and national adjustments to the hazard rather than on measures taken by the individual. The emphasis is almost exclusively upon flood control and abatement and various forms of public relief and insurance (Figure 3). This policy is not only narrow in range, but it shifts a large share of the burden of flood damage reduction from the individual, and often the local community, to the nation as a whole. In this manner the nation may well be subsidising the occupance of hazardous zones, or, as Craik (1970, 65) aptly puts it, 'part of the rent paid to nature for the occupance of flood plains is shared nationwide.' For example, a flood protection scheme is paid for not only by the ratepayers of the community protected, but also by the taxpayers of the nation. However, the cost to the taxpayer may prove greater than anticipated for although the probability of an over-topping or an engineering failure may be very low for a given site, the chances of such occurrences nationwide are less reassuring. The taxpayer also foots the bill for flood relief, yet such relief is typically provided for the reoccupance of the flood plain. This does not eliminate the possibility of losses recurring so the taxpayer may have to provide relief again. The Otorohanga and Opotiki experience would suggest that those planning the utilisation of flood plain resources in New Zealand should consider a broader and more flexible

approach so that in addition to conventional engineering works, thought is given to the adoption of other alternative adjustments such as zoning ordinances, building codes, the regulation of sub-division, urban renewal, and structural changes to buildings (Ericksen, 1970, 1971; Murphy, 1958). Wherever possible, the regulation of land use and development on flood plains would help ensure that further increases in the potential for flood loss does not occur. In the long run this would probably lead to less costly and more efficient uses of urban flood plains in particular. A more efficient policy of flood loss reduction will also require an education programme which will encourage private individuals to consider the risks of flood plain occupance and to take appropriate measures to curb flood losses. Such a programme may entail the periodic dissemination of material on the nature of the hazard and possible adjustments to it.[1] It will require, however, more hydrological data relating to flood magnitudes, frequencies and distributions, and more co-ordination in the activities of the water expert, town planner and various central and local government agencies.

It is hoped that the present study may contribute to planning for a better policy of flood loss reduction than exists in New Zealand at present. Before such a policy can evolve, however, planners will require more empirical evidence along the lines of the present work and that in

Opotiki (Bricksen, 1967 b). There is a need for studies to be made of managerial perception and response in areas with varying degrees of hazard and protection. In undertaking such research it is well to remember that the human occupance of hazardous regions should be viewed in an ecological perspective. Only by investigating the social, psychological, technological and political processes involved in the man-land system in areas of natural risk can the likely consequences of social policies for adjustment to hazard be adequately anticipated.

NOTES

Chapter I

1 The use of the word 'manager' throughout this study follows the terminology developed by White (1961 a, 25). Managers are the individuals, groups, corporations or government agencies who 'act as a unit in the management of an establishment.' An establishment is defined as a single residence or organisational unit that has 'a distinct usage of area.' Thus, a city dweller is the manager of a city residence which is the establishment; the New Zealand Forest Service is the manager of a State Forest; and a runholder is the manager of a high country sheep station.

2 The significance of the 'behavioural environment' in geographic research was first stressed by Kirk (1951; 1963).

Chapter II

1 Provisional figure from the census taken on March 23, 1971 (Waikato Times, April 29, 1971, page 1).

2 Estimate by J. Hunter Young, Chief Soil Conservationist, Waikato Valley Authority (King Country Chronicle, July 26, 1968).

Chapter III

1 The provisions of the Town and Country Planning Act 1953 that allow suitable controls of land use to be introduced in flood-prone areas are discussed by Ericksen (1970, 4-6).

2 Figures for March 31, 1960 from Waikato Valley Authority (1960, Table II); for March 31, 1970 from a letter to the author from B.I. Riach, Town Clerk, Borough of Otorohanga (February 24, 1971).

3 Personal communication with C.W. Loveridge, Senior Engineer, D.N. Mudd, Design Engineer, and G.T. Ridall, Hydrologist, Waikato Valley Authority.

Chapter IV

1 Otorohanga's Civil Defence organisation was the first such organisation officially approved under the Civil Defence Act 1962.

2 A scheme for the clearance of the Waipa River along its entire length has been proposed by the Waikato Valley Authority and the county councils in the area are currently trying to agree on a

cost-sharing basis for the estimated $15,000 that will be required annually for possibly the next 12 years if the scheme is to be implemented (Waikato Times, April 21 and 26, 1971).

3 Estimate by J. Hunter Young, Chief Soil Conservationist, Waikato Valley Authority (King Country Chronicle, July 26, 1968).

4 A concise outline of the forms of insurance open to flood plain occupants in New Zealand is given by Bricksen (1971, 25-27).

Chapter V

1 Cypra and Peterson (1969) have discussed the possibilities of providing technical services to urban flood plain managers in the United States.

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APPENDIX A (I)

INTERVIEW SCHEDULE FOR RESPONDENTS RESIDENT ON LOW FLOOD PLAIN

Sample Number.....Date.....

Address.....

A. DETAILS OF RESIDENCE

1) How many years have you lived in Otorohanga or the surrounding district?..... ( ) years

2) How many years have you lived in this house?..... ( ) years
So you first came to live in this house in the year?..... (19)

3) How old is your present house?( ) years

4) Do you own or rent this house?( ) own ( )rent

5) Where did you live before taking up residence in this house?..... ( ) elsewhere in the borough
( ) in the country near Otorohanga (.....)
( ) elsewhere in New Zealand (.....)

6) For those who have previously lived elsewhere in Otorohanga

(a) Where was your previous home in Otorohanga? Street.....
Map Ref.....
(19) to (19)

(b) Can you point it out on this map? Street.....

(c) During which years did you live in your old house? Map Ref.....(19) to (19)

B. ADVANTAGES/DISADVANTAGES OF LIVING IN OTOROHANGA

1) What do you see as the advantages of living in Otorohanga? Rank in order of importance.

( ) Small town atmosphere
( ) Protection from flooding
( ) Employment opportunities
( ) Social advantages (e.g. easy to make friends)
( ) Educational facilities
( ) Central location
( ) Community spirit
( ) Sports facilities
( ) Other advantages (.....)
( ) No advantages

2) Do you think there are disadvantages to living in Otorohanga? Rank in order of importance.

( ) Lack of employment opportunities
( ) Shopping difficulties
( ) Danger of flooding
( ) Isolation
( ) Education difficulties
( ) Social disadvantages
( ) Lack of entertainment
( ) Lack of sports facilities
( ) Other disadvantages (.....)
( ) No disadvantages

C. EXPERIENCE AND KNOWLEDGE OF PAST FLOODING

For those resident in Otorohanga in February, 1958 and earlier

1) Have you experienced a flood while living in this house? ( ) Yes ( ) No

2) If so, how many floods have there been inside this house or on this section since you have been here?..... Experienced( ) floods in present home.

3) For relocatees within Otorohanga
Did you experience flooding in your previous home/s in Otorohanga?..... Experienced ( ) floods in previous house.

4) In which years did the floods that you have actually experienced occur? Were these major or minor floods?
( ) Can't name years
Major floods ( )1958
( ) 1907
Minor floods (19)
(19) (19)

5) Have you heard of any floods that occurred in Otorohanga before you came to live in the town?..... ( ) Yes ( ) No
In which years did these floods occur? Were these major or minor floods?
Major floods ( )1958
( ) 1907
Minor floods (19)
(19) (19)
( ) Can't name years

6) For those aware of minor flooding
(a) How frequent has minor flooding been in the past?(.....)
(b) Which parts of the town were affected during minor floods?..... (.....
.....
.....)

7) For those who have experienced a major flood

(a) How high did flood waters rise on your section during the last major flood you experienced?
( ) Entered house and rose above floor by ( )ft( ) ins.
( ) Did not enter house (i.e.only covered lawn; entered basement)

(b) Can you remember or estimate how much damage you suffered during this major flood?
( ) No damage
( ) Light ($1 - $49)
( ) Moderate ($50 - $199)
( ) Heavy ($200 or above)

For those who have taken up residence in Otorohanga since 1958

1) Have you ever heard of floods occurring in Otorohanga before you came to live in the town?.....( ) Yes ( ) No

2) Can you name the years in which these floods occurred?
( ) Can't name years
Major floods ( )
1958 ( ) 1907

Were they minor or major floods?
Minor floods
(19) (19) (19)

3) For those aware of minor flooding

(a) How frequent has minor flooding been in the past?..... (.....)

(b) Which parts of the town were affected during minor floods?..... .....)

D. KNOWLEDGE OF FLOOD PROTECTION SCHEME

1) Do you know of anything that has been done to help protect Otorohanga from flooding?..... ( ) Yes ( ) No

2) Can you describe what sort of flood protection measures have been taken?.....

- ( ) Stopbanking
- ( ) Channel diversion
- ( ) Channel improvements (e.g.willow clearing)
- ( ) Berm widening
- ( ) Pumping stations
- ( ) State Highway and railway realignment and raising
- ( ) Flood warning system

3) Which organisation was responsible for designing the flood protection scheme?...

- ( ) Waikato Valley Authority

4) Where did the money come from to pay for this scheme.....

(N.B. is correct if can name 3 of the 4 sources)

- ( ) National Roads Board
- ( ) New Zealand Railways
- ( ) Rating for flood protection by Borough
- ( ) Government Subsidy

5) For what size flood is the scheme designed? (i.e. design flood discharge/frequency)

- ( ) 33,000 cusecs (Mangapu confluence)
- ( ) 100 year flood

6) <u>For those who answer '100 year flood'</u>

What does this mean?.....

- ( ) One flood in 100 years
- ( ) 1% chance of occurring in any one year

7) Have you ever seen newspaper reports on the scheme? What did they tell you?.....

( ) Yes ( ) No

(.....
.....)

8) Did you see the information booklet put out for the official opening of the scheme in March, 1966?.....() Yes ( ) No

E. CONFIDENCE IN THE FLOOD PROTECTION SCHEME

N.B. If unaware of scheme give a brief outline.

1) How much protection do you think the flood control scheme gives Otorohanga?

( ) From all floods regardless of size (i.e. Otorohanga will never be flooded again)
( ) From most floods but not sure about all (i.e.Otorohanga might possibly be flooded again)
( ) Otorohanga will be flooded again

2) Because of the scheme do you think there will be no future floods in Otorohanga, or will the number be more, less or about the same as that experienced before the scheme was completed?

( ) No future flooda
( ) More floods than before
( ) Less floods than before
( ) About the same number as before

3) <u>For those who think Otorohanga will not be flooded again</u>
Apart from the protection scheme is there any other reason why you think Otorohanga will not be flooded again?

( ) No
( ) Yes (..... .....)

4) <u>For those who think Otorohanga will be, or might possibly be, flooded again</u>

Why do you think that Otorohanga could be flooded again?

( ) Floods will occur regardless of what man does
( ) 'Design flood' suspect

( ) Insufficient protective measures taken
( ) Existing measures ineffective (e.g. stopbanks not strong/high enough)
( ) Other (.....)

5) Do you think anything else should be done to prevent flood damage in Otorohanga? If so, what? (N.B. include extensions of existing measures)

( ) Nofurther measures required
( ) Higher/stronger stopbanks
( ) Further channel clearing and straightening
( ) Regulation of land use
( ) Watershed management
( ) Other .....)

6) Do you think it was necessary to make the protection scheme as large and as costly as it is, or would an alternative scheme have been better? For example, would it have been better to shift to higher ground those houses most likely to be flooded?

( ) Existing scheme necessary
( ) Scheme too large: only some of measures taken were necessary (.....)
( ) Shift to higher sites houses most liable to flooding
( ) Other (..... .....)

7) If there was no flood protection scheme do you think Otorohanga would have been flooded again at some time in the future? ( ) Yes ( ) No

8) If there was no protection scheme what do you think the spread of flood water would be in the event of the largest flood you think likely to occur? Show this by drawing a line across this map of the borough.

F. EXPECTANCY OF FUTURE FLOODING IN PRESENT HOME

1) Do you expect you will ever have a flood on this section or inside this house in the future?
( ) Yes (i.e. pessimistic attitude)
( ) No (i.e. optimistic attitude)
( ) Uncertain

2) Have you done anything to reduce the possibility of loss due to flood damage to your home?
( ) Yes ( ) No

If so:

(a) What measures have you taken?
( ) House and possessions covered against flood damage by insurance.
( ) Had new house built above, or old house raised above, known flood level
( ) Installed flood proofing measures to keep water out of house
( ) Stand by preparations (e.g. stocked materials to fight flood)
( ) Other (.....)

(b) Does this make you more confident of avoiding flood loss?
( ) Yes ( ) No

3) What actions could a house-holder living in a flood prone area take to reduce the possibility of flood loss?

( ) Insure property against flood loss
( ) Structural changes to house
( ) Flood proofing
( ) Emergency actions requiring prior preparation (e.g. store materials for flood fighting)
( ) Emergency actions requiring no prior preparation (e.g. elevate possessions)
( ) Other (.....)

4) <u>For those who are certain their home will not be flooded</u>

Why do you think your house and section will not be flooded in the future?

( ) Protection scheme
( ) House above flood level
( ) Have adopted measures to prevent loss
( ) Floods like 1958 only occur once in a lifetime/million years
( ) Other (.....)

5) If you did suffer losses due to flooding could you recover it? How?

( ) Would just have to accept loss
( ) Compensation from insurance
( ) Compensation from Earthquake and War Damages Commission
( ) Rely on relief assistance/charity

6) <u>For those who say they could claim compensation through insurance</u>

Under what type of insurance policy are you eligible to claim compensation for flood losses?

( ) Comprehensive house owner/householder policy
( ) Fire policy

7) <u>For those aware of the Earthquake and War DamagesCommission</u>

On what basis does the Commission pay compensation to victims of flooding?

( ) Do not know
( ) To holders of a fire insurance policy but only after they have exhausted their own insurance policies

G. <u>MOTIVES FOR CHOICE OF HOME LOCATION</u>

<u>For those resident on the low flood plain in February, 1958 and earlier</u>

1) When you decided to build/buy/rent this house did you know that Otorohanga had a flood problem?

( ) Yes ( ) No

2) After experiencing the 1958 flood did you consider leaving this part of town?

( ) Seriously considered it
( ) Yes, but only at first
( ) Never really thought of it

3) Why then have you remained living in an area flooded in the past? (rank if more than one reason given)

( ) Have complete confidence in flood protection scheme
( ) Social reasons (e.g. family ties)
( ) Would have cost too much to move/couldn't sell house

( ) Cheaper rates/rent
( ) Handy to schools, shops, etc.
( ) Like this house and/or section
( ) No place else to go
( ) Will never get another flood like 1958
( ) Have elevated house
( ) Received adequate compensation in 1958
( ) House goes with job
( ) Other (.....)

<u>For those who have taken up residence on the low flood plain since 1958</u>

1) When you decided to build/buy/ rent this house did you know that Otorohanga had a flood problem? ( ) Yes ( ) No

2) Before you moved into this house did you know of anything being done to prevent flooding in Otorohanga? ( ) Yes ( ) No

3) <u>For those who were aware of the flood problem</u>

Knowing that Otorohanga had been flooded in the past, why did you choose to live in this part of town? (Rank if more than one reason given)

( ) Knew of the flood protection scheme
( ) This section is beyond the reach of flood waters
( ) Made floor level above known flood level
( ) Economic reasons: Cheaper property/rent/ rates

( ) Like this house and/or section
( ) Handy to schools, shops, etc.
( ) House goes with job
( ) One of the few houses available at time of looking for a house to rent
( ) Other
(.....
.....
.....)

H. FREE CHOICE OF LOCATION IF SOCIO-ECONOMIC CONSTRAINTS REMOVED

1) Given a free choice where in Otorohanga would you prefer to live? (show on map)
( ) No other place
( ) Somewhere else on low flood plain
( ) Somewhere on high flood plain
( ) Somewhere on northern hill-land

2) Would you prefer to leave Otorohanga altogether? ( ) Yes ( ) No
If yes, where would you move to? (.....)

3) For those who prefer the northern hill-land

Why do you prefer the hill-land in the northern portion of the borough?
( ) Flood free area
( ) It is socially desirable
( ) More rural atmosphere
( ) Property values higher: better resale prospect
( ) Better view
( ) Climatic advantages: no fog;less damp; more sunshine

( ) Sloping section: allows effective landscaping/basement
( ) Other (.....)

4) <u>For those who prefer the high flood plain</u>

Why do you prefer the higher portion of the river flat?

( ) Above the maximum recorded flood level.
( ) Property values higher: better resale prospect
( ) Handy to schools, shops and other services
( ) Other (.....)

5) <u>For those who would choose to relocate elsewhere on the low flood plain</u>

Why would you choose to live in this part of town?

( ) Handy to schools, shops and other facilities
( ) Other (.....
.....)

6) <u>For those who would prefer to leave Otorohanga altogether</u>

Why do you want to leave Otorohanga altogether?

( ) Lack of employment opportunities
( ) Isolation
( ) Danger of flooding
( ) Lack of entertainment
( ) Don't like small town atmosphere
( ) Prefer coastal location
( ) Want to travel
( ) Educational difficulties
( ) Shopping difficulties
( ) Economic reasons

( ) Other
(.....
.....)

7) For those who would choose to remain in Otorohanga

Why do you prefer Otorohanga to anywhere else in New Zealand?

( ) Family ties
( ) Social ties (e.g. all my friends live here)
( ) Like the small town atmosphere
( ) Don't like city life
( ) Too old to move
( ) Have lived in Otorohanga all my life
( ) Borough has a flood protection scheme
( ) Other
(.....
.....)

I. PERSONAL ITEMS

1) What age group would you place yourself in?

( ) Under 20
( ) 20 - 29
( ) 30 - 39
( ) 40 - 49
( ) 50 - 59
( ) Over 60

2) What is your/your husband's occupation? (i.e. occupation of head of house)

(.....)

Classification:
( ) Professional
( ) Official
( ) Manager
( ) Proprietor
( ) Clerical
( ) Skilled
( ) Semi-skilled
( ) Unskilled
( ) Pensioner
( ) Unemployed

3) In which one of the following categories would you put your/your husband's gross annual income? (i.e. income of head of house)
( ) Less than $2,199
( ) $2,200 to $3,199
( ) More than $3,200

4) Did you/your husband gain any qualifications during your education? (i.e. completed formal education of head of house)
( ) Does not have School Certificate
( ) Has Sch.Cert.or Univ. Ent.
( ) Univ.,Teachers' Coll., etc.

5) Race.....
( ) European
( ) Maori
( ) Other

6) Sex.....
( ) Male
( ) Female

APPENDIX A (II)

INTERVIEW SCHEDULE FOR RESPONDENTS RESIDENT ON THE HIGH FLOOD PLAIN

Sample Number..... Date.....

Address.....

A. DETAILS OF RESIDENCE

1) How many years have you lived in Otorohanga or the surrounding district? ( ) years

2) How many years have you lived in this house?..... ( ) years
So you first came to live in this house in the year?..... (19)

3) How old is your present house ( ) years

4) Do you own or rent this house? ( ) own ( ) rent

5) Where did you live before taking up residence in this house?..... ( ) elsewhere in the borough
( ) in the country near Otorohanga(.....)
( ) elsewhere in New Zealand (.....)

6) For those who have previously lived elsewhere in Otorohanga

(a) Where was your previous home in Otorohanga? Street .....
Map Ref.....(19) to (19)

(b) Can you point it out on this map? Street.....
Map Ref.....(19) to (19)

(c) During which years did you live in your old house?

B. ADVANTAGES/DISADVANTAGES OF LIVING IN OTOROHANGA

1) What do you see as the advantages of living in Otorohanga? Rank in order of importance.

( ) Small town atmosphere
( ) Protection from flooding
( ) Employment opportunities
( ) Social advantages (e.g. easy to make friends)
( ) Educational facilities
( ) Central location
( ) Community spirit
( ) Sports facilities
( ) Other advantages (.....)
( ) No advantages

2) Do you think there are disadvantages to living in Otorohanga? Rank in order of importance.

( ) Lack of employment opportunities
( ) Shopping difficulties
( ) Danger of flooding
( ) Isolation
( ) Education difficulties
( ) Social disadvantages
( ) Lack of entertainment
( ) Lack of sports facilities
( ) Other disadvantages (.....)
( ) No disadvantages

C. EXPERIENCE AND KNOWLEDGE OF PAST FLOODING

For those resident on the high flood plain/northern hill-land in February, 1958 and earlier

1) Have there ever been any floods in Otorohanga since you have been living in the town? ( ) Yes ( ) No

2) Have you heard of any floods that occurred in the borough before you came to live here? ( ) Yes ( ) No

3) In which years did the floods that you are aware of occur? Were they minor or major floods? ( ) Can't name years
Major floods ( ) 1958
( ) 1907
Minor floods (19)
(19) (19)

4) <u>For those aware of minor flooding</u>

(a) How frequent has minor flooding been in the past?(.....)

(b) Which parts of the town were affected during minor floods? (.....
.....)

<u>For those who have previously lived on the low flood plain</u>

1) Did you ever experience a flood inside your house, or on your section, when you were living in the lower lying part of town? ( ) Yes ( ) No
If so, how many floods did you experience? Experienced ( ) floods when living on the low flood plain

2) In which years did the floods that you have actually experienced occur? Were these major or minor floods? ( ) Can't name years
Major floods ( ) 1958
( ) 1907
Minor floods (1)
(19)
(19)

3) Have you heard of any floods that occurred in Otorohanga before you came to live in the town? ( ) Yes ( ) No

In which years did these floods occur? Were these major or minor floods?

( ) Can't name years
Major floods ( ) 1958
( ) 1907
Minor floods (19)
(19)
(19)

4) For those aware of minor flooding

(a) How frequent has minor flooding been in the past? (.....)

(b) Which parts of the town were affected during minor floods? (.....)

5) For those who have experienced a major flood

(a) How high did flood waters rise on your section during the last major flood you experienced?
( ) Entered house and rose above floor level by ( ) ft.( )in.
( ) Did not enter home (i.e. only covered lawn; entered basement)

(b) Can you remember or estimate how much damage you suffered during this major flood?
( ) No damage
( ) Light ($1 - $49)
( ) Moderate ($50 - $199)
( ) Heavy ($200 or above)

For those who have taken up residence in Otorohanga since February, 1958

1) Have you ever heard of floods occurring in Otorohanga before you came to live in the town ( ) Yes ( ) No

2) Can you name the years in which these floods occurred? Were they major or minor floods?
Major floods ( ) 1958
( ) 1907
Minor floods (19) (19)
(19)

3) For those aware of minor flooding

(a) How frequent has minor flooding been in the past? (.....)

(b) Which parts of the town were affected during minor floods? (.....
.....)

D. KNOWLEDGE OF FLOOD PROTECTION SCHEME

1) Do you know of anything that has been done to help protect Otorohanga from flooding?..... ( ) Yes ( ) No

2) Can you describe what sort of flood protection measures have been taken?
..... ( ) Stopbanking
( ) Channel diversion
( ) Channel improvements (e.g. willow clearing)
( ) Berm widening
( ) Pumping stations
( ) State Highway and railway realignment and raising
( ) Flood warning system

3) Which organisation was responsible for designing the flood protection scheme ( ) Waikato Valley Authority

4) Where did the money come from to pay for this scheme?..... ( ) National Roads Board
(N.B. is correct if can name 3 of the 4 sources) ( ) New Zealand Railways
( ) Rating for Flood protection by Borough
( ) Government Subsidy

5) For what size flood is the scheme designed? (i.e. design flood discharge/frequency) ( ) 33,000 cusecs (Mangapu confluence)
( ) 100 year flood

6) For those who answer '100 year flood'
What does this mean?..... ( ) One flood in 100 years
( ) 1% chance of occurring in any one year

7) Have you ever seen newspaper reports on the scheme? What did they tell you? ( ) Yes ( ) No (.....)

8) Did you see the information booklet put out for the official opening of the scheme in March, 1966? ( ) Yes ( ) No

E. CONFIDENCE IN THE FLOOD PROTECTION SCHEME

N.B. If unaware of scheme give a brief outline

1) How much protection do you think the flood control scheme gives Otorohanga?
( ) From all floods regardless of size (i.e. Otorohanga will never be flooded again)
( ) From most floods but not sure about all (i.e. Otorohanga might possibly be flooded again)
( ) Otorohanga will be flooded again

2) Because of the scheme do you think there will be no future floods in Otorohanga, or will the number be more, less or about the same as that experienced before the scheme was completed?
( ) No future floods
( ) More floods than before
( ) Less floods than before
( ) About the same number as before

3) <u>For those who think Otorohanga will not be flooded again</u>

Apart from the protection scheme is there any other reason why you think Otorohanga will not be flooded again?
( ) No
( ) Yes (.....)

4) <u>For those who think Otorohanga will be, or might possibly be, flooded again</u>

Why do you think that Otorohanga could be flooded again?

( ) Floods will occur regardless of what man does
( ) 'Design flood' suspect
( ) Insufficient protective measures taken
( ) Existing measures ineffective (e.g. stopbanks not strong/ high enough)
( ) Other (.....)

5) Do you think anything else should be done to prevent flood damage in Otorohanga? If so, what? (N.B. include extensions of existing measures)

( ) No further measures required
( ) Higher/stronger stopbanks
( ) Further channel clearing and straightening
( ) Regulation of land use
( ) Watershed management
( ) Other (.....)

6) Do you think it was necessary to make the protection scheme as large and as costly as it is, or would an alternative scheme have been better? For example, would it have been better to shift to higher ground those houses most likely to be flooded?

( ) Existing scheme necessary
( ) Scheme too large : only some of measures taken were necessary(.....)
( ) Shift to higher sites houses most liable to flooding
( ) Other (.....)

7) If there was no flood protection scheme do you think Otorohanga would have been flooded again at some time in the future? ( ) Yes ( ) No

8) If there was no protection scheme what do you think the spread of flood water would be in the event of the largest flood you think likely to occur? Show this by drawing a line across this map of the borough.

F. MOTIVES FOR CHOICE OF HOME LOCATION

1) For what reasons did you choose to live in this part of Otorohanga? (Rank in order of importance)

( ) This section is beyond the reach of flood waters
( ) Economic reasons: Cheaper property/rent/rates
( ) Like this house and/or section
( ) Social reasons (e.g. close to family and/or friends)
( ) Handy to schools, shops and other facilities
( ) House goes with job
( ) Other (.....)

2) What disadvantages did you see of living in the lower lying part of town?

( ) Flood risk
( ) Couldn't get State Advances loan to build/buy in this area
( ) Resale value of houses not so good
( ) Suitable house/section not available there
( ) Other (.....)

3) When you decided to build/ buy/rent this house how important was the reason 'to escape the possibility of being flooded' ?
( ) Major reason
( ) Minor reason
( ) Of no importance

G. FREE CHOICE OF LOCATION IF SOCIO-ECONOMIC CONSTRAINTS REMOVED

1) Given a free choice where in Otorohange would you prefer to live (Show on map)
( ) No other place
( ) Somewhere else on high flood plain
( ) Somewhere on low flood plain
( ) Somewhere on northern hill-land

2) Would you prefer to leave Otorohanga altogether? If yes, where would you move to?
( ) Yes ( ) No
(.....)

3) For those who prefer the northern hill-land

Why do you prefer the hill-land in the northern portion of the borough? (Rank if more than one reason given)
( ) Flood free area
( ) It is socially desirable
( ) More rural atmosphere
( ) Property values higher: better resale prospect
( ) Better view
( ) Climatic advantages: no fog; less damp;more sunshine
( ) Sloping section: allows effective landscaping/ basement
( ) Other
(.....)

4) For those who would choose to relocate elsewhere on high flood plain

Why do you prefer the higher portion of the river flat?
( ) Above the maximum record -ed flood level
( ) Property values higher: better resale prospect
( ) Handy to schools,shops and other services
( ) Other
(.....)

5) <u>For those who would choose to relocate to the low flood plain</u>

Why would you choose to live in the lower lying part of town?

( ) Handy to schools, shops and other facilities
( ) Other
(.....
.....)

6) <u>For those who would prefer to leave Otorohanga altogether</u>

Why do you want to leave Otorohanga altogether?

( ) Lack of employment opportunities
( ) Isolation
( ) Danger of flooding
( ) Lack of entertainment
( ) Don't like small town atmosphere
( ) Prefer coastal location
( ) Want to travel
( ) Educational difficulties
( ) Shopping difficulties
( ) Economic reasons
( ) Other
(.....
.....)

7) <u>For those who would choose to remain in Otorohanga</u>

Why do you prefer Otorohanga to anywhere else in New Zealand

( ) Family ties
( ) Social ties (e.g. all my friends live here)
( ) Like the small town atmosphere
( ) Don't like city life
( ) Too old to move
( ) Have lived in Otorohanga all my life
( ) Borough has a flood protection scheme
( ) Other
(.....
.....)

H. PERSONAL ITEMS

1) What age group would you place yourself in?

( ) Under 20
( ) 20 - 29
( ) 30 - 39
( ) 40 - 49
( ) 50 - 59
( ) Over 60

2) What is your/your husband's occupation? (i.e. occupation of head of house)

(.....)

Classification:

( ) Professional
( ) Official
( ) Manager
( ) Proprietor
( ) Clerical
( ) Skilled
( ) Semi-skilled
( ) Unskilled
( ) Pensioner
( ) Unemployed

3) In which one of the following categories would you put your/ your husband's gross annual income?

( ) Less than $2,199
( ) $2,200 to $3,199
( ) More than $3,200

4) Did you/your husband gain any qualifications during your education? (i.e. completed formal education of head of house)

( ) Does not have School Certificate
( ) Has Sch.Cert. or Univ. Ent.
( ) Univ.,Teachers' Coll., etc.

5) Race.....

( ) European
( ) Maori
( ) Other

6) Sex.....

( ) Male
( ) Female

APPENDIX A (III)

INTERVIEW SCHEDULE FOR RESPONDENTS RESIDENT ON THE NORTHERN HILL-LAND

Sample Number.....Date.....

Address.....

A. DETAILS OF RESIDENCE

1) How many years have you lived in Otorohanga or the surrounding district? ( ) years

2) How many years have you lived in this house? ( ) years
So you first came to live in this house in the year?(19)

3) How old is your present house? ( ) years

4) Do you own or rent this house? ( ) own ( ) rent

5) Where did you live before taking up residence in this house..... ( ) elsewhere in the borough
( ) in the country near Otorohanga(.....)
( ) elsewhere in New Zealand (.....)

6) For those who have previously lived elsewhere in Otorohanga

(a) Where was your previous home in Otorohanga? Street.....
Map Ref.....(19)
to (19)

(b) Can you point it out on this map?

(c) During which years did you live in your old house?

Street.....
Map Ref.....(19) to (19)

B. ADVANTAGES/DISADVANTAGES OF LIVING IN OTOROHANGA

1) What do you see as the advantages of living in Otorohanga? Rank in order of importance

( ) Small town atmosphere
( ) Protection from flooding
( ) Employment opportunities
( ) Social advantages (e.g. easy to make friends)
( ) Educational Facilities
( ) Central location
( ) Community spirit
( ) Sports facilities
( ) Other advantages (.....)
( ) No advantages

2) Do you think there are disadvantages to living in Otorohanga? Rank in order of importance.

( ) Lack of employment opportunities
( ) Shopping difficulties
( ) Danger of flooding
( ) Isolation
( ) Education difficulties
( ) Social disadvantages
( ) Lack of entertainment
( ) Lack of sports facilities
( ) Other disadvantages (.....)
( ) No disadvantages

C. EXPERIENCE AND KNOWLEDGE OF PAST FLOODING

For those resident on the high flood plain/northern hill-land in February 1958 and earlier

1) Have there ever been any floods in Otorohanga since you have been living in the town? ( ) Yes ( ) No

2) Have you heard of any floods that occurred in the borough before you came to live here? ( ) Yes ( ) No

3) In which years did the floods that you are aware of occur? Were they minor or major floods?
( ) Can't name years
( ) Major floods ( ) 1958
( ) 1907
Minor floods (19)
(19)
(19)

4) <u>For those aware of minor flooding</u>

(a) How frequent has minor flooding been in the past? (.....)

(b) Which parts of the town were affected during minor floods? (.....
.....)

<u>For those who have previously lived on the low flood plain</u>

1) Did you ever experience a flood inside your house, or on your section, when you were living in the lower part of town? If so, how many floods did you experience?
( ) Yes ( ) No
Experienced ( ) floods when living on the low flood plain

2) In which years did the floods that you have actually experienced occur? Were these major or minor floods?
( ) Can't name years
Major floods ( ) 1958
( ) 1907
Minor floods (19)
(19)
(19)

3) Have you heard of any floods that occurred in Otorohanga before you came to live in the town? ( ) Yes ( ) No
In which years did these occur? Were these major or minor floods? ( ) Can't name years
Major floods ( ) 1958
( ) 1907
Minor floods (19)
(19)
(19)

4) <u>For those aware of minor flooding</u>

(a) How frequent has minor flooding been in the past?(.....)

(b) Which parts of the town were affected during minor floods? (.....)

5) <u>For those who have experienced a major flood</u>

(a) How high did flood waters rise on your section during the last major flood you experienced?
( ) Entered house and rose above floor level by ( )ft.( )in.
( ) Did not enter home (i.e. only covered lawn; entered basement)

(b) Can you remember or estimate how much damage you suffered during this major flood?
( ) No damage
( ) Light ($1 - $49)
( ) Moderate ($50 - $199)
( ) Heavy ($200 or above)

<u>For those who have taken up residence in Otorohanga since February, 1958</u>

1) Have you ever heard of floods occurring in Otorohanga before you came to live in the town? ( ) Yes ( ) No

2) Can you name the years in which these floods occurred? Major floods ( ) 1958
( ) 1907

Were they major or minor floods?
Minor floods (19)
(19)(19)

3) For those aware of minor flooding

(a) How frequent has minor flooding been in the past? (.....)

(b) Which parts of the town were affected during minor floods? (.....
.....)

D. KNOWLEDGE OF FLOOD PROTECTION SCHEME

1) Do you know of anything that has been done to help protect Otorohanga from flooding?..... ( ) Yes ( ) No

2) Can you describe what sort of flood protection measures have been taken?
( ) Stopbanking
( ) Channel diversion
( ) Channel improvements (e.g. willow clearing)
( ) Berm widening
( ) Pumping stations
( ) State Highway and railway realignment and raising
( ) Flood warning system

3) Which organisation was responsible for designing the flood protection scheme?
( ) Waikato Valley Authority

4) Where did the money come from to pay for this scheme?..... (N.B. is correct if can name 3 of the 4 sources)
( ) National Roads Board
( ) New Zealand Railways
( ) Rating for flood protection by Borough
( ) Government subsidy

5) For what size flood is the scheme designed? (i.e. design flood discharge/frequency)
( ) 33,000 cusecs (Mangapu confluence)
( ) 100 year flood

6) For those who answer '100 year flood'
What does this mean?.....
( ) One flood in 100 years
( ) 1% chance of occurring in any one year

7) Have you ever seen newspaper reports on the scheme? What did they tell you?
( ) Yes ( ) No
(.....
.....)

8) Did you see the information booklet put out for the official opening of the scheme in March, 1966?
( ) Yes ( ) No

E. CONFIDENCE IN THE FLOOD PROTECTION SCHEME

N.B. If unaware of scheme give a brief outline.

1) How much protection do you think the flood control scheme gives Otorohanga?
( ) From all floods regardless of size (i.e. Otorohanga will never be flooded again)
( ) From most floods but not sure about all (i.e. Otorohanga might possibly be flooded again)
( ) Otorohanga will be flooded again

2) Because of the scheme do you think there will be no future floods in Otorohanga, or will the number be more, less or about the same as that experienced before the scheme was completed?
( ) No future floods
( ) More floods than before
( ) Less floods than before
( ) About the same number as before

3) <u>For those who think Otorohanga will not be flooded again</u>

Apart from the protection scheme is there any other reason why you think Otorohanga will not be flooded again?

( ) No

( ) Yes (.....
.....)

4) <u>For those who think Otorohanga will be, or might possibly be, flooded again</u>

Why do you think that Otorohanga could be flooded again?

( ) Floods will occur regardless of what man does
( ) 'Design flood' suspect
( ) Insufficient protective measures taken
( ) Existing measures ineffective (e.g. stopbanks not strong/ high enough)
( ) Other (.....)

5) Do you think anything else should be done to prevent flood damage in Otorohanga? If so, what? (N.B. include extensions of existing measures)

( ) No further measures required
( ) Higher/stronger stop-banks
( ) Further channel clearing and straightening
( ) Regulation of land use
( ) Watershed management
( ) Other (.....)

6) Do you think it was necessary to make the protection scheme as large and as costly as it is, or would an alternative scheme have been better?

( ) Existing scheme necessary
( ) Scheme too large; only some of measures taken were necessary(.....
.....)

For example, would it have been better to shift to higher ground those houses most likely to be flooded?

( ) Shift to higher sites houses most liable to flooding
( ) Other (.....)

7) If there was no flood protection scheme do you think Otorohanga would have been flooded again at some time in the future? ( ) Yes ( ) No

8) If there was no protection scheme what do you think the spread of flood water would be in the event of the largest flood you think likely to occur? Show this by drawing a line across this map of the borough.

F. MOTIVES FOR CHOICE OF HOME LOCATION

1) For what reasons did you choose to live in this part of Otorohanga? (Rank in order of importance)

( ) Flood free area
( ) It is socially desirable
( ) A more rural atmosphere
( ) Property values higher: better resale prospect
( ) Better view
( ) Climatic advantages: no fog; less damp; more sunshine
( ) Sloping section: allows effective landscaping/ basement
( ) House goes with job
( ) Other (.....)

2) What disadvantages did you see of living in the lower lying part of town?

( ) Flood risk
( ) Couldn't get State Advances loan to build/buy in this area
( ) Resale value of houses not so good
( ) Suitable house/section not available there
( ) Other
(.....
.....)

3) When you decided to build/ buy/rent this house how important was the reason 'to escape the possibility of being flooded'?

( ) Major reason
( ) Minor reason
( ) Of no importance

G. FREE CHOICE OF LOCATION IF SOCIO-ECONOMIC CONSTRAINTS REMOVED

1) Given a free choice where in Otorohanga would you prefer to live? (show on map)

( ) No other place
( ) Somewhere else on northern hill-land
( ) Somewhere on low flood plain
( ) Somewhere on high flood plain

2) Would you prefer to leave Otorohanga altogether? If yes, where would you move to?

( ) Yes ( ) No
(.....)

3) For those who would choose to relocate elsewhere on the Northern hill-land

Why do you prefer the hill-land in the northern portion of the borough? (Rank if more than one reason given)

( ) Flood free area
( ) It is socially desirable
( ) More rural atmosphere
( ) Property values higher: better resale prospect

( ) Better view
( ) Climatic advantages: no fog; less damp; more sunshine
( ) Sloping section: allows effective landscaping/ basement
( ) Other (.....)

4) For those who prefer the high flood plain

Why do you prefer the higher portion of the river flat?

( ) Above the maximum recorded flood level
( ) Property values higher: better resale prospect
( ) Handy to schools, shops and other services
( ) Other (.....)

5) For those who would prefer to relocate to the low flood plain

Why would you choose to live in the lowest lying part of town?

( ) Handy to schools, shops and other facilities
( ) Other (.....
.....)

6) For those who would prefer to leave Otorohanga altogether

Why do you want to leave Otorohanga altogether?

( ) Lack of employment opportunities
( ) Isolation
( ) Danger of flooding
( ) Lack of entertainment
( ) Don't like small town atmosphere
( ) Prefer coastal location

( ) Want to travel
( ) Educational difficulties
( ) Shopping difficulties
( ) Economic reasons
( ) Other
(.....
.....)

7) For those who would choose to remain in Otorohanga

Why do you prefer Otorohanga to anywhere else in New Zealand?

( ) Family ties
( ) Social ties (e.g. all my friends live here)
( ) Like the small town atmosphere
( ) Don't like city life
( ) Too old to move
( ) Have lived in Otorohanga all my life
( ) Borough has a flood protection scheme
( ) Other
(.....
.....)

H. PERSONAL ITEMS

1) What age group would you place yourself in?

( ) Under 20
( ) 20 - 29
( ) 30 - 39
( ) 40 - 49
( ) 50 - 59
( ) Over 60

2) What is your/your husband's occupation?
(i.e. occupation of head of house)

(.....)

Classification:

( ) Professional
( ) Official
( ) Manager
( ) Proprietor
( ) Clerical
( ) Skilled

( ) Semi-skilled
( ) Unskilled
( ) Pensioner
( ) Unemployed

3) In which one of the following categories would you put your/your husband's gross annual income? (i.e. income of head of house)

( ) Less than $2,199
( ) $2,200 to $3,199
( ) More than $3,200

4) Did you/your husband gain any qualifications during your education? (i.e. completed formal education of head of house)

( ) Does not have School Certificate
( ) Has School Certificate or Univ. Ent.
( ) Univ.,Teachers' Col.,etc.

5) Race.....

( ) European
( ) Maori
( ) Other

6) Sex.....

( ) Male
( ) Female

APPENDIX B

THE CHI-SQUARED TEST FOR THE COMPARISON OF FREQUENCY DISTRIBUTIONS

The chi-squared Test is a test that evaluates whether or not the 'observed frequencies of a given phenomenon differ significantly from the frequencies which might be expected according to some assumed hypothesis' (Gregory, 1963, 151). Finding many applications, the Chi-squared Test is most frequently used for contingency problems.

In contingency problems we wish to consider whether or not a relationship exists between two or more nominal scales. The natural hazard researcher, for example, may wish to determine whether or not there is a significant relationship between managerial expectation of future hazard occurrences and experience of past hazard events. He might reasonably expect managers with the most experience to have the greatest expectation, and managers with no experience to have little or no expectation of future hazard occurrences. Through the application of the Chi-squared Test he can establish whether in fact such a relationship exists.

Contingency problems are approached in a somewhat inverted manner since it is always necessary to set up a suitable

null hypothesis which assumes that there is no relationship between (or no difference among) the variables. On the basis of this null hypothesis it should be possible to obtain the expected frequencies of the given phenomenon assuming that the variables are independent. The aim is then to assess the probability that the observed conditions (or frequencies) are a reflection of the expected ones. The Chi-square (X^2) is a measure of the differences between the observed and the expected frequencies. If the differences fluctuate around zero then the laws of probability are sufficient to explain the observed frequencies (i.e. the null hypothesis is valid and the variables are independent). Thus, if it is largely true that the observed conditions are a reflection of the expected ones, then probabilities of between 95 percent and 100 percent may be obtained. If, on the other hand, this is largely untrue, then low probability values occur. If these are five percent or less, then it is justifiable to say that the inverse of the null hypothesis is probably true, while if the value is one percent or less then the likelihood of this inverse relationship being true is very great. In other words, if the laws of probability are contradicted, then the assumption of statistical independence is also contradicted and a relationship exists.

In contingency problems the empirically obtained data

(in the form of frequencies) is recorded in contingency tables according to suitable nominal scales. The following is a generalised 2 x n contingency table:

	I	II	III..... n	Totals of Rows
A	a_1	a_2	a_3 ..... a_n	N_a
B	b_1	b_2	b_3 ..... b_n	N_b
Totals of Columns	N_1	N_2	N_3 ..... N_n	N

where:

1) A and B are the categories of the nominal scale for the particular phenomenon the researcher is interested in.

2) I, II, III .... n are the categories of the nominal scale for the variable which may or may not be related to the particular phenomenon the researcher is interested in.

3) a_1, a_2, ... a_n; b_1, b_2, ... b_n are the observed frequencies.

4) N is the total frequency:

$$N = \sum a + \sum b$$

5) Using the totals of the rows and the columns the expected frequency (fe) for any cell can be computed.

For example -

$$\text{fe for cell } a_1 = \frac{N_a \times N_1}{N}$$

From the contingency table the Chi-square (X^2) can be calculated using the formula:

$$X^2 = \frac{N}{N_a}\left[\frac{a_1^2}{N_1} + \frac{a_2^2}{N_2} + \ldots\ldots + \frac{a_n^2}{N_n}\right] + \frac{N}{N_b}\left[\frac{b_1^2}{N_1} + \frac{b_2^2}{N_2} + \ldots\ldots + \frac{b_n^2}{N_n}\right] \cdot N$$

The calculated Chi-square can then be used to determine whether or not the laws of probability are sufficient to explain the observed frequencies. Through an examination of the sampling distribution of Chi-square the researcher can test the null hypothesis and determine whether or not the Chi-square value (X^2) obtained differs sufficiently from zero for the laws of probability to be rejected. Rejection implies that a relationship does exist between the variables. The sampling distribution of Chi-square is both known and tabulated (e.g. Gregory, 1963, 155).

No matter what size Chi-square is, its probability depends upon the degrees of freedom (d.f.) of the contingency table. The degrees of freedom depend upon the number of cells in the contingency table and may be determined using the formula:

$$d.f. = (r - 1).(c - 1)$$

where r = number of rows in the contingency table,
and c = number of columns in the contingency table.

Having obtained the value of Chi-square and the degrees of

freedom, the probability value can be read off the graph of Chi-square distribution (Gregory, 1963, 155). A probability value of less than 0.1 percent means that there is a highly significant difference between the observed and the expected frequencies; a value between 0.1 and 1.0 percent indicates a significant difference; and a value between 1.0 and 5.0 percent that the difference is probably significant. Where the probability value is less than 5.0 percent there is only a small percentage chance that observed differences could have occurred by chance. Indeed, if the probability value is less than 0.1 percent, then it is virtually certain that the differences could not have occurred by chance. The laws of probability are thus likely to be contradicted and the null hypothesis may therefore be rejected. This means that the assumption of statistical independence is probably false and in fact a relationship is likely to exist between the variables. If the probability value is one percent or less the likelihood of a relationship is very great. Beyond five percent it is not justifiable to reject the null hypothesis.

Coefficient of Contingency

Chi-square testing only indicates whether or not there is a relationship between variables. It does not inform us how important or strong the relationship is. However, descriptive measures, in the form of coefficients of contingency, are available for indicating the importance of

a relationship. The coefficient of contingency is 'a coefficient purporting to measure the strength of dependence between two characteristics (of a sample) on the basis of a contingency table' (Kendall and Buckland, 1957, 62). Best known is K. Pearson's Contingency Coefficient (C) which is defined by:

$$C = \sqrt{\frac{X^2}{X^2 + N}}$$

where X^2 = Chi-squared

N = total frequency.

The closer the coefficient is to 1.0, the stronger the relationship, or, in other words, the closer the relationship is to complete dependence between the variables.