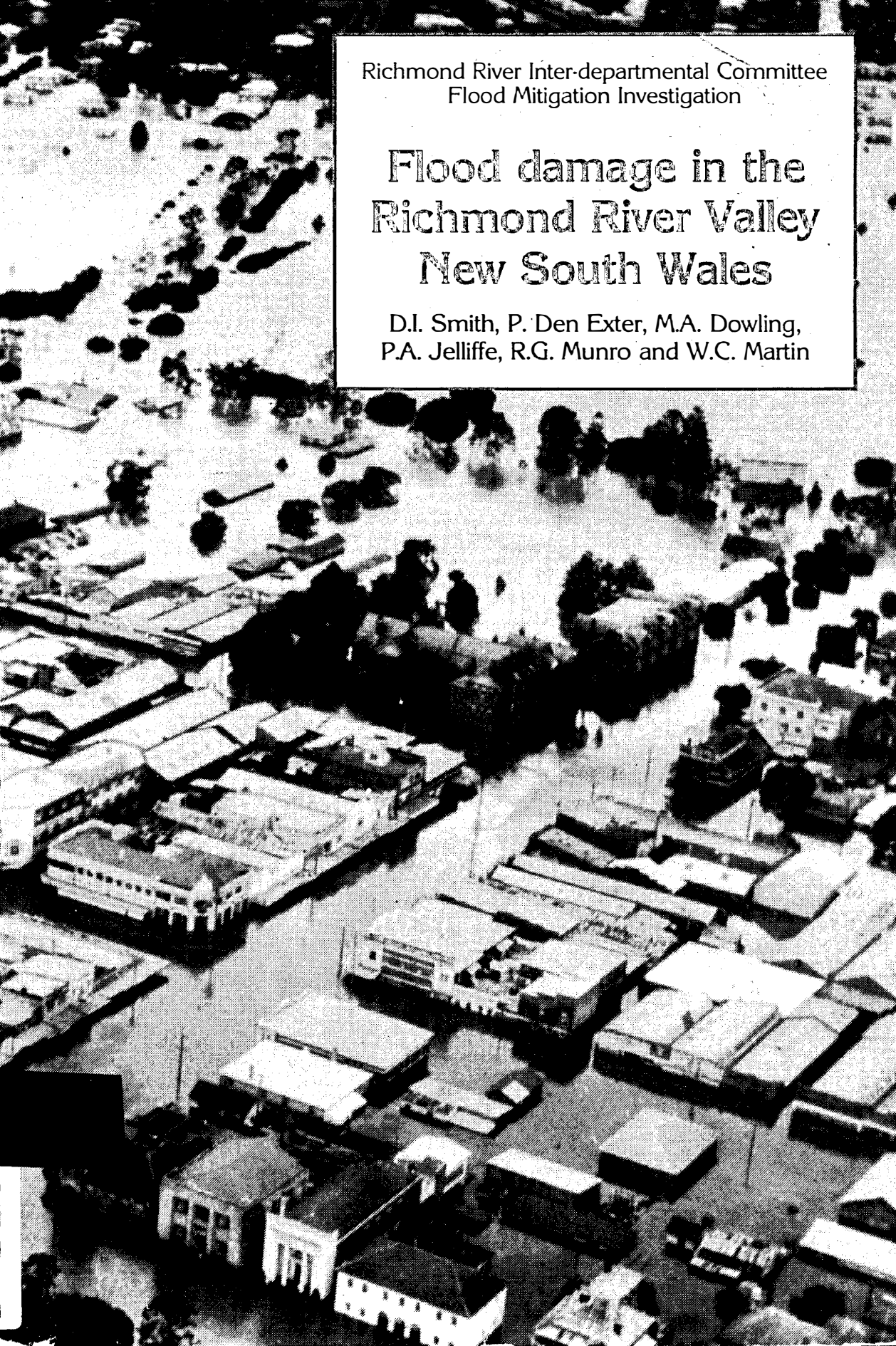




Richmond River Inter-departmental Committee
Flood Mitigation Investigation

Flood damage in the Richmond River Valley New South Wales

D.I. Smith, P. Den Exter, M.A. Dowling,
P.A. Jelliffe, R.G. Munro and W.C. Martin

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**Flood damage in the
Richmond River Valley
New South Wales**
An assessment of tangible
and intangible damages

D.I. Smith, P. Den Exter, M.A. Dowling,
P.A. Jelliffe, R.G. Munro and W.C. Martin

Northern Rivers CAE, Lismore, NSW

Centre for Resource and Environmental Studies
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CHAPTER 1

BACKGROUND AND INTRODUCTION

1.1 INTRODUCTION

The Richmond River Valley, in common with the other coastal rivers of northern New South Wales, experiences frequent flooding. These floods are essentially natural phenomena although it is possible that the frequency and magnitude may have been increased due to the action of man. While interference by indigenous peoples can be discounted, clearing, agriculture, and modifications to the natural drainage since European settlement may well have had adverse effects. However, regardless of these changes, there is no question that the damage to both urban and rural settlement, services, and agriculture in the Valley is extensive. There is little doubt that Lismore is one of the most flood-prone towns of its size in the State and perhaps within the Commonwealth.

1.2 BACKGROUND TO THE INTER-DEPARTMENTAL COMMITTEE

The first Inter-Departmental Committee concerned with flooding in the Richmond River Valley was established in 1948 and its report was completed in 1958. This provided guidelines for flood mitigation measures for the following years. However, changes in attitudes to flood mitigation and the major flood of 1974 led to a call by the Richmond River County Council for the establishment of a second Inter-Departmental Committee (hereafter 'the IDC') to investigate the whole question of flooding in the Richmond River Valley. The current IDC was approved, in principle, by the Premier on 6 February 1975 and the draft terms of reference and constitution on 29 September 1975.

The details of the IDC's approach, a summary of submissions and an account of the background detail are set out in a document produced

by that Committee and entitled, *The Proposed Form of the Final Report of the Richmond River Valley Inter-Departmental Committee*. A salient feature of the report is, '... that the public and local government must be involved (p.5)'.

1.3 BACKGROUND TO THE PRESENT STUDY

In addition to the various local government bodies, a major submission was made to the IDC by the Richmond River Valley Flood Action Committee which was formed in May 1976, and represents both rural and urban sectors of the community. The current study by the Northern Rivers College of Advanced Education and the Centre for Resource and Environmental Studies of the Australian National University arose from discussions with the Flood Action Committee. A proposal outlining procedures by which flood damage could be assessed was drawn up by staff from these two institutions and submitted to the IDC. After further discussions and modifications, the IDC funded the study which commenced in July 1977.

1.4. AIMS AND OBJECTIVES OF THE STUDY

The major aim was to provide an assessment of flood damage in the Richmond River Valley, including both rural and urban damage. Such assessments can take a variety of forms, but the estimates would, as far as possible, include both damages resulting from the 1974 flood and, by using the available records of past floods, estimates of the damage expressed in mean annual terms. The estimates of flood losses would not only include tangible damage to property and agriculture, but also a qualitative assessment of the intangible damage. Additional information would be collected on related topics such as the perception of the flood hazard, response of the community, insurance, etc.

The study was not specifically a cost-benefit analysis, rather the objective was to provide estimates of flood losses against which decisions of future flood mitigation measures could be assessed. It was agreed that the flood costs should be estimated in respect of the current situation in the valley, i.e., flood mitigation measures already in operation were included, but no attempt was made to assess the effects of any possible plans for the future.

1.5 METHODOLOGY USED IN THE STUDY

There is a considerable body of literature describing techniques for the assessment of flood losses and the methods used in this study follow, as far as possible, these accepted practices. However, it must be stressed that actual examples of comprehensive flood damage assessment, especially for complete river valley systems and including both tangible and intangible damage, are few. Indeed, there is no directly comparable study within Australia.

It was therefore considered necessary in the report to describe the actual procedures and assumptions in some detail. Thus, if some of the assumptions are queried, or additional information becomes available, it should be possible to adjust the estimates accordingly. Also, it is hoped that the methods employed will be of value to any similar studies undertaken either for other coastal river valleys in New South Wales or elsewhere.

1.6 STRUCTURE OF THE REPORT

The structure of the report is as follows:

(a) Chapter 2: Direct Damage for the Urban Area of Lismore.

This chapter deals separately with the residential, commercial and industrial sectors that comprise the flood prone section of Lismore.

For each sector details of the number, type, size and height of all properties are given. The damage data was obtained by the use of questionnaires distributed to a sample drawn from each sector. This was combined with other information to produce stage-damage curves. These formed the basis for the calculation of the damage for floods of differing magnitude.

The damage figures are presented in relation to flood gauge height. The 1974 flood was assumed to have a gauge height of 13.0 m. In addition, the damage figures for differing gauge heights were analysed in relation to the available flood record to obtain mean annual direct damage costs. As in later chapters, these are presented for three time periods, namely 1945-1975, 1921-1976 and 1875-1975.

(b) Chapter 3: An Assessment of Indirect Flood Damage for the Urban Area of Lismore. This represents an attempt to deal with the indirect damage to the urban area. The major topics considered are the costs of clean-up, loss of wage and salary, costs of removal and storage, and inconvenience and loss of amenity. In the commercial and industrial sectors loss of trade, production and business confidence were also considered. The available literature on the assessment of indirect loss is less clear and contains fewer examples than for direct damage. However, knowledge of the relative significance of indirect damage in relation to direct damage is likely to be of value.

(c) Chapter 4: Direct Flood Damage for the Rural Richmond Valley Agriculture and Rural Settlement. The assessment of agricultural flood damage is a very much more difficult task with no generally agreed methodology. The concept of stage-damage is not readily applicable and the approach followed was to map the rural land-use of the

flood-prone area and to combine this with damage data for individual crop types on a per hectare basis. The damage data was obtained from a questionnaire distributed to a sample of farms in the flood-prone zone. Due to the paucity of basic information, particularly the lack of data on elevation and flood limits, the agricultural losses should be regarded as having a broad error range. It was clear however, that properties above Lismore and Casino suffered relatively little damage compared to those located downstream. It was not possible to produce a reliable estimate for mean annual agricultural damage.

The values for damage to rural settlements should similarly be regarded as broad estimates since information is lacking for ground and floor heights of the property involved. It was clear that the total direct damage to isolated farm residential property is relatively small.

It should be noted that although this chapter is dominantly concerned with 'direct' damage, it also includes much of the agricultural loss that should strictly fall within the 'indirect' category, e.g., agistment, loss of milk production, etc.

(d) Chapter 5: Indirect Flood Damage for the Rural Richmond River Valley, Agriculture and Rural Settlement.

The account of the agricultural section of this chapter is dominantly concerned with the disruption to services and the effects of noxious pests, diseases, etc. Assessment of the indirect damages to the rural settlements follows the approach outlined for the Lismore urban sector. It did not prove possible to assess quantitatively the effects of disruption to the transport network.

(e) Chapter 6: Intangible Flood Damage in the Richmond River Valley. This section is concerned solely with an assessment

of the effects on health of the 1974 flood and is based upon information from the rural and urban questionnaires.

(f) Chapter 7: Estimates of Potential Urban Damage. The

calculation of potential flood damage was only undertaken for the urban area of Lismore. Potential damage is the damage that would occur if no attempt whatsoever was undertaken to reduce loss. The difference between potential and actual damage gives a measure of the effectiveness of the warning system and the degree of adjustment of the appropriate section of the community. There are problems of detail, but it would appear that the industrial sector exhibits the best adjustment and the residential sector the worst. The results of the value of house contents obtained by a professional valuer are included in this section.

(g) Chapter 8: Population Structure, Perception and Response.

This chapter presents basic demographic data for the flood-prone area and the results obtained from the questionnaires for a wide range of social questions. More specifically, it deals with aspects of flood perception, attitudes to proposed mitigation measures, sources of assistance during flood and questions of flood alleviation measures taken by individual property owners. It covers both the rural and urban communities.

(h) Chapter 9: Summary and Conclusions. This presents a broad

overall summary of the magnitude of flood losses and the major social effects. The damage costs are all expressed in dollars at 1974 prices.

1.7 PUBLICATION OF THE RESULTS

This report describes the major results of the study, but it is hoped that additional reports will also be published in the near future. These will include a short summary of this report which will also incorporate the major findings of a social and demographic survey of the flood-prone area of Lismore undertaken by the Northern Rivers College of Advanced Education. A further publication will present, in detail, computer damage maps of the urban area of Lismore based on information presented in this report. A related, but separately funded study, will discuss an analysis of the effects of floods on health based on the hospital admission records in Lismore for the year preceding the flood of 1974 and for the year subsequent to the flood.

1.8 ACKNOWLEDGEMENTS

The results presented in the report involved prior discussions on the aims and objectives with both the IDC and the Richmond River Valley Flood Action Group. However, the exact methodology and the collection and presentation of the data was undertaken entirely by the authors of the report. Thus the responsibility for the damage estimates presented is theirs.

Both the Northern Rivers CAE and the Australian National University would like to gratefully acknowledge the opportunity afforded by the IDC to undertake the study which enabled essentially theoretical methods and techniques to be applied to real world conditions. The members of the IDC with whom the form of study was discussed willingly gave of their time and experience and we would particularly like to acknowledge the assistance of John Russell, Supervising Engineer of the Flood Mitigation Section of the Public Works Department, who was the Executive Officer of the IDC.

The assistance of Ken Parr, District Engineer, of the Lismore District of the Public Works Department and his staff was much appreciated. The day-to-day contact with Fred Hogan of that Department was particularly valuable.

The assistance of all members of the Richmond River Valley Flood Action Committee was especially useful, particularly in discussions concerning the form of the questionnaires and information regarding local contacts and problems.

The assistance at all stages given by Fred Barlow, Engineer to the Richmond River County Council, was invaluable. There is no doubt that but for the co-operation and assistance afforded by Fred Barlow and his staff, the study would have been very much the poorer. In particular, the prompt and efficient manner with which the survey of flood and ground heights was accomplished was critical to the assessment of urban damage.

The co-operation of Peter Robinson, a professional valuer resident in Lismore, in collecting the data on the value of the contents of residential property was much appreciated.

Dr E.C. Penning-Rowse of the Middlesex Polytechnic in the United Kingdom, generously gave of his experience at the initial stage of the project by making available both published and unpublished material regarding flood studies in the United Kingdom.

The authors would also wish to thank colleagues, academic, technical and secretarial, for their willing and patient assistance. Our thanks especially to Mrs Ettie Oakman and Mrs Joan Macy for the typing of many drafts of the report and to Mrs Elizabeth Barta for drawing the diagrams.

CHAPTER 2

DIRECT FLOOD DAMAGE FOR THE URBAN AREA OF LISMORE

2.1 INTRODUCTION

There are a variety of ways in which flood damage can be assessed. One widely used classification, which will be adopted in this report, is to subdivide damage into three major classes, namely direct, indirect and intangible. Examples of the major categories of damage within each of these classes is given in Table 2.1. If sufficient data is available both direct and indirect damage can be expressed in monetary terms but this is not the case with intangible damages.

TABLE 2.1
TYPES OF FLOOD DAMAGE

	Examples of damage in each category
Direct	Structural damage to property and contents due to contact with flood waters
Indirect	Loss of trading profit or enforced absence from work Traffic disruption and diversion costs
Intangible	Ill health, both physical and psychological. Anxiety General inconvenience

2.2 DIRECT DAMAGE - GENERAL PROCEDURE

For the urban area of Lismore it is useful, for the purposes of analysis and presentation, to consider direct flood damage

separately for the residential, commercial and industrial sectors.

The procedure for each sector can be subdivided as follows.

- (a) Variations in urban land-use were surveyed for the area below the 13.0 m flood line, which for the purposes of this study is considered to delimit the flood prone area of the city.
- (b) Questionnaires were distributed to a selected sample of property holders in various subcategories of each of the three major urban land-uses.
- (c) The questionnaire data were analysed to produce stage-damage curves for the various land-use categories. Stage-damage curves enable the damage at differing flood heights to be obtained.
- (c) The stage-damage curves were used to obtain values for direct damage at specific flood heights.
- (d) The damage values for each land-use class were combined with information on the frequency of flooding to obtain an estimate of mean annual damage.

2.3 DIRECT DAMAGE - RESIDENTIAL SECTOR

The procedure outlined above was applied to the residential sector of the flood prone area of Lismore in order to assess direct damage.

2.3.1 Residential Land-use

All the houses in the flood-prone area were subjected to external examination and salient characteristics noted. For each house information was noted on the following:

- (a) Road name and number.
- (b) Whether the house was raised above the general ground level.
- (c) The type of floor material.
- (d) The type of wall material.
- (e) A broad classification of size.
- (f) External condition.
- (g) Classification of house type and use, by Bunker Code.

The information obtained for each of these land-use characteristics is discussed below.

2.3.1.1 Road Name and Number

There is a considerable problem in allocating the street number that is applicable to an individual property. In many of the statistical tables related to residential property the small differences in numbers between differing tables and figures are due to difficulties in relating surveys undertaken by differing bodies to specific properties. The extra time outlay in attempting to resolve the street numbering problem was considerable. There was a total of 1906 residential properties in the flood-prone area.

2.3.1.2 Raised Property

The land-use survey listed 1561 (82%) of the 1906 properties in the flood-prone area as 'raised'. There is a difficulty from a visual

survey in distinguishing between properties raised after their initial construction and those that were constructed to be well above ground level. Many of the older houses will have been raised after construction. It should be noted that since 1954 the City Council's building regulations require residential floor levels to be at least one foot above record flood levels.

Figure 2.1 shows the percentage of properties in the flood prone area in relation to ground height, grouped into 0.5 m classes. Approximately 50% of the properties have ground heights below 11.0 m. Figure 2.1 shows, in a similar manner, the distribution of floor heights. In this case only 1.6% of the properties have a floor height below 11.0 m and 55% have floor heights at 13.0 m or more. The information is also given in Table 2.2.

The significance of raised property to the flood damage is further demonstrated in Figure 2.2 which shows the number of houses with water at ground level and above floor height in relation to gauge height. This data is reorganised in Figure 2.3 to give the number of houses, at each flood height, which are flooded to differing depths above floor height.

It is apparent from these illustrations that the raising of houses in Lismore, which has been progressively undertaken over the last forty years or more, represents a clear and valuable response to the problems of flood hazard. These essentially individual owner-occupier decisions have reduced the direct flood damage suffered by the residential sector by a very large amount.

Figure 2.4 shows the percentage of residential properties in each band (ground height) that are raised. This varies from 56.0% for the properties with ground heights in the 12.5-13.0 m band to 100% for those below 8.0 m. While the number of raised houses in each height range is

greater than 50.0% those with ground heights between 8.0 and 9.5 m and those which are close to the upper flood zone show the lowest proportion of raised houses. In the former case it is suggested that the costs and practicability of raising the house by 3.0 m or more are such as to cause many owners not to take this step. In the latter case the houses are only liable to very occasional flooding to a limited depth and the owners probably do not consider it worthwhile to undertake the costs and disturbance of having their house raised.

TABLE 2.2
DISTRIBUTION BY GROUND AND FLOOR HEIGHT OF RESIDENTIAL
PROPERTY IN RELATION TO GAUGE HEIGHT

Height in relation to flood gauge in metres	Ground height		Floor height	
	Number in population	Number in sample	Number in population	Number in sample
6.5 up to 7.0	2 (0.1%)			
7.0 up to 7.5	2 (0.1%)			
7.5 up to 8.0	3 (0.15%)	1 (0.7%)		
8.0 up to 8.5	9 (0.7%)	1 (0.7%)		
8.5 up to 9.0	24 (1.3%)	3 (2.1%)		
9.0 up to 9.5	75 (4.0%)	7 (4.9%)	3 (0.2%)	
9.5 up to 10.0	147 (7.8%)	20 (14.1%)		
10.0 up to 10.5	269 (14.3%)	25 (17.6%)	11 (0.6%)	4 (2.8%)
10.5 up to 11.0	413 (22.0%)	32 (22.5%)	15 (0.8%)	1 (0.7%)
11.0 up to 11.5	304 (16.2%)	29 (20.4%)	54 (2.8%)	3 (2.1%)
11.5 up to 12.0	321 (17.1%)	13 (9.1%)	131 (6.9%)	17 (12.0%)
12.0 up to 12.5	225 (12.0%)	10 (7.0%)	239 (12.6%)	23 (16.2%)
12.5 up to 13.0	84 (4.5%)	1 (0.7%)	396 (20.9%)	34 (23.9%)
13.0 up to 13.5			463 (24.4%)	33 (23.2%)
13.5 up to 14.0			277 (14.6%)	19 (13.3%)
14.0 up to 14.5			189 (10.0%)	6 (4.2%)
14.5 up to 15.0			112 (5.9%)	2 (0.7%)
TOTAL	1878	142	1895	142

The data from the survey of ground and floor height enables a breakdown to be made of the height to which houses have been raised. This information is presented in Table 2.3 and Figure 2.5. It should be noted that this information is for all houses in the flood-prone area and not limited to houses noted as 'raised' in the land-use survey. Over 50% of the floor heights of the properties are between 2.0 and 2.5 m above ground level, while only 18.8% of the ground floor levels are less than 1.5 m above the local ground level. If 1.5 m is taken as the minimum height between floor and ground level for 'raised' houses this figure corresponds closely to the number of houses reported in the land-use survey as 'raised'. It would also appear that few owners are prepared to raise their houses more than 3.0 m above ground level.

TABLE 2.3
DIFFERENCES BETWEEN GROUND AND FLOOR LEVEL FOR RESIDENTIAL
PROPERTIES IN THE FLOOD-PRONE AREAS OF LISMORE

Difference between floor and ground level	Number of properties	Percentage
0.0 to 0.5 m	51	2.6
0.5 to 1.0 m	180	9.6
1.0 to 1.5 m	125	6.6
1.5 to 2.0 m	232	12.3
2.0 to 2.5 m	992	52.5
2.5 to 3.0 m	197	10.4
3.0 to 3.5 m	84	4.4
3.5 to 4.0 m	25	1.3
4.0 to 4.5 m	5	0.3
Above 4.5 m	0	0.0
TOTAL	1891	100.0

Information was not available for fifteen properties.

2.3.1.3 Floor Material

Of the 1899 properties for which information was obtained, 1872 (98.6%) had wooden floors and the remainder were of varying forms of concrete construction. Differences in relation to height range are considered as insignificant.

2.3.1.4 Wall Material

Information was available for 1854 properties and 1726 (93.1%) had wooden walls. Other forms of wall construction were 3.6% of fibro construction, 2.8% were brick and 0.8% were of other material.

2.3.1.5 Size Classes

The external visual survey divided residential property into three classes, the relationship between size and frequency is given in Table 2.4.

TABLE 2.4
ANALYSIS OF SIZE OF PROPERTIES

	Floor area	Number of properties	Percentage of properties
Small	Less than 80 m ²	524	27.6
Medium	80 - 140 m ²	1336	70.4
Large	Greater than 140 ²	38	2.0
Total number of properties	1898		

In all later discussions that include size, the 'medium' and 'large' categories were merged.

There is some variation in the proportion of properties of various sizes with height. For properties with a ground height of less than 10.0 m there are 40.9% in the category smaller than 80 m² compared to 26.8% in the height range of 10.0 to 13.0 m.

It should be stressed that the assessment of size was undertaken by visual inspection and the data presented should be considered as approximate although the information is thought to have an internal consistency as one surveyor was used throughout this aspect of the study.

2.3.1.6 External Condition

Condition was based solely on external appearance and the criteria used for the visual assessment are given in Appendix 2.1. Again the internal consistency is regarded as satisfactory but care should be taken not to extrapolate the results to other urban areas.

An outline of the number of properties in each 'condition' class is given in Table 2.5 and a more detailed analysis of condition in relation to height is presented in Figure 2.6.

TABLE 2.5
ANALYSIS OF EXTERNAL CONDITION

Condition	Number of properties	Percentage of properties
Poor	318	16.7
Fair	1517	79.7
Good	68	3.6
Total number of properties	1903	

Apart from the very small number of houses in the lowest height classes there is a consistent fall in the number classified as having a 'poor' external condition with increasing ground height elevation. There would appear to be a marked change for houses whose ground elevation is less than 10.0 m with those above that height. For those with a ground elevation below 10.0 m, 42.3% are classified as poor as opposed to 12.4% for those above 10.0 m.

The houses classified as in good condition are a very small class, only 3.6% of the total. Below 10.0 m, 0.7% of the houses are in this category and above the figure is 3.8%.

This information is for all houses and not just for those that are raised but there is a clear indication that the houses that experience more frequent flooding, and flood to a greater depth, are in poorer condition.

2.3.1.7 Bunker Code Classification of House Type

The urban land-use survey also classified the residential properties in relation to the Bunker Code. Only three categories were used, namely Codes 111, 112 and 114. Code 111 corresponds to 'detached cottage, house or dwelling', 112 is for 'semi-detached or duplex construction', and 114 is used for 'flats'. In this study any residence that was clearly divided into two or more separate living units was classified as a 'flat'. It should be stressed that the survey was based solely on external features and the number falling into this category is likely to be an underestimate. The results are presented in Table 2.6.

The number of properties in classes 112 and 114 is small and the variation of the occurrence of these forms of residence with height, shows little systematic pattern.

TABLE 2.6
CLASSIFICATION OF PROPERTY BY BUNKER CODE

Bunker classification	Number of properties	Percentage of properties
Class 111, detached houses	1800	94.4
Class 112, semi-detached houses	42	2.2
Class 114, flats	64	3.4
Total number of properties	1906	

2.3.2 Residential Questionnaire

A draft questionnaire was drawn up and submitted to a small group of householders in order to assess its usefulness in obtaining the information required. This draft questionnaire was administered by post. The original questionnaire was modified and the final residential questionnaire consisted of thirty-six possible sections, many of which were subdivided into additional questions. A copy of the questionnaire is given in Appendix 2.2.

The majority of the one-hundred-and-fifty questionnaires were collected using interview techniques. The interviewer called at a selected house and interviewed a responsible adult member of the household. Although the completed number of questionnaires was one-hundred-and-fifty, for individual questions the response rate is less. The reasons for this vary with the question, in some cases the ownership of the property had changed since the 1974 flood, some houses were not flooded above the floor boards, for various questions the respondents did not know the answer and in other cases particular questions were

not applicable. However, the overall co-operation of the respondents was excellent and there were very few refusals to participate.

The distribution of the questionnaires was chosen to be as representative of the total 'population' of residential properties as possible. The properties were selected after the urban land-use survey had been completed and the sample was chosen in relation to the results obtained in that survey. The sample was selected to take account of both the spatial distribution of the houses within the flooded area of Lismore (i.e., North, South, and East Lismore) and to the likely depth and frequency of flooding. To select a sample that is truly representative of all these factors is virtually impossible, but Table 2.7 presents details of the chosen sample in relation to the total population of 1906 properties.

The questions used to obtain information for the calculation of actual flood damage curves are Nos. 4a and b, and 5, on the Residential Questionnaire. The information from the other sections of the questionnaire is discussed elsewhere in this report and a copy of the questionnaire is given in Appendix 2.2.

2.3.3 Residential Stage-damage Curves

The object of a stage-damage curve is to obtain, for a particular class of property, a measure of the direct damage due to water flooding the building to differing heights (or stage). In the Lismore study these figures were obtained from the questionnaire data by considering questions 4a and b, and 5. These yielded information on the depth of flooding and the respondent's estimate of direct flood damage, and were combined to give an overall stage-damage curve. Where the major flood damage did not occur in the 1974 flood the damage estimates are adjusted to 1974 prices.

TABLE 2.7

SAMPLE SIZE FOR VARYING CHARACTERISTICS OF THE TOTAL
NUMBER OF RESIDENTIAL PROPERTIES

	Number in population	Number in sample
RAISED PROPERTY		
Raised	1561 (82.0%)	120 (83.4%)
Not raised	343 (18.0%)	20 (16.6%)
FLOOR MATERIAL		
Wood	1872 (98.6%)	140 (100.0%)
Concrete and other	27 (1.4%)	Nil
WALL MATERIAL		
Wood	1726 (93.1%)	134 (95.8%)
Fibro	66 (3.6%)	3 (2.1%)
Brick	47 (2.5%)	1 (0.7%)
Other	15 (0.8%)	2 (1.4%)
SIZE OF PROPERTY		
Small	524 (27.6%)	39 (27.9%)
Medium	1336 (70.4%)	99 (70.7%)
Large	38 (2.0%)	2 (1.4%)
CONDITION		
Poor	318 (16.7%)	32 (22.9%)
Fair	1517 (79.7%)	106 (75.7%)
Good	68 (3.6%)	2 (1.4%)
BUNKER CODE CLASSIFICATION		
Detached (111)	1800 (94.4%)	140 (100.0%)
Semi-detached (112)	42 (2.2%)	-
Flats (114)	64 (3.4%)	-

GEOGRAPHICAL LOCATION

	Location of sample
North Lismore	43 (28.7%)
South Lismore	46 (30.7%)
East Lismore	61 (40.6%)

The information for ground and floor height is given in Table 2.2.

There are a number of problems involved in the construction of a stage-damage curve from questionnaire data of the kind used in this study.

- (a) The survey was conducted two to three years after the major flood of 1974 had occurred. As a result some of the householders questioned were not resident at the time of the flood and this reduced the number of usable questionnaires.

- (b) The damage figures used are estimates produced by the householder and the decision was made (Question 5) to ask for these estimates to be within certain damage classes. This procedure has the advantage in that few householders will express the damage in absolute figures but are prepared to estimate the damage within class limits. However, it does add a complication in attempting to draw up average figures which are based upon class interval data.

- (c) The stage-damage curve used to estimate the overall residential damage is an average figure obtained by 'lumping' all the residential data regardless of house size, construction material or external condition. However, separate stage-damage curves related to size and external condition were produced but are not presented in this account. The decision to use the 'lumped' data was taken in order to use the largest possible sample. As the sample of houses used to calculate the overall stage

damage curve was chosen to be representative of the total number of residential properties the use of this 'lumped' information is considered to be the most appropriate.

- (d) Many of the houses in the flood affected area are raised and flood waters do not reach the floor level although the grounds may be substantially inundated. However, the area immediately underneath the house is frequently used for storage and occasionally contains heavy items of household equipment such as washing machines, work benches etc. Information was gathered by the interviewers on the losses sustained by damage to items stored in this 'under-house' space. Although the sample of houses in this category was limited a separate stage-damage curve for this under-house storage was calculated and used in obtaining overall flood estimates.

The stage-damage curve in Figure 2.7 was obtained by considering depth of flooding and the direct damage for all houses that reported water over the floor boards. The curve is itself a mean of damage for houses in various height classes. It is important to note that the scatter of the damage for individual houses shows considerable variation. This scatter is comparable to that obtained in similar studies and the mean value is normally taken. A scatter plot for the ninety-five houses with water over the floor boards for which height and damage data is available, is given in Figure 2.8. This was analysed so that damage values were obtained for the following height classes, 0.0 to 0.24 m, 0.25 to 0.59 m, 0.60 to 1.09 m, 1.10 to 2.5 m, and above 2.5 m. The mean points of these classes are plotted at 0.11, 0.37, 0.83, 1.4 and 3.0 m to give the overall stage-damage curves used in Figure 2.7.

The data was also analysed for houses in relation to property size or condition, but the differences were small and it was considered appropriate to use the mean stage-damage curve for the whole population of houses in the flood-prone area. A scatter plot for 95 houses that reported water over the floor is given in Figure 2.8.

The only modification to the overall stage-damage curve was for raised houses. An analysis of the direct damage to material stored in the under-house space indicated that a mean figure of \$76 was appropriate for floods that reached a height of 1.0 m over ground height. In cases where the under-house was flooded to depths of less than 1.0 m the damage was assumed to be linear; this is illustrated in Figure 2.9. Where flood water went over floor level, in raised houses, this additional sum of \$76 was added to the information obtained from the stage-damage curve in Figure 2.7.

2.3.4 Residential Flood Damage at Specific Flood Heights

The analysis was very considerably aided by the availability of information on ground and floor levels for the whole of the flood-prone area of Lismore. This data was collected during the earlier part of the study period by the Richmond River County Council, under the supervision of County Engineer, F. Barlow. The height data was presented in relation to the Lismore Flood Gauge Datum. This information was made available to the study and the lists were coded and are available on tape.

The coded information thus included details for every residential property in urban Lismore in terms of the road name and number, whether the property was raised, construction material, size, external condition, ground and floor height and a grid square reference.

Residential damages were calculated from this data base. The stage-damage curve given in Figure 2.7 was included in the program as well as the modification for raised houses presented in Figure 2.9. The

computer was then set for a specified flood gauge height and searched the data file for each individual property. If the property was flooded the appropriate stage-damage value was stored (with a separate consideration for under-house damage for raised properties). These individual property damages were then added to give total residential direct damage for that stage. In practice, this operation was normally combined with a routine that also added the property damage for each grid square and, if required, the damage value can be plotted out in computer map form.

Having established this procedure which uses surveyed ground and floor heights, two further refinements were built into the program. First, allowance was made for the presence in Lismore of flood protected areas and second, the effects of flood water gradient were considered. In both cases the information used was supplied by F. Barlow.

There are two protected areas which are shown in Figure 2.10, namely the Browns Creek and the South Lismore areas.

For the Browns Creek area some stormwater flooding occurs within the protected area and the levels that were used in the calculation of damage are given in Table 2.8. At a stage height of 11.0 metres, protection ceases.

TABLE 2.8
FLOOD GAUGE AND BASIN LEVEL HEIGHTS FOR THE BROWNS
CREEK PROTECTED AREA

Gauge height	Basin level
Below 10.4 m	6.5 to 7.0 m
10.6 m	7.5 m
10.8 m	8.0 m
10.9 m	9.0 m
11.0 m and above	River level

In the case of the South Lismore protected area at heights of 12.0 m and above, there is no protection, and for flood heights less than this, the level within the protected area is assumed to be 2 m below river level. This information regarding the extent of the protected areas, in relation to gauge height, was incorporated into the overall damage estimates.

The information of the effects of flood water gradient were also incorporated on a trial basis into the residential damage program. The potential importance of such data is that the damage is normally assessed for a specific flood gauge height and the water surface is assumed to be at that level throughout the flooded urban area. In reality there is a gradient on the flood water surface and the slope of this gradient increases with flood stage. Thus at the 12.0 m gauge height the actual flood heights in the Lismore area can vary from 12.4 to 11.6 m for the upstream and downstream limits of the urban area. The gradient is less for smaller floods. The effects of the flood gradient were considered but the difference between the total residential damage with a single flood height and with a flood gradient surface were so insignificant that the procedure was dropped from the study. It should be noted that the program used is quite capable of including flood gradient information, and for either a larger urban area than Lismore or for an urban area where the flood gauge is not centrally located, the effects of the flood gradient could be considerable.

Thus the estimates for residential flood damage presented for Lismore in this report, and used in assessing mean annual damage, make allowance for the existing flood protected areas in Lismore, but do not include allowances for flood gradient. The results are presented in Figure 2.11 and in Table 2.9. Table 2.9 also shows estimates of the direct damage that would be sustained without the protection afforded in the Browns Creek and South Lismore areas.

TABLE 2.9
ESTIMATED TOTAL DIRECT FLOOD DAMAGE FOR THE RESIDENTIAL
SECTOR IN RELATION TO GAUGE HEIGHT

Gauge height	Total damage	Total damage (without protected areas)
9.50 m	Negligible	6,200
10.0 m	6,800	17,800
10.5 m	20,300	41,400
11.0 m	74,500	80,100
11.5 m	137,000	160,800
12.0 m	328,800	328,000
12.5 m	625,900	625,900
13.0 m	1,118,900	1,118,900

All damage figures in dollars at 1974 prices.

2.3.5 Mean Annual Estimates for Direct Flood Damage - Residential Sector

For planning and management purposes the simplest way to express flood damage is as a mean annual value. To obtain a meaningful mean annual damage estimate a long record of flood heights is required from which the probability of occurrence of floods of specific heights can be calculated.

2.3.5.1 Flood Probabilities for Lismore

The situation for the Richmond River at Lismore is that a long record of stage heights for major floods is available but there is, inevitably, some query as to the reliability of the early part of the series. The data used in this report are 'best estimates' and were made available by the Public Works Department and the Richmond River Council. The flood record on which the probability curves and damage calculations are based is given in Appendix 2.3.

The flood record has been divided into three series by the Public Works Department. Thus separate curves are available for the years 1921-1976, 1945-1975 and for the whole run of record, 1875-1975. These three curves are presented in Figure 2.12, and are currently the best estimates available.

In the present study attempts were made to analyse the data set using differing techniques to calculate probability, but the overall conclusion is that the method used by the authorities in Lismore, and the periods chosen for the differing flood series, are the most appropriate for the estimation of flood damage. The dates chosen for the breaks in the series correspond either to periods of more reliable information or, in the case of 1945, to a period when the frequency of flooding would have appeared to increase. For the purposes of the calculation of the 1% (1 in 100 years) flood, the flood stage was taken as 13.00 m. Thus in presenting the mean annual damage estimates for Lismore, a value is presented for each of the three flood series.

Those responsible for drawing up the flood probability curves would like it to be stressed that these are 'best estimates' obtained from a flood record which may be far from perfect. However, it would be a relatively simple exercise to combine the direct damage estimates, presented in Figure 2.11, with any other form of statement concerning the flood probabilities of the Richmond River to obtain the corresponding mean annual damage.

2.3.5.2 The Mean Annual Damage Costs for the Residential Sector of Lismore

The mean annual damage for the residential sector can be calculated in two ways.

- (a) The height of each major flood from the record presented in Appendix 2.3 is noted and then summed for the length of record used. The mean is then obtained by dividing by the number of years in the record.
- (b) The probability curves in Figure 2.12 are converted so that flood damage replaces stage. An example for the 1921-1976 series is given in Figure 2.13. The mean annual damage is then found by integrating the area under the curve. This operation was performed using a simple computer routine. This can be considered as the normal procedure.

The results were similar although the first method gave results that were approximately 10% lower. All the annual damage costs presented in this report use the second of the methods described above.

The mean annual direct damage estimates for the residential sector of Lismore are presented in Table 2.10. These are at 1974 prices and allow for the protected areas as defined in section 2.3.4.

TABLE 2.10
MEAN ANNUAL DIRECT DAMAGE ESTIMATES FOR THE
RESIDENTIAL SECTOR OF LISMORE

Period of flood record	Mean annual damage
1945-1975	\$125,000
1921-1976	\$80,200
1875-1975	\$59,800

All values at 1974 prices.

It can be seen that there is a very considerable variation in the damage figures depending on what period of record is selected. If it is necessary to select a single figure for planning purposes the choice should, in our opinion, be between \$125,000 and \$80,000 per year. The flood data for the earlier period of the 1875-1975 series is too suspect for detailed analysis and decision-making. The higher figures for the years 1945-1975 are not unexpected as there is some evidence that there was a general increase in rainfall and flood frequency in eastern Australia during this period. However, assumptions as to whether this is likely to be a longer-term trend or a short-term variation, are pure speculation

2.4 DIRECT DAMAGE - COMMERCIAL SECTOR

The major problem in commercial flood damage assessment is the wide range in size and type of individual enterprise. This is particularly marked for Lismore which, due to its function as a regional service centre, has a large number of commercial outlets. The general procedure was to survey the total range of commercial premises in the flood-prone area, to distribute questionnaires to a selected sample and to use the results to construct stage-damage curves adjusted for floor area size.

2.4.1 Commercial Land-use Survey

The urban land-use survey, described for the residential sector (section 2.3.1) also classified all the commercial outlets in terms of the type of business undertaken. This initial survey used the Bunker Code classification. The land-use survey did not classify the commercial buildings in the detail undertaken for the residential sector as, with

a few minor exceptions, the commercial premises are all of brick or stone and usually of two-storey construction.

2.4.2 Floor Heights of Commercial Premises

The differences in the nature and type of construction of the commercial properties, in comparison to those of the residential sector, have a marked influence on the flood damage. This results essentially from the fact that it is not possible to raise existing commercial properties in the manner undertaken for the majority of the flood-prone houses in the residential sector.

The distribution of the floor heights for the commercial sector is given in Figure 2.14. This is in marked contrast to the corresponding diagram (Figure 2.1) for the floor heights of the residential property. The data is presented in a different form in Figure 2.15 which shows the number of commercial outlets which are flooded to differing heights above floor level for differing gauge heights. The contrast to the residential sector is seen by comparing this figure to Figure 2.3.

With the exception of a very small number of retailers, who could be classified as 'corner shops', none of the commercial property has been raised subsequent to construction. A limited number of recently built premises in the central area were constructed so that the ground floor is used for car parking or similar purposes; in these cases the floor height used is that corresponding to the level on which commercial activity is carried out.

2.4.3 Range of Commercial Activity

There are some 680 commercial premises in the flood-prone area of Lismore. As would be expected these range in size from a few square metres, for some of the arcade shops, to areas of several thousand

square metres for services that involve storage of bulk materials. The range of commercial service provided is also extensive and susceptibility of the products and equipment to flood damage also shows wide variations. In some cases damage by total immersion would have little effect, e.g., monumental masons, in others the losses would be virtually the whole stock, e.g., many types of perishable food shops.

The variations in type of commercial activity and variations in size, cause very considerable problems in assessing flood damage by stage-damage methods.

2.4.3.1 Types of Commercial Activity

During the course of the urban land-use survey every commercial outlet in the flood-prone area was classified. This classification was undertaken using the Bunker Code, which represents the classification used for most planning purposes in Australia. There are some 150 commercial Bunker Code classes represented in Lismore and a listing of these is given in Appendix 2.4. As with any classification there are numerous minor problems. These stem from the multipurpose nature of many shops and detailing these problems is considered out of place in this report. The type of problem can be readily appreciated by a cafe which also sells 'take-away' food, retails bread and a limited range of groceries, plus newspapers and tobacco.

The general principle was to classify these multipurpose shops in relation to an assumed major enterprise.

The Bunker Code classification is too detailed for a useful summation of the major commercial classes, although it is hoped that the detailed classification may be of value for general planning purposes and the complete listings are available on computer tape. For the purposes of the flood study the Bunker classes represented were

re-grouped into 21 classes. The aim of this re-grouping was to classify Bunker Code classes so that commercial operations which would be likely to experience similar forms of flood damage were in the same class. For example, Commercial Flood Category 4 includes all perishable food establishments, retail and wholesale, plus cafes and men's hairdressing. The latter service activity is included as from the data collected the flood damage profile for men's hairdressing was similar to that for perishable foods! The detailed composition of the Commercial Flood Categories used in this study are listed in Appendix 2.4 and a very brief description of the categories is given in Table 2.11.

The classification of commercial undertaking in relation to the number of establishments is presented in Table 2.11 which also shows the number in each class that was included in the sample for which questionnaire information was collected.

The four major Commercial Flood Categories are perishable foods (Category 4), filling stations, car repairs and accessories (Category 11), establishments that are essentially of an office nature (Category 17) and car, tractor and marine sales plus other establishments where much of the value is in vehicles that can be moved (Category 10). These four classes account for nearly 50% of the commercial outlets. The salient feature of the commercial sector in Lismore is the very large number of individual outlets which are located in the flood-prone area. This reflects both the importance of the town as a regional centre and the concentration of commercial property in the flood-prone area.

2.4.3.2 Size of Commercial Premises

For the residential properties in Lismore there is relatively little difference in damage sustained, at a given flood height, for houses of differing sizes. However, for the commercial sector size is

undoubtedly an important feature. For example, the damage sustained by general grocery shops will vary enormously from a unit that is a corner shop in a residential area to a supermarket located in the central business area. This problem is recognised in all flood studies of commercial property and the usual practice is to present damage figures in terms of area. The unit area taken in this study was measured in 1000's of square feet although the results are also presented in terms of metric equivalents.

The problem is how to assess the relevant area for an individual enterprise for flood damage purposes. For example, for many shops the floor area can be divided into shop space, indoor storage space and the total area occupied, which frequently includes a concrete area at the rear of the premises used for loading and unloading of supplies. Assessment of the use of floor area was obtained for those premises included in the full commercial questionnaire but it is not possible to undertake such an assessment for the total number of properties in the commercial sector. After preliminary analysis of the data the 680 properties comprising the total flood-prone commercial sector were classified into three size categories, classes 1, 2, and 3. In very general terms, the size categories chosen represent small shops (typical of single frontage properties in the central shopping area), larger shops and premises that covered a very much larger area. The latter class would include the largest shops, most filling stations and many services that involve bulk storage. The size classes used and the numbers in each class are given in Table 2.12.

An analysis was made of the frequency of size class in relation to gauge height but the distribution for all three classes was essentially similar.

TABLE 2.11
NUMBERS OF OUTLETS IN EACH COMMERCIAL FLOOD CATEGORY

Flood Category	Number in population	Number in sample
1. Motels and retirement homes	17 (2.5%)	2 (0.9%)
2. Wholesale petroleum products	5 (0.7%)	2 (0.9%)
3. Hardware and building materials	51 (7.5%)	18 (8.5%)
4. Perishable foods	115 (16.9%)	36 (17.1%)
5. Electrical goods	52 (7.6%)	11 (5.2%)
6. Department stores	7 (1.0%)	2 (0.9%)
7. Beer, wines and spirits	19 (2.8%)	6 (2.8%)
8. Furniture and antiques	15 (2.2%)	7 (3.3%)
9. Drapery, clothing and footwear	54 (7.8%)	11 (5.3%)
10. Vehicle sales	55 (8.0%)	22 (10.4%)
11. Service stations and motor accessories	75 (11.0%)	23 (10.8%)
12. Sporting goods, music	23 (3.8%)	7 (3.4%)
13. Plants and shrubs	5 (0.7%)	4 (1.9%)
14. Other basic supplies	4 (0.6%)	1 (0.9%)
15. Chemists and opticians	13 (1.9%)	4 (1.9%)
16. Books and newsagents	9 (1.3%)	5 (2.4%)
17. Offices	75 (11.0%)	30 (14.1%)
18. Other personal services - medical	3 (0.4%)	-
19. Libraries and museums	2 (0.2%)	2 (0.9%)
20. Servicing and manufacturing - <u>not</u> included in Industrial Sector	52 (7.6%)	16 (7.5%)
21. Vacant floor area	31 (4.5%)	-
TOTALS	682	212

NOTE: A full listing of the Bunker Code classes included in each Flood Category is given in Appendix 2.4.

TABLE 2.12
SIZE OF PROPERTIES IN THE COMMERCIAL SECTOR

	Area	Number of properties	Mean size of class	Number in sample
Class 1 (small)	Less than 186 m ² (2000 ft)	357 (52.5%)	78 m ²	98 (48.4%)
Class 2 (medium)	186-650 m ² (2000-7000 ft ²)	187 (27.5%)	335 m ²	64 (31.7%)
Class 3 (large)	Greater than 650 m ² (7000 ft ²)	136 (20.0%)	2300 m ²	40 (19.9%)

2.4.4 Commercial Questionnaire

A sample of commercial outlets was selected for the distribution of a detailed questionnaire. The sample was chosen after the Bunker Code classes had been re-classified into Commercial Flood Categories. In contrast to the residential and industrial sectors there was a relatively poor response from many of the commercial properties. In part, this may be due to the time taken to complete the questionnaire for busy owner-occupiers of small shops but perhaps most disappointing was the unwillingness of many large interstate concerns to provide even the more basic information. However, a total of 197 of these full commercial questionnaires were completed although information on all sections of the questionnaire was not always given.

Due to the variability of size, range of service provided, and the relatively poor response, a second questionnaire was circulated to a selection of commercial properties that had not completed the full questionnaire. This second questionnaire was very much shorter and only asked for information on size, flood damage and depth of floodwater in

the 1974 flood. This added a further 100 or so questionnaires. The commercial flood damage assessment is based on a total of 212 respondents. There was considerable difficulty with this section of the survey due to the problems of street numbers. Indeed many shops in the central shopping area did not actually know what their street number was!

Copies of both the full and attenuated questionnaire are given in Appendices 2.5 and 2.6. Details of the sample used in relation to the total population of commercial outlets is presented in Tables 2.11 and 2.12.

2.4.5 Commercial Damage

The damage included in this section is that sustained by buildings, stock and equipment. For purposes of comparison the damage is presented in terms of damage per 1000 ft² (approximately 93 m²). Ideally stage-damage curves would be constructed for each Flood Category (as defined in section 4.3.1). However, this is not a viable approach as the number of commercial outlets sampled in most of the Flood Damage Categories is too limited.

The difficulties of this approach are illustrated in Figure 2.16 which shows the damage sustained by the premises sampled in Flood Category 4 (perishable foods) and 10 (vehicles) when flooded to differing depths. The scatter of data is immense but it is also clear that damage to Category 4 premises is very much greater than for Category 10. The data is per unit area but it should be noted that 24 of the 28 premises in Category 4, are of class 1 size (less than 2000 ft²) while 14 out of 18 in Category 10, are in class 3 (greater than 25,000 ft²).

Some information can be gained by considering the mean damage value (in per unit area terms) for each of the Commercial Flood

Categories for which a reasonable number of values are available.

The means for the Flood Categories with the larger samples are given in Table 2.13.

TABLE 2.13

MEAN DAMAGE VALUES PER UNIT AREA FOR DIFFERING FLOOD CATEGORIES

	Damage per 1000 ft ² in dollars	Damage per square metre in dollars	Number in sample
		\$	
3. Hardware building material	1780	19	18
4. Perishable foods	2582	28	36
5. Electrical goods	4548	49	11
7. Beer, wine and spirits	2000	22	6
8. Furniture and antiques	2264	24	7
9. Drapery, clothing and footwear	5564	60	11
10. Vehicle sales	1076	12	22
11. Service stations and motor accessories	2278	24	23
12. Sporting goods, music	1342	14	7
15. Chemists and opticians	2384	26	6
16. Books and newsagents	2298	25	5
17. Offices	1243	13	30
20. Services and manufacturing	979	11	16

All values at 1974 prices

2.4.6 Commercial Stage Damage Curves

The use of individual stage-damage curves for each of the differing categories of commercial activity is not a practical approach for this present study. The method adopted was to produce three separate stage-damage curves based solely on a consideration of the size of the premises. The three curves are illustrated in Figure 2.17 and were constructed regardless of the type of commercial activity.

The data used to construct the commercial stage-damage curves was based upon mean damage costs per 1000 sq.ft and this was then adjusted to the mean size of each of the three classes used. For example, the initial stage-damage curve for Size Class 1 was in terms of damage per 1000 sq.ft but to obtain the stage-damage curve used in the study, and illustrated in Figure 2.17, this was adjusted to the mean of that class which was 840 sq.ft.

This was far from ideal, but the sample chosen for the distribution of the questionnaire closely represented the total commercial population both in terms of Flood Categories and Size, see Tables 2.11 and 2.12.

2.4.7 Commercial Flood Damage at Specific Flood Heights

The procedure closely followed that described for the residential sector. The data for all the flood-prone commercial properties was put onto computer tape and the damage assessed for a pre-set flood gauge height. The computer information listed for each property the number and street, the floor height, the Bunker Code classification, the size class and a grid square reference. Thus for a given flood height each commercial property was considered in turn in relation to the appropriate stage-damage curve and the values summed to give the total commercial damage for that flood height. As a sub-routine, computer maps of commercial damage by grid square can be produced.

The results of the estimates of direct flood damage for the commercial sector at various flood heights are given in Table 2.14 and in Figure 2.18. The data is presented with allowance for the protected flood areas and without such protection.

These figures are very much larger than those sustained by the residential and industrial sectors. It may be helpful to present the

direct damage at 13.0 m as a cost per commercial property - this value is about \$5400. At that flood height the average depth of water over the floor of the commercial properties is nearly 2.0 m with some properties having in excess of 5.0 m of water.

TABLE 2.14
ESTIMATED TOTAL DIRECT FLOOD DAMAGE FOR THE COMMERCIAL
SECTOR IN RELATION TO GAUGE HEIGHT

Gauge height	Damage in dollars	Damage in dollars (no allowance for protected areas)
10.00 m	45,600	246,000
10.25 m	54,600	291,853
10.50 m	84,400	356,700
10.75 m	411,800	456,000
11.00 m	600,000	607,800
11.50 m	1,092,900	1,140,924
12.00 m	1,944,300	1,944,300
12.50 m	2,842,600	2,842,600
13.00 m	3,699,800	3,699,800

All damage figures at 1974 price.

2.4.8 Mean Annual Estimates for Commercial Flood Damage

The same general procedure was applied to the commercial data, to obtain mean annual costs, as was used for the residential sector. The results for the three series of flood records are presented in Table 2.15.

The mean annual estimate for direct damage that is considered the most appropriate for planning purposes would be in the range from about \$400,000 to \$590,000. This is slightly less than \$1000 per year for each commercial outlet.

TABLE 2.15
MEAN ANNUAL DIRECT DAMAGE ESTIMATES FOR THE COMMERCIAL
SECTOR OF LISMORE

Period of flood record	Mean annual damage
1945-1975	\$591,200
1921-1976	\$406,700
1875-1975	\$294,100

All damage figures at 1974 prices.

2.5 DIRECT DAMAGE - INDUSTRIAL SECTOR

The number of industrial enterprises in the flood-prone area of Lismore is small compared to those in the residential and commercial sectors. All the industrial establishments were visited and a questionnaire completed in an interview situation with a senior member of the management. The co-operation was such that every management agreed to give such an interview.

2.5.1 Range of Industrial Enterprise

There are some minor difficulties in differentiating between certain 'commercial' and 'industrial' concerns. This did not present a major problem for the present study and those classified as industrial could be considered as manufacturing industries, most repair services (of which garages are the major class) were included with the commercial sector. The number of industrial establishments identified in the flood-prone area of Lismore, and included in this survey, amount to a total of twenty-six.

As would be expected there is a wide range of industrial enterprise and classifications by number of employees, type of industry and value of plant and machinery, are given in Tables 2.16, 2.17 and 2.18 respectively.

TABLE 2.16
SIZE OF INDUSTRY BY NUMBER OF EMPLOYEES

Number of employees	Class frequency
1 - 5	4
6 - 10	8
11 - 20	4
21 - 30	3
31 - 40	3
41 - 50	2
51 - 100	-
101 - 200	1
201 - 300	-
301 - 400	1
TOTAL	26

TABLE 2.17
CLASSIFICATION OF INDUSTRY IN THE FLOOD-PRONE AREA
AND NUMBER OF EMPLOYEES

Type of industry	Number	Number of employees
Building and construction	12	201
Food processing	6	482
Engineering	4	75
Textiles	1	200
Printing	1	9
Other	2	7
TOTAL	26	974

TABLE 2.18
VALUE OF PLANT AND MACHINERY IN INDUSTRIAL ENTERPRISES

Value in dollars	Class frequency
\$	
0 - 4,999	2
5,000 - 9,999	-
10,000 - 19,999	2
20,000 - 29,999	2
30,000 - 39,999	2
40,000 - 49,999	2
50,000 - 99,999	4
100,000 - 249,999	5
250,000 - 499,999	3
500,000 - 999,999	1
1,000,000 and larger	3
TOTAL	26

2.5.2 Industrial Questionnaire

The questionnaire for the industrial sector comprised some 48 questions, with various subsections, and a copy is given in Appendix 2.7. This was distributed to all the 26 industries and either completed in an interview setting or initially completed by the management and checked in a later interview. The questions concerning direct damage are Nos.4 and 5 (which deal with the heights and distribution of floor levels), No.16 which is concerned with the depth of flooding, and Nos.39 and 40 which are concerned with direct damage experienced in the 1974 flood.

2.5.3 Industrial Stage-damage Curves

For each establishment information was obtained on the direct damage for the 1974 flood. The depth of flooding varied from a few

centimetres to 3.0 m and the direct damage from zero to \$130,000. The total direct damage for the industrial sector was approximately \$340,000. Six of the flooded premises reported no direct damage.

With such wide variations it is not possible to use an overall stage-damage curve for either the whole sector, as in the residential case, or for properties classed according to size as for the commercial properties. The approach taken was to consider the damage and depth of flooding for the 1974 flood for each establishment and then to construct an estimated curve for that property taking into account additional information from the questionnaire. Particular attention was given to the arrangement of differing floor levels for the property and some allowance was made for the distribution of plant and materials in relation to these levels. Stage-damage curves were constructed for each of the twenty properties that reported direct damage from the 1974 flood. Examples of two of these curves are given in Figure 2.19 to illustrate the procedure.

The method employed is clearly unsophisticated but has the advantage that consideration is given to each establishment. In many cases, as in Figure 2.19A the stage damage curve is linear from the 1974 flood height to the lowest floor height; in other cases it was possible to make some variation to the curve by using additional information from the questionnaire. The salient feature is that direct damages for the industrial sector are relatively small when compared to the residential or commercial sectors. Thus errors for the damage at flood stages below that of 1974 are likely to be small in relation to the overall urban loss. The losses at lower stages are probably slightly over-estimated by the method employed. The reasons for the very low damage in the industrial sector are due to excellent

organisation to alleviate flood damage undertaken by the individual companies. This will be further discussed later in this report.

2.5.4 Industrial Flood Damage at Specific Flood Heights

As there were only 20 industrial premises that reported flood damage for the 1974 flood, the information was processed manually, in contrast to the residential and commercial sectors where the data was processed by computer.

The estimates of total direct damage are given in Table 2.19 and Figure 2.20. The damage estimates in Figure 2.20 allow for the protected areas in South Lismore and Browns Creek.

TABLE 2.19
ESTIMATED TOTAL DIRECT FLOOD DAMAGE FOR THE INDUSTRIAL SECTOR
IN RELATION TO GAUGE HEIGHTS

Gauge height	Damage	Damage (no allowance for protected areas)
	\$	\$
10.0 m	800	1,700
10.5 m	1,500	3,300
11.0 m	13,800	24,700
11.5 m	35,600	35,600
12.0 m	77,800	77,800
12.5 m	193,000	193,000
13.0 m	337,800	337,800

All values at 1974 prices

2.5.5 Mean Annual Estimates for Direct Flood Damage - Industrial Sector

The same general procedure was applied to the industrial sector to obtain mean annual estimates as was used for the residential and commercial sectors. The results for the three series of flood records are presented in Table 2.20.

TABLE 2.20
MEAN ANNUAL DIRECT DAMAGE ESTIMATES FOR THE INDUSTRIAL
SECTOR OF LISMORE

Period of flood record	Mean annual damage
1945-1975	\$ 34,960
1921-1976	21,600
1875-1975	16,800

All values at 1974 prices

It is suggested that the mean annual estimate for direct damage applicable to the industrial sector for planning purposes lies between \$34,900 and \$21,600.

2.6 ESTIMATES FOR TOTAL DIRECT DAMAGE - ALL SECTORS

Estimates have been presented for the direct damage costs to the residential, commercial and industrial sectors. These can be combined in various ways to give the total direct damage costs for the urban area of Lismore. However, there is one additional sector that should be included in such estimates and that relates to the

damage sustained by various government agencies. Figures have been obtained for the government sector for the 1974 flood but it has not proved possible to present these as stage-damage curves to estimate the losses at lower flood levels.

2.6.1 Direct Damage - Government Sector

This is a difficult sector to define and, in part, some of the costs have been included within the commercial sector. For example, the offices of many government agencies are located in the central flood-prone area of Lismore and have been included under that heading. A separate questionnaire was distributed to many of these in order to assess both the flood damage to the actual office and to obtain estimates of the damage incurred by flooding to their field operations. The majority of the government agencies sustained no office damage and few had other direct 'field' costs. Examples of this form of government agency, which is dominantly office-based, would be Youth and Community Affairs, the Housing Commission, Labour and Industry. It is interesting to note that virtually all government agencies of this type in the flood-prone area are located in first floor offices in the central section of Lismore where direct flood damage is negligible.

However, there are other sectors of government which are clearly susceptible to flood damage. These would include areas for which the City of Lismore was able to claim grant aid from the New South Wales Department of Public Works, and undertakings such as Telecom, the Northern Rivers College of Advanced Education, and the State Railways. Estimates for the first group are based on the certificates of expenditure made by the City of Lismore and for Telecom, the College of Advanced Education and the Railways from interviews.

Estimates of the damage to various of the components of the government sector are given in Table 2.21. Some of these losses would not be repeated if a flood of 1974 intensity was to re-occur. For example, the bulk of Telecom's direct losses were to a motor repair shop which has subsequently been re-located away from the flood-prone area. However, it is likely that unexpected losses from other sections of the government sector would occur in any future major flood.

TABLE 2.21

ESTIMATES OF DIRECT DAMAGE FOR THE GOVERNMENT SECTOR

	Loss 1974 flood	Comments
Gas works	\$ 5,600	
Library	41,300	\$39,000 of this damage was to books
City Hall	2,600	\$2,000 of this was for damage to pianos
Restoration work	48,000	\$27,400 of this for cleaning the storm-water drainage system
Roadworks	57,500	This figure is <u>only</u> for roads in the Lismore city area
Telecom	40,000	Major costs were to the Motor Repair Shop (now re-located)
Northern Rivers College of Advanced Education	6,000	-
State Railways	Nil	This is only for station and goods yard. It <u>does not</u> include track repair costs
TOTAL	201,000	

There are undoubtedly other components of the government sector that have not been included but it is thought unlikely that any major losses have been omitted. Thus a conservative estimate of the government sector losses would be \$200,000 for a flood gauge height of approximately 13.0 m.

It has not proved possible to construct stage-damage curves for government sector damage. However, in relation to total direct damage that of the government sector is small, amounting to certainly no more than 5% of the overall total.

2.6.2 Total Direct Damage Costs at Specific Flood Heights

The total direct damage costs given in this section are summations of the estimates for the residential, commercial and industrial sectors which have been presented in detail in preceding sections. The combined estimates for the damage at varying gauge heights are given in Table 2.22 and Figure 2.21.

Table 2.22 also gives, for each selected gauge height, the percentage of the direct damage sustained by each sector. This is portrayed diagrammatically in Figure 2.22. The major conclusion is that commercial damage costs are the largest contributing factor to the total direct damage at any given flood height. The percentage of the total damage for the commercial sector varies between about 72% and 86% and there is some indication that the proportion decreases with the depth of flooding.

2.6.3 Mean Estimates for Total Direct Damage Costs

The mean annual estimates for the residential, commercial and industrial sectors are presented in Table 2.23 which also gives an overall summation.

TABLE 2.22
ESTIMATED TOTAL DIRECT FLOOD DAMAGE FOR THE LISMORE URBAN
AREA IN RELATION TO GAUGE HEIGHT

Gauge height	Residential	Commercial	Industrial	Total
10.0 m	6,800 (12.8)	45,600 (85.7)	800 (1.5)	53,200
10.5 m	20,300 (19.1)	84,400 (79.5)	1,500 (1.4)	106,200
10.0 m	74,500 (10.8)	600,000 (87.2)	13,800 (2.0)	688,300
11.5 m	137,000 (10.8)	1,092,900 (86.4)	35,600 (2.8)	1,265,500
12.0 m	328,000 (14.0)	1,922,300 (82.7)	77,800 (3.3)	2,350,100
12.5 m	625,900 (17.1)	2,842,600 (77.6)	193,000 (5.3)	3,661,500
13.0 m	1,118,900 (21.6)	3,699,800 (71.8)	337,800 (6.6)	5,156,500

The figures in brackets are percentages of damage sustained by each sector at specific gauge heights. All damage values in dollars at 1974 prices.

TABLE 2.23
TOTAL MEAN ANNUAL DIRECT DAMAGE FOR THE LISMORE URBAN AREA

Period of flood record	Mean annual damage (in dollars)			
	Residential	Commercial	Industrial	Total
1945-1975	125,000	591,000	34,900	751,000
1921-1976	80,200	406,700	21,600	508,500
1875-1975	59,800	294,100	16,800	370,700

All values at 1974 prices.

For planning purposes it is suggested that the total mean annual direct damage costs for the urban area of Lismore are in the range of \$500,000 to \$750,000.

It should be stressed that these values are specifically for direct damage and do not include estimates for indirect and intangible costs. An assessment of the other costs will be given later in this report. Further, the direct damage values presented are based upon questionnaires asking the recipients to give estimates of the costs of their own direct damage. In our opinion, and in that of similar surveys undertaken elsewhere, this is likely to lead to under- rather than over-estimates. We strongly suspect that if the survey had been of the kind that would either lead to insurance payments for damage or for major government assistance that the figures would have been greater. The estimates do not include figures for direct damage to the various undertakings considered as comprising the government sector although in terms of direct costs these are unlikely to increase the values by more than 5%.

CHAPTER 3

AN ASSESSMENT OF INDIRECT FLOOD DAMAGE FOR THE URBAN AREA OF
LISMORE3.1 INTRODUCTION

The methodology for the calculation of direct damage due to flood loss is well established although there are few estimates available in Australia. However, the situation with the assessment of indirect flood loss differs in that there is no widely accepted methodological approach although all workers in the field agree that such losses can be substantial. Most regional flood loss studies do not undertake any detailed assessment but suggest that the indirect costs are taken as a fixed proportion of the direct damage.

Kates (1965) from studies in the USA, proposed that indirect residential damage be taken as 15% of direct damage (clean-up costs were considered as direct damage). He further suggested that the indirect damage for commercial and industrial premises be 37% and 45% respectively. The study of the Brisbane floods by the Snowy Mountain Engineering Corporation also employed these estimates but their own results indicated a higher percentage for industrial indirect damage. This approach has recently been criticised by Penning-Rowsell and Chatterton (p.53, 1977) who stress that indirect damage is markedly site specific, the authors of this report concur with this view. However, the actual assessment of indirect damage remains a difficult problem both as regards the overall theoretical approach and the difficulty of collecting the requisite data. While the information on indirect data included in this section is open to criticism on methodological grounds it is hoped that it will be of value to flood management and planning.

3.2 INDIRECT DAMAGE - THE URBAN AREA

The urban area is divided into residential, commercial and industrial sectors. The information on which this section is based is from the questionnaire circulated to each sector; the general description of the sample completing each questionnaire has been discussed in the section dealing with direct damage.

The question of what should, or should not, be included in a definition of urban indirect damage has no clear answer. However, in this study the labour costs of clean-up will be included as an indirect loss. Discussions with the representatives of the Inter-Departmental Committee lead to the conclusion that to include clean-up costs with direct damage is possibly misleading. The problem is that for the residential sector the labour involved in cleaning up was usually provided by the householder and his family, and was not as easy to quantify as other direct costs. For the commercial and industrial sectors it is normal practice to use the workforce for cleaning up and they were therefore already in receipt of a salary. In this latter case adjustments will be made to assessing the loss in trade so that labour costs are estimated in such a way as to include the cost of the clean-up.

It should be noted that the intangible damages will be considered separately in Chapter 5.

3.3 INDIRECT DAMAGE - THE RESIDENTIAL SECTOR

The indirect damage to the residential sector of Lismore can, for convenience, be considered under the following headings:

- (a) Clean-up costs
- (b) Loss of wage or salary

(c) Costs of removal and accommodation

(d) Inconvenience and loss of amenity

(a) Clean-up costs: This information was based upon questions 33, 34 and 35 of the residential questionnaire (see Appendix 2.2). These sought information on the time required for the clean-up operation in the house, how long before the house and garden were back to normal, costs of clean-up (time apart), and if income was lost in order to undertake clean-up operations. If time was lost from work, an estimate of the lost income was requested.

Unfortunately the nature and layout of these questions was not ideal, particularly in respect of time taken for the house clean-up. The suggested time divisions ceased at 'one week' although in many cases the interviewers were able to extend this time scale. Also it is not clear from the questionnaire how many individuals in the household were engaged in the clean-up operation. Thus the information presented under-estimates the answers to these questions.

The 127 replies to the question on length of time for house clean-up give a mean time of five days per house. It has been assumed that in the terms of person-days, this could be taken as 7.5 days. It should be noted that the sample of 127 includes many raised houses in the flood-prone area which did not have water over the floor boards. The next difficulty is how to cost the labour involved. The average weekly earnings for early 1974 were close to \$100 per week which can be taken as \$20 per day. Thus the mean cost per household for clean-up labour for all the residences in the flood-prone area is \$150.

The SMEC Brisbane Flood Study produced more detailed data on the time for house clean-up which were greatly in excess of those reported in this study. For a flood of 1 ft over the floor, the time

was 62 man-days, at 3 ft, 80 man-days, and at 6 ft, 91 man-days. A labour cost of \$50 per week was used which is approximately half the average wage in order to allow for '... those who would not normally be employed'. There is little doubt that the cost of this study of \$150 per household is an under-estimate.

Question 34 asked for information on costs other than those of time. There were 99 replies with an average cost slightly in excess of \$17 per household. Again this includes residences in the flood-prone area which did not have water over the floor. This figure seems remarkably low and it would appear that few households employed professional firms to clean carpets etc.

There were 127 replies to the question asking if income was lost in order to undertake house clean-up. Some 21% (27 respondents) did in fact take time off. The mean loss of income per household for those taking time off was \$140, which was \$30 per household when the total sample of 127 was included. This sum will however be considered under loss of income rather than as a clean-up cost.

Thus the mean household clean-up cost was:

Allowance for time at average wage rate	\$150.00
Materials and other non-labour costs	<u>\$17.50</u>
TOTAL	<u>\$167.50</u>

Again it should be stressed that imperfections in the original questionnaire coupled with a tendency, noted by other workers, for respondents to under-estimate clean-up costs, strongly suggest that this figure is an under-estimate.

(b) Loss of wages and salary: As discussed above, 21% of the households had one or more members who took time off from work to assist with the residential clean-up. The sample suggests that this is \$30 per household. Related to this is the fact that approximately 25% of the industrial workforce were laid-off for a short period without wages.

(c) Costs of removal and accommodation: Of the 145 households sampled, 72 moved to temporary accommodation because of the floods. In virtually all cases this involved taking up short-term residence with relatives or friends. Specific information on the length of this temporary accommodation was not gathered but a reasonable assumption is that a mean period would be three days. Also the mean household size is close to three persons. Thus for costing purposes the total is about 8000 accommodation nights. Most of this accommodation would have been freely given by the receiving households, but in order to assess indirect costs, a value of \$5 per person per night (at 1974 prices), would seem a reasonable estimate.

Costs of removal, of both goods and people, also represents a valid indirect cost. However, relatively few people actually moved goods from their house, other than by private car and the journey costs to temporary accommodation would, in the majority of cases, be very small. A token cost of \$10 per household is suggested.

Thus the mean removal and accommodation costs per household are:

Temporary accommodation, 50% of households affected, thus 1.5 persons for 3 days at \$5 per night	\$22.50
Removal costs, suggested as \$10 per household	\$10.00
TOTAL	\$32.50

(d) Inconvenience and loss of amenity: There is no doubt that this broad category represents a real social loss and is a valid indirect cost. It is difficult to quantify but the questionnaire did produce some information on one specific aspect, namely an estimate of the time '... before the house and garden were back to normal'. There were 106 responses to this question and the various categories are illustrated in Figure 3.1.

It should be noted that exactly 50% of the sample stated that it took more than two months for the return of normality and 7.5% replied that the house and garden would 'never' return to normal. These latter replies are particularly significant in that the survey was conducted some three years after the 1974 event which formed the basis of these assessments. As this question included 'garden' it comprises the views of all the houses in the flood-prone area, including those that are raised.

Other expressions of inconvenience were obtained from the final question on the questionnaire which invited the respondents to comment on other household disruptions brought about by the flood. Those pertinent to indirect damage assessment included such diverse comments as 'cancellation of a wedding', 'cancellation of holidays', 'not being able to get to the pub' (the public houses were only closed for a very brief period, but beer was in short supply), and the loss of personal momentos of small market value such as '... drawings made in the 1938-45 war'. Loss of schooling is another contribution to this category, but this has not been investigated in detail.

The problem is how to attempt to quantify these various 'losses' into a tangible dollar equivalent. There are two alternatives: one is to leave many of the indirect costs in a qualitative form or to add a

nominal proportion of the direct damage costs. The former approval has been taken in this study

3.4 TOTAL INDIRECT RESIDENTIAL COSTS

The total number of residences in the flood-prone area is taken to be 1900, thus combining the varying indirect costs per household as discussed in paragraphs (a), (b), and (c) above, results are as follows:

(a) Clean-up costs, \$167.5 per household	\$320,000
(b) Loss of wages and salary, \$30 per household	\$57,000
(c) Costs of removal and accommodation, \$32.5 per household	\$62,000
Total for 1974 flood	\$439,000

This does not include any estimate for inconvenience and loss of amenity.

These figures are calculated for the 1974 flood and compare to the residential direct damage of \$1,119,000.

3.5 MEAN ANNUAL INDIRECT RESIDENTIAL COSTS

The data given above is for the 1974 flood which is taken to correspond to a flood gauge reading of 13.0 m. If it is assumed that the indirect costs of lesser floods have the same relationship to the 13.0 m flood as the residential direct damage (this would appear to be a valid assumption), the mean annual costs are as given in Table 3.1.

These figures are certainly under-estimates for the reasons stated and do not include any addition for inconvenience and loss of amenity.

TABLE 3.1
MEAN ANNUAL INDIRECT DAMAGE FOR THE RESIDENTIAL
SECTOR OF LISMORE

Period of flood record	Mean annual damage
1945-1975	\$49,000
1921-1976	\$31,000
1875-1975	\$23,000

All values in dollars at 1974 prices.

3.6 INDIRECT DAMAGE - COMMERCIAL SECTOR

Indirect commercial damage can be subdivided into the following categories:

- (a) Clean-up costs
- (b) Costs of removal and storage
- (c) Loss of business confidence
- (d) Loss of trading profit.

The longer of the commercial questionnaires, see Appendix 2.5, requested information that was pertinent to these costs. However, many commercial outlets either did not have the full information available or were reluctant to divulge details of a financial nature. Thus the information is not complete for all respondents but it is sufficient to give an overall indication of the general trend of much of the data. The various categories will be considered individually but it should be noted that there is considerable variation in the number of questionnaires analysed.

As general background to the indirect damage costs, Table 3.2 presents information on the length of time that the commercial buildings were flooded. 'Flooded' is defined as water over floor level.

TABLE 3.2
DURATION OF FLOODING OF COMMERCIAL PREMISES

Duration of flooding	Number
Less than 3 hours	0
3 - 5 hours	1 (1.4)
6 - 11 hours	13 (17.8)
12 - 23 hours	12 (16.4)
24 - 47 hours	25 (34.2)
48 hours and longer	22 (30.2)
TOTAL	73

Percentage values are given in brackets.

- (a) Clean-up costs: For the purpose of this study, clean-up costs have been considered as an indirect cost.

Information was sought on the period that water remained in the building (over floor level), the time taken for the clean-up operations and the cost of the clean-up. There was minor confusion in obtaining estimates of the cost in that some respondents either did not include, or clearly under-estimated, the staff costs. It is certainly

established that the general pattern with respect to clean-up is that this is undertaken by the normal staff with some outlets employing extra staff on a casual basis and some paying their staff overtime rates. Few premises specifically contracted professional cleaners. The details of the answers to these questions are given in Table 3.3.

TABLE 3.3
EMPLOYMENT OF STAFF FOR COMMERCIAL CLEAN-UP OPERATIONS

	Yes	No	Number in sample
Does your business -			
1. Employ extra staff during clean-up?	22.7%	77.7%	103
2. Pay overtime rates to staff during clean-up?	26.2%	73.8%	103
3. Contract professional cleaners?	5.8%	94.2%	103
4. Expect all staff to report for work immediately to help with clean-up operations?	79.6%	20.4%	103

All responses as percentages of total.

The time for the clean-up operations for a sample of 97, was a mean of 2.6 days. This can be further divided into the time for differing size classes and the results are presented in Table 3.4.

TABLE 3.4
TIME AND COSTS FOR CLEAN-UP OPERATIONS FOR THE COMMERCIAL
SECTOR

Size	Time for clean-up (days)	Cost of clean-up	Wages and salary for clean-up
Class 1 (less than 186 ² m ²)	1.95 (57)	\$125 (43)	\$115 (37)
Class 2 (186-165 m ²)	3.20 (24)	\$357 (18)	\$490 (20)
Class 3 (greater than 650 m ²)	2.94 (19)	\$1160 (17)	\$1001 (18)

All values at 1974 prices. Figures in brackets give size of sample.

There would appear to be a significant difference in time between the smaller premises and the larger size classes. This may, in part, result from the fact that many of the smaller (Class 1)

commercial outlets are family businesses and many are perishable food shops where the demand for a continuing supply is particularly great.

The estimated costs of the clean-up operation (taken directly from Question 31) are also presented in Table 3.4. These show an increase with size class. It was decided to try an independent check on these figures by combining the time taken for the clean-up with the average wage bill (from Question 40). This was also undertaken by size. The results are given in Table 3.4 where they can be conveniently compared with the direct estimate of clean-up costs. The comparison is generally close in that for size class 1 and 3, the estimated costs of wages and salary are somewhat less than the estimated clean-up costs. This would allow for the payment of overtime, the very occasional use of outside contractors, casual labour and the like, plus the cost of any materials used. For class 2, the wages bill exceeds the estimated clean-up costs and this is thought to be due to under-estimates of the cost of wages. In calculating the overall clean-up costs in the following section, the values that will be used are Class, 1, \$125 per unit; Class 2, \$500 per unit, and Class 3, \$1000 per unit.

(b) Costs of removal and storage: Approximately 85% of the commercial premises sampled either own (55%) or have access to (30%) flood-free storage capable of holding their entire flood susceptible stock. Further, 75% of the firms have permanent arrangements to move stock in the event of flood. Unfortunately the data is insufficient to further divide this information into those outlets that actually have to transport their goods to another building

and those where the flood-free storage is on an upper storey of the same building. For many of the commercial outlets in central Lismore this upper storey storage is in fact available. It was found that 25% of the outlets with permanent plans to move material, use other organisations such as truck or removal companies. More detailed aspects of this organisation will be discussed later in this report.

In response to the request for details of the cost of movement to flood-free storage, only 33 respondents gave an actual cost. The majority of these non-respondents would have used their own transport and the distance moved would be small. Many of these non-respondents were family business, the larger concerns detailed the costs. The costs of those responding are given in Table 3.5, and are subdivided into class size. The percentage of the firms in each class that reported removal costs is also given. For purposes of totalling transport costs to give mean values for each class, the costs have been distributed so as to include those not reporting transport costs. These mean costs per unit are also given in Table 3.5.

TABLE 3.5
COSTS OF REMOVAL OF GOODS TO FLOOD-FREE STORAGE FOR THE COMMERCIAL SECTOR

Size	Mean removal cost for those using transport	Percentage of sample with transport costs	Overall mean cost of transport
Class 1 (less than 186 m ²)	\$198 (37)	33%	\$65
Class 2 (186 - 650 m ²)	\$230 (7)	29%	\$67
Class 3 (greater than 650 m ²)	\$600 (6)	29%	\$174

All values at 1974 prices.

The overall mean values will be used in calculating total transport costs but there is no doubt that these are under-estimates as they do not include the transport costs of the smaller enterprises.

It is interesting to note that three individual respondents gave values of \$1000 or greater for transport costs. Two of these were involved with car and marine engines and parts, and one of these had a stock of approximately \$500,000 but suffered losses of less than \$1000. The third was a major bank and questions of security against robbery were overriding.

(c) Loss of business confidence: Question 30 asked whether or not the occurrence of flooding had led to the cancellations of contracts, loss of business confidence etc. If the answer was 'yes' the respondent was asked to estimate the financial loss for the 1974 flood. The replies are presented in Table 3.6.

TABLE 3.6

INDIRECT COMMERCIAL DAMAGE DUE TO LOSS OF BUSINESS CONFIDENCE

	Number in sample	Number reporting loss	No loss reported	Average loss
Class 1 (small)	44	22	22	\$350
Class 2 (medium)	15	8	7	\$560
Class 3 (large)	16	8	8	\$1030

All values at 1974 prices.

In general there was a poor response to this question. Of the 75 replies, 36 stated that business confidence was not affected, while 37 suggested that it was. For our purposes it will be assumed that 50% of the businesses suffered from this indirect loss which did not include actual loss of trading due to closure of the business by flooding. This would give a mean financial loss for the sample of 75, of \$545. The breakdown of mean cost in relation to size is also given in Table 3.6. The values used for small, medium and large premises are \$350, \$560 and \$1030, respectively.

The nature of these questions and the relatively small size of the sample make it clear that these figures should only be treated as broad estimates. It is clear that there is considerable variation in this form of indirect loss depending on the nature of the service offered.

The information was also sought on the length of time before business confidence returned to normal, this is given in Table 3.7.

TABLE 3.7
LENGTH OF TIME FOR BUSINESS CONFIDENCE TO RETURN TO NORMAL

Time	Number	Percentage in class
No loss	28	42.5
Up to 3 days	5	7.6
4 days - 1 week	11	16.6
8 days - 2 weeks	3	4.5
15 days - 4 weeks	7	10.6
1 month - 60 days	1	1.5
2 months - 3 months	4	6.1
Greater than 3 months	7	10.6
SAMPLE SIZE 66		

The overall feature is the relatively short time before respondents considered that confidence was back to normal. The data should be compared to that shown in Table 3.8, which gives information on the period of time before trading is back to normal. It is clear that confidence has returned well before trading normality.

TABLE 3.8
LENGTH OF TIME FOR COMMERCIAL TRADING TO RETURN TO NORMAL

Time	Number	Percentage in class
No disruption	8	9.0
Up to 3 days	25	28.2
4 days - 1 week	29	32.6
8 days - 2 weeks	8	9.0
15 days - 4 weeks	10	11.2
1 month - 60 days	2	2.2
2 months - 3 months	2	2.2
Greater than 3 months	5	5.6
SAMPLE SIZE	89	

(d) Loss of trading profit: Loss of trading profit is a difficult value to assess. It should not be confused with the loss of turnover for the period for which the commercial outlet is closed. Penning-Rowsell and Chatterton (p.42, 1977) suggest that:

... the best approximation to the loss that would occur is to take the loss of the gross margin of the business for the period of disruption, being the turnover less purchases, assuming stocks remain constant.

The available information includes data on the period of disruption to the normal weekly gross profit (equivalent of the 'gross margin') and the normal average weekly wage bill. In this study the staff wages have already been included as a component of the clean-up costs.

There were 89 replies to the question seeking information on the length of time that trading took to return to normal after the 1974 flood. The details are given in Table 3.8. Differences based on the size class are not included as this variable was of little significance.

The most significant aspect of the table is that 70% of the sample reported that trading was back to normal within one week or less. Those businesses which reported lengthy periods of disrupted trading were normally back in business in a much shorter period but trading was below normal.

A separate question asked if the business experienced an increase in turnover after a flood had subsided, and some 22% reported that they did. Based on the information in this section, plus the related information on the duration of flooding (see Table 3.8), it would seem that a period of a little under a week should be taken as representing a return to normal trading, i.e., five working days.

Data for the normal weekly wages bill has already been presented. If this is compared to the data on weekly turnover, the wages component is almost exactly 50%. The breakdown by size is given in Table 3.9.

The weekly values given in Table 3.9 should however be used with caution in assessing loss of trading profit. It has already been noted that 22% of the commercial premises report an increase in trade after a flood, and the data on trading returning to 'normal' should

not be taken to mean that no trading took place. After a flood, both customer loyalty and regional problems in communication, combine to assist a rapid recovery in trading. Overall it is thought that a figure representing about half a trading week would be a fair estimate of loss of trading profit. Thus for small, medium, and large businesses, the mean estimated values would be \$250, \$450, and \$1000, respectively.

TABLE 3.9
MEAN WEEKLY TURNOVER IN RELATION TO SIZE CLASS

Size	Number in sample	Mean weekly turnover	Mean weekly wages	Turnover less wages
Class 1	39	\$1092	\$575	\$517
Class 2	13	\$1723	\$766	\$957
Class 3	13	\$3954	\$1701	\$2253

All values at approximately 1974 prices.

It should be noted that the loss to the premises in the flood-prone area will inevitably be transferred to business to other outlets in the region that were not directly affected by flooding. Thus if the figures were to be used in a regional benefit-cost analysis they would be substantially reduced.

3.7 TOTAL INDIRECT COMMERCIAL COSTS

The mean costs for commercial premises of differing sizes for the various components of indirect damage sustained during the 1974 flood are consolidated in Table 3.10. The details have been discussed in the preceding sections.

TABLE 3.10
MEAN INDIRECT DAMAGE FOR INDIVIDUAL COMMERCIAL PREMISES
IN DIFFERING SIZE

Size	Clean-up costs (including wages)	Transport costs	Loss of business confidence	Loss of trading profit
Class 1 (small)	\$125	\$54	\$350	\$250
Class 2 (medium)	\$500	\$67	\$560	\$450
Class 3 (large)	\$1000	\$174	\$1030	\$1000

All values in dollars at 1974 prices.

To obtain the overall costs for the 1974 flood, these figures have been multiplied by the number of commercial outlets in each of the size classes and the overall totals are given in Table 3.11.

The estimate for the total indirect cost is \$1,012,700. In applying this figure it is important to remember two points. Firstly, clean-up costs have been included as an indirect cost and no allowance has been made for the transfer of trade during the period of closure to other outlets in the non-flood affected parts of Lismore. With indirect costs calculated in this way they amount to some 27.0% of the direct damage estimates for the commercial sector.

If the oft followed suggestion of Kates (see section 3.1), that indirect damage is some 37% of the direct damage, had been applied, the values would have been much higher. The work by Kates includes

clean-up costs as direct damage and if this was applied to the present study the indirect damage would be 18.5% of the total direct damage estimate.

TABLE 3.11
TOTAL INDIRECT DAMAGE FOR THE COMMERCIAL SECTOR

Size	Number of outlets	Total clean-up costs	Total transport costs	Loss of business confidence	Loss of trading profit	Overall totals
Class 1 (small)	357	44,600	23,200	125,000	89,200	282,000
Class 2 (medium)	187	93,500	12,500	104,700	84,200	294,900
Class 3 (large)	136	136,000	23,700	140,100	136,000	435,800
TOTAL	680	274,100	59,400	369,800	309,500	1,012,700
Percent- of total indirect damage		27.1%	5.8%	36.5%	30.6%	

All values in dollars at 1974 prices.

The difference between the Kates figure and that obtained for Lismore is thought, at least in part, to be due to the previous flood experience of the Lismore commercial sector.

3.8 MEAN ANNUAL INDIRECT COMMERCIAL COSTS

The data for indirect flood costs has been calculated in relation to the 1974 (13.0 m) flood. To convert these to mean annual figures it is necessary to make the assumption that indirect damage would maintain the same relationship to flood height as did direct damage. The results obtained on this basis are presented in Table 3.12

TABLE 3.12
MEAN ANNUAL INDIRECT DAMAGE FOR THE COMMERCIAL SECTOR OF
LISMORE

Period of flood record	Mean annual damage
1945-1975	\$161,800
1921-1976	\$111,300
1875-1975	\$80,500

All values at 1974 prices.

3.9 INDIRECT DAMAGE - INDUSTRIAL SECTOR

The indirect industrial costs can be subdivided in a similar manner to that employed for the commercial sector.

- (a) Clean-up costs
- (b) Costs of removal and storage
- (c) Loss of business confidence
- (d) Loss of production

The method used to obtain the values for the industrial sector differs in that all the industrial undertakings completed a questionnaire. Thus the total indirect costs are calculated directly rather than via a cost per unit. The response to the questionnaire was good but inevitably not all respondents answered all questions and the missing data has been estimated in relation to other comparable industries and to answers given to other questions.

The duration that flood waters remained over the floor level is tabulated in Table 3.13.

TABLE 3.13
DURATION OF FLOODING OF INDUSTRIAL PREMISES

Duration of flooding	Number
Less than 3 hours	1
3 - 5 hours	0
6 - 11 hours	1
12 - 23 hours	3
24 - 47 hours	6
48 hours and longer	12
TOTAL	23

If Table 3.13 is compared to the comparable data for the commercial sector (Table 3.2), the mean duration for the flooding of industrial premises is considerably longer. This probably results from the greater use of particularly low-lying land by the industrial sector although it should be remembered that in most cases much of the industrial plant will be free of flood water long before the time recorded in the table, which gives the maximum duration that water remains over floor level in any part of the enterprise.

- (a) Clean-up costs: The details of the time involved in the clean-up costs are given in Table 3.14.

The mean time is close to 2½ days which is close to the overall figure for the commercial sector.

To obtain an overall value for the whole industrial sector the estimated costs for each of the 26 concerns were combined. The estimates include, as the major factor, the wages and salaries of the staff involved. The total is taken to be \$40,000.

TABLE 3.14
CLEAN-UP TIME FOR INDUSTRIAL PREMISES

Time	Number
Less than 6 hours	3
7 hours to 2 days	6
2 days	5
Greater than 2 days	10
TOTAL	24

In every case the clean-up was undertaken by the normal staff supplemented in two instances by a very limited addition of casual labour, this has been ignored in the estimates. None of the businesses employed professional cleaning agencies. Five of the 26 did not pay full wages during the shut-down period. However, those unemployed were, in some cases, paid at a reduced rate. As far as can be estimated the number of worker-days for which payment was not made is close to 150, this allows for part-payment. As the total labour force of the flood-prone industrial sector is close to 1000, this wage loss has not been considered further in estimating overall costs. Considered in a regional context the small figure of 150 days would be off-set to some extent by the limited employment of casual workers in the clean-up operation.

(b) Costs of removal and storage: Nineteen of the 26 industrial premises have flood-free storage facilities for the whole of their flood susceptible stock. In the majority of cases this is owned by the firm concerned. In the two cases where the flood-free storage is

not owned it would appear that the charges for use during flood periods are nominal. Questions were asked to establish the cost of maintenance of the flood-free facilities, but in every case this was dismissed as of no significance. There is undoubtedly a cost involved but the respondents consider this as minimal and it has been ignored.

Only 3 of the 23 respondents did not have a permanent plan for the movement of stock to safe storage. It is not clear from the questionnaire to what extent the movement of stock involves transport away from the flood location. However, all respondents were asked to give a cost estimate for stock movement and whether this involved other organisations. In 5 cases other organisations were involved but the size and scale of this varied greatly, at one extreme 25 truck loads and at the other other, the short-term loan of a fork-lift. Only 6 of the respondents actually gave costs for the service and these totalled approximately \$4000. Other establishments used their own transport and in most cases did not provide cost estimates. As the distances involved are very small the major input would be the use of staff to move stock and equipment. The time involved is unlikely to exceed 3 or 4 hours so that some approximate estimate can be obtained. The cost of staff time would therefore be small, and an overall figure of \$5000, at 1974 prices, is suggested.

Thus the overall cost of removal and storage is some \$10,000. It is clear that this figure is very much an estimate but certainly these costs, in relation to the direct damage, are of little significance.

(c) Loss of business confidence: The questions on which the assessment of this form of indirect damage are based specify such costs as cancellation of contracts, loss of supplies etc.,

they do not include costs due to the loss of production or to the effects of the flood on plant and machinery. Of the 26 industrial concerns, 18 replied that they had no such losses, 7 that they did, and there was one 'don't know'. The estimated value for the 1974 flood totalled approximately \$25,000 although most businesses noted that it was difficult to quantify such losses. This figure is likely to be an underestimate but it does include a large sum for the rather special problems encountered by the milk factory where a proportion of the supply is from local dairy farms which were also flooded. Supply was adversely affected for a period of twelve months.

(d) Loss of production: The assessment of this form of indirect industrial damage presents similar problems to those outlined for the commercial sector. The losses should not be calculated by taking a mean figure for turnover and then adjusting for the duration of lost production. Penning-Rowse and Chatterton (p.53, 1977) state that the appropriate figure is the gross trading profit and suggest that this can be estimated from the turnover figures. They present a table giving gross trading profit as a percentage of turnover for differing types of industrial enterprise. For example, the mean gross profit margin for textile industries is 12.6% of turnover, the corresponding figure for drink manufacture is 12.7% and for food 7.2%.

The data collected in the present study includes information for mean weekly turnover for each of the flooded industrial concerns plus information on the period of time before production and trading returned to normal. Again there is a difficulty in deciding the amount of production undertaken before normality was attained and 11 of the 26 reported that there was a slight increase in turnover

after the flood had subsided. In addition some of the firms volunteered information on their actual losses of production.

In order to give some general idea of the time involved before before production and trading regained normality the data has been summarised in Table 3.15. This table also shows the responses to the question asking how long it took business confidence to return to normal.

Comparisons with Tables 3.7 and 3.8, which present corresponding data for the commercial sector, suggest that there is less loss of business confidence for the industrial sector but that it takes longer for full production to be resumed than it does for normal trading in the commercial sector. The latter is perhaps to be expected, as for many of the commercial premises once water is clear of the building, some form of trading can commence immediately.

TABLE 3.15
TIME BEFORE PRODUCTION AND CONFIDENCE RETURNED TO NORMAL

Time	Production and trading	Business confidence
Not affected	-	14
Less than 1 week	8	1
1 week less than 2 weeks	7	1
2 weeks less than 4 weeks	5	1
1 month less than 2 months	2	-
Greater than 2 months	1	2
Never	-	1
TOTAL	23	20

As there was a complete sample for the industrial firms it was possible to total estimates of the loss in turnover. The full questionnaire of each concern was considered in detail to estimate the likely loss of production. The overall total is close to \$750,000, it is not considered appropriate to give full individual details as this could be considered as a breach of confidentiality. The turnover figures were then subjected to the analysis suggested by Penning-RowSELL and Chatterton, employing the gross trading profit/turnover ratios. Using this method an estimate of the loss of gross trading profit of \$85,000 is obtained, i.e., the estimated loss of gross trading profit was 11.4% of the turnover.

It is suggested that a figure close to the Penning-RowSELL and Chatterton method is utilised. It is important to note that a wages element has already been included in the clean-up cost although the clean-up period is often very much shorter than the time needed to return to full production. A figure of \$100,000 is considered to be a reasonable estimate for this aspect of indirect damage.

In presenting these figures for the flood-prone industrial enterprises two related salient feature should be mentioned. It is possible that the loss in production of the flooded premises could be counted as a gain to similar manufacturers within the general Richmond River region. This is unlikely to be as significant for the industrial sector as it is for the commercial. Second, industries not located within the flood zone are also likely to suffer indirect damage as the general regional transport network will have been disrupted. These losses are not investigated.

3.10 TOTAL INDIRECT INDUSTRIAL COSTS

The estimates discussed in the preceding sections are as follows:

(a) Clean-up costs	\$40,000
(b) Costs of removal and storage	\$10,000
(c) Loss of business confidence	\$25,000
(d) Loss of production	\$100,000

This gives a total indirect industrial
loss of \$175,000

This is considered to be a conservative estimate for the reasons stated in the discussion of the various components of the indirect damage.

For the present study the indirect industrial costs are approximately 52% of direct damage. If the suggestion of Kates is followed, the indirect damage would be taken as 45%. However, Kates includes clean-up as a direct cost which, when applied to the present study, would give indirect damage as 36% of the direct damage.

3.11 MEAN ANNUAL INDIRECT COSTS

If the indirect costs for the 1974 flood bear the same relationship to direct costs for lower flood levels, as has been assumed elsewhere in this study, the corresponding mean annual costs are as presented in Table 3.16.

3.12 OVERALL INDIRECT DAMAGE FOR THE LISMORE URBAN AREA

The information from the preceding sections for the indirect damage for the 1974 flood has been consolidated in Table 3.17.

The overall cost was close to \$1.5 million with clean-up costs accounting for some 40% of the total. The indirect costs, including the clean-up figures, are some 28.5% of the direct damage estimates for the 1974 flood. While other sets of assumptions would

have led to differing absolute figures it should be noted that the cost of loss of trade and production only account for 24.1% of the damage.

TABLE 3.16
MEAN ANNUAL INDIRECT DAMAGE FOR THE INDUSTRIAL SECTOR OF
LISMORE

Period of flood record	Mean annual damage
1945-1975	\$18,200
1921-1976	\$11,200
1875-1975	\$8,500

All values at 1974 prices.

TABLE 3.17
INDIVIDUAL COMPONENTS OF THE LISMORE URBAN INDIRECT DAMAGE FOR
THE 1974 FLOOD

Form of damage	Residential	Commercial	Industrial	Total all sectors
	\$	\$	\$	\$
Clean-up costs	320,000 (72.9)	274,000 (27.1)	40,000 (22.9)	634,000 (40.0)
Loss of wages	57,000 (13.0)	-	-	57,000 (3.5)
Cost of removal, storage and accommodation	62,000 (14.1)	59,400 (5.8)	10,000 (5.7)	131,400 (8.1)
Loss of business confidence		369,000 (36.5)	25,000 (14.3)	394,800 (24.3)
Loss of trade and production		309,500 (30.6)	100,000 (57.1)	409,500 (24.1)
TOTAL	439,000	1,012,700	175,000	1,626,700

Figures in brackets are in percentages for columns. All other figures in dollars at 1974 prices.

The data can also be expressed in mean annual terms. The consolidated information is given in Table 3.18.

TABLE 3.18
TOTAL MEAN ANNUAL INDIRECT DAMAGE FOR THE LISMORE URBAN AREA

Period of flood record	Mean annual damage (in dollars)			
	Residential	Commercial	Industrial	Total
1945-1975	\$ 49,000	\$ 161,800	\$ 18,200	\$ 229,000
1921-1976	31,000	111,300	11,200	153,000
1875-1975	23,000	80,500	8,300	111,000●

All values at 1974 prices.

The figure recommended for planning purposes would be \$150,000 per year.

CHAPTER 4

DIRECT FLOOD DAMAGE FOR THE RURAL RICHMOND VALLEY
AGRICULTURE AND RURAL SETTLEMENT4.1 INTRODUCTION

The flood damage sustained by the rural areas can be grouped into the same divisions as were used for urban Lismore, namely direct and intangible. However, all flood damage surveys agree that it is impossible to produce as precise, or meaningful, estimates of rural damage as for urban. This is certainly the situation with the present survey, but the estimates presented should give some relative values which can be judged against the magnitude of the urban losses.

For the purposes of this study the rural losses are subdivided into those associated with farming and those due to residential and commercial damage for individual rural properties or small settlements outside the Lismore urban area. The division is into *Agricultural* and *Rural Residential* sectors. The estimates do not include flood losses sustained by the urban area of Casino or for Ballina and the immediately adjacent coastal settlements.

In sections 8 and 9 of this Chapter, some of the damage incurred is of an indirect nature. The costs have not been repeated in Chapter 5.

4.2 DIRECT DAMAGE - GENERAL PROCEDURE RURAL SECTOR

In broad outline the overall procedure was similar to that employed for the urban area. The first three stages were:

- (a) The flood-prone rural area was delimited in terms of the maximum stage reached by the flood of March 1974.

- (b) A land-use survey was undertaken to assess the agricultural utilisation of the flood-prone area. This did not include a detailed analysis of farm or rural residential buildings.
- (c) After analysis of the land-use survey a questionnaire was distributed to a sample of farms selected to include properties engaged in differing types of farming and located in various parts of the flood-prone area.

At this point the procedure employed for the Lismore urban area was no longer possible. In practical terms, it is not possible to define stage-damage curves for rural crops in a manner similar to that employed for urban land-use. Without such curves it is impossible to proceed to detailed presentation of the damage sustained at differing flood heights or to present data on mean annual costs. Thus the information is in terms of damage estimates for the 1974 flood with only broad indications of the likely costs for damage at lower flood stages. It may be of value to briefly discuss the difficulties of assessing flood damage in the rural area of the Richmond River Valley as this may be a guide to any future study.

4.2.1 Difficulties of Flood Damage Assessment in the Rural Area

The problems can be divided into three major categories .

- (a) Basic hydrological problems and data. No continuous stage records are available and small changes in river level can result in major changes in the area inundated. Further the lower Richmond River is, even in times of

high river stage, affected by tidal influences. However, if sufficient stage records were available, these could be adjusted to take account of the tidal influences.

Perhaps the major hydrological difficulty is that the stage height on the flood plain is poorly related to that in the adjacent rivers.

- (b) Duration and season in relation to crop damage. The analysis of urban flood damage assumes that the effects of season and the duration of immersion by flood water have relatively little effect on flood damage. This assumption, while reasonable for the flood effects in urban Lismore, is certainly not valid for the assessment of crop damage. The duration of immersion of varying crops plays a major factor in loss sustained. Also the season at which the flood occurs clearly has a marked effect on crop loss. For example, floods early in the season leave farmers the possibility of re-sowing and the temperature of the flood water is important in relation to cane losses. It is theoretically possible to make allowance for these factors but the variety of farming practice in the Richmond Valley is such that this was not attempted in the present study.

- (c) Delimiting the area inundated. An estimate was made of the maximum area inundated by the 1974 flood. However, attempts to obtain information on the area inundated by floods of lesser magnitude were not successful. The local memory for the area flooded at the maximum stage of lesser floods is poorer than for major floods and would demand a

near full survey of the farmers in the area. Also maps depicting the height of land in the lower Richmond River Valley, at a sufficiently detailed scale to define the flooded area in relation to the gauging stations, are not available. A local difficulty is the problem of water impounded behind levees causing distortions to the overall pattern of flooding.

A related problem is that even if the area flooded at differing stages were available there is no readily available precise cartographic information on the land held by individual farm owners. The Valuer General maps are not fully adequate for this purpose as although they define land owners the relationship to specific farm units is poor.

While many of these difficulties, e.g., tidal effects and seasonal damage effects, are problems that would occur in flood assessment in any analogous area some of the difficulties could be overcome by further basic survey work. For example, maps defining the area inundated by floods of varying probability would be a useful additional planning tool. The use of air photography or satellite imagery undertaken as close to the peak flood conditions as possible may represent the cheapest and most appropriate manner to obtain much of this information.

4.3 DELIMITATION OF THE FLOOD-PRONE AREA

The first stage in assessing the direct damage in the rural sector was to delimit the area inundated by the major flood of 1974. The final map was obtained by using a combination of various methods and sources.

The provisional line was delimited in consultation with Mr F. Barlow and combined his first-hand experience of the flood with information from air photographs and maps. A line representing the limit of inundation of the 1974 was drawn onto a set of 1:25,000 maps of the area. Minor modifications were made to this map as the fieldwork in the area proceeded and in some cases information gained from the farm interviews was also included. A complete set of the maps, with the 1974 flood line superimposed have been made available to the Public Works Department. A map of the flooded area is presented in Figure 4.1, but the scale at which it is produced only gives a very general outline of the flooded area.

During the course of the farm interviews it became apparent that for some areas of the Lower Richmond Valley flooding was slightly more extensive for the flood of 1954 than for 1974, but overall the 1974 flood could be considered as presenting a regional flood with low recurrence interval (probably within the range of 2.0 to 1.0%).

4.4 RURAL LAND-USE SURVEY

The field assessment of the land-use in the flood area was undertaken during January 1978. The rural land-use was classified into four major classes and these were marked directly on to the 1:25,000 map sheets in the field. A set of air photographs (taken several years earlier) were also used, mainly in order to position the boundaries of individual paddocks on the maps. The land-use was then drawn from the field sheets onto transparent sheets that could be overlaid onto the set of 1:25,000 maps on which the 1974 flood limits were marked. The original set of overlay sheets has been made available to the Public Works Department. A small-scale representation of the area under cane is given in Figure 4.1. Thus the land-use mapped was for early 1978 and

the assumption was made that changes in land-use since February 1974 were minor. This is thought to be a valid generalisation for the flood area concerned. Urban areas were omitted from this survey.

The classes of land-use recognised were as follows:

(a) Grass and pasture. This was subdivided into three sub-classes:

- (i) Very limited areas of high grade sown grass which, under the dry conditions of January 1978, were often irrigated.
- (ii) Pasture of good condition.
- (iii) Poor grade pasture often associated with water-logged and swamp conditions.

(b) Sugar cane. This was the easiest crop type to delimit.

(c) Areas of arable cropping (other than cane or sown grass).

This was subdivided into two sub-classes:

- (i) Areas under maize.
- (ii) Areas under other crops or arable likely to be used for crops other than sugar or maize.

(d) Woodland. This was not subdivided and in large part corresponds to the area marked as woodland on the 1:25,000 map series. Minor modifications were, however, made to the 1:25,000 maps where appropriate. A local problem was that some areas marked as 'woodland' are also used as poor quality grazing.

The whole of the flood-prone area was mapped in the field, but there is clearly some subjectivity in applying the above criteria consistently, particularly in subdividing the 'grass and pasture'. Also small areas of arable cultivation used mainly for vegetable production may have been omitted. However, the survey was essentially undertaken by a single surveyor so that there is likely to be a reasonable degree of internal consistency.

The area falling in each category is presented in Table 4.1.

TABLE 4.1
LAND-USE OF THE AREA INUNDATED BY THE 1974 FLOOD

Area	Cane	Grass	Woodland	Arable	Total Area
Upper Valley	-	18,541	23	195	18,759
Lower Valley	8,320	82,722	7,350	886	80,737
TOTAL	8,320	101,263	7,373	1,081	99,496

All figures are in hectares.

THE TOTAL FLOODED AREA IS 106,980 HECTARES OF WHICH 99,496 HECTARES ARE AGRICULTURE AND WOODLAND. THE REMAINDER IS COMPOSED OF URBAN LAND USE.

4.5 RURAL QUESTIONNAIRE

The questionnaire was designed after discussions with a number of groups and individuals who were well-informed in respect of farming practice in the Richmond River Valley. Considerable assistance was obtained from discussions with groups of farmers representative of

varying farming types. The questionnaire contains 52 sections plus a dairy farming supplement, a copy is presented in Appendix 4.1.

We would like to specifically record our thanks to all those involved with the farm survey for their willing co-operation which, due to the lengthy nature of the questionnaire, often required a considerable outlay of time. In all cases, the questionnaire was completed, or checked in detail by a lengthy interview, on the farm property.

The sample of farmers to whom the questionnaire was distributed was selected after the land-use survey had been completed. Four major factors were considered in selecting the sample.

- (a) The dominant land-use type. In terms of farming practice these can be designated as cane, dairying, and grazing. A small number of farms with a mixed economy were also included.
- (b) The distribution within the flood-prone area. The aim was to include farms from both the upper and lower section of the flooded area. It was clear that both the duration of inundation and the proportion of individual farm holdings flooded are smaller in the upper valley. The division of the flooded valley into upper and lower sections, is shown in Figure 4.1.
- (c) Size of farm holdings. An attempt was made to include a range of size for all the farming types.

- (d) Proportion of farm holdings in the flood zone. This was considered important in that holdings which are 100% flood-prone undoubtedly suffer more than those that include some flood-free property.

In comparison with the assessment of urban flood damage, it is impossible to establish, in any detail, the composition of the total farm population with which to compare the sample. However, it is thought that overall, the sample selected can be regarded as representative.

4.5.1 Distribution of the Questionnaire

A total of 81 questionnaires were completed and the broad classification of the farming types represented is given in Table 4.2.

TABLE 4.2
FARM TYPES REPRESENTED IN THE RURAL QUESTIONNAIRE

Cane	14
Cane and grazing	7
Dairy	29
Dairy and grazing	4
Grazing	27
TOTAL	81

In order to analyse the direct damage, in relation to the divisions recognised on the land-use map, this initial classification of farm types was re-organised to give the groups presented in Table 4.3. Specifically some of the 'mixed' farms were omitted from this aspect of the study. This reduces the number of questionnaires utilised to assess direct damage to 73.

TABLE 4.3
CLASSIFICATION OF FARMS USED IN ASSESSING CROP DAMAGE

Area	Cane	Dairy	Grazing
Upper Valley	-	17	9
Lower Valley	18	17	12
TOTAL	18	34	21

The number of replies used in varying aspects of rural flood damage assessment varies slightly as the answers from the full sample of 81 are not always applicable to specific problems.

4.6 VARIATIONS IN FLOODING - UPPER AND LOWER VALLEY

As mentioned in section 2.1, the duration of inundation varies greatly in the upper and lower sections of the Richmond Valley. Respondents were asked to state how long water took after the 1974 flood peak to recede to cover only half the maximum area flooded and also the time before the flood waters receded to 'normal'. A summary of the responses to these questions is given in Table 4.4. Farmers were also asked how soon after the flood the land was suitable for stock or for the use of a tractor. The answers are presented in Table 4.5.

TABLE 4.4
DURATION OF INUNDATION

	Floods retreat to half area	Floods fully receded
0 - 12 hours	6 (8.4)	1 (1.3)
13 - 24 hours	15 (20.9)	3 (4.0)
25 - 48	8 (11.1)	14 (18.4)
49 hours - 4 days	18 (25.0)	7 (9.2)
5 days - 1 week	10 (13.9)	16 (21.1)
1 - 2 weeks	14 (19.4)	21 (27.6)
2 - 3 weeks	1 (1.3)	7 (9.2)
In excess of 3 weeks	-	7 (9.2)
TOTAL	72 (100.0)	78 (100.0)

Figures in brackets are percentages.

TABLE 4.5
PERIOD BEFORE INUNDATED AREA CAN BE STOCKED OR TRACTOR
EMPLOYED

	Re-stocked	Tractor
0 - 7 days	20 (29.2)	19 (24.3)
8 - 14 days	4 (5.8)	5 (6.3)
15 - 21 days	2 (2.8)	9 (11.4)
22 - 1 month	5 (7.2)	20 (26.2)
1 - 2 months	7 (10.2)	19 (24.3)
2 - 3 months	10 (14.5)	2 (2.5)
3 - 6 months	17 (24.7)	3 (3.7)
6 - 9 months	2 (2.8)	1 (1.3)
In excess of 9 months	2 (2.8)	-
TOTAL	69 (100.0)	78 (100.0)

Figures in brackets are percentages.

There is a wide range in the answers to these questions, but broadly the pattern is very different for the upper and valley sections as delimited in Figure 4.1.

- (a) Cane. In general, half the area is free of flood water within about 7 days of the flood peak and the flood waters have receded to normal after about 14 days. For properties adversely situated, in this respect, parts of the land may be waterlogged for periods in excess of 4 weeks, but this is unusual. In general a tractor can be used on the land within about 4 weeks, but this would depend very much on the season of the year and the subsequent rainfall.
- (b) Dairying and Grazing. In the upper valley half of the flood-affected area is generally only covered for a period of less than 24 hours and stock can be returned to the area after about a week or so. This contrasts markedly with the lower valley where for most areas half the land is still submerged after a week, and low-lying sections may retain a water cover for periods in excess of a month.

For many grazing properties it is not possible to restock the flooded areas for periods of several weeks and a number of owners report that the land cannot be used for grazing for 6 months. For a flood of the 1974 magnitude the delay in returning the area to grazing is very dependent on the subsequent rainfall conditions and the stocking rate per hectare can be reduced for much longer

periods. For the dairying properties the time for the return of stock is slightly less due mainly to the use of better drained land. However, not only do many properties report an inability to restock for 2-3 months, but the quality of the pasture by that time is very poor indeed.

The effects on farming far exceed the period that elapses before stock can be returned to the flooded pasture. In addition, all the lower valley dairying and grazing properties report army worm infestation subsequent to the withdrawal of the flood waters. A considerable proportion also note that sedimentation is an additional burden.

4.7 DIRECT DAMAGE - CANE

The 18 properties sampled had a total of some 450 hectares of cane directly affected by flooding. The range of cane flooded on individual properties was from 1 to 120 hectares. The damage figures presented are based on the loss of the crop, as estimated by the farmers, plus associated direct losses to equipment and farm buildings. They do not include damage to residential farm property or losses sustained by other agricultural activities, e.g., if cattle were also run on the property. Details of property size, proportion flooded, area of cane effected, cane loss per property and loss per hectare for the full sample, are given in Table 4.6.

The problems in assessing cane loss include:

- (a) Duration the crop was covered by flood water.
- (b) Age of crop and problems of carry-over costs onto subsequent years.

(c) Savings of not harvesting crops lost (this is likely to be relatively small and has been ignored in this report).

TABLE 4.6
CANE FARM TOTAL AREA, PROPORTION AND AREA FLOODED AND LOSS PER
HECTARE

Farm No.	Total area in hectares	Percentage of area flooded	Flooded area of cane in hectares	Loss in dollars per hectare of flooded area	Loss for property
1	79	100	18	\$1,445	\$26,000
2	72	100	12	\$1,000	\$12,000
3	200	100	100	\$150	\$15,000
4	33	83	12	\$1,580	\$19,000
5	174	56	12	\$1,000	\$12,000
6	64	95	1	\$1,500	\$1,500
7	121	99	4	\$625	\$2,500
8	152	100	2	\$1,000	\$2,000
9	71	90	8	\$1,000	\$8,000
10	84	60	48	208	\$10,000
11	32	100	9	\$1,220	\$11,000
12	77	16	3	\$1,334	\$4,000
13	342	65	60	\$250	\$15,000
14	261	100	7	\$858	\$6,000
15	86	56	5	\$1,400	\$7,000
16	168	88	120	\$84	\$10,000
17	244	25	8	\$1,875	\$15,000
18	206	41	16	\$160	\$2,500
AVERAGE TOTAL	137	76.4	25	\$406	\$9,900

All costs at 1974 prices.

To some extent the manner in which the sample was chosen 'averages' the problems of loss variations due to duration and age. In a number of individual cases where the loss per hectare was small, see Table 4.6, the cane was inundated for a very short period. It is likely that costs tend overall to be under-estimated due to difficulty of assessing the effect on subsequent crop years.

The total estimated damage of the cane for the farms sampled was divided by the area of flooded cane to give a mean damage per hectare. The value obtained is approximately \$400 per hectare at 1974 prices.

4.8 DIRECT DAMAGE - DAIRYING IN THE UPPER VALLEY

The 17 properties that comprised the sample had an average farm size of 95 hectares and a little over half of the total area was inundated at the peak of the 1974 flood. With the exception of a few acres of maize the properties were given over exclusively to dairying. The loss figures are given in Table 4.7, and have a mean value of \$32 per hectare. The losses used to calculate this value do not include damage to residential farm property or losses of maize.

A breakdown of direct losses into various categories is given in Table 4.8. Purchase of fodder, damage to fences and farm equipment and loss of milk production, comprise over 80% of the damage.

4.8.1 Direct Damage - Dairying in the Lower Valley

The sample comprises 17 properties and the mean damage was \$92 per hectare; details are given in Table 4.9. The subdivision of direct damage costs, in Table 4.8, shows that the loss of milk production accounted for nearly half the loss. Other forms of indirect damage affecting these, and other farms, will be given in Chapter 5.

TABLE 4.7
DAIRY FARMS (UPPER VALLEY) SIZE, PROPORTION AND AREA FLOODED
AND LOSS PER HECTARE

Farm No.	Total area in hectares	Percentages of area flooded	Flooded area in hectares	Loss in dollars per hectare of flooded area	Loss for property
1	49	66	36	\$37	\$1,340
2	75	45	54	\$103	\$5,580
3	58	27	16	\$21	\$340
4	124	64	84	\$6	\$560
5	66	40	26	\$127	\$3,360
6	70	65	40	\$52	\$2,100
7	68	18	16	\$6	\$100
8	37	50	18	\$59	\$1,000
9	84	86	72	\$21	\$1,500
10	67	62	44	\$25	\$1,110
11	110	100	110	\$37	\$4,000
12	176	50	88	0	0
13	322	12	36	\$22	\$800
14	94	90	84	\$33	\$2,780
15	63	38	24	\$4	\$100
16	92	15	14	\$7	\$100
17	165	55	92	\$27	\$2,500
Mean	95	52.6	50	\$32.0	\$1,600

4.9 DIRECT DAMAGE - GRAZING IN THE UPPER VALLEY

The sample comprised 9 properties and details of size and damage are presented in Table 4.10. The damage per acre, \$7.8 per hectare, was small and in most instances was confined to damage to fences and gates. Only one of the properties lost any stock by drowning and only one found it necessary to purchase extra fodder directly due to the flood.

TABLE 4.8

A SUBDIVISION OF DIRECT DAMAGE FOR DAIRYING AND GRAZING PROPERTIES

	Loss of stock by drowning	Losses due to premature sale of stock	Purchase of fodder	Re-planting and loss of sown pasture	Agistment costs	Loss of milk production	Damage to farm buildings and fences	Mean damage per property
Dairying (Upper Valley)	5.2%	3.0%	29.3%	10.7%	Nil	37.5%	14.3%	\$1,600
Dairying (Lower Valley)	14.1%	6.2%	13.2%	10.8%	5.5%	45.9%	4.3%	\$9,600
Grazing (Upper Valley)	7.6%	Nil	30.4%	Nil	Nil	-	62.0%	\$300
Grazing (Lower Valley)	35.0%	30.7%	5.0%	8.2%	17.7%	-	3.4%	\$9,500

All damage figures from data for the 1974 flood.

TABLE 4.9
DAIRY FARMS (LOWER VALLEY), SIZE, PROPORTION AND AREA FLOODED
AND LOSS PER ACRE

Farm No.	Total area in hectares	Percentages of area flooded	Flooded area in hectares	Loss in dollars per hectare of flooded area	Loss for property
1	81	85	69	\$48	\$3,345
2	106	100	106	\$119	\$12,600
3	71	75	53	\$287	\$15,200
4	184	80	147	\$8	\$1,140
5	84	100	84	\$167	\$14,030
6	144	83	120	\$187	\$22,400
7	184	98	180	\$79	\$14,200
8	70	99	69	\$160	\$8,000
9	62	56	35	\$54	\$1,900
10	60	100	60	\$130	\$7,800
11	46	75	35	\$90	\$3,150
12	54	22	12	\$32	\$380
13	80	99	79	\$165	\$13,000
14	117	86	101	\$61	\$6,200
15	260	99	258	\$69	\$15,700
16	211	100	211	\$64	\$13,450
17	162	100	165	\$69	\$11,100
Mean	116	90.5	105	\$92	\$9,600

TABLE 4.10

GRAZING PROPERTIES (UPPER VALLEY), SIZE, PROPORTION AND AREA
FLOODED AND LOSS PER HECTARE

Farm No.	Total area in hectares	Percentages of area flooded	Flooded area in hectares	Loss in dollars per hectare of flooded area	Loss for property
1	40	20	8	\$18	\$150
2	160	5	8	\$4	\$35
3	113	30	34	\$42	\$1,415
4	233	12	28	\$5	\$150
5	200	80	160	\$3	\$450
6	80	5	4	-	-
7	188	50	94	\$4	\$400
8	36	50	18	-	-
9	77	36	28	\$14	\$400
Mean	125	33.6	42	\$7.8	\$300

4.9.1 Direct Damage - Grazing in the Lower Valley

The damage was estimated to be \$46 per hectare and details are given in Tables 4.8 and 4.11. The major losses for these properties is for stock lost by drowning and in the premature sale of stock due to the flooding. The estimated loss per head of stock sold was between \$10 and \$20. These losses do not include depreciation of the value of stock that were still held on the properties on land badly affected by the flooding.

Differing grazing properties employed differing strategies to cope with the effects of the 1974 flood. Some sold large numbers of their cattle while others agisted their stock (the cost of agistment was approximately 30¢ per head per day). In some cases poor grazing land associated with wooded areas was employed. In

others losses due to the drowning of stock were large, the largest loss from the sample was \$14,000. Many of the lower valley grazing properties are large in extent and it is very much more difficult to move stock under flood conditions than it is for smaller dairying properties where the stock are pastured in smaller paddocks associated with milking sheds.

TABLE 4.11
GRAZING PROPERTIES (LOWER VALLEY), SIZE, PROPORTION AND AREA
FLOODED AND LOSS PER HECTARE

Farm No.	Total area in hectares	Percentages of area flooded	Flooded area in hectares	Loss in dollars per hectare of flooded area	Loss for property
1	724	67	485	\$71	\$34,360
2	535	52	278	\$26	\$7,050
3	486	14	68	\$18	\$1,260
4	1,087	30	326	\$12	\$3,900
5	665	95	632	\$29	\$18,400
6	224	100	224	\$30	\$6,650
7	173	30	52	\$67	\$3,500
8	115	80	92	\$94	\$8,600
9	62	45	28	\$5	\$130
10	99	97	96	\$156	\$15,000
11	150	80	120	\$75	\$9,040
12	90	80	72	\$88	\$6,300
Mean	368	56.1	206	\$46.0	\$9,500

4.10 ARABLE LOSSES

A number of farms throughout the flooded area had some areas given over to maize. The losses reported for this crop were grouped to obtain a mean figure for the loss per unit area. The details are presented in Table 4.12, and the mean loss is \$224 per hectare. This value has been assumed as applicable to all the arable agricultural land except that planted specifically as pasture grass. The latter has been included in the per unit area costs already presented for dairying and grazing.

TABLE 4.12
DAMAGES SUSTAINED BY MAIZE

Farm No.	Maize in hectares per farm	Maize loss, dollars per hectare	Loss for property
1	4.0	\$125	\$500
2	16.0	\$187	\$3,000
3	2.0	\$500	\$1,000
4	10.4	\$240	\$2,500
5	2.0	\$400	\$800
6	4.0	\$300	\$1,200
7	4.8	\$625	\$3,000
8	12.0	\$42	\$500
9	4.8	\$208	\$1,500
10	3.2	\$312	\$1,000
11	6.0	\$250	\$1,500
12	6.0	\$137	\$820
13	2.4	\$375	\$900
14	4.0	\$150	\$600
15	3.2	\$312	\$1,000
16	4.0	\$150	\$600
Mean	5.5	\$224.3	-

4.11 DIRECT DAMAGE TO THE RURAL AGRICULTURAL SECTOR

The areas of differing forms of land-use inundated by the 1974 flood have been presented in Table 4.1. To obtain estimates of the damage the areas of differing types of land-use are multiplied by the per unit damages discussed in the preceding sections and given in Table 4.13.

TABLE 4.13
ESTIMATED DAMAGE PER HECTARE FOR DIFFERING LAND-USE

Area	Cane	Dairying	Grazing	Maize and arable
Upper Valley	-	32	7.8	224
Lower Valley	406	92	46.0	

All figures in dollars per hectare at 1974 prices.

Some of the difficulties in using this technique should be noted:

- (a) The per unit damage figures have been obtained from farm questionnaires selected to distinguish differing types of farming practice. However, we have no direct information on the number of farms that could be described as 'dairying' or 'grazing' that occur on the flood prone area. Thus to extrapolate, for example, the costs for dairying in the lower valley only a broad estimate can be made as to how much of the grassland should be included in this division.

- (b) There are three sub-categories of grass mapped on the land-use maps, but in conducting the farm surveys it was only possible to distribute the damages to one class of grass.
- (c) Damages vary according to the proportion of the land of a particular property that was inundated. It has proved impossible to map farm boundaries for the whole area. This effect may however, be partly overcome by the sample selection which tried to include properties with varying proportions flooded in 1974.

In constructing Table 4.14, which shows the direct agricultural damage, the assumption was made that for the Upper Valley approximately half the properties were dominantly grazing, and half dairying, and for the lower valley, 25% were dairying, and 75% grazing. It would be a relatively simple matter to vary these estimates using the information from Tables 4.1 and 4.13. Damage estimates are not included for the 'woodland' areas although in some cases these are used as poor quality grazing.

Thus the total estimated cost is about \$8.75 million. This compares to a cost of about \$5.5 million for the total direct costs of the Lismore urban area. There is little doubt that the quality of the data for the rural area is inferior to that of the urban sector of the study. Two of the salient features of Table 4.14 that are based on aspects of the rural study that represent less debatable aspects of the data collection and analysis, are the cane damage and the proportion of agricultural damage for the upper and lower valley.

TABLE 4.14
ESTIMATED DIRECT AGRICULTURAL DAMAGE FOR DIFFERING
AGRICULTURAL SECTORS FOR THE 1974 FLOOD

Area	Cane	Dairying *	Grazing *	Maize and arable
Upper Valley	Nil	297,000	72,000	44,000
Lower Valley	3,378,000	1,903,000	2,854,000	198,000
TOTAL	3,378,000	2,200,000	2,926,000	242,000

All figures in dollars at 1974 prices

* For Upper Valley 50% of the grass is considered to be dairying and 50% grazing, for the Lower Valley 75% is assumed to be for grazing and 25% for dairying.

Losses to cane forms a very substantial part of the total agricultural damage. A value of about 40% is suggested. Also the agricultural damage of the upper valley is less than 5% of the total damage. In considering the total area flooded, regardless of land-use, the 1974 damage is about \$87 per hectare.

4.12 TOTAL DIRECT DAMAGE AT SPECIFIC FLOOD HEIGHTS

As earlier discussed, it is not possible to produce any form of precise estimate of agricultural losses for flood levels less than those experienced in 1974.

Some generalised comparisons can be made to the losses sustained by the urban area of Lismore. It is likely that minor floods, that cause only limited damage in the urban area, will have a greater effect in the agricultural sector of the lower valley. This may well apply for floods up to a return period of perhaps one in ten years, with major floods having a proportionately greater effect in the urban areas.

The problems of applying any form of stage-damage curve to agricultural land have been listed in section 4.2.1. It would be extremely difficult to produce information on the damage at lower flood heights even if extra time and funding had been made available to the study. Indeed the problems raised, and complications of duration, season, and the like, lead to real doubt if the method is really applicable to the assessment of the flood losses of agricultural lands.

4.13 MEAN ANNUAL ESTIMATES FOR TOTAL DIRECT DAMAGE COSTS

These figures would be based upon damage at differing stage heights and the probability of recurrence of certain flood levels. It is not possible to produce even broad estimates of these figures apart from the most generalised comment that it would appear that the mean annual estimates for agricultural direct losses and the mean annual estimates for total direct urban losses for Lismore would appear to be broadly similar.

4.14 DIRECT DAMAGE TO FARM RESIDENCES FOR THE FARMING RESIDENTIAL SECTOR

In addition to information regarding agricultural loss, the farm questionnaire was also used to gather information on direct damage to residential farm buildings. The questions were essentially the same as those asked in the urban residential questionnaire. The details of the sample are given in Table 4.15 (for the upper valley) and Table 4.16 (for the lower valley).

The questionnaire sought information for both the 1954 and 1974 floods, but for the upper valley, only one household was affected and it is suggested that damage to farm residential property for the upper valley should be ignored.

TABLE 4.15
SUSCEPTIBILITY OF RESIDENTIAL FARM BUILDINGS IN THE UPPER
VALLEY TO FLOOD DAMAGE

	Number in sample	Out of flood area	Raised	Flooded
Dairy farming	17	16	1	0
Grazing	13	10	2	1
TOTAL	30	26	3	1

TABLE 4.16
SUSCEPTIBILITY OF RESIDENTIAL FARM BUILDINGS IN THE LOWER
VALLEY TO FLOOD DAMAGE

	Number in sample	Out of flood area	Raised	Flooded 1954	Flooded 1974
Cane	21	7	5	14	7
Dairy farming	16	11	3	3	1
Grazing	12	5	2	5	3*
TOTAL	49	23	10	22	10

* A raised house with foundation damage is included.

Approximately half the properties included in the questionnaire in the lower valley were situated in the flood-prone zone, i.e., that

major floods could be expected to be above floor height unless remedial action is taken. Twenty-two of these properties experienced household damage in the major flood of 1954 but only ten in 1974. To a limited extent this is explained by the slightly greater magnitude of the earlier flood, but the major factor is the raising of houses undertaken between the dates of the two major floods. From the sample it would appear that about 20% of the residential farm properties in the lower valley are at risk for a flood with a depth close to that of 1974.

4.15 DIRECT DAMAGE COSTS TO FARM RESIDENCES

The ten properties that reported damage in the 1974 flood were flooded by water up to about 1.3 m over floor height. The mean damage to these flooded properties was about \$1500. It is interesting to note that the major damage (some \$2500) was sustained by a raised property, the foundations of which were affected as a direct result of the flooding. The mean damage per farm residence for the whole sample, regardless of whether flood damage occurred or not, is about \$300.

4.16 TOTAL DIRECT DAMAGE TO THE FARMING RESIDENTIAL SECTOR

Lack of height data for the rural areas plus the paucity of direct information regarding the number of farms makes any firm estimate of farm residential damage difficult. However, as a broad estimate there is likely to be in the order of 800 farming properties in the lower valley. Many of these will not be located on flood-prone land and others will be raised, but if we allow a figure of \$300 as the mean damage, then the total for the 1974 flood is approximately \$250,000.

4.17 ANNUAL DAMAGE ESTIMATES

It is impossible to attempt a measure of mean annual damage due to lack of base information, see section 4.2.1. However, the losses

that would be sustained for minor floods would be much less than those of 1974. The maximum flood depth from the survey was 1.3 m over floor level, but the majority of flooded farms had depths of water of less than 0.5 m. Thus direct residential damage would be relatively slight for any but the most major floods. It should also be noted that the farming community has been particularly active in raising residential property and it is likely that a significant proportion of the properties flooded in 1974 may have undertaken structural alterations to withstand a recurrence of similar flood levels.

4.18 DIRECT DAMAGE TO THE RICHMOND VALLEY URBAN SETTLEMENTS

There is no doubt that the major direct urban damage is sustained by Lismore and this has been detailed in Chapter 2. However, other urban centres are affected and it is important that some estimate is given for these.

The data base for these centres is very much more limited in terms of data for flood frequency, ground height of buildings and information on the type and size of property. Table 4.16 presents the information made available by the Public Works Department for nine urban settlements. The properties included are described as 'flood-prone' and this has been taken to indicate a likelihood of flooding at somewhere near the 1% recurrence interval, i.e., approximately the 1 in 100 year flood. It is probable that all the property listed was affected by the 1954 and 1974 floods.

In total there are 472 residential properties and 88 commercial premises in the flood-prone area. This data should only be regarded as a broad estimate and it does not include any of the more detailed information that will become available once the flood map for Casino is complete. All that can be attempted in this report is to apply

average data from the Lismore urban study. Thus if the mean direct damage for residential property in Lismore, approximately \$595 per house, is extrapolated, the total cost would be some \$275,000.

The situation for estimating the likely damage sustained by the 88 commercial outlets is very much more difficult. The mean damage for the 680 commercial outlets in Lismore was approximately \$5400, but this includes a number of very large concerns. From the limited data available it would seem unrealistic to extrapolate this figure to the properties involved in Table 4.16. If a figure of \$2,700 per commercial outlet is used (i.e., half the average value for Lismore), the total commercial sector has direct damage close to \$250,000.

Thus the overall direct damage to the residential and commercial properties listed in Table 4.16 is some \$500,000 for the 1974 flood.

4.19 DIRECT DAMAGE - GOVERNMENT SECTOR

It proved difficult to obtain comprehensive information for the government sector. However, information with respect to the damage to roads and flood structures was made available by the Public Works Department. This was in the form of sums made available to various local government units over a period of some years. The figures presented here are those that would appear to most closely correspond with finance related to the floods of early 1974. It is possible that some Shires have not been included and there are difficulties with data relating to local government authorities whose geographical area is only partly within the Richmond Valley flood area as defined in Figure 4.1, e.g., Ballina.

The figures that are appropriate to the present study are given in Table 4.18.

TABLE 4.17

RESIDENTIAL AND COMMERCIAL FLOOD-PRONE PROPERTY IN URBAN CENTRES IN THE
RICHMOND RIVER VALLEY (EXCLUDING URBAN LISMORE)

	Bangalow	Broadwater	Casino	Coraki	Kyogle	Nimbin	East Wardell	Wardell	Woodburn	Totals
Houses	19	69	22	89	92	4	5	45	127	472
Commercial	8	11	-	13	20	2	-	10	24	88

Data made available by the Public Works Department.

Thus the suggested total for the government sector is \$174,000. This is likely to be an under-estimate as it does not apply to the full range of government costs. For example, no allowance has been made for extra labour employed at various phases during the flood period.

TABLE 4.18
DAMAGE TO ROADS AND FLOOD STRUCTURES FROM THE RECORDS OF THE
PUBLIC WORKS DEPARTMENT

Shire	Amount
Richmond River Flood Council	\$60,000
Tintenbar Shire	\$46,000
Terania Shire	\$13,000
Richmond River Shire (Coraki-Woodburn)	\$29,000
Byron Shire	\$26,000
TOTAL	\$174,000

4.20 MEAN ANNUAL ESTIMATES FOR THE RICHMOND VALLEY URBAN SETTLEMENT

The estimate of the 1974 flood for direct damage of \$674,000 (the combined totals from sections 4.18 and 4.19), should be regarded with considerable caution, but the extrapolation to give the figures in terms of a mean annual figure demands more data than is available. The only possible strategy to give a mean annual figure rests on the premise that both the flood frequency and the distribution of the buildings with altitude, is directly comparable to that for the urban area of Lismore. This is not a warranted assumption.

However, from the data presented in Table 4.16, and the assumptions outlined above, the best guess at a mean annual direct damage figure for the Richmond River Valley urban settlements and government sector damage, not including Lismore itself, would be some \$60,000 per year.

CHAPTER 5
INDIRECT FLOOD DAMAGE FOR THE RURAL RICHMOND VALLEY
AGRICULTURE AND RURAL SETTLEMENT

5.1 INTRODUCTION

The indirect costs of flood damage for the Richmond River Valley can be divided into those for the agricultural sector, the various urban settlements and disruptions to the transport network. The indirect costs for the urban area of Lismore have been considered separately in Chapter 3.

There are difficulties in defining exactly what comprises 'indirect', as opposed to 'direct', damage. It was possible to present a detailed statement for the indirect damage for Lismore but this is not the case for the remainder of the Richmond River Valley. For the agricultural sector many of the damage components presented as direct costs in Chapter 4, e.g., agistment of cattle, loss of milk production etc., are in a strict sense, indirect costs. However, it was thought appropriate to present the agricultural costs that could be quantified in the one section. The information on the indirect agricultural losses presented below is an attempt to outline some of the additional details obtained from the questionnaires.

5.2 AGRICULTURAL SECTOR - DAIRYING

It is generally difficult to separate direct and indirect effects in the farming sector. Dairying however, is probably more amenable due to the reliance on milk production where cash losses can be obtained with some confidence from farm records. It is also true to say that dairy farmers are particularly susceptible to large losses and individual hardships that are difficult to portray adequately in a series of statistical tables. One of the major problems is that individual farms have a set milk quota. If this quota is not met,

due in this case to flood effects, the quota can be removed or reduced. This has a disastrous effect on a dairy farm as the income from the quota is the basis of both budget and management.

5.2.1 Disruption due to Flood and Loss of Milk Revenue

General information on the duration of inundation has been presented in Tables 4.4 and 4.5, but these do not give a detailed picture of the disruption to dairying. Table 5.1 presents data on how long the dairy farms in the questionnaire sample took to resume 'normal milk production'. The sample is divided into dairy farms in the Upper and Lower portions of the valley as defined in Figure 4.1.

TABLE 5.1
PERIOD REQUIRED FOR MILK PRODUCTION TO RETURN TO NORMAL
AFTER THE 1974 AND 1975 FLOODS

	No disruption	Up to 1 month	1 - 3 months	3 - 6 months	6 - 12 months	Over 1 year	Total
<u>Upper Valley</u>							
1974	6	3	4	1	2	0	16
1975	7	4	4	0	1	0	16
<u>Lower Valley</u>							
1974	0	3	3	2	3	4	17*
1975	0	6	2	5	2	0	15

* Two Lower Valley Dairy farms changed their farming practice as a result of the 1974 flood.

Table 5.1 gives an idea of the scale of the disruption to dairying but suffers in that it is based on the respondent's subjectivity understanding of the phrase 'return to normal'. It is interesting to note that the Lismore milk factory independently stated that it took some twelve months after the 1974 flood for their milk supplies to return to normal. The questionnaire data can also be used as background to the magnitude of the financial loss to farms from the disruption to dairying. For the 16 dairy farms in the Upper Valley sample, the mean 1974 loss was \$530, while for the Lower Valley sample the loss was \$3250, with 5 of the 17 farms recording losses of over \$5000. Also two of the sample went out of milk production completely after the 1974 flood.

5.2.2 Dairy Farming and Off-farm Employment

In assessing the effect of loss of milk production, the possibility of the farmers affected taking up part-time or short-term employment away from the farm was considered. Of the total sample of 33, only 4 report income other than from the farm, in two of these cases such income was from investments and in one case from a pension. The remaining case involved a new dairy farmer who undertook a short-term post in quarrying in order to remain financially solvent. These results are important and are likely to arise from the close tie to the farm that is required in dairying: in order to maintain a milk yield sufficient to meet the quota requirements, part-time or short-term employment is not a viable option. In other words the milk yield, which is the basic income, is drastically reduced but any 'time' apparently made available cannot be used for other employment.

5.2.3 Disruption of Services

Farmers were questioned (Question 14 on the rural questionnaire, see Appendix 4.1), as to the causes of the disruption to milk production. Undoubtedly the effects of pasture inundation were overwhelming, but disruption of milk collection services as a result of flooding also played a significant role in a number of cases. Further analysis shows that the mean time that milk collection services were affected in the Upper Valley was 2½ days and the corresponding figure for the Lower Valley was six days. Indeed, for the Upper Valley this was the major cause of disruption for many of the dairy farms. It should be noted that many farmers are able to store their milk for a period of a few days.

Information was also sought (Question 20), on the loss of electricity, clean water, and telephones, for the 1974 and 1975 floods. Such disruptions were minimal and for electricity and clean water could be ignored apart from individual cases. Some 25% of the total dairying sector reported phone problems ranging from a few hours to a week. There was relatively little variation between 1974 and 1975 although many farmers volunteered the information that the disruption to such services was very much more severe in the flood of 1954.

The disruption to electricity, which is essential to dairying, can be ignored it is a minor factor.

5.2.4 The Milk Quota

The significance of the quota has already been discussed but the opportunity was taken to ask the farmers if they could maintain their quota if a flood of 1974 proportions was to occur in the near future. All the Upper Valley farmers thought that this would be

possible but some 50% of those in the Lower Valley considered that they would be unable to meet their quota and many of the remainder were unsure.

5.3 AGRICULTURAL SECTOR - GRAZING

Indirect costs such as agistment, loss or enforced sale of stock etc., have been included in the assessment of direct damage in Chapter 4.

5.3.1 Grazing and Off-farm Employment

In contrasts to the dairying sector, some 60% of the total sample of 21 have regular outside income apart from the farm. In some cases this is from investments and pensions but the possibility of working grazing properties on a part-time basis is clear. None of the sample lost any portion of this outside income due to flooding. In two cases part-time employment was taken as a result of the flood losses.

5.3.2 Disruption of Services

Problems of inaccessibility due to flooded roads were considerable although the effects are not as severe as those suffered by dairy farms where milk collection was affected. The grazing properties in the Upper Valley were isolated from the road network for an average time of just over two days in 1974. The corresponding figure for the Lower Valley was nine days.

Electricity and water supply were only affected in a very small number of cases but approximately half the properties sampled experienced difficulties with telephones both in 1974 and 1975. Again

many ventured the comment that the disruptions to these services, and to road accessibility, were very much more severe for the floods of 1954.

5.4 AGRICULTURAL SECTOR - CANE

Assessments have already been presented for losses in cane production and these included estimates of the carryover losses of cane into years subsequent to the flood of 1974. Other information related to indirect effects of the flood is presented below.

5.4.1 Cane and Off-farm Employment

The cane sample discussed in this section consists of 21 respondents and includes some farmers who combine cane production with grazing. Nine of these have regular income and employment in addition to that of the farm itself and in no case was this affected by the flooding. In one case short-term employment was obtained after the flood in order to maintain a viable income.

5.4.2 Disruption of Services

Cane properties were isolated for a mean duration of seven days after the 1974 flood. The only severe disruption to service supplies was to telephone communication, which was affected for periods of up to three weeks.

5.5 LONG-TERM EFFECTS OF PESTS, EROSION AND DISEASE

The rural questionnaire invited comment (Question 11), on indirect effects of the flood on farming. This included comments on various forms of disease, noxious weeds, sediment deposition, erosion etc. While this was a qualitative description, it was clear that

this aspect of indirect damage is, in some cases, severe. This particularly applies to the grazing and dairying sectors in the Lower Valley and also to cane farmers who maintain a side interest in grazing.

There is no doubt that Army worm infestations subsequent to the retreat of the flood waters are a major problem. Some 90% of the sample of farmers in the Lower Valley stressed the significance of this particular pest. There were many comments that the effects of the Army worms were worse than the direct effects of inundation on the pasture and delayed re-stocking for additional periods of up to six months. It is impossible from the information collected to put a value on this form of indirect damage but it is substantial and only partially included in the earlier assessment of damage.

The significance of the Army worm problem is considerable, and the farmers are convinced that this is directly linked to the flooding. However, many other indirect effects are also listed for individual farms and include noxious weeds, the deposition of silt and localised loss of land due to erosion. It would be particularly difficult to put an economic value on these effects, as silt deposition and limited erosion could be regarded as both a reasonable feature of flood plain flooding and in the case of sediment deposition, as having a latent beneficial effect.

5.6 SUMMARY OF INDIRECT EFFECTS ON AGRICULTURE

While the effects discussed in this chapter only represent the indirect effects that are difficult or impossible to quantify in monetary terms, it is stressed that their overall importance is considerable. Any measure undertaken to alleviate the intensity and frequency of flooding, especially in the Lower Valley, would result

in a considerable benefit as regards the indirect effects on the agricultural community.

5.7 INDIRECT DAMAGE TO RURAL SETTLEMENT

For the purpose of this study the rural settlements can be divided into two categories. These are:

- (a) The rural farm residences that were assessed through the rural sample. In general these are isolated farms connected to the main road network by tracks. As a result, they suffer more severely than other residential property from isolation during major floods.
- (b) The Richmond Valley urban settlements. These are very much smaller than the urban centre of Lismore. The nucleated settlements included in this group are given in Table 4.16. For these settlements information as to the number of flood-prone residences and commercial outlets was made available by the Public Works Department.

These two forms of rural settlement will be considered separately as they differ both in the nature of the various forms of indirect damage sustained and in the detail of information obtained

5.8 INDIRECT DAMAGE - RURAL FARM RESIDENCES

The questionnaires distributed to the agricultural sector included similar questions on damage to the farm residence similar to those in the urban residential questionnaire. However, a much smaller proportion of farm residences are actually affected by water encroaching over floor level. In section 4.14 it was estimated that

only 20% of the rural residences were affected in this manner in the Lower Valley and for practical purposes none of those located in the Upper Valley were affected.

In assessing the costs of indirect damage to the residential property in the rural sector the same categories will be used as for the residential sector. These are:

- (a) Clean-up costs
- (b) Loss of salary or wage
- (c) Costs of removal and accommodation
- (d) Inconvenience and loss of amenity

5.8.1 Clean-up Costs

The detail of the calculation of clean-up was considered in section 3.3. It was estimated that the cost of labour and materials was \$167.5 per household. There is some evidence that the time taken for the clean-up of farm residences is slightly less, probably due to the shallower depth of flooding over the floor in the Lower Valley. It is therefore proposed that \$150 might be a better estimate for the clean-up costs of rural residential properties.

5.8.2 Loss of Salary or Wage

Only 3 of the 80 respondents to this question (Question 52), reported any loss of income due to absence from work to assist with the clean-up operation. This clearly, does not include loss of time from the dominant occupation of farming which has been considered elsewhere in this report. Thus for the purposes of calculating indirect residential farm damage this item has been ignored. The total loss sustained by the 3 respondents was less than \$400.

5.8.3 Costs of Removal and Accommodation

Approximately 50% of the urban residential sample moved to temporary accommodation as a result of the 1974 floods. The corresponding figure for the farming sample was almost exactly 25%. The cost per household for the farming population who moved temporarily is estimated to be \$55. The details of the reasoning to obtain this figure are given in section 3.3.

5.8.4 Inconvenience and Loss of Amenity

There is no doubt that the inconvenience suffered by the households included in the farm questionnaire is considerable. Table 5.2 presents the data on the longest period that the respondents to the rural questionnaire had been isolated, in some cases this information is for the 1954 flood.

TABLE 5.2
MAXIMUM PERIOD OF TIME THAT FARM RESIDENTS WERE ISOLATED
BY FLOOD WATERS

Time isolated	Number	Percentage
Never	3	3.8
Less than 12 hours	1	1.3
12 hours to less than 24 hours	7	8.9
24 hours to less than 2 days	6	7.6
2 days to less than 5 days	26	32.8
5 days to less than 7 days	17	21.5
1 week to less than 2 weeks	18	22.8
Over 2 weeks	1	-
TOTAL	79	

This table includes information for the Upper Valley sample where isolation is usually less than three days. Thus, the difficulties not only to farming, but also to normal household activity in the Lower Valley, are large and exceed those of the residential sector in urban Lismore.

The effects of the 1974 flood on farming losses has already been analysed but the data, given in Table 5.3, for the period before the farm '... was back to normal' is also relevant to this form of indirect loss.

TABLE 5.3
TIME TAKEN FOR THE FARM TO RETURN TO NORMAL

	Cane	Dairy- ing Lower Valley	Dairy- ing Upper Valley	Grazing Lower Valley	Grazing Upper Valley	Total
0 to less than 3 months	3	0	11	2	7	23
3 months to less than 6 months	2	5	1	2	1	11
6 months to less than 1 year	3	4	1	3	1	12
1 year to less than 2 years	3	4	0	4	0	11
Over 2 years	7	3	0	1	0	11
TOTALS	18	16	13	12	9	68

There is little doubt that these estimates of the period before the farm returned to normality are also relevant to the inconvenience component of indirect damage. However, as was the case with the residential sector, it is not thought possible to quantify this form of indirect damage.

5.9 TOTAL INDIRECT RURAL RESIDENTIAL DAMAGE

There is a difficulty in assessing the total indirect rural residential loss even for the 1974 flood as there is no firm information on the number of rural residences in the agricultural sector. It was estimated in section 4.16 that there may be a total of 800 rural farm residences in the Lower Valley. However, it was also thought that for a flood with a stage comparable to that of 1974 that only 20% of these would have water over floor level. This is because a large number of the houses are raised, the majority of which would have had water beneath the house and covering the house surrounds. For the urban residential sector all houses in the flood-prone area were included, whether raised or not. However, since a greater proportion of the rural farm residences are raised or outside the flood limits, it is thought appropriate to consider that half (i.e., 400) of the rural residences should be included in the estimation of clean-up costs.

This is 400 residences at \$150, a total of \$60,000. Loss of wages and salary from non-farming occupation incurred in order to assist with the clean-up operations, would appear to be small and is ignored in these calculations.

Costs of removal and accommodation are likely to affect about 25% of the rural farm households at an estimate of \$55 per household. This total is thus 200 times \$55 or \$11,000.

The totals are therefore:

(a) Clean-up costs	\$60,000
(b) Loss of wages and salary	Nil
(c) Costs of removal and accommodation	\$11,000
Total for the 1974 flood	\$71,000

Inconvenience and loss of amenity will be large for this category of residence, but it is not considered possible to present a firm dollar value.

5.10 INDIRECT DAMAGE - RICHMOND VALLEY URBAN SETTLEMENTS

The number of flood-prone houses included in this category is 742, see Table 4.16. This information was supplied by the Public Works Department and no field mapping was undertaken to extend this information base.

Thus to obtain estimates for the indirect flood loss, sustained average figures have been obtained from the more detailed assessment undertaken for the urban area of Lismore.

5.11 INDIRECT DAMAGE - RICHMOND VALLEY RESIDENTIAL SETTLEMENT

The 1974 losses for residential property due to clean-up, loss of wage, removal and accommodation from the urban Lismore study are given in section 3.3 and are as follows:

(a) Clean-up costs	\$167.50 per household
(b) Loss of wage or salary	\$30.00 per household
(c) Costs of removal and accommodation	\$32.50 per household
Total per household	\$230.00

The costs of removal and accommodation assume that 50% of the households moved to temporary accommodation.

This gives an estimated total indirect damage in the 1974 flood for the residential property in the smaller Richmond Valley urban settlements of \$109,000 (i.e., 472 times \$230.0).

5.12 INDIRECT DAMAGE - RICHMOND VALLEY COMMERCIAL PREMISES

It is assumed that the 88 flood-prone commercial outlets in the smaller urban centres of the Richmond Valley, fell into the 'small' category discussed in section 4.3.2. To obtain an estimate for the indirect losses, the average figures given in Table 3.10 have been used.

The mean figures per commercial outlet are:

(a) Clean-up costs	\$125
(b) Costs of removal and storage	\$65
(c) Loss of business confidence	\$350
(d) Loss of trading profit	\$250
Total per unit	\$790

Thus for the 88 commercial premises, the total estimated indirect loss is \$69,500. It is likely that some of the enterprises would be of the medium size category so an overall total indirect estimate for the 1974 flood of \$80,000 is proposed.

5.13 OVERALL INDIRECT PROPERTY DAMAGE FOR THE AGRICULTURAL AND RICHMOND RIVER VALLEY URBAN SETTLEMENTS

The indirect damage resulting from the 1974 flood that can be estimated in monetary terms is as follows:

Rural Residential Sector (see 5.9)	\$71,000
Richmond Valley Urban Residential (see 5.11)	\$109,000
Richmond Valley Urban Commercial (see 5.12)	\$80,000
Total	\$260,000

Again it must be stressed that this figure does not include indirect damage due to inconvenience and loss of amenity which in the rural residential sector is likely to be substantial.

There are a number of assumptions and the absolute figure could be open to doubt but its relative significance against the comparable indirect damage to the residential and commercial sectors of Lismore itself, at \$1,450,000, is of value and interest.

5.14 DISRUPTION TO THE TRANSPORT NETWORK

The disruption to road, and to a lesser extent, rail transport, is considered as a major component of indirect damage. Unfortunately it did not prove possible to obtain any detailed data to enable the calculation of this flood loss for the Richmond Valley.

The normal procedure is to use information on the length of time that transport links were cut and to combine these with traffic counts obtained for traffic flows under normal conditions. The 'normal' traffic flows are chosen so that comparable days of the week and seasons of the year are employed. This data, and estimates of the extra mileage incurred in order to avoid the flooded region, enables estimates to be made of the indirect loss.

Initially losses of this type may be thought to be large for the Richmond Valley especially as the Pacific Highway traffic was disrupted. However, care must be exercised in calculating such losses and apportioning them solely to the Richmond River. The actual situation is that the rain which caused the 1974 floods in the Richmond Valley, also severely dislocated the whole regional transport network and, for example, the Pacific Highway was rendered impassable at several river crossings in addition to that of the Richmond River.

While no specific information is available from the present study, this form of indirect damage should be taken into account in any flood management study for the region.

5.15 A SUMMARY OF INDIRECT DAMAGE TO THE RICHMOND RIVER VALLEY

It is inevitable that the assessment of indirect damage leaves a number of the categories unresolved in respect of monetary values. But it is important that the elements of such damage that are left as qualitative assessments are not ignored when considering flood plain management.

CHAPTER 6
INTANGIBLE FLOOD DAMAGE IN THE RICHMOND RIVER VALLEY

6.1 INTRODUCTION

It is possible to calculate monetary values for direct and indirect flood damage and such estimates form a valuable base from which to design flood alleviation or flood plain management schemes. The third category of flood damage, intangible damage, is very much more difficult to assess and is frequently omitted from flood planning studies. However, many such studies comment that the combined intangible effects of anxiety, annoyance, and inconvenience, may be as significant as the other forms of quantifiable damage. Further, the various factors included in the intangible category can result in health effects both of a physical and psychological nature. There is little doubt that information can be gathered on the health effects of intangible damage although studies of this kind, specifically related to flood damage and stress, are few.

The classic study, which is quoted in most comprehensive flood damage reviews, is by Bennett (1970) and was concerned with the health effects of a major flood in Bristol, United Kingdom, in July 1968.

The abstract of that study states:

An investigation into the health of people in Bristol flooded in July 1968 was made by means of a controlled survey and a study of mortality rates. There was a 50% increase in the number of deaths among those whose homes had been flooded, with a conspicuous rise in deaths from cancer.

Surgery attendances rose by 53%, referrals to hospital and hospital admissions more than doubled. In all respects the men appeared less well able to cope with the experience of disaster than the women.

There is no cause to doubt either the methodology or the conclusions of this detailed study, the problem is the degree to which

the conclusions can be extrapolated to major floods in other areas. One of the few comparable published accounts is by Abrahams *et al.*, (1976) for the Brisbane floods of 1974. The abstract is as follows:

In the 12 months following the Brisbane flood of 1974, 234 flooded families (695 persons) and 163 non-flooded families (507 persons) were interviewed to ascertain changes in health status. We found that the number of visits to general practitioners, hospitals and specialists, were all significantly increased for flood persons in the year following the flood. Persistent nervous tension and depressed mood, predominated in those seeking medical care, and the consumption of sleeping tablets and psychotropic drugs rose. Increased psychological symptoms were significantly more common in both sexes than increased physical complaints. There was no increase in mortality after the flood. The incidence of psychiatric symptoms was directly related to dissatisfaction with help received.

The results of the Brisbane study certainly confirm the effects of floods on health, but cause slightly less concern since the marked increase in mortality, found for the Bristol floods, is absent.

It should be stressed that the adverse effects on health of floods obtained from interview or analysis of medical records, do not represent the full range of intangible damage. Such studies present a partial picture of 'flood event anxiety' but only include a portion of the 'threat anxiety' which is likely to be ever-present for residents of flood-prone areas. In addition to both flood event and threat, there is a broad area of annoyance and inconvenience which cannot be considered in medical terms.

6.2 BACKGROUND TO THE INTANGIBLE DAMAGE IN THE RICHMOND RIVER VALLEY

Studies of intangible damage are few because of the difficulty of such work, the lack of an accepted methodology, and the time factor

in obtaining and analysing the data. However, it was decided to include a limited range of questions concerned with this problem on the questionnaires distributed during the present study.

The results from these questionnaires should not be interpreted as a detailed study comparable with those of Bennett (1970) or Abrahams *et al.*, (1976). However, they should serve to give some indication of the relative magnitude of the health effects in the Richmond River Valley. This is particularly important as the area has a much greater frequency of flooding than either Bristol or Brisbane and intuitively it could be thought that the magnitude of intangible damage would be relatively less.

6.3 PREVIOUS STUDIES IN THE RICHMOND RIVER VALLEY

An unpublished report by Petroff and Leatch (1976), who were the constant psychiatrist and clinical psychologist of the Richmond Clinic, assessed the effects of the 1974 flood on psychiatric patients attending the Lismore Base Hospital. The salient results were as follows.

The inpatient population of the Richmond Clinic, which has a 23-bed acute admission ward, did not change significantly in the period after the 1974 floods. This is interpreted as indicating that the floods did not precipitate severe extra psychotic breakdowns or re-admissions.

Analysis of the effects on outpatient contacts at the clinic revealed a very significant increase in cases.

- (a) The figures for the Woodburn-Coraki area, which was extensively inundated by the March flood, showed a five-fold increase in the numbers of patients seen.

Similar trends were observed for the outpatient contacts from Lismore and Ballina.

- (b) The increase in referrals and contacts for these areas was most noticeable in the month succeeding the time of maximum inundation. There was in fact no increase, and some evidence of a decrease, at the time of maximum inundation.
- (c) The average age of patients who improved was 30 years while for those who deteriorated, it was 49 years. No children were referred to the clinic.
- (d) For existing patients there is 'the impression that crises of flood had a beneficial effect on the emotional state of more patients rather than a crippling effect.
- (e) 'The at-risk population was older, had undergone crises of tensions in the family, lived in severely flooded areas, felt emotionally unsupported, did not participate in flood shelters and, most importantly, whose need to communicate, to be active to help others, was frustrated.'

This study is particularly valuable as it was undertaken by experienced medical staff already familiar with the region. However, the numbers of patients involved was small, a total of 24 of whom 9 were existing patients. Also the patients could be regarded as representing the severe end of the spectrum of psychiatric victims of the flood.

There is no doubt however, that the effects described in this report demonstrate that health-related aspects of intangible flood damage are of significance in the Richmond River Valley.

6.4 QUESTIONNAIRE INFORMATION GATHERED IN THE PRESENT STUDY

The questionnaires circulated to both the urban and rural sample requested information on health effects associated with the flood. This included a description of the health problem in terms of 'psychological' (e.g., stress), or 'physical' (e.g., broken limb, bronchitis), and the respondent's assessment as to whether it was 'serious' and whether the ill-health seriously disrupted the household. Further information on the age, sex, and position within the household of the affected person(s), was also requested, as well as information on whether visits to the doctor increased for the period after the flood. These are questions numbered 24, 25, 26 and 27, on the Residential Questionnaire given in Appendix 2.2. Details of the exact nature of the ill-health were not formally requested, but in the majority of cases the information was volunteered by the respondents and noted by the interviewers.

The classification of ill-health into 'serious' or 'not serious' (hereafter referred to as 'minor'), was by the respondent's view of the situation, but in some instances this was modified in relation to the reply requesting information on increase or decrease in doctor visits.

The total sample consisted of 79 rural and 146 residential households with information covering a total of some 753 persons.

6.5 RESULTS OF THE QUESTIONNAIRE INFORMATION

The overall results are presented in Table 6.1. This categorises the replies into rural and urban respondents. The rural

category is further subdivided according to the type of farming and whether the farm is located in the Upper or Lower Valley. The urban sample is entirely drawn from the inundated area of Lismore.

TABLE 6.1
DATA ON FLOOD EFFECTS ON HEALTH

	Size of sample		Number of people affected		Number of households affected	
	Total number of people	Households	Serious	Minor	Serious	Minor
<u>Dairy</u>						
Upper Valley	75	17		2		1
Lower Valley	61	16	3	4	2	2
<u>Grazing</u>						
Upper Valley	41	12	1			
Lower Valley	46	13	2	6	2	2
<u>Cane</u>	90	21	7	4	5	2
<u>Rural</u>						
Total	313	79	29 13	16	9	8
<u>Urban</u>						
Total	440	146	30 23	7	18	6
<u>Total</u>						
Rural and Urban	753	225	59 36	23	27	14

Tables 6.2 to 6.5 further analyse the results in terms of location, sex, age, and proportion of the total population affected.

TABLE 6.2
HEALTH EFFECTS BY AGE AND SEX FOR THE RICHMOND VALLEY
RURAL/AGRICULTURAL SAMPLE

	0-15 years	16-24 years	25-44 years	45-65 years	Over 65 years	Totals
<u>Serious</u>						
Male	-	-	-	3	2	5
Female	-	-	2	3	1	6
Children	2	-	-	-	-	2
TOTALS	2	-	2	6	3	13
4.2% of sample affected.						
<u>Minor</u>						
Male	-	-	2	6	-	8
Female	-	-	1	7	-	8
Children	8	-	-	-	-	- *
TOTALS	8	-	3	13	-	16

5.2% of sample affected.

* Omitted from totals, see text.

6.6 COMPARISON OF RURAL AND URBAN SAMPLES

Overall 7.9% of the sample reported adverse health effects due to the flooding, whether of a serious or minor nature. The figures for the rural and urban sectors are 9.4% and 6.8% respectively.

However, if this comparison is limited to individuals reporting serious effects the combined figure is 4.9% with the individual rural and urban values 4.2% and 5.2% respectively.

TABLE 6.3
HEALTH EFFECTS BY AGE AND SEX FOR THE LISMORE RESIDENTIAL SAMPLE

	0-15 years	16-24 years	25-44 years	45-65 years	Over 65 years	Totals
<u>Serious</u>						
Male	-	-	-	2	6	8
Female	-	-	3	4	2	9
Children		-	-	-	-	
TOTALS	6	-	3	6	8	23
4.2% of sample affected.						
<u>Minor</u>						
Male	-	-	-	-	2	2
Female	-	-	-	-	5	5
Children	-	-	-	-	-	-
TOTALS	-	-	-	-	7	7

5.2% of sample affected.

It is clear that the proportion of the rural population situated in the Lower Valley is affected to a larger degree than residents of the flooded Upper Valley. For the Lower Valley the combined serious and minor reports are 13.2% of the total population, with 6.1% reporting serious effect.

Bearing in mind the relatively small size of the sample the differences between rural and urban flood victims in the Richmond Valley would appear to be small with some indication that the rural population in the Lower Valley is more adversely effected.

TABLE 6.4
HEALTH EFFECTS BY AGE AND SEX FOR THE COMBINED RURAL AND URBAN
SAMPLE

	0-15 years	16-24 years	25-44 years	45-65 years	Over 65 years	Totals
<u>Serious</u>						
Male	-	-	-	5	8	13
Female	-	-	5	7	3	15
Children	8	-	-	-	-	8
TOTALS	8	-	5	12	11	36
<u>Minor</u>	4.9% of sample affected.					
Male	-	-	2	6	2	10
Female	-	-	1	7	5	13
Children	8*	-	-	-	-	0
TOTALS	8*	-	3	13	7	0
<u>Serious and Minor Combined</u>	4.9% of sample affected. * Omitted from totals, see text.					
Male	-	-	2	11	10	23
Female	-	-	6	14	8	28
Children	8	-	-	-	-	8
TOTALS	8	-	8	25	18	59

7.9% of sample affected.

6.7 RELATIONSHIP OF SEX TO HEALTH EFFECTS OF FLOOD

From Tables 6.2, 6.3 and 6.4, it would appear that overall there is little statistical difference between the health effects on

males and females. The sex of children under 15 years of age was not ascertained in the sample surveyed.

TABLE 6.5
PROPORTION OF POPULATION REPORTING HEALTH EFFECTS BY AGE

	0-15 years	16-24 years	25-44 years	45-65 years	Over 65 years
Rural	2.1%	-	9.3%	20.8%	14.3%
Urban	4.4%	-	3.5%	6.3%	19.2%
TOTALS	3.4%	-	5.7%	13.4%	18.0%

This information is for 'serious' and 'minor' effects combined.

6.8 RELATIONSHIP OF HEALTH EFFECTS TO AGE

This information is given in Table 6.2, 6.3, 6.4 and 6.4 and all children aged 15 years or less are grouped within the one category.

In general the effects on this youngest age group were small. However, in Tables 6.2 and 6.4, the problems of small sample analysis are illustrated. One rural household in the Lower Valley reported that the whole family suffered minor psychological effects as a result of the 1974 flood, the family included eight children under 15 years of age. In this case it was decided to omit the children from the overall analysis although the parents were included.

There is little doubt that the health effects are particularly marked for the upper age categories (over 45 years). Table 6.5 presents the data in terms of the proportion of each age group that report adverse health due to the flood. The population for each age class was obtained from Question 38 on the rural, and Question 20 on the residential (urban) questionnaires.

From Table 6.5 the marked effects of the flood on the health of the upper age categories are clearly illustrated. Over one in seven of those aged 45-65 report adverse health effects and for those of age 65 or greater, the number is nearly one in five.

6.9 DISRUPTION TO HOUSEHOLDS

In total, nearly 20% of the sample report either serious or minor disruption to the household. If the sample from the less affected Upper Valley is omitted, 13% (close to one in eight) of the households suffered serious disruption. For the rural sample in the Lower Valley alone, over 17% (one in six) of households are seriously affected.

This demonstrates that the flood effects on health represent a major form of intangible damage and household disruption of this type must seriously compound the already major disruption resulting from direct and indirect flood damage to the same households.

6.9.1 NATURE OF HEALTH EFFECTS

The questionnaire did not formally request details of the form of adverse health resulting from the flooding and only asked for a division into 'physical' and 'psychological' effects. However, in many cases extra detail was volunteered and was noted. A summary of this information is given in Table 6.6.

It is important to note that the classification into 'physical' and 'psychological' is very broad and many respondents were unsure of the classification. In part, this problem has been recognised in Table 6.6 by the use of 'combined' class. This is not based on any rigorous medical criteria and includes, for example, 'heart attacks' and 'stomach ulcers' (i.e., cases where the respondents considered that the flood event anxiety was responsible for the onset of the physical

symptoms). There is also likely to be some residual difficulty with the classification into serious and minor.

When the serious and minor effects are combined there is an even balance between the physical and psychological classes. However, there is some evidence that more serious physical cases occur in the urban area and more minor psychological effects in the rural community. The former is difficult to explain but the latter may be due to the relatively greater disruption of the more isolated farms in the Lower Valley. The livelihood of many of the farms was more seriously threatened than was that of the majority of the urban residents and the farms were physically isolated by the flood waters for a much longer period.

6.9.2 Physical Health Effects

The majority of these were bronchitis and asthma but also included physical injury that could be related directly to effects of the flood. The latter included back strains, fractures and cuts although it should be noted that these were a minority of the physical effects.

6.9.3 Psychological Effects

Many of these fall in the minor category as they did not result in extra visits to medical practitioners. However, their importance should in no way be discounted on that score alone. This perhaps reflects the fact that patients with physical injury are more likely to visit doctors than those suffering mental stress.

TABLE 6.6
A TABULATION OF SERIOUS AND MINOR, PHYSICAL, AND PSYCHOLOGICAL
HEALTH EFFECTS

	Serious	Minor	Total
<u>Rural</u>			
Psychological	6	14	20
Physical	4	2	6
Mixed	3	-	3
TOTAL	13	16	29

Sample size 313

<u>Urban</u>			
Psychological	4	6	10
Physical	14	1	15
Mixed	5	-	5
TOTAL	23	7	30

Sample size 440

<u>Rural and Urban Combined</u>			
Psychological	10	20	30
Physical	18	3	21
Mixed	8	-	8
TOTAL	36	23	59

Sample size 753

6.9.4 Deaths

The sample is much too small to allow any satisfactory statistical comment. However, from the questionnaire information the respondents considered that two deaths could be attributed to the

flood. In both cases the fatalities were to males over 65 years, resident in the Lismore urban area. It is of interest to outline these two cases as they may well be indicative of the fatalities which could give increased mortality subsequent to a major flood.

In the first case, the death resulted from an elderly male sustaining a fall during the flood and considered as directly related to the flood event. This fall was then associated with pneumonia which resulted in death. The second case was that of a male who was in fact away from home at the time of the flood. However, the worry over the likely flood damage precipitated a heart attack from which he subsequently died.

There is little doubt that in both cases the deaths were to elderly and near infirm persons but the associated family certainly attribute the deaths to the flood event.

6.10 RELATIONSHIP OF HEALTH EFFECTS TO SEVERITY OF FLOODING

6.10.1 Urban Area

Of the 23 households reporting adverse health effects all but one had water over the floor boards and most of these households reported a flood depth in the house of greater than 0.5 m. The depth of flood water over the floor for the disrupted households is given in Table 6.7. It also presents information on the percentages of houses flooded to the same depths over the floor for the inundated area of Lismore.

Despite the limited sample size there is no doubt that there is a marked relationship between households reporting adverse health effects and the depth of flooding within the house. The only household reporting adverse health effects and not having water over floor level had water to within 2 cm of entering the house.

Thus, whatever the cost-benefit of raising residential property in the flood-prone area to decrease direct and indirect damages, there is little doubt that raising can be expected to decrease intangible damage.

TABLE 6.7
DEPTHS OF FLOODING FOR HOUSEHOLDS REPORTING DISRUPTION
DUE TO HEALTH EFFECTS

Depth of water over floor level in metres	Number of households with health effects	Percentage	Percentage of whole population of flooded urban area
Below floor level	1	4.1%	55.0%
0 - 0.49 m	2	8.4%	16.8% 21.0%
0.05 - 0.24 m	2	8.4%	
0.25 - 0.49 m	0	0	
0.50 - 0.99 m	8	33.3%	12.6%
1.00 - 1.99 m	8	33.3%	9.7%
Greater than 2.00 m	3	12.5%	1.6%

Total households in sample, 24.

6.10.2 Rural Area

In the rural area only 11 of the 79 households sampled reported water over floor level. However, of the 17 households that reported serious disruption, 6 had water over floor level.

6.11 CONCLUSION

The discussion of intangible damage has been limited to the health effects directly attributable to the 1974 flood. It has not considered the questions of general inconvenience or the significance of flood threat anxiety.

- (a) Nearly 8% of the sampled population of 753 reported health effects that, in their opinion, could be attributed to the 1974 flood. There were 36 reports of illness that could be regarded as serious, that is some 5% of the sampled population.
- (b) The effects were approximately equally divided between males and females. However, there was a clear indication that the effects were very much more marked for those with ages of 45 years or more. Approximately 18% of the sampled population with ages in excess of 65, reported adverse health effects.
- (c) The most marked health effects in the urban area were strongly associated with depth of water over the floor boards.

The information presented in this section is not based upon a detailed health or medical study. However, it has demonstrated that the health of a substantial number of people, in the flooded section of the Richmond River Valley, was adversely affected by the major flood of 1974. Prior to the survey it was thought that because of the accumulated flood experience of the inhabitants of the Valley the adverse effects of flooding on health would be much less than for areas without previous flood experience. This may well not be the case and it is urged that further, more detailed studies of the health of the population in relation to flooding should be undertaken. A suggested starting point would be the analysis of the medical records for the area before and after the 1974 flood.

The indication is that this form of intangible damage is very real and could, in cost terms, be extensive. It should certainly form a major factor in any discussion of projected flood plain management for the Richmond River Valley.

CHAPTER 7

ESTIMATES OF POTENTIAL URBAN DAMAGE

7.1 INTRODUCTION

Potential damage is here considered as the damage that would result from a flood if no remedial action was taken. The difference between potential and actual (or real) damage is a measure of that remedial action. The difference is clearly compounded from many factors and represents the response of many individuals and corporate bodies. One of the major factors is the accumulated flood experience of the affected population. For example, the difference between potential and actual damage due to an unexpected dam failure would be small, whereas the difference for river flooding to a community with flood experience would be very much larger. A related factor is the accuracy of flood forecasting both in respect of the magnitude and time of the flood peak. If the assumption is made that improvements in flood forecasting, and dissemination of the information to the flood-prone community, would result in a reduction of flood losses then the difference between potential and actual flood damage would give some basis for a cost-benefit study of such forecasting. It must be stressed that even with perfect forecasting and maximum public action it is not possible to attain a zero figure for actual damage.

The community of Lismore has a wide experience of flooding and has available a good flood forecasting system. Thus information on the relationship between potential and actual damage may provide some guide as to what could be attained in other flood-prone communities. In addition, attention can be drawn to sectors where savings could be expected by more efficient damage prevention.

The estimation of potential damage has been separately assessed for the residential, commercial and industrial sectors of Lismore.

7.2 POTENTIAL DAMAGE - RESIDENTIAL SECTOR

The data on which the estimates of residential potential damage are based were obtained from a detailed survey undertaken by Peter Robinson, a professional valuer resident in Lismore. The sample comprised about 100 houses located in the flood-prone area and was selected after the urban land-use survey had been completed. The composition of the sample is given in Table 7.1.

TABLE 7.1
SAMPLE IN RELATION TO TOTAL POPULATION

	Population	Sample
<u>Size</u>		
Small	524 (27.6%)	27 (25.9%)
Medium	1,374 (72.4%)	77 (74.1%)
<u>Condition</u>		
Poor	318 (16.7%)	28 (26.9%)
Fair	1,585 (83.3%)	76 (73.1%)

The majority of the houses included in the valuation survey were also included in the urban residential survey. Thus there is the opportunity to compare the potential loss to estimates of actual damage provided by the householders.

7.2.1 House Contents

The valuer designed and used a check-list to record the possible loss in terms of market value for the total house contents. An example of a completed form is given in Appendix 7.1. The survey was undertaken room by room and included all appliances, furniture, soft furnishing, clothing, etc. The value recorded is an estimate of the loss in value for a particular item due to immersion in flood water. For some items this would be the total market value while for others it would be only a proportion of the market value. The damage was assessed at five differing heights above floor level, namely 0.05, 0.25, 0.5, 1.0 and 2.0 m. These heights were selected by the valuer as being of particular significance, e.g., 0.05 m, corresponded to damage to floor coverings, and other heights were of significance to bedding and household appliances.

The mean value for the potential damage at the selected heights is given in Table 7.2, and in the form of a potential stage-damage curve in Figure 7.1. Damage in excess of 2.0 m is assumed to remain at the 1.99 m damage value.

TABLE 7.2
POTENTIAL LOSS IN MARKET VALUE TO HOUSE CONTENTS AND BUILDING DAMAGES

Depth of water over floor	Contents	Building damage	Total
0 - 0.049 m	256	36	292
0.05 - 0.24 m	752	149	901
0.25 - 0.49 m	2,176	185	2,361
0.50 - 0.99 m	3,491	486	3,977
1.00 - 1.99 m	4,066	677	4,743

All values in dollars at approximate 1974 prices. Sample size approximately 100.

The variation in the range of the contents of stage-damage curves is considerable. In calculating the total potential damage \$160 was added for potential damage to the 'under-house' contents for those residences where flood height was 1.0 m or more above ground level. The application of this under-house curve followed the procedure outlined in Figure 2.9.

In addition to this measure of potential flood damage a single estimate was made of the total contents value at market price. This value represents total loss and not the value after flood immersion. As this value is also of assistance in assessing the greatest possible loss the results are presented in Figure 7.2. The overall range was from \$800 (in two cases) to \$15,000. The mean value for the total sample of 103 properties was \$6487. From the residential questionnaire it was possible to divide the sample into houses which had water over floor level and those where the water was on the grounds of the property but did not exceed floor level (these houses were raised to avoid flood damage). The mean total contents value for the 50 flooded houses was \$6118. This is very little different from the overall mean and indicates that the total contents of houses most liable to flood is very little different from those that are raised. In other words any feeling of despair by the residents is not generally reflected in the value of the house contents. By inspection of the information, there did not appear to be a close relationship between either size or external quality of house and the total contents value. Perhaps more important is the increase in contents value with the number of residents.

7.2.2 Building Damage

The valuer also assessed the likely damage that would be caused to decoration, walls and built-in fittings. There was a wide variation

in the potential damage in this class, the absolute range was from \$25 to \$5500. The higher values were where decorations were recent and included expensive wallpaper and walls constructed of material that was likely to be badly affected by water. The potential stage-damage curve for this form of building damage is given in Table 7.2 and Figure 7.1.

In this case there was more evidence of the effects of direct flooding affecting the value. Many of the houses flooded in 1974 had not been re-decorated at the time of the survey and thus the potential damage that would occur with an additional flood was relatively small.

The estimates do not include possible structural damage due to flooding.

7.3 TOTAL POTENTIAL RESIDENTIAL DAMAGE

The potential stage-damage curve for contents and building damage for the residential sector was combined with the floor height information to estimate the total potential damage at varying flood heights. In addition to the actual numerical estimates, maps of the distribution of potential damage are also available.

The total potential damage was calculated with, and without, the inclusion of the two Lismore protected areas. The results are presented in Table 7.3. The potential damage is compared to the estimates of direct damage in section 2.13. In general terms the actual damage is approximately half that of the potential damage. The relationship is illustrated in Figure 7.3 for the case with protected areas.

7.4 MEAN ANNUAL ESTIMATES OF POTENTIAL RESIDENTIAL DAMAGE

The total residential potential damage estimates for differing gauge heights were combined with the flood probability data to obtain

estimates of mean annual damage. The general methodology has been described in section 2.3.3. The results calculated for the flood probabilities for differing periods of record are given in Table 7.4.

The value for the period 1921-1976, with allowance for the protected areas, of approximately \$150,000 is considered the most appropriate for comparative purposes.

TABLE 7.3
ESTIMATED TOTAL POTENTIAL RESIDENTIAL DAMAGE IN RELATION TO
GAUGE HEIGHT

Gauge height	Total potential damage (with protected areas)	Total potential damage (without protected areas)
8.0 m	500	800
8.5 m	900	1,300
9.0 m	1,800	2,900
9.5 m	5,300	9,700
10.0 m	14,300	33,300
10.5 m	37,900	81,000
11.0 m	149,800	160,300
11.5 m	262,600	303,200
12.0 m	598,500	598,500
12.5 m	1,154,600	1,154,600
13.0 m	2,138,500	2,138,500

All damage figures in dollars at approximate 1974 prices.

7.5 POTENTIAL DAMAGE - COMMERCIAL SECTOR

The valuer's survey was confined to the residential sector and therefore a differing methodology was used to assess the potential damage costs for the commercial sector. The results are based upon

information from the two questionnaires, the distribution of which has been previously discussed in section 2.4.4. The results are likely to be less precise than those for the residential sector although they are fully adequate in order to assess the relationship of potential to actual damage relative to other urban sectors.

TABLE 7.4
MEAN ANNUAL POTENTIAL DAMAGE ESTIMATES FOR THE RESIDENTIAL
SECTOR OF LISMORE

Period of flood record	Mean annual damage	
	Without protected areas	With protected areas
1945-1975	\$240,000	\$228,000
1921-1976	\$166,000	\$153,000
1875-1975	\$129,000	\$119,000

All damage values at approximately 1974 prices.

7.6 POTENTIAL VALUE OF STOCK

Full information regarding the total value of stock was available for 84 premises. These were divided into large, medium, and small, on the basis of area, for detail see section 2.4.3. The mean value of stock for each size class is given in Table 7.5.

Information was also available on the proportion of the loss in value of the stock due to immersion of flood water. This is also shown in Table 7.5. The decrease with increasing size is probably a reflection of the fact that many of the larger premises either store low value goods (such as constructional building material) or are concerned with the sale of vehicles. In the latter case damage is sustained by flooding, but the goods are not a total write-off.

TABLE 7.5
VALUE OF STOCK AND LOSS OF VALUE AFTER IMMERSION FOR
DIFFERING SIZE CATEGORIES

Size	Mean value of stock	Loss in value after immersion
Small (less than 186 m ²)	\$16,300 (54)	87.3% (56)
Medium (186-650 m ²)	\$49,600 (16)	82.3% (21)
Large (larger than 650 m ²)	\$96,500 (14)	71.0% (15)

All values at approximate 1974 prices. Numbers in sample shown in brackets.

Ideally the sample would have been broken down still further into the value of stock, and its liability to flood damage, by both category and size. Unfortunately the sample was insufficient to attempt this subdivision for all classes, however information for those classes where there was a reasonable sample size is given in Table 7.6.

7.7 STAGE-DAMAGE RELATIONSHIPS

Only 61 of the detailed questionnaires successfully completed the question that asked for information concerning the value of stock stored at differing heights above floor level. The stage-damage curve, in terms of proportion of the value of stock stored at these differing levels, is given in Table 7.7 and Figure 7.4.

A subsample of premises included in Flood Category 4 (perishable foodstuffs), was separately analysed and the results are also shown in Table 7.7. There is very little difference between the total sample and those for Category 4. The overall stage-damage relationship was employed in all calculations of potential damage loss.

TABLE 7.6
MEAN VALUE OF STOCK AND LOSS IN VALUE AFTER IMMERSION BY
FLOOD CATEGORY

Flood category	Loss in value after immersion	Mean value of contents		
		Small	Medium	Large
3 Hardware building material	69.0% (10)	\$10,000 (4)	\$19,500 (4)	\$385,000 (2)
4 Perishable foods	97.0% (16)	\$7,500 (12)	\$44,500 (5)	-
5 Electrical goods	86.9% (12)	\$21,000 (7)	-	-
9 Drapery, clothing, footwear	85.0% (8)	\$18,000 (7)	-	-
10 Vehicle sales	57.0% (8)	-	-	\$223,000 (5)

All values at approximate 1974 prices. Number in sample given in brackets.

TABLE 7.7
PROPORTION OF STOCK BY VALUE STORED AT DIFFERING HEIGHTS
ABOVE FLOOR LEVEL

Depth over floor in metres	Total sample	Perishable goods Flood Category 4
0 - 0.49 m	23%	23%
0.5 - 0.99 m	34%	34%
1.0 - 1.49 m	28%	28%
1.5 - 1.99 m	10%	11%
Over 2 m	5%	4%
Number in sample	61	17

Analysis of the records from a sample of 138 commercial premises indicates that 72% of the damage sustained was to stock, so that an additional 28% should be added to the figures to get a full estimate of potential damage.

7.8 TOTAL POTENTIAL COMMERCIAL DAMAGE

The information from the stage-damage curve in Table 7.7 was combined with the total stock estimates in Table 7.5 to produce overall mean stage-damage curve for each size class. The figures used are given in Table 7.8.

TABLE 7.8
POTENTIAL STAGE-DAMAGE DATA FOR THE STOCK OF COMMERCIAL PROPERTIES

Depth of water over floor	Small	Medium	Large
2.00 - 2.49 m	16,300	49,600	96,500
1.50 - 1.99 m	15,650	47,600	92,600
1.00 - 1.49 m	13,850	42,150	82,000
0.5 - 0.99 m	9,300	28,450	55,000
0 - 0.49	3,750	11,400	22,200

All values in dollars at approximate 1974 prices.

These three stage-damage curves were then fed into the computer routine to obtain the total potential damage figures at selected flood heights. The overall methodology was identical to that described in section 2.4.7 for the calculation of total direct damage. The estimates of potential damage were calculated with and without

protected areas and the values obtained are given in Table 7.9.

However, the stock value takes no account of the vulnerability of the materials to water damage. From Table 7.6 a mean figure for the proportion of stock damage (weighted for value and size) is 82.7%. Values for potential damage given in column 3 of the table, allow for this factor. A further 28% should be added to allow for total potential damage to equipment.

TABLE 7.9
ESTIMATES FOR POTENTIAL COMMERCIAL DAMAGE TO STOCK AND EQUIPMENT
IN RELATION TO GAUGE HEIGHT

	Column 1	Column 2	Column 3	Column 4	Column 5
Gauge height in metres	Stock damage (without protected areas)	Stock damage (with protected areas)	Stock damage (82.7% of stock affected)	Equipment damage	Equipment and stock damage
13.0	17,782,000	17,782,999	14,706,000	4,118,000	18,824,000
12.5	14,161,000	14,161,000	11,711,000	3,270,000	14,990,000
12.0	10,110,000	10,110,000	8,361,000	2,341,000	10,702,000
11.5	6,128,000	5,795,000	4,792,000	1,342,000	6,134,000
11.0	3,194,000	3,142,000	2,598,000	727,000	3,325,000
10.5	1,774,000	436,000	361,000	56,000	417,000
10.0	1,177,000	209,000	173,000	48,000	221,000
9.5	851,000	147,000	122,000	34,000	156,000
9.0	582,000	93,000	77,000	21,000	98,000

The most appropriate estimates, in Table 7.9, of potential damage to stock and equipment is column 5. This includes the contemporary protected areas and allowance is made for the residual value of flooded goods and equipment. The most appropriate estimates for stock or equipment individually, are columns 3 and 4 respectively. It should be noted that none of the values given in the table make any allowance for potential damage to decoration or building structure and fabric.

The values are very much higher than those for the residential sector and in part, this is a reflection of the fact that many of the houses are raised and the commercial premises are not. This factor also goes far to explain the considerable differences, at the lower floor heights, of the potential damage with and without the protected areas.

7.9 MEAN ANNUAL ESTIMATES FOR POTENTIAL COMMERCIAL DAMAGE

The calculations are presented both for the situation with and without the protected urban areas, column 1 in Table 7.9, and use the values of stock and equipment as given in column 5, Table 7.9.

TABLE 7.10

MEAN ANNUAL POTENTIAL DAMAGE ESTIMATES FOR COMMERCIAL SECTOR OF LISMORE

Period of flood record	Mean annual damage	
	Without protected areas	Protected with allowances
1945-1975	3,397,000	2,464,000
1921-1976	2,559,000	1,733,000
1875-1975	2,015,000	1,304,000

All values in dollars at approximate 1974 prices.

For reasons previously discussed the estimate of mean annual damage for the period 1921-1976 would appear to be most appropriate for comparative purposes. This value is close to \$1.75 million.

7.10 POTENTIAL DAMAGE - INDUSTRIAL SECTOR

The 26 industrial enterprises, within the flood-prone area of Lismore, all completed a full questionnaire. The background detail of the industrial sector is given in section 2.5.1. Potential stage-damage curves were constructed manually for each of the industrial premises and allowance was made, where appropriate, for the distribution of plant on more than one floor level. The potential value of plant, machinery, raw material and finished products, were summed for each of the gauge heights to give total potential damage. The overall total potential damages for the industrial sector is given in Table 7.11.

TABLE 7.11
ESTIMATED TOTAL POTENTIAL INDUSTRIAL DAMAGE IN RELATION
TO GAUGE HEIGHT

Gauge height	Total potential damage (with protected areas)	Total potential damage (without protected areas)
10.0 m	56,000	69,000
10.5 m	80,000	105,000
11.0 m	139,000	165,000
11.5 m	953,000	1,024,000
12.0 m	1,435,000	1,435,000
12.5 m	2,489,000	2,489,000
13.0 m	4,667,000	4,667,000

All values in dollars at approximate 1974 prices.

The figures in Table 7.11 are for plant, machinery, raw materials and finished goods that would be affected at the appropriate heights. The total value within the flood-prone area, but including material above the 13.0 m flood height is nearly \$10 million. However, much of the plant and machinery does not suffer anywhere near total damage after flood immersion. Approximately 57% of the \$4.6 million potential damage is in this category. A broad estimate would represent the actual loss that would be incurred if flooding took place without any attempt at alleviation.

7.11 MEAN ANNUAL ESTIMATES FOR POTENTIAL INDUSTRIAL DAMAGE

Mean annual estimates were produced by combining the data from Table 7.11 with the flood probabilities. These are presented in Table 7.12.

TABLE 7.12
MEAN ANNUAL POTENTIAL DAMAGE FOR THE INDUSTRIAL SECTOR
OF LISMORE

Period of flood record	Mean annual damage	
	Without protected areas	Protected with allowances
1945-1975	541,000	529,000
1921-1976	369,000	357,000
1875-1975	291,000	282,000

All values in dollars at approximate 1974 prices.

The most appropriate overall value for planning purposes is \$338,000. This makes allowance for the estimated 57% of the potential damage that would not suffer from flood immersion.

7.12 POTENTIAL DAMAGE - GOVERNMENT SECTOR

A general description of the government sector was given in section 2.6.1. There is insufficient information available to make any detailed estimate of the potential damage, but there is little doubt that it is small in comparison to the potential damage of the commercial or industrial sectors. Some 25% of the recorded direct damage was to roads and bridges and while the theoretical potential damage in these areas is large, the likely damage will always remain relatively small although repeated flooding undoubtedly shortens the actual life of structures.

7.13 TOTAL ESTIMATES OF POTENTIAL DAMAGE

The estimates for the potential damage at various gauge heights are presented in Table 7.13. The estimates used are those that consider the current situation with respect to protected urban areas.

The damage for the industrial sector does not make any allowance for the value of goods and equipment after immersion in water, i.e., it is the value of goods and equipment prior to flooding and assuming a total loss. Thus the industrial values are somewhat inflated compared to those for the residential and commercial sectors. However, to some extent this over-estimate is balanced for the total potential damage estimates in that no allowance has been made for the government sector.

TABLE 7.13
ESTIMATED TOTAL POTENTIAL FLOOD DAMAGE FOR THE LISMORE URBAN
AREA IN RELATION TO GAUGE HEIGHT

Gauge height	Residential	Commercial	Industrial	Total
13.0 m	2,139,000 (8.3)	18,824,000 (73.5)	4,667,100 (18.2)	25,630,000
12.5 m	1,155,000 (6.2)	14,990,000 (80.4)	2,489,000 (13.4)	18,634,000
12.0 m	598,000 (4.7)	10,702,000 (84.0)	1,435,000 (11.3)	12,735,000
11.5 m	263,000 (3.6)	6,134,000 (83.5)	953,000 (12.9)	7,350,000
11.0 m	150,000 (4.4)	3,325,000 (91.9)	139,000 (3.7)	3,614,000
10.5 m	38,000 (7.1)	417,000 (77.9)	80,000 (15.0)	535,000
10.0 m	14,300 (4.9)	221,000 (76.0)	56,000 (19.1)	

Figures in brackets are percentage of total damage at specific gauge heights. All values in dollars at approximate 1974 prices.

Of more importance than the estimates in absolute figures are the percentages of damage to the varying sectors at differing gauge heights. These figures are given in Table 7.14 and are illustrated graphically in Figure 7.5, which should be compared to the information for direct damage presented in a comparable format in Figure 2.22.

It is clear that the potential for damage is greatest for the commercial sector with the total damage varying from 73.5% to 91.9% of the overall total.

7.14 COMPARISONS OF ACTUAL TO POTENTIAL DAMAGE

For management purposes it is the relative importance of the varying sectors that is of most value. It has been demonstrated that

the commercial sector has both largest direct and potential damage, but it is also apparent that the proportion of direct to potential is of significance.

7.14.1 Comparisons of Total Damage

The data for direct and potential damage is compared for differing gauge heights in Table 7.14.

TABLE 7.14
PROPORTION OF ACTUAL TO POTENTIAL DAMAGE FOR THE VARYING
SECTORS IN RELATION TO GAUGE HEIGHT

Gauge height	Actual to Potential as a percentage			
	Residential	Commercial	Industrial	Total
13.0 m	52.3	19.6	7.2	20.1
12.5 m	54.2	19.0	7.8	19.7
12.0 m	55.0	18.2	5.4	18.5
11.5	52.1	17.8	3.8	17.2
11.0	50.0	18.0	9.9	19.1
10.5	53.4	20.1	1.8	19.8
10.0	47.6	20.4	1.4	18.1

Thus for the residential sector the ratio of actual to potential remains relatively constant at about 50% regardless of flood height. For the commercial sector the value is some 20% and for the industrial in the range 2-10%. It could, therefore, be suggested that flood management, aimed at reducing flood losses, could expect to make relatively greater savings in damage in the residential sector than in

the commercial or industrial. Indeed, as the actual industrial damage is already reduced to about 7% of the potential, it may well be that this sector is so well-adjusted that further savings would be difficult.

Figure 7.6 illustrates the estimates for total direct and potential damage for the urban area of Lismore at varying gauge heights.

7.14.2 Comparisons of Mean Annual Damage

The comparisons discussed above are in terms of total damage at varying gauge heights. The most apt simple comparisons are the mean annual estimates for actual and potential damage. These are given in Table 7.15 which uses the estimates for the period 1921-1976.

TABLE 7.15
COMPARISON OF TOTAL MEAN ANNUAL DAMAGE ESTIMATES FOR LISMORE

Urban sector	Mean annual potential damage with protected areas	Mean annual direct damage with protected areas	Potential as a percentage of direct damage
Residential	153,000	80,200	52.4%
Commercial	1,733,000	406,700	23.5%
Industrial	357,000	21,600	6.1%
All sectors	2,243,000	508,500	22.7%

All values in dollars at approximate 1974 prices.

This confirms the general pattern described for the total potential damage estimates. The commercial sector has both the largest actual and potential damage while the residential sector offers the greatest possibility for further damage reduction.

CHAPTER 8

POPULATION STRUCTURE, PERCEPTION AND RESPONSE

8.1 INTRODUCTION

This chapter moves away from the concentration on estimates of loss and damage due to flooding and looks at the characteristics of the population affected and its perception of and response to the problem. These latter factors are particularly important in the present conditions of increasing interest on a world-wide level in non-structural flood alleviation measures. The attempt to ascertain respondents' views on possible measures for the Richmond River Valley should be seen in this light rather than as a method of constructing flood policy by popular vote.

The first section of this chapter uses data from the 1976 census. A description of how this was constructed and the problems of comparability is to be found in Appendix 8.1. The Lismore residential, commercial, industrial and agricultural questionnaires from which most of the information in this chapter was obtained are to be found in Appendices 2.2, 2.5, 2.7, and 4.1 respectively.

8.2 DEMOGRAPHIC CHARACTERISTICS OF RURAL AND URBAN RESIDENTIAL POPULATIONS

The demographic characteristics of a population are highly relevant to an assessment of the kinds of problems it is likely to face in an emergency such as a flood. To take a crude but relevant example, a population with a relatively old and structure may have considerable difficulties in time of flood if it becomes necessary to remove or lift furniture to prevent its damage. This section of the report aims to outline some demographic characteristics of the urban and rural populations of the flood-prone areas of the Richmond River Valley. Comparisons with the population of New South Wales as a whole and that of the flood free parts of Lismore are made.

8.2.1 Age

Table 8.1 gives data on population age obtained from the rural and Lismore urban questionnaires and from the 1976 census. The urban sample appears to show an over-representation of the over 65 age group when compared to the flood-prone area as a whole, with the 16-44 age group being proportionately under-represented. This is probably because most of the interviewing was done during the day when retired people are more likely to be at home than those of working age.

TABLE 8.1
AGE DISTRIBUTIONS OF URBAN AND RURAL POPULATIONS

Age (Completed years)	Questionnaire samples		1976 Census			
	Rural	Urban	Flood- prone Lismore	Flood- free Lismore	Rural	NSW
5 or under	7.4% (23)	7.8% (36)	8.0%	8.3%	10.3%	8.6%
6 - 15	23.7% (74)	21.6% (100)	20.3%	18.6%	23.5%	19.4%
16 - 24	15.4% (48)	14.5% (67)	17.0%	19.5%	14.3%	15.0%
25 - 44	17.3% (54)	18.6% (86)	21.4%	22.9%	24.9%	26.9%
45 - 65	29.2% (91)	20.6% (95)	20.9%	19.3%	19.4%	20.8%
> 65	7.0% (22)	16.9% (78)	12.3%	11.1%	6.9%	9.2%

Comparison of both the questionnaire and the census figures for the flood-prone area with those for the rest of Lismore and for New South Wales as a whole indicates that the population in the flood-prone area is relatively old. Most noticeable, however, is the significant under-representation of 25-44 year olds in all the Lismore

populations as compared with New South Wales as a whole. This is probably a reflection of an often discussed trend of population movement towards the few large cities in Australia.

The age distribution of the rural sample presents a slightly different picture. There are relatively few people in the over 65 age group whereas a very high proportion of the sample is in the 45-65 age group. Once again the 25-44 age group appears greatly depleted, in fact the rural sample has the smallest proportion of all the populations in this age range. Comparison of the age structure of the sample with equivalent census data suggests that, while in most respects the sample is representative, there is a considerable over-representation of 45-65 year olds and a proportionate under-representation of 25-44 year olds.

8.2.2 Occupation

Table 8.2 shows the proportion of persons in our samples and in various census areas in the workforce. Clearly our residential sample over-represents those not in the workforce, however, this is consistent with the slightly distorted age structure of our sample (see section 8.2.1). The rural sample also contains a greater proportion of people not in the workforce than the equivalent census figures would suggest. In general one would expect our questionnaires to yield lower workforce participation rates than the census because the census counts as employed anyone who worked at all during the week preceding the census, whereas our questionnaire tended to identify as employed only those with full-time jobs.

A comparison of the various census figures indicates that, compared with New South Wales as a whole, the study region and, most particularly the Lismore urban area had a high proportion of residents not in the labour force. Also interesting is that the unemployment

rate in the flood-prone areas of Lismore was nearly two-thirds as high again as that in the rest of Lismore.

TABLE 8.2
EMPLOYMENT STATUS

Status	Questionnaire samples		1976 Census			
	Rural	Urban	Flood-prone Lismore	Flood-free Lismore	Rural	NSW
Employed	35.1%	23.1%	34.7%	36.1%	39.6%	42.5%
Unemployed	1.3%	4.5%	3.6%	2.1%	3.0%	2.3%
Not in labour force	63.2%	67.6%	61.7%	61.8%	57.2%	55.1%
No answer	0.3%	4.5%	-	-	-	-

Table 8.3 shows the number and proportion of persons in our samples in various main activity categories. Table 8.4 compares the proportion employed in various occupations with the closest equivalent proportions from the 1976 census. Clearly there are significant differences between our samples and the equivalent census groups. Our urban sample appears to over-represent tradesmen and manual workers at the expense of those in the managerial/professional and sales worker classes. The flooded area of Lismore has a smaller proportion of those in these latter classes (and in the clerical class) than the rest of the town.

TABLE 8.3
MAIN ACTIVITY OF LISMORE RESIDENTIAL AND RURAL RESPONDENTS
AND THEIR FAMILIES

Main activity	Lismore *	Rural *
Manager/Professional	2.8% (13)	1.0% (3)
Clerical	3.0% (14)	1.3% (4)
Tradesman	9.5% (44)	2.6% (8)
Manual	6.7% (31)	2.6% (8)
Farmer	-	27.9% (87)
Salesman	1.1% (5)	-
Domestic	16.4% (76)	22.7% (71)
Retired/Pensioner	18.8% (87)	2.2% (7)
School student	21.4% (15)	30.4% (95)
Tertiary student	3.2% (15)	2.9% (9)
Child not at school	7.8% (36)	5.1% (16)
Not employed	4.5% (21)	1.3% (4)
No answer	4.5% (21)	0

* Number in brackets is number of people in sample in each category.

The rural sample greatly over-represents farmers and under-represents the managerial/professional and clerical groups. This is not surprising since our rural sample was designed to include only families actively involved in farming.

TABLE 8.4
OCCUPATION: URBAN, RURAL, AND NEW SOUTH WALES
(Employed persons only)

Occupation	Questionnaire samples		1976 Census			
	Rural *	Urban *	Flood-prone Lismore	Flood-free Lismore	Rural	NSW
Managerial/ Professional	12.1% (13)	2.7% (3)	31.6%	35.6%	21.0%	26.4%
Clerical	13.1% (14)	3.6% (4)	15.3%	17.5%	10.4%	18.3%
Tradesman	41.1% (44)	7.3% (8)	25.4%	20.2%	20.1%	25.7%
Manual	29.0% (31)	7.3% (8)	13.9%	10.6%	55.2%	16.3%
Farmer		79.1% (87)				
Salesman	4.7% (5)	0	9.1%	12.0%	6.7%	7.8%
Other	0	0	4.7%	3.9	6.7%	5.9%

* Number in brackets is number of people in sample in each category.

In comparison with New South Wales as a whole, the urban area of Lismore has relatively high proportions of residents in the manager/professional and sales worker categories, whereas farmers and to some extent clerical workers form smaller groups than is the case for the whole State. As Lismore is a significant regional centre, this is not surprising. Naturally in the rural area, farmers form a much greater proportion of the workforce than in New South Wales as a whole.

8.2.3 Period of Residence

Consistent with the relatively old age of the urban sample population is the fact that just under 80% of respondents had lived in their present homes for over five years (see Table 8.5). In fact, over 20% had been at their present address for more than fifty years. Table 8.6 presents the closest equivalent 1976 census data. Clearly our sample over-represents people with a residence period of over five years.

However its picture of a very stable permanent population with consequent considerable flood experience is significant.

TABLE 8.5
YEARS IN RESIDENCE: URBAN RESIDENTIAL, INDUSTRIAL
AND COMMERCIAL SAMPLES

Years in residence	Urban residential	Industrial	Commercial
0 - 5	31 (21.1%)	1	44
6 - 10	25 (19.0%)	4	29
11 - 15	18 (12.2%)	4	10
16 - 20	17 (11.6%)	3	7
21 - 30	25 (17.0%)	9	8
31 - 40	16 (10.9%)	2	6
41 - 50	10 (6.8%)	0	5
51 +	32 (21.8%)	2	3

TABLE 8.6
PERIOD OF RESIDENCE FROM 1976 CENSUS: URBAN RESIDENTIAL
AND NEW SOUTH WALES

	Flood-prone Lismore	Flood-free Lismore	NSW
Living in same house in 1971	59.9%	64.3%	58.4%
Not in same house in 1971	40.1%	35.7%	41.6%

The period of operation of industrial concerns on the present site is also shown in Table 8.5. Clearly the pattern here is also for long periods of occupancy, with more than half the businesses having been on their present sites for well over twenty years. The commercial

sample presented a somewhat different picture with 65% of respondents having been at their present address for ten years or less.

8.2.4 Property Ownership

In accord with the view of a stable permanent population in the residential sample is the information in Table 8.7. Here a very high rate of home ownership is found. The rural sample showed a similar pattern. In the business area, commercial premises tended to be rented, whereas almost all industrial concerns owned the sites on which they operated.

TABLE 8.7

OWNERSHIP OF PROPERTY: LISMORE: RESIDENTIAL, COMMERCIAL,
INDUSTRIAL AND RURAL SAMPLES

	Lismore residential	Commercial	Industrial	Rural ^o
Rented	19	65	2	7 ⁺
Owned	128	48	23	73 [*]

^o Refers to ownership vs leasing of farm land.

⁺ Includes two who both lease and own.

^{*} Includes one sharefarmer.

The information from our questionnaires on residential ownership can be compared with similar information from the 1976 Census (see Table 8.8). It is obvious that the Census rates of dwelling ownership are much lower than those for our samples. Also significant is that in Lismore the rates of home ownership the Census shows on the flood plain is much lower than that outside it. The rate for New

South Wales as a whole lies between these two. The Census home ownership rate for the rural area is not strictly comparable with the ownership rate from the rural sample since the questionnaire referred to the land farmed rather than the home occupied. Further, the rural area covered by the Census figures include a number of small towns which may reduce the home ownership rate. It therefore seems reasonable to conclude that most farmers work their own rather than leased land.

TABLE 8.8
OWNERSHIP OF PROPERTY: 1976 CENSUS

	Flood-prone Lismore	Flood-free Lismore	Rural	NSW
Rented	31.7%	19.8%	24.8%	19.4%
Owned	61.9%	75.0%	68.0%	69.1%
Not stated and other	6.4%	5.0%	7.2%	11.4%

8.2.5 Household Income

Table 8.9 presents data from the 1976 Census on household income in the study area. There are quite significant differences between Lismore households on the flood plain and those away from it. Households on the flood plain tend to have considerably lower incomes than do those in the rest of Lismore. In fact while just over half the non-flood plain households had incomes over \$9000, only just over a third of flood plain households had this amount. The rural income figures are fairly similar to those for the flood plain area of Lismore. While it is notable that the proportion of households not stating income is considerably higher in both the rural and urban flood plain

areas than in the urban non-flood plain area, the difference is not large enough to materially alter the situation.

TABLE 8.9
HOUSEHOLD INCOMES: 1976 CENSUS

Income (\$)	Flood-prone Lismore	Flood-free Lismore	Rural	NSW
None	1.0%	1.0%	1.8%	1.4%
0-3000	11.4%	8.2%	10.8%	8.0%
Over 3000-6000	18.3%	14.2%	20.1%	12.7%
Over 6000-9000	22.0%	18.4%	20.7%	18.0%
Over 9000-18,000	31.2%	37.4%	28.3%	35.8%
Over 18,000	5.7%	13.1%	6.3%	13.9%
Not Stated	10.4%	7.2%	12.0%	10.1%

The income pattern for the flood-free area of Lismore is fairly similar to that for New South Wales as a whole. Obviously, however, the rural and urban flood plain areas present a picture of notably lower incomes than in the rest of New South Wales.

8.2.6 Summary

In the town of Lismore a picture emerges of a community in which living on the flood plain tends to be associated with different social characteristics to living out of it. Compared to the non-flood plain dweller, the flood plain resident is less likely to own his home, less likely to have a high income (probably because of slightly lower occupational prestige, greater age, and a greater chance of being unemployed), and slightly older. These characteristics are heightened

when the flood plain dweller is compared with his fellow New South Welshman (with the exception of home ownership) with the additional factor in the income difference of a smaller chance of being in the workforce.

Our questionnaire sample in Lismore appears significantly older, lower in occupational prestige, lower in workforce participation rate and to have been resident for longer than the average.

Not surprisingly the rural population is notably different from the urban one and from that of New South Wales as a whole in many characteristics, particularly age and occupational structure. Due to uncertainty about the comparability of the rural Census population and the rural questionnaire sample, it is hard to draw strong conclusions about the sample's representativeness. However, it seems to be reasonably similar to the population of farm dwellers as a whole.

8.3 FLOOD EXPERIENCE AND PERCEPTION

This section analyses people's responses to questions relating to the way they view the flood problem. Because the main thrust of the questionnaires was towards damage assessment, the results reported here are necessarily tentative. However, it is felt that they are of considerable importance.

8.3.1 Flood Experience

Before considering how people see the flood problem, it is worth taking a brief look at their flood experience. Table 8.10 shows the number of floods experienced by respondents in the various samples. The figures for the urban sample show that while it was relatively rare to have had the home flooded more than twice, most respondents (over 60%) had had flood water in their homes at some time. The rural sample presented a totally different picture, nearly two-thirds of respondents

had never had flood waters in their homes. This confirmed a general impression that only a small proportion of farm dwellings were built on ground that is flood-prone. Most houses seemed to be on small rises, on the edge of the flood plain, or raised following an earlier flood.

TABLE 8.10
FLOOD EXPERIENCE: LISMORE RESIDENTIAL, COMMERCIAL
INDUSTRIAL AND RURAL SAMPLES

Number of times business/home flooded*	Rural ^Ø	Commercial ^Ø	Industrial ^Ø	Lismore residential
0	65.0% (52)	23.5% (27)	0	36.7% (55)
1	17.5% (14)	20.0% (23)	26.9% (7)	26.7% (40)
2	10.0% (8)	13.0% (15)	23.1% (6)	14.7% (22)
3	2.5% (2)	11.3% (13)	0	10.7% (16)
4	1.2% (1)	6.1% (7)	3.8% (1)	4.0% (6)
5 +	3.7% (3)	26.1% (30)	42.3% (11)	7.3% (11)

* A home or business is here defined as flooded if there is water above the ground floor level.

Ø Number in brackets indicates number in sample in each category.

The business community of Lismore has even greater flood experience than the residential population. No industrial concerns had remained unflooded and 23% of commercial premises had never been flooded. Eleven of the twenty-six industrial firms (42%) claimed to have been flooded five or more times, and over a quarter of commercial respondents claimed the same experience.

Overall then, most residents and businessmen on the flood plain had had flood experience not simply in the sense of having seen a flood, but to the extent of having flood waters in their present premises. On

the other hand, few rural respondents had experienced flood waters in their homes (though all had had their farm land flooded to some extent).

Table 8.11 demonstrates the extent of respondents' flood experience in premises other than the present ones. Clearly a considerable proportion of each sample had had experience of floods before moving to their present premises, with commercial owners having the greatest frequency of such experience. This, combined with the information in Table 8.10 suggests that, in a community with considerable flood experience, the commercial and industrial sectors have more flood experience than the residential sector.

TABLE 8.11
WAS RESPONDENT FLOODED IN PREVIOUS PREMISES?

	Commercial	Lismore residential	Industrial
Yes	32	58	13
No	18	72	12
Not applicable	55	5	0
No answer	17	15	1

8.3.2 Flood Experience, Perception and Building Modification

Tables 8.12 and 8.13 show responses to questions about whether people had considered the risk of flooding when moving to their present site and whether the building was modified to prevent flood waters entering before they took up residence. It was hoped that, by cross-tabulating these answers with each other and with flood experience, some measure of the effect of experience on perception and behaviour could be obtained. Unfortunately in most cases responses were too one-sided

to allow the possibility of meaningful cross-tabulations. It is interesting, for instance, that in every sector, of those answering the question, over half claimed to have considered the risk of flooding when moving to their present site. The residential sector offered the only opportunity to look at the effect of experience on perception and behaviour through these questions.

TABLE 8.12
DID RESPONDENT CONSIDER RISK OF FLOODING WHEN MOVING
TO PRESENT SITE?

	Commercial	Lismore residential	Industrial	Rural
Yes	48	74	20	57
No	6	52	2	12
Not applicable	55	5	0	12
No answer	13	19	4	0

TABLE 8.13
WAS THE PRESENT BUILDING MODIFIED TO PREVENT FLOOD WATERS
ENTERING BEFORE THE RESPONDENT MOVED IN?

	Commercial	Lismore residential	Industrial	Rural
Yes	4	73	7	58
No	52	56	18	21
Not applicable	55	3	0	0
No answer	11	18	1	2

Cross-tabulation showed that in the urban residential sector there was no significant relation between previous flood experience and either the consideration of the risk of flooding or the choice of a house with flood modifications. However, as Table 8.14 shows, there

was a tendency for those who claimed to have considered the risk of flooding to choose houses with flood modifications. Those who claimed not to have considered the flood risk were just as likely to have chosen a house with modification as to have chosen one without.

TABLE 8.14
CROSS-TABULATION OF BUILDING MODIFICATION AND CONSIDERATION OF
FLOOD RISK: LISMORE RESIDENTIAL SAMPLE

Did you consider the risk of flooding?		Was the building already modified to prevent the entry of flood waters		
		Yes	No	Total
	Yes	45	26	71
	No	24	27	51
	TOTAL	69	53	122

8.3.3 Perceived Change in Flood Risk

Table 8.15 shows rural and Lismore residential respondents' perception of whether the risk of flooding was increasing, decreasing, or remaining the same. About 50% considered it to be increasing, 20-30% thought it was decreasing, and 10% thought it exhibited no change. The rural respondents were a little more pessimistic than the urban, though given the sample size the difference is not very significant. Notably only a small proportion (14% of urban and 7% of rural) respondents were uncertain of whether the risk was changing.

In Table 8.16 rural and urban respondents' beliefs about the reasons for changes in flood risk are shown. While respondents in both samples were likely to think that silting of rivers and ditches and building of river banks and levees are relevant, the rural respondent

was much more likely to also see town building and subdivision, forest felling or general flood mitigation works as important. It is necessary to note in relation to this and the following two tables that no indication of the importance of a particular factor in changes in flood risk was given by the respondent. Furthermore, respondents were allowed to nominate as many reasons as they chose, up to five were thought to be relevant by some respondents.

TABLE 8.15
RESPONDENTS' VIEWS ON DIRECTION OF CHANGE IN FLOOD RISK

Flood risk	Lismore residential *	Rural *
Increasing	46% (69)	58% (47)
Decreasing	27% (41)	20% (16)
No change	9% (13)	11% (9)
Don't know	14% (21)	7% (6)
Other +	4% (6)	4% (3)

* Number in brackets indicates number in sample in each category.

+ Includes those not answering the question.

Tables 8.17 and 8.18 cross-tabulate rural and urban respondents' perception of the flood risk change with the reasons to which changes are attributed. Rural respondents who thought the flood risk was increasing were most likely to see silting of rivers and ditches and/or forest felling as reasons. However, the second most commonly given reasons for increasing flood risk were general flood mitigation works and building of river banks and levees, both of which are measures designed to reduce flood risk. In fact, of those who thought either of these measures had an influence on flood risk, about two-thirds thought that they increased

rather than decreased it. The one slightly encouraging fact is that among respondents who thought the flood risk to be decreasing, flood mitigation works and building of river banks and levees were the most frequently cited reasons.

TABLE 8.16
RESPONDENTS' VIEWS ON REASONS FOR FLOOD RISK CHANGE

Reason	Number	
	Lismore residential *	Rural *
Changes in climate	19 (13%)	12 (15%)
Highway construction	11 (7%)	3 (4%)
Town buildings and subdivisions	15 (10%)	16 (20%)
Silting of rivers/ditches	82 (55%)	36 (44%)
Building of river banks/levees	40 (32%)	31 (38%)
Reservoir management upstream	13 (9%)	-
Forest felling	21 (14%)	33 (41%)
Forest planting	6 (4%)	9 (11%)
Flood mitigation	9 (6%)	33 (41%)
Other	-	6 (7%)
No answer ^ø	37 (25%)	14 (17%)

* The percentage in brackets refers to the percentage of respondents giving each reason.

NOTE: respondents gave up to five reasons.

ø This includes respondents who did not know the reasons for changes in flood risk.

Lismore dwellers had a somewhat different pattern of views on the reasons for changes in flood risk (see Table 8.18). They were much more unanimous in their views than rural residents. Among those who thought that the flood risk was increasing, 81% believed that silting of rivers and ditches was one of the reasons; no other reason came close to this in unanimity of support.

Only 17% of urban respondents (compared with over half of rural ones) believed that forest felling was associated with an increased flood risk. Significantly the second most commonly cited reason for an increase in flood risk was the building of river banks and levees. However, in contrast to the overall sample, a greater number of urban respondents believed that this measure resulted in a decreased risk of flooding. In fact, this was by far the most commonly given reason for a decrease in flood risk.

TABLE 8.17

CROSS-TABULATION OF PERCEPTION OF DIRECTION OF CHANGE OF FLOOD RISK BY REASON FOR CHANGE: RURAL SAMPLE, RAW FREQUENCIES

Reason*	Increasing flood risk	Decreasing flood risk
No answer	2	0
Change in climate	8	3
Town building and subdivision	9	6
Highway construction	3	0
Silting of rivers and ditches	25	6
Building of river banks and levees	20	8
Forest felling	26	3
Forest planting	4	3
Flood mitigation works	19	10
Other	1	4

* NOTE: Respondents could give more than one reason.

TABLE 8.18
CROSS-TABULATION OF PERCEPTION OF DIRECTION OF CHANGE OF
FLOOD RISK BY REASON FOR CHANGE: LISMORE RESIDENTIAL
SAMPLE, RAW FREQUENCIES

Reason *	Increasing flood risk	Decreasing flood risk
No answer	2	12
Change in climate	10	6
Town building and subdivision	10	2
Highway construction	7	3
Silting of rivers and ditches	56	11
Building of river banks and levees	17	23
Forest felling	12	5
Forest planting	3	2
Reservoir management	6	5
Other	1	3

* NOTE: Respondents could give more than one reason.

8.3.4 Respondents' Views on Flood Alleviation Schemes

Table 8.19 presents the views of respondents on various flood alleviation schemes. All of these schemes had been suggested for the Richmond River Valley following the 1974 flood and would therefore probably have been familiar to respondents. In general it appears that most respondents see structural measures as being worthwhile, with one major exception: in both the rural and urban residential samples about two-thirds of respondents opposed river straightening. Overall the most popular measures were river diversion (either by tunnel or in the lower river) and the construction of dam storage upstream of Lismore.

TABLE 8.19
PERCENTAGE* OF RESPONDENTS IN FAVOUR OF AND OPPOSED TO VARIOUS FLOOD ALLEVIATION SCHEMES
SF=Strongly Favour F=Favour Somewhat OS=Oppose Somewhat SO=Strongly Oppose

	Diver- sion by tunnel	Lower river diver- sion	More and larger levees	Dam storage	Deepen and widen rivers	River straight- ening	everything	Every- body should pay more	Flood- prone should pay more	Govern- ment grant or loan	Govern- ment housing	Allow more development on flood plain even if it aggravates flooding
	N=22		N=22	N=23	N=22		N=22	N=23	N=23	N=23		
<u>INDUSTRIAL</u>												
SF	50%		32%	52%	32%		14%	13%	35%	43%		
F	18%		27%	21%	27%		14%	13%	22%	22%		
OS	23%		5%	4%	23%		22%	17%	4%	4%		
SO	9%		36%	13%	13%		50%	57%	39%	31%		
Sample = 26												
<u>RESIDENTIAL</u>												
	N=90	N=82	N=90	N=87	N=93	N=87	N=88	N=89	N=89	N=95	N=92	
SF	65%	30%	24%	29%	63%	17%	9%	6%	13%	53%	44%	
F	29%	43%	30%	38%	18%	20%	3%	16%	17%	28%	30%	
OS	2%	6%	19%	12%	10%	18%	23%	14%	23%	13%	12%	
SO	4%	21%	27%	21%	9%	45%	65%	64%	47%	6%	14%	
Sample = 150												
<u>RURAL</u>												
	N=53	N=68	N=75	N=72	N=71	N=70	N=75	N=73	N=63	N=73	N=72	
SF	46%*	71%	17%	40%	38%	13%	24%	8%	13%	45%	29%	
F	27%	19%	21%	31%	28%	21%	16%	14%	27%	30%	28%	
OS	11%	7%	22%	15%	16%	26%	13%	7%	6%	11%	15%	
SO	16%	3%	40%	14%	18%	40%	47%	71%	54%	14%	28%	
Sample = 81												
<u>COMMERCIAL SERVICES</u>												
	N=81		N=82	N=86	N=82		N=74	N=81	N=80	N=77		N=73
SF	41%		40%	49%	46%		10%	18%	14%	31%		12%
F	30%		32%	29%	22%		4%	25%	20%	33%		19%
OS	11%		13%	14%	20%		14%	16%	21%	18%		26%
SO	18%		15%	8%	12%		72%	41%	45%	18%		43%
Sample = 122												

* NOTE: Don't know' answers and non-response have been excluded when calculating percentages.

Construction of more and larger embankments and levees was a more controversial proposal. In line with their views on the effect of these works on flood risk, many (62%) rural respondents were against them. In fact, lower river farmers were almost unanimous in their disapproval of these schemes. While in all other samples more than half of the respondents favoured work on levees and embankments, only in the commercial sample did less than 40% oppose such works.

The proposal of deepening and widening rivers met with a fair amount of approval. In the urban residential sample, 81% favoured such a proposal. This corresponded with the commonly-held belief that silting of rivers and ditches was a cause of increased risk of flooding.

In general, respondents were not in favour of leaving the river and its tributaries alone. However, in the industrial and, more particularly, the rural samples, there was a significant minority in favour of such a proposal. This is in line with the rural samples' tendency to see all forms of flood mitigation works as increasing rather than decreasing flood risk.

Opinion about non-structural measures for dealing with the flood problem was generally less unanimous than in the case of structural measures. The proposal that everyone should pay more in taxes to pay for flood protection was opposed by a majority of respondents in all four samples. However, significant minorities of both the industrial and commercial groups (26% and 43% respectively) favoured such a proposal. Only the industrial sample showed a majority in favour of the proposition that the flood-prone should pay for their own protection. However, significant minorities in the other three samples favoured this idea. A majority of respondents in all categories favoured government grants or loans to allow people to protect themselves against flooding. This proposal was most popular among the

non-business (i.e., rural and urban residential) samples. Correspondingly a majority of both urban and rural respondents were in favour of government financial support for the re-housing of flood plain residents in safer areas. The greater proportion of urban compared to rural respondents favouring this scheme is probably attributable to the low proportion of farm houses which are flood-prone (see section 8.3.1).

8.3.5 Conclusion

Before moving on to consider the response to flood hazard it is worth noting a few anomalies in the figures presented in Tables 8.17, 8.18 and 8.19. Table 8.18 indicates that eleven urban respondents felt that silting of rivers and ditches decreased the flood risk. This was the second most commonly given reason for a perceived decrease in the flood risk. Among rural respondents an even higher proportion thought the flood risk was decreasing because of river silting. While most of the other reasons for a change in flood risk could be seen to influence it in either direction, it is very hard to see what logical reasons one would have for believing the flood risk was decreased by silting.

In Table 8.19, 40% of rural respondents are shown to have supported 'preserving everything as it is', yet 90% claimed to favour lower river diversions. Clearly some respondents were not being consistent. Careful cross-tabulation of responses used to construct Tables 8.17, 8.18 and 8.19 would probably show more anomalies. However, the ones listed above are significant enough to warrant further investigation. In particular, it is necessary to question the notion that people's reactions to and ways of thinking about floods are always rational, logical, and consistent. Studies aimed at looking at these issues through unstructured in-depth interviews and other such techniques, not possible in the present study, would be of value. It is

important to realise that these are not simply problems arising out of a pedantic academic interpretation of logic.

Many government policies in relation to flooding, particularly those arising out of the increasing interest in non-structural measures, are based on the assumption that flood plain residents follow the same logical ways of thinking about floods as policy makers. If in fact they do not, an understanding of the character of their thinking should increase the effectiveness of policy directed at them.

8.4 RESPONSE

In the following section the response of the various samples to flooding is considered. Both the long-term preparations and the actual activities during time of flood are examined.

8.4.1 Insurance

Table 8.20 shows the number of respondents in each sample who had taken out insurance against floods. The very small number who had taken this measure is no surprise. In general insurance against floods is simply unavailable, and where a company will quote a premium it is far too large to be considered. It seems likely that the two urban residential respondents who claimed to have insurance simply misunderstood the question.

Among businesses flood insurance was obtained only where a branch of a statewide or nationwide company was covered by a policy of the whole company. For locally-owned businesses insurance (when it was available) was far too costly.

TABLE 8.20
NUMBER OF RESPONDENTS WHO HAVE TAKEN OUT FLOOD INSURANCE
IN EACH SAMPLE

	Insurance	No insurance
Lismore residential	2	144
Rural	0	81
Commercial	6	98
Industrial	4	22

8.4.2 Individual Response

Table 8.21 shows the frequency of various responses to the flood hazard. The first two measures (making permanent structural changes to keep out flood water and the purchase of a boat) must be taken well before the occurrence of a flood to be effective. Both have been taken by relatively small proportions of respondents. Since many rural and urban residential respondents' homes were raised before the present owners purchased them, it is probable that in most cases where permanent structural changes would be beneficial they have been taken. However, commercial and industrial respondents appear much less willing to make such changes, presumably because of the significant costs involved.

Over 80% of respondents in each of the urban, commercial, and industrial samples had moved valuables to a higher level. Significant proportions of both the urban and commercial samples had moved temporarily to other accommodation because of floods. Probably because of the impossibility of temporary relocation, few industrial respondents had taken this measure. However, a vast majority had raised machinery and equipment. Relatively few rural respondents had either moved

valuables or moved to temporary accommodation, probably because such a large proportion (64%) had never had flood waters in their homes.

8.4.3 Sources of Help During Floods

In Table 8.22 the number of rural and residential respondents receiving help from various sources is shown. Clearly, in both samples, the most commonly obtained help was informal aid from neighbours. The SES was the second most common source of help in both samples, though far fewer people had received support from it than from neighbours. Among residential respondents the rates of help from the police, church organisations and family outside the flood zone were nearly as high as that for help from the SES; whereas among rural respondents, help from the Army (the next most frequent after the SES) was only received in about half as many cases. In general, then, though a significant number of people received help from formal organisations, by far the single most common source was neighbours.

Table 8.23 shows urban residential and rural respondents' perception of whether or not the SES and other organisations could do more to develop and co-ordinate evacuation and relief programs. Clearly in both samples a majority of respondents felt that evacuation and relief were well organised. Among those who did not, the vast majority believed that more evacuation boats were needed. Rural respondents most often complained of a lack of communication equipment, particularly two-way radios; however, a significant number believed that more or better evacuation boats were required. Another frequent complaint among rural respondents was that flood warnings and information broadcast by radio were aimed at Lismore residents only and therefore frequently ended before the flood peak reached lower valley farmers or started after it had passed upper valley residents.

TABLE 8.21

NUMBER OF RESPONDENTS IN EACH SAMPLE WHO HAVE TAKEN VARIOUS FLOOD ALLEVIATION MEASURES

	Measures						
	Bought a boat for use during floods	Made permanent structural changes to building	Used sandbags	Moved valuables to higher level	Made special arrangements to receive flood warnings	Moved to temporary accommodation storage	Raised machinery and equipment
<u>URBAN</u>							
Yes	-	3	1	114	3	72	-
No	-	128	128	28	128	73	-
<u>RURAL</u>							
Yes	-	5	1	30	5	16	-
No	-	76	80	50	76	65	-
<u>COMMERCIAL</u>							
Yes	11	28	4	88	28	45	-
No	91	74	100	16	74	57	-
<u>INDUSTRIAL</u>							
Yes	-	1	1	26	1	4	22
No	-	25	25	0	25	22	4

TABLE 8.22
ORGANISATIONAL SOURCES OF HELP: LISMORE RESIDENTIAL AND RURAL
SAMPLES

Source	Lismore residential		Rural	
	Received help	Did not receive help	Received help	Did not receive help
Police	19	112	9	72
Church organisation	15	111	4	77
SES	22	100	20	61
Neighbours	50	63	42	39
Council	12	118	5	76
Army	5	128	11	70
Fire brigade	2	130	0	81
Family from outside flood zone	19	103	9	71

TABLE 8.23
NUMBER OF RESPONDENTS WHO BELIEVE SES OR OTHER ORGANISATIONS
COULD DO MORE DURING FLOOD RELIEF AND EVACUATION

Sample	Could do more	Could not do more	Don't know
Rural	22	49	9
Lismore residential	31	41	23

Table 8.24 breaks down who helped respondents in the 1974 flood into various non-organisational categories. In both the rural and urban residential samples neighbours were, once again, the most common source of help. It is interesting to note that whereas only 34% of urban respondents answering the question received no help, 59% of rural

respondents were in this position. It is also notable that in both samples help was most often received from people already known to the respondents (only 16% of urban and 6% of rural respondents received help from people they had never met before).

TABLE 8.24
NUMBER RECEIVING HELP FROM NON-ORGANISATIONAL SOURCES*

Source	Lismore residential	Rural
No help received	45	48
Neighbours	62	27
Friends	42	15
Family	45	15
People never met before	22	5

* Some respondents were helped by more than one group.

Table 8.25 breaks down people to whom respondents gave help in the same way. Neighbours were the most common recipients of help. However, fewer urban respondents gave than received help from neighbours whereas in the rural sample slightly more respondents gave than received help from neighbours. This was the general pattern among rural respondents so that slightly fewer received help of any sort than gave it (41% vs 48%), whereas many more urban respondents received help than gave it (64% vs 46%).

Table 8.26 shows the number of people in the residential sample giving help to others broken down by whether or not their homes ever flooded. Clearly a majority of those who had not been flooded themselves helped others, almost invariably people they already knew. Although understandably a smaller proportion of those who had themselves been

flooded found time to help others, a significant minority (42%) did. Once again most help was given to people who respondents would already have known.

TABLE 8.25
NUMBER HELPING NON-ORGANISATIONAL GROUPS

Recipient	Lismore residential	Rural
No help given	75	42
Neighbours	48	35
Friends	27	21
Family	20	15
People never met before	16	14

TABLE 8.26

CROSS-TABULATION OF THOSE HELPING OTHERS BY WHETHER RESPONDENT HAD EVER BEEN FLOODED.* LISMORE RESIDENTIAL SAMPLE

Flooded	Recipient of help					Total
	No-one	Neighbours	Friends	Family	People never met before	
Yes	56	29	13	9	12	96
No	17	18	13	10	4	41

* A respondent was considered to be flooded if water had risen above floor level.

Tables 8.27 and 8.28 present some data on the source of urban residential and rural respondents' information during floods. It should be noted that the tables are not strictly comparable for two

reasons: first, the questions on which the information is based were worded slightly differently; secondly the possible sources of information suggested to the two samples were slightly different. Despite these reservations some interesting patterns emerge. Not surprisingly in both samples radio broadcasts and the SES were frequently cited sources of information. The major difference between the samples was that while over 80% of rural respondents used their own judgement as a source of information, only 20% of urban respondents did so. This is probably because radio forecasts cease shortly after the flood peak passes Lismore. Since the peak travels down the river fairly slowly, this means that for many farmers radio forecasts at the most critical times are simply non-existent.

TABLE 8.27

NUMBER BELIEVING VARIOUS SOURCES OF INFORMATION* TO BE RELIABLE
IN TIME OF FLOOD: LISMORE RESIDENTIAL SAMPLE

Source	Number
Police	7
Council	1
SES	51
Radio and TV broadcast	108
Newspapers	1
Your own judgement	30
Other	6
No answer	4

* NOTE: Respondents could give more than one reason.

TABLE 8.28
NUMBER BELIEVING VARIOUS SOURCES OF INFORMATION TO BE
RELIABLE IN TIME OF FLOOD: RURAL SAMPLE*

Source	Number
Police	1
SES	26
Radio	58
Other State media	0
Your own judgement	66
Judgement of friends upstream	13
Other	2
No answer	1

* NOTE: Respondents could give more than one source of information.

Table 8.29 shows each samples' perception of the level of adjustment of people and businesses to the flood problem. Almost unanimously respondents believed people to be well-adjusted.

TABLE 8.29
NUMBER BELIEVING PEOPLE OF THE AREA TO BE ADJUSTED TO THE
FLOOD PROBLEM

Level of adjustment	Lismore residential	Rural	Commercial	Industrial
Well adjusted	128	71	100	26
Partly adjusted	17	7	13	0
Poorly adjusted	2	1	1	0
Not adjusted	1	2	0	0

Table 8.30 shows urban residential and rural respondents' belief about the effect of flooding on community spirit. In both samples, well over half those answering the question believed community spirit to be heightened, a very small number believed it was lessened and the remainder thought it remained the same.

TABLE 8.30
NUMBER BELIEVING COMMUNITY SPIRIT TO BE HEIGHTENED,
LESSENED OR NOT CHANGED DURING TIME OF FLOOD:
LISMORE RESIDENTIAL AND RURAL SAMPLES

	Lismore residential	Rural
Heightened	90	52
Lessened	4	4
Not changed	48	25

These last two tables have been included to emphasise what appears to be the dominant mode of coping with the flood problem in the Richmond River Valley. In general in time of flood, people tend to rely heavily on their established social networks for help. Formal organisations appear to be used infrequently. Even where there is a perception that more could be done by the SES or some other authority, most suggestions relate to better provision of equipment (such as boats) necessary in the extreme emergency of the flood. Most respondents appeared to feel quite happy that the burden of coping with flood falls on themselves and on the informal networks of their community. Many even felt that their community was strengthened during times of flood.

CHAPTER 9

SUMMARY AND CONCLUSIONS

9.1 INTRODUCTION

The major aim of the study was to provide an assessment of flood damage in the Richmond River Valley in relation to which possible flood mitigation measures could be evaluated.

Flood damage has been interpreted in the broadest terms to include direct, indirect and intangible effects. Assessment in monetary terms has been presented for direct and indirect damages and a qualitative account given of intangible damage. The losses due to the major flood of 1974 have been estimated for both the Lismore urban area and the rural sections of the Richmond River Valley. The direct and indirect losses for the urban area are presented in terms of mean annual damage values. Potential damage estimates are also given for the urban sector. In addition to the estimates of damage, the salient factors associated with a range of social effects of the 1974 floods are also reviewed.

The basic methodology for flood damage assessment is well established in the literature, but there is a paucity of detail on the exact procedures that should be followed. Indeed, no directly comparable flood damage studies have been undertaken in Australia. The only broadly similar study was that undertaken by SMEC (1975) for the Brisbane River floods of January 1974. Thus, it was considered important in the preceding chapters to present details of the methods used and the assumptions that were made. The intention is that if individual assumptions are challenged or shown to be incorrect, alternative values can be substituted and the damage attributed to the various components re-assessed.

9.2 SUMMARY OF DIRECT AND INDIRECT DAMAGE FOR THE 1974 FLOOD

Table 9.1 presents, in summary form, the direct and indirect damage sustained by the Richmond River Valley for the flood of March 1974. The figures are drawn from the detailed presentation given in Chapters 2, 3, 4 and 5. The estimates are based upon the assumption that the flood of March 1974 corresponded to a 13.0 m reading on the Lismore city flood gauge.

The total direct and indirect damage for the Richmond River Valley for the flood of March 1974 is estimated to be \$17,000,000. The component for the urban damage of Lismore is approximately \$7,000,000 and that for the remaining sector of the Richmond River Valley \$10,000,000.

The contributions of the differing components to this overall total are also shown on Table 9.1. In addition, average costs per unit are given. For example, the mean cost for each of the 1900 residential properties in the flood affected area of Lismore was \$820. The average direct and indirect agricultural losses to crops was some \$87 per hectare.

9.2.1 Limitations to the 1974 Damage Figures

The procedure by which the damages for the 1974 flood were assessed is set out in the preceding chapters. In our opinion these are likely to err slightly in favour of under-estimates, firstly because some damages are omitted due to lack of data and, secondly, where estimates of data differed the figure chosen tended towards the lower limit of the range. The major limitations to the data are set out below.

TABLE 9.1
DIRECT AND INDIRECT COSTS FOR THE 1974 FLOOD: RICHMOND RIVER
VALLEY: LISMORE URBAN AREA

	Totals	Per Unit
<u>Residential</u> (1904 properties)		
Direct	\$1,118,900	\$590)
Indirect	\$439,000	\$230) \$820
<u>Commercial</u> (680 outlets)		
Direct	\$3,699,800	\$5,450)
Indirect	\$1,012,700	\$1,490) \$6,940
<u>Industrial</u> (26 firms)		
Direct	\$337,800	\$13,000)
Indirect	\$175,000	\$6,730) \$19,730
<u>Government Sector</u>	\$201,000	
	<u>\$6,984,200</u>	

RICHMOND RIVER VALLEY : AGRICULTURAL AND RURAL SETTLEMENT

		Totals
<u>Agriculture - Direct and Indirect Losses</u>		
Cane	\$3,378,000	
Dairying	\$2,200,000	
Grazing	\$2,926,000	
Maize/arable	\$242,000	
	<u></u>	\$8,746,000
<u>Agriculture - Residences</u>		
Direct	\$250,000	
Indirect	\$71,000	
	<u></u>	\$321,000
<u>Rural Settlements</u>		
Direct	\$500,000	
Indirect	\$189,000	
	<u></u>	\$689,000
<u>Government Sector</u>	\$174,000	\$174,000
	<u></u>	\$9,930,000

This is a cost per hectare of \$87. All values in dollars at 1974 prices.

- (a) Intangible effects. The values given in Table 9.1 do not include monetary values for intangible damages which comprise stress, general anxiety and inconvenience. These could be considerable, and the impact may effect up to 10% of the population in the flooded areas.
- (b) Disruptions to the transport network. This aspect of indirect damage has not been included in the estimates due to lack of data. The problem is discussed in more detail in section 5.14.
- (c) Government damage. This is likely to be an under-estimate and does not include the costs incurred for extra hours worked by government employees, e.g., roads department, police, etc., or the involvement of governmental agencies based outside the region, e.g., assistance from the armed forces.
- (d) Clean-up costs. These are difficult to estimate for the residential sector as it is necessary to cost the labour of the individual householders. The estimates used in this report are less than those included in the SMEC (1975) study of the 1974 Brisbane floods.
- (e) Rural damage. Many of the problems stem from a lack of basic data. For example, there is no clear information on either the number of farm residences or the number of farm holdings that are located within the area inundated by the 1974 flood. The land-use map undertaken as a

part of the study cannot distinguish between the 'use' of pasture in terms of dairying or grazing. It should be clearly stated that the financial information supplied by the sample of the farming community covered by the rural questionnaire is thought to be of a high standard. In most cases the respondents abstracted the data from the farm account books during the course of the interview.

9.3 SUMMARY OF THE MEAN ANNUAL DAMAGE ESTIMATES

Information presented in terms of mean annual damage is undoubtedly the most useful single statistic for the planning and management of flood-prone lands. However, the calculation of such values requires the availability of a large data base, essential components of which are a long period of flood stage records and detail of the limits of land inundated by floods of differing intensity. In this study the data base was considered adequate for the estimation of mean annual damage figures for the Lismore urban area, but inappropriate for the extension of the calculations to the rural section of the Richmond River Valley. The specific data limitations for the rural sector are detailed in Section 4.2.1.

9.3.1 Mean Annual Damage Estimates for the Lismore Urban Area

The mean annual estimates for direct and indirect damage for the Lismore urban area are summarised in Table 9.2. Three differing mean annual estimates are presented for 1875-1975, 1921-1976 and 1945-1975. The mean annual damage contributed by the various urban sectors is given in Table 9.2, together with the costs per unit. For example, the mean cost for each of the residential properties in the flood-prone area is \$92 for the period 1945-1975. The procedure used to obtain these values is given in section 2.3.5.1.

TABLE 9.2

MEAN ANNUAL DIRECT AND INDIRECT FLOOD DAMAGE FOR THE LISMORE URBAN AREA

Period of record	Direct Residential	Indirect Residential	Direct Commercial	Indirect Commercial	Direct Industrial	Indirect Industrial	Total
1945-1975	125,000	49,000	591,000	161,800	34,900	18,200	979,900
1921-1976	80,200	31,000	406,000	111,300	21,000	11,200	661,300
1875-1975	59,800	23,000	294,100	80,500	16,800	8,300	482,500

MEAN ANNUAL COSTS PER RESIDENTIAL UNIT

Period of record	Direct	Indirect	Total
1945-1975	66	26	92
1921-1976	42	16	58
1875-1975	31	12	43

MEAN ANNUAL COSTS PER COMMERCIAL UNIT

1945-1975	869	238	1,107
1921-1976	597	164	761
1875-1975	433	118	551

All values in dollars at 1974 prices

The suggested mean annual direct and indirect damage values appropriate for planning purposes for urban Lismore are within the range of \$660,000 to \$1,000,000 per year.

These estimates are subject to the limitations given above in section 9.2.1. However, as these estimates form the key to many aspects of flood plain management, some further discussion may be of value.

9.3.2 Problems in Estimating Mean Annual Damage Values

The essential information necessary to produce an estimate of mean annual damage is a long flood record. Lismore is fortunate in that the gauge heights of major floods are available for approximately the last hundred years. The data base used in this study was taken from a summary of records made available by Mr F. Barlow, the Engineer to the Richmond River County Council. The readings for the Lismore gauge are given in Appendix 2.3 and floods over 6.0 m are shown graphically in Figure 9.1. This flood record was compiled from a comprehensive survey of all pertinent sources and for the earlier floods is based upon conversion to gauge heights of accounts of the magnitude of flooding from a variety of historic and newspaper records.

In our opinion further extension of this earlier record is unlikely and while the record is undoubtedly incomplete for the more minor floods, it is unlikely to have omitted major events. This is significant as little damage is sustained until the flood height exceeds 10.0 m. The record for floods since 1921 is thought to be much more complete in that all major events (in excess of 10.0 m) are likely to be included and the actual gauge reading is likely to be more reliable.

It is apparent that the flood frequency during the period of record has shown marked variations. Thus the mean annual estimates have been separately calculated for the complete period of record (1875-1975), for the period for which the flood record is thought to be of a good standard (1921-1976) and the post-war period (1945-1975).

The records for the post-war period are known to be of the best standard and the query is whether the marked increase in the major floods is due to the quality of the records or represents a period with a greater frequency of flooding.

The significance of the selection of these differing periods of flood record on the mean annual direct and indirect damage can be seen from Table 9.2. The estimates for the period 1945-1975 are approximately double those calculated for the full length of record.

In our opinion, these very considerable differences in mean annual damage are dominantly a reflection of an increase in the occurrence of major floods and are not due to deficiencies in the earlier flood record. The reasons for the post-1945 increase in flood frequency are to some degree speculative. It is unlikely that changes in forest clearing or land-use practice are responsible and it is worth noting that a growing body of evidence exists that the rainfall regime in eastern Australia has exhibited a marked change in the post-1945 period. This has tended towards an increase in annual rainfall totals, together with some indication of increased storm activity. For planning purposes however, the reasons for the increase are only of value if they give some guidance to future flood probabilities. The general consensus is that any such increase in rainfall is a climatic variation, not a climatic change, and that no firm conclusions can be drawn as to the pattern of future events either on a short or medium-term time-scale.

Thus it is difficult to give guidance on which set of mean estimates to use for planning purposes. As there is some doubt as to the completeness of the pre-1921 data, values based on the 1921-1976 and 1945-1975 estimates are recommended. More specific recommendations become increasingly speculative, but it would be prudent to err towards the upper value, i.e., that for the period 1945-1975.

9.3.3 The Damage Record for the Period 1875-1975

The mean annual damage estimates given throughout this report are based upon considerations of flood frequency and probability. While this is the accepted procedure, it is of interest to present the flood damage for the whole period of record in graphical form. Figure 9.1 shows the occurrence of floods in excess of 6.0 m for the period 1875-1976. This enables a visual appreciation to be made of the possible changes in flood frequency. However, as damage increases markedly in relation to flood magnitude it is of interest, although a theoretical situation, to give the combined direct and indirect damage that would be sustained if the present urban area of Lismore was flooded to the depths shown on the historic record. All values are at 1974 prices and the protection afforded by the urban mitigation measures, discussed in section 2.3.4, is included. Flood damage at gauge heights below 10.0 m is insignificant.

Allowing for the imperfections of the earlier flood record it would appear that there has been an increase in major floods, and therefore in flood damage, since 1945.

9.4 POTENTIAL DAMAGE FOR URBAN LISMORE

Potential damage can be defined as the damage that would occur if no remedial action was undertaken, e.g., no materials were moved to flood-free locations. The major value of such a concept is that a comparison of the potential to actual damage gives some measure of the effectiveness of flood warnings and the general preparedness of the sectors affected. The detail of the damage potential of the various sectors that make up the urban community is given in Chapter 6.

In summary, it would appear that urban Lismore is well prepared for major flood events. However, there is some imbalance between the

various urban sectors. The residential sector would appear to suffer losses that are estimated to be about 50% of the potential value while the corresponding figures for the commercial and industrial sectors are approximately 23% and 6%. Comparative values for the other flood-prone towns are few, but the overall values for Lismore demonstrate that the community is aware and the flood warning system effective.

However, with a mean annual potential damage figure in excess of \$2,000,000 for the urban area alone, any investment in further improving flood forecasting and warning systems, is likely to have a very favourable cost-benefit ratio.

9.5 ADDITIONAL INFORMATION

During the course of the study a considerable amount of information was assembled both in order to calculate the direct and indirect damages and also to provide information on a range of problems that are associated with the general field of flood damage assessment and possible mitigation measures. A list of such material is given below and, if required, the original drafts could be consulted.

9.5.1 Rural Section of the Richmond River Valley

- (a) The agricultural land-use map is available as a series of transparent overlays which correspond to the 1:25,000 maps of the area.
- (b) The original rural questionnaires are available together with a computer listing of the responses.

9.5.2 The Urban Area of Lismore

- (a) A computer listing, by address, of the results of the external survey of all residential property in the flood-prone zone. This also gives the ground and floor height of each property and its location, by grid-square, within the Lismore area.
- (b) A computer listing of all commercial premises, dominantly retail outlets, with ground and floor heights and a classification of the type of retail activity. A broad classification by size is also given.
- (c) The original questionnaires for the sample of residential, commercial and industrial properties. For the residential and commercial sample the information from the questionnaires is also available as a computer listing.
- (d) Computer maps are available which show various forms of damage plotted by grid square, each grid square has an area of 25,000 square metres. Available maps separately show direct damage for the residential and commercial sectors at incremental gauge heights of 0.5 m from 10.0 m to 13.0 m. Other maps portray potential damage and the combined direct damage for the residential, commercial and industrial sectors. It is intended that a selection of these maps will be separately published in report form by the Interdepartmental Committee.

It should be noted that there may be restrictions on the use of the individual questionnaires if it is considered that such use would breach the assurance of confidentiality which was given to the respondents at the time the data was collected.

9.6 INTANGIBLE COSTS

The major category of intangible costs comprises the effects of floods upon health either physical or mental, and no estimate for these is included in either Table 9.1 or 9.2. Indeed, it is difficult to find any detailed assessment of this aspect of intangible damage in the available literature. The most frequently quoted study is that by Bennett (1970), for the Bristol, United Kingdom flood of 1968. The approach taken by Bennett was to carefully monitor a sample of the flooded population and to compare this with a control sample drawn from a comparable non-flooded population. The study reports alarming increases in both mortality and the frequency of disease and illness in the year subsequent to the flood event. A comparable Australian study was reported for the Brisbane floods of 1974 by Abrahams *et al.* (1976). It should be noted that in both these cases the flooded population had little previous flood experience.

By contrast, the Richmond River Valley community has a very considerable degree of accumulated flood experience and it could be argued that the effects of flooding upon health would be considerably less.

9.6.1 The Questionnaire Information on Intangible Costs

A detailed investigation of intangible damage was beyond the scope of the present work. However, information was collected from the questionnaire distributed to the various sectors of the community

and this gives some indication of the effects of the 1974 flood upon health, both physical and mental. The details are presented in Chapter 6. The number of individuals included in this sample was 753 and 59 reported either minor or serious health effects as the result of the 1974 flood experience. It is clear that older age groups were particularly prone regardless of their previous flood experience. For the over 65 year age group some 18% reported adverse health effects and this figure was very much higher for those in dwellings where the flood level exceeded floor level.

While this survey was insufficient to fully investigate all the relationships of age to location and flood experience, it was sufficient to indicate that the intangible effects in the Richmond River Valley are very real. It should not be assumed that intangible health effects resulting from major flood events can be discounted due to the accumulated flood experience of the community. A further study is in hand to ascertain if hospital admissions in the year subsequent to the 1974 flood showed any increase for the community directly affected by flooding when compared with a non-flooded community.

9.7 DEMOGRAPHIC STRUCTURE

Any consideration of the problems of flood affected communities is incomplete without background information on the demographic structure of the population and associated factors such as income levels, occupation and the like. This is given in Chapter 8 which presents information from the 1976 Census and compares this to the questionnaire sample to assess the representativeness of that sample. In general terms the sample can be considered as representative although there is a difficulty in applying this methodology to the rural

sector. The urban sample shows a tendency to over-represent the older residents of the flooded area.

Compared to the rest of Lismore or to the overall population of New South Wales the flood-prone community is generally older, with below average household income, more likely to be unemployed and with less likelihood of owning its home dwelling. Particularly noticeable is the under-representation of the 25-44 year old group and the lengthy period of residence in the home dwelling. Both the industrial and commercial undertakings are likely to have been long established.

9.7.1 Flood Experience and Building Modification

It was particularly noticeable that the commercial and industrial respondents had a considerable experience of flooding both on the present site and, where applicable, prior to moving to that location. This was shared, to a lesser extent, by the residential population although it is worth noting that relatively few of the farming respondents had experienced water over the floor of their actual dwelling. Overall the community has a very considerable pool of flood experience and this is particularly the case with the commercial and industrial sectors.

The degree of urban and rural residential adjustment to flood risk is perhaps the most significant feature. Within the flood-prone area of Lismore over 80% of the houses are raised essentially to lessen flood risk, and in the rural sector the current situation is that only a very small number of residential farm dwellings would experience water over floor level even in the event of a major flood. In most cases the form of the initial construction of the commercial and industrial buildings is such that raising is not a viable option. However, many of these enterprises have undertaken other measures to alleviate flood damage.

9.7.2 Response to Flooding - Insurance and Other Sources of Assistance

It must be stressed that for the majority of the population in the flood affected areas flood insurance is not possible. This is either because insurance is not available or because the premiums are so high that it is not a viable proposition. The commercial sector is the only group with a small proportion of the individual enterprises covered by flood insurance and that is only available in those cases where the outlet is part of a state- or nation-wide chain that has group flood insurance.

Similarly monies made available as aid after major floods either as cash payments or in the form of special loans are extremely limited both as regards the overall sum, and the number of individual recipients.

The major assistance for those resident in the flood areas was from within the community specifically from 'friends and neighbours'. This local co-operative assistance also extends to the commercial and industrial sectors with an intricate network of arrangements which would appear to have evolved over a number of years. This is not to belittle the assistance offered by a variety of organisations, of which the State Emergency Service (SES) is the most widely mentioned, but to stress that informal community assistance is regarded as the major form of aid.

9.7.3 Respondents' Views of Flood Mitigation Measures

An attempt was made to assess the views of the various sectors with respect to actual and proposed flood mitigation measures as well as questions regarding the reasons for perceived increase or decrease in flood frequency. The responses are difficult to summarise but it is

hoped that the information will form a framework which may assist with the dissemination of information regarding flood mitigation measures of both structural and non-structural forms. The survey was far from exhaustive but may assist in stressing the need for the gathering of this form of social data.

9.8 A SUMMARY OF THE SOCIAL ASPECTS

The Richmond River Valley is, by any standard, extremely flood-prone. The dominant characteristics of the social aspects of the study are, that despite the accumulated experience, there is still ample evidence of intangible costs. Available direct or indirect financial aid is minute compared to the actual damages sustained. The awareness of the flood hazard is high and individual responses in all sectors to lessen flood damage are well developed. The degree of internal community assistance is a noteworthy feature and all sectors feel that the community is well adjusted to flooding. There is a general feeling that flood mitigation measures should be increased although, not unexpectedly, there is no general consensus as to how this might best be achieved.

9.9 VALUE AND USE OF THE FLOOD REPORT

The major emphasis throughout the study has been to provide a comprehensive assessment of flood damage in the Richmond River Valley. It is hoped that this information will form a useful base for the future planning of both structural and non-structural flood mitigation measures. While effort has been made to produce quantitative estimates for the damage we would like to stress that the intangible costs should also be given full consideration in the formulation of any future policy.

It is clear that the accumulated flood experience of all sectors of the community has played a major role in the high degree of flood adjustment exhibited throughout the Valley. It is also clear that the community feels that further assistance with the flood problem is required but, not surprisingly, is uncertain as to the form that this should take. It is important that further flood mitigation measures, of whatever type, should be undertaken with the maximum possible community involvement and that explanation and education have major roles to play in achieving this aim.

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FIGURE 2.1
DISTRIBUTION OF GROUND AND FLOOR HEIGHT OF RESIDENTIAL PROPERTIES IN RELATION
TO GAUGE HEIGHT

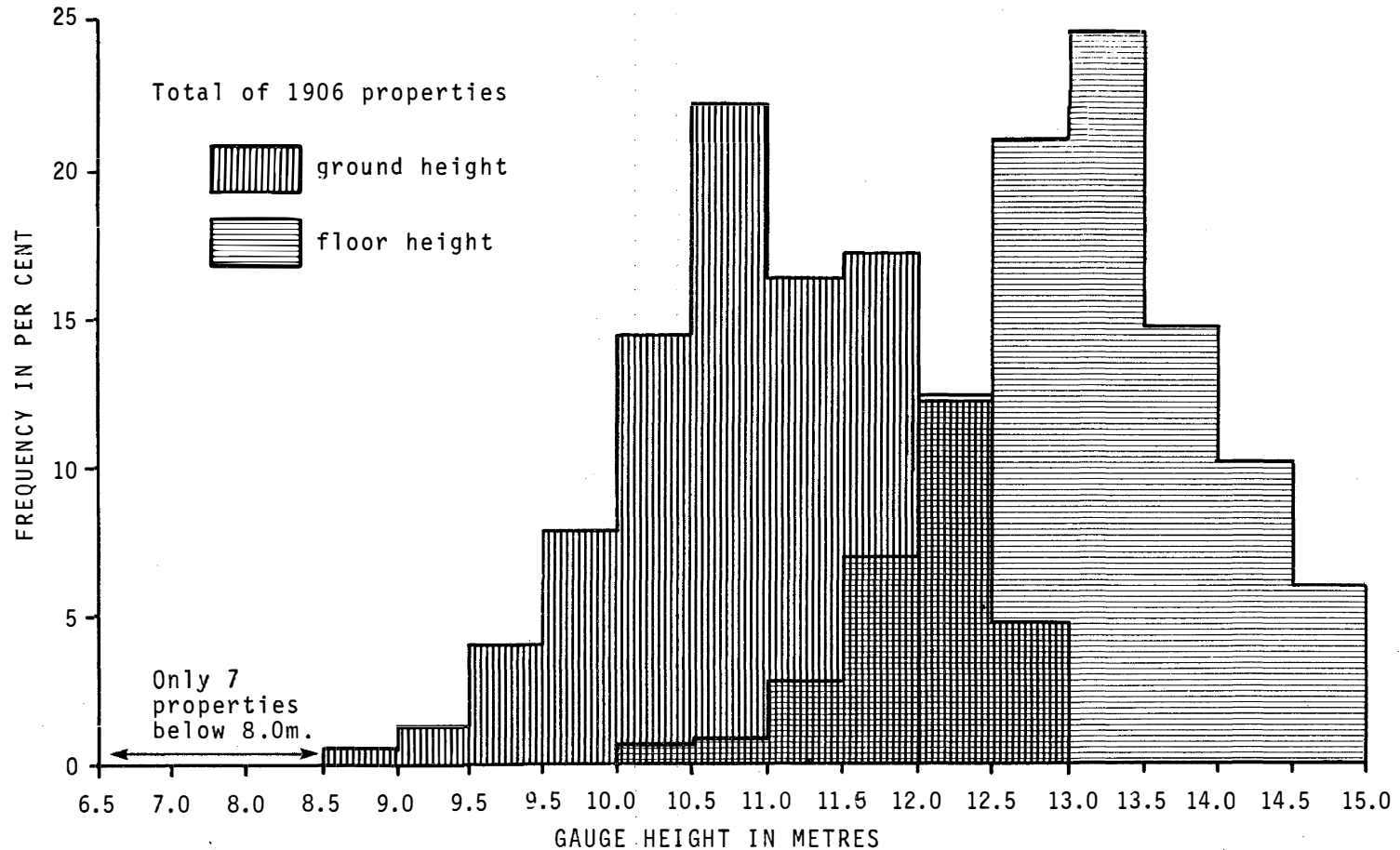


FIGURE 2.2

NUMBER OF RESIDENTIAL PROPERTIES WITH WATER ON THE GROUND OR
OVER FLOOR LEVEL IN RELATION TO GAUGE HEIGHT

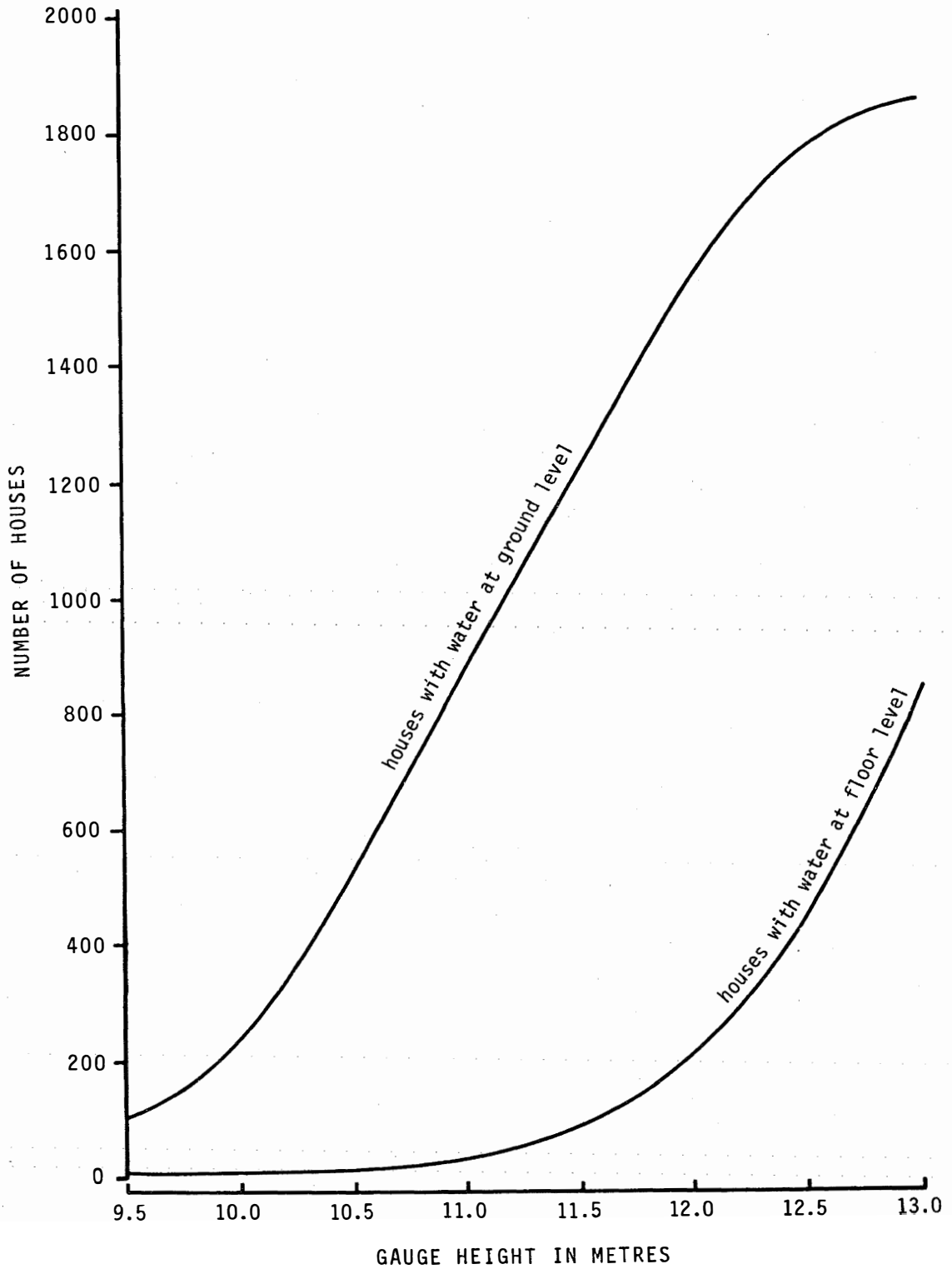
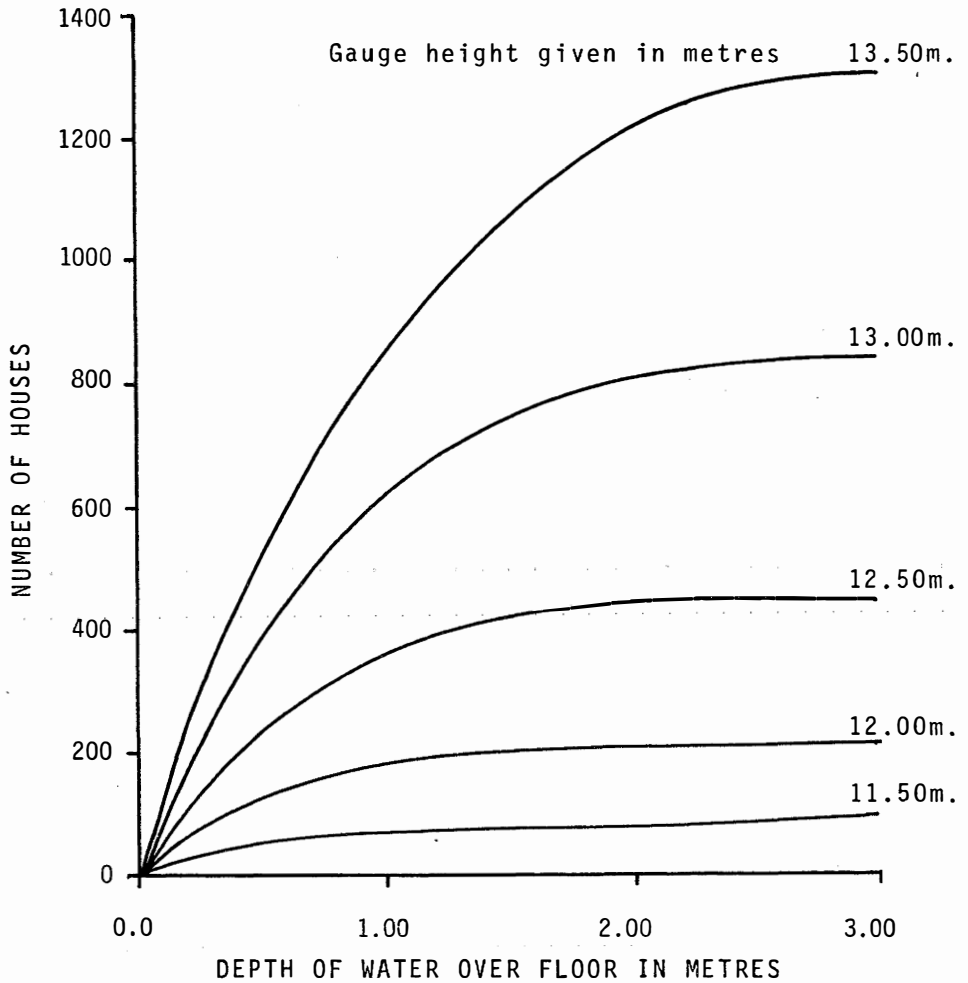


FIGURE 2.3
 CUMULATIVE FREQUENCY OF HOUSES WITH DIFFERENT DEPTHS OF
 WATER OVER FLOOR LEVEL AT DIFFERING FLOOD STAGES



NOTE: An example of the usage of this figure is as follows. To find the number of houses with 2.0 to 3.0 m of water over floor level for a 13.0 m flood read from the graph that 800 houses have 3.0 m or less of water and 770 houses have 2.0 m or less. Thus 30 houses have between 2.0 and 3.0 m of water.

FIGURE 2.4

PERCENTAGE OF HOUSES IN EACH HEIGHT CLASS THAT ARE RAISED

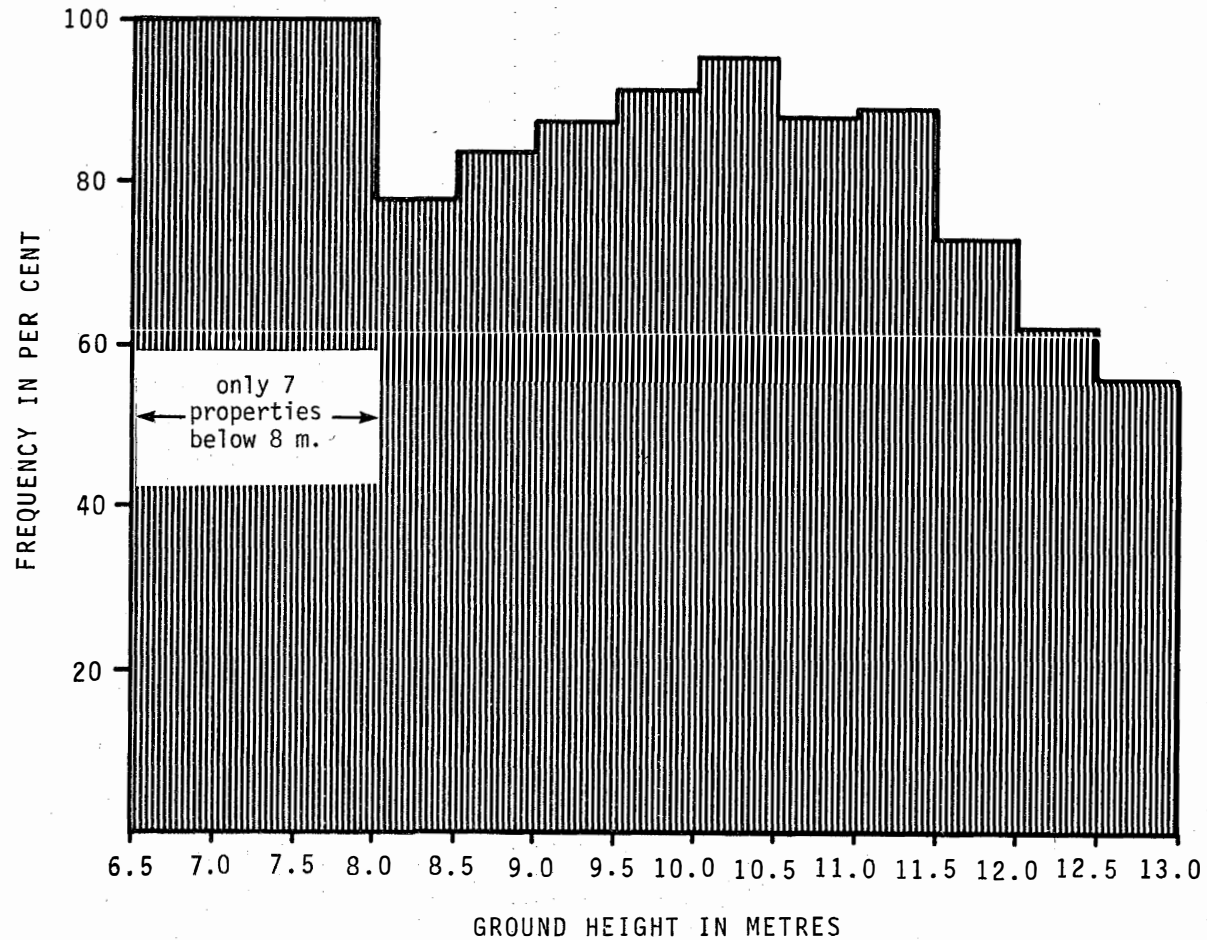


FIGURE 2.5
DIFFERENCE IN GROUND AND FLOOR HEIGHT FOR ALL FLOOD-PRONE
RESIDENTIAL PROPERTY

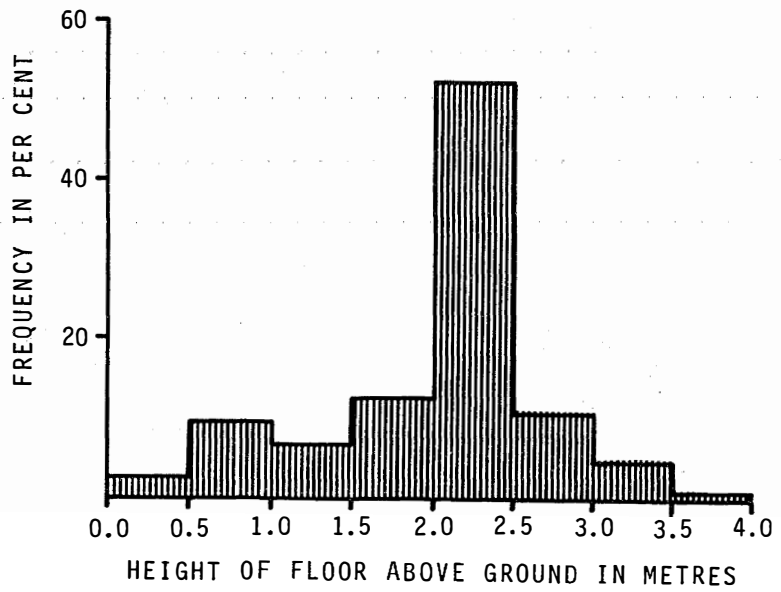


FIGURE 2.6
FREQUENCY OF PROPERTIES WITH POOR EXTERNAL CONDITION IN
RELATION TO GROUND HEIGHT

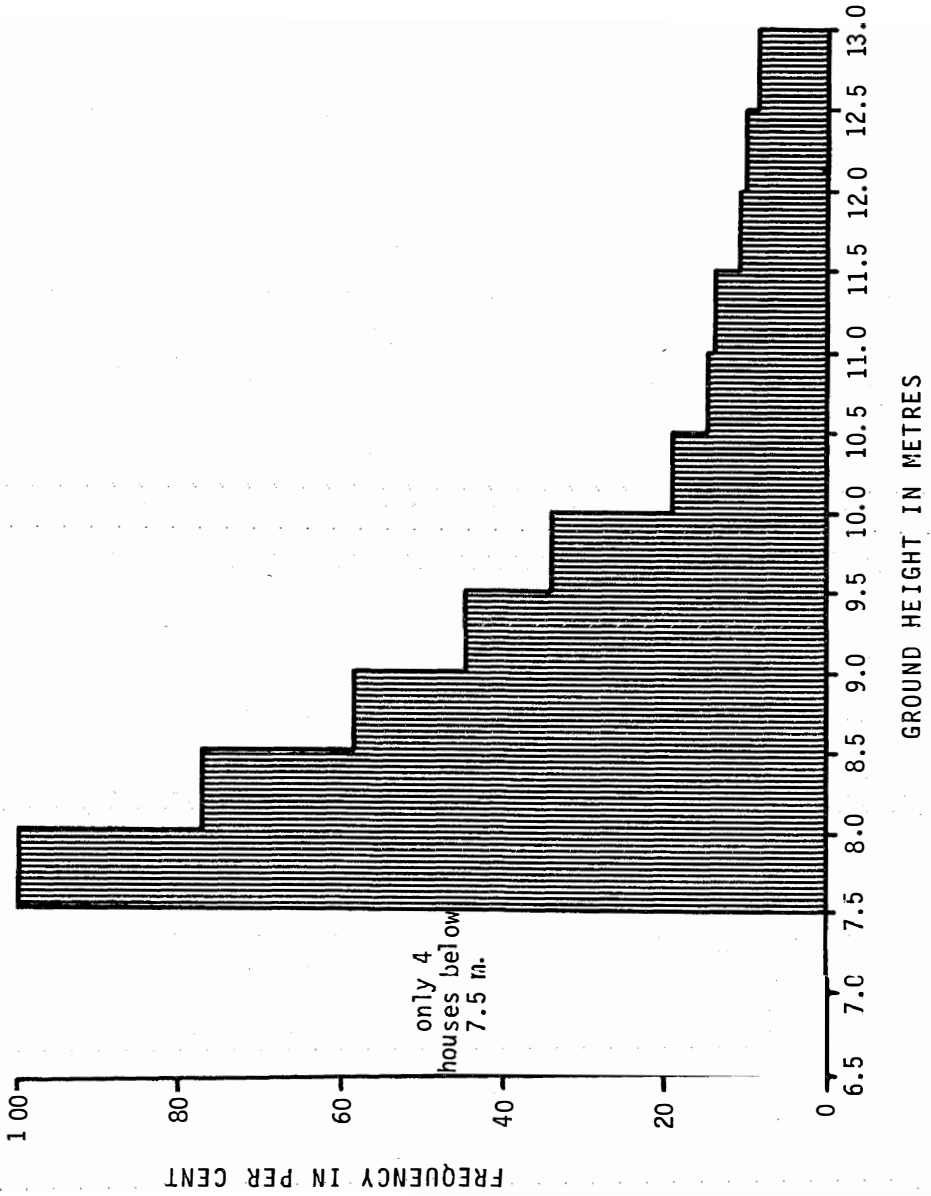


FIGURE 2.7
COMPOSITE STAGE-DAMAGE CURVE FOR RESIDENTIAL PROPERTY

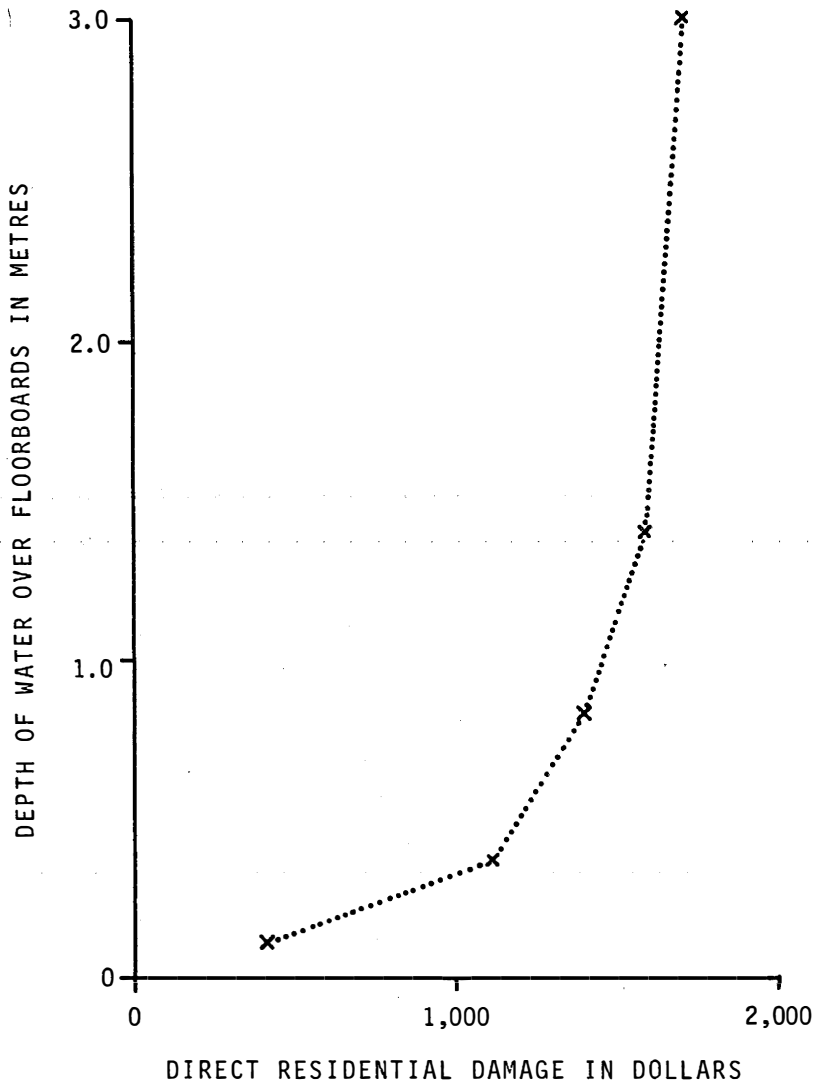


FIGURE 2.8

SCATTER PLOT OF DAMAGE AND DEPTH OF WATER OVER FLOOR HEIGHT

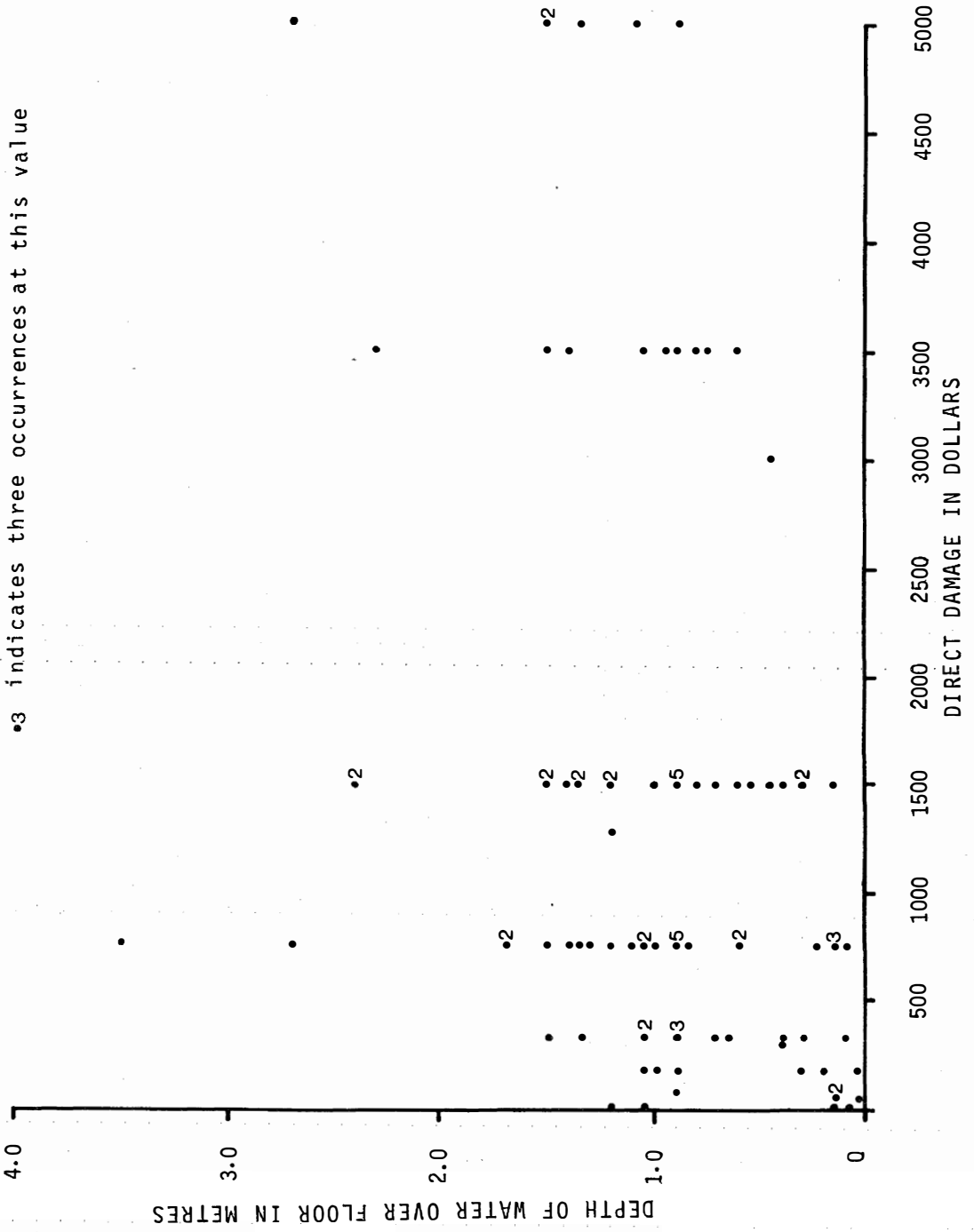


FIGURE 2.9
STAGE-DAMAGE PROCEDURE FOR UNDER HOUSE DAMAGE

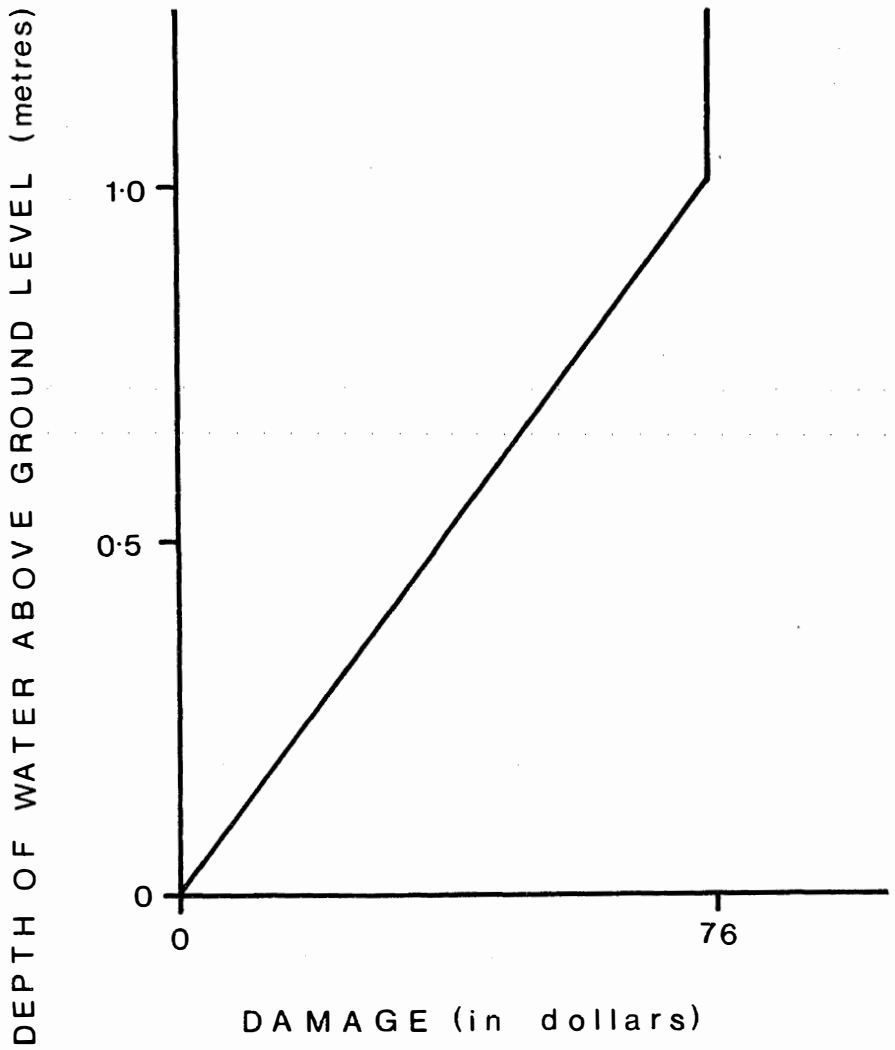


FIGURE 2.10
 MAP SHOWING THE PROTECTED AREAS OF BROWNS CREEK AND
 SOUTH LISMORE

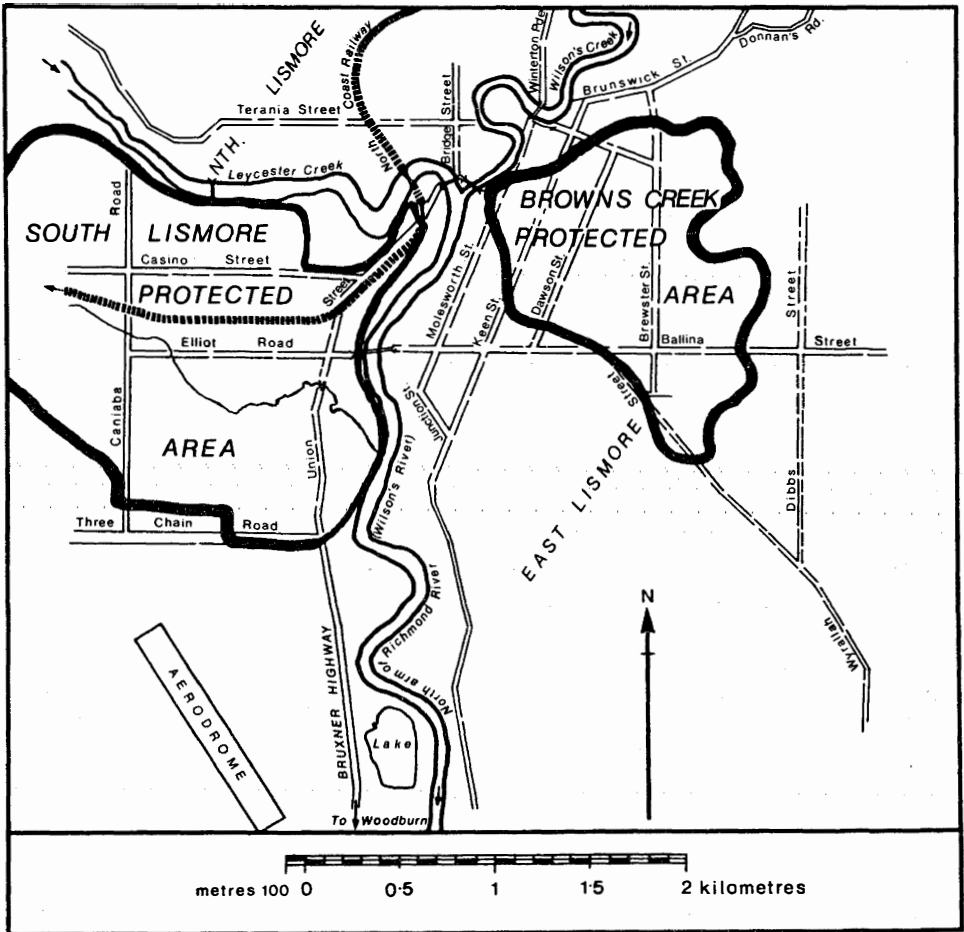


FIGURE 2.11
TOTAL RESIDENTIAL DIRECT FLOOD DAMAGE IN RELATION TO
GAUGE HEIGHT

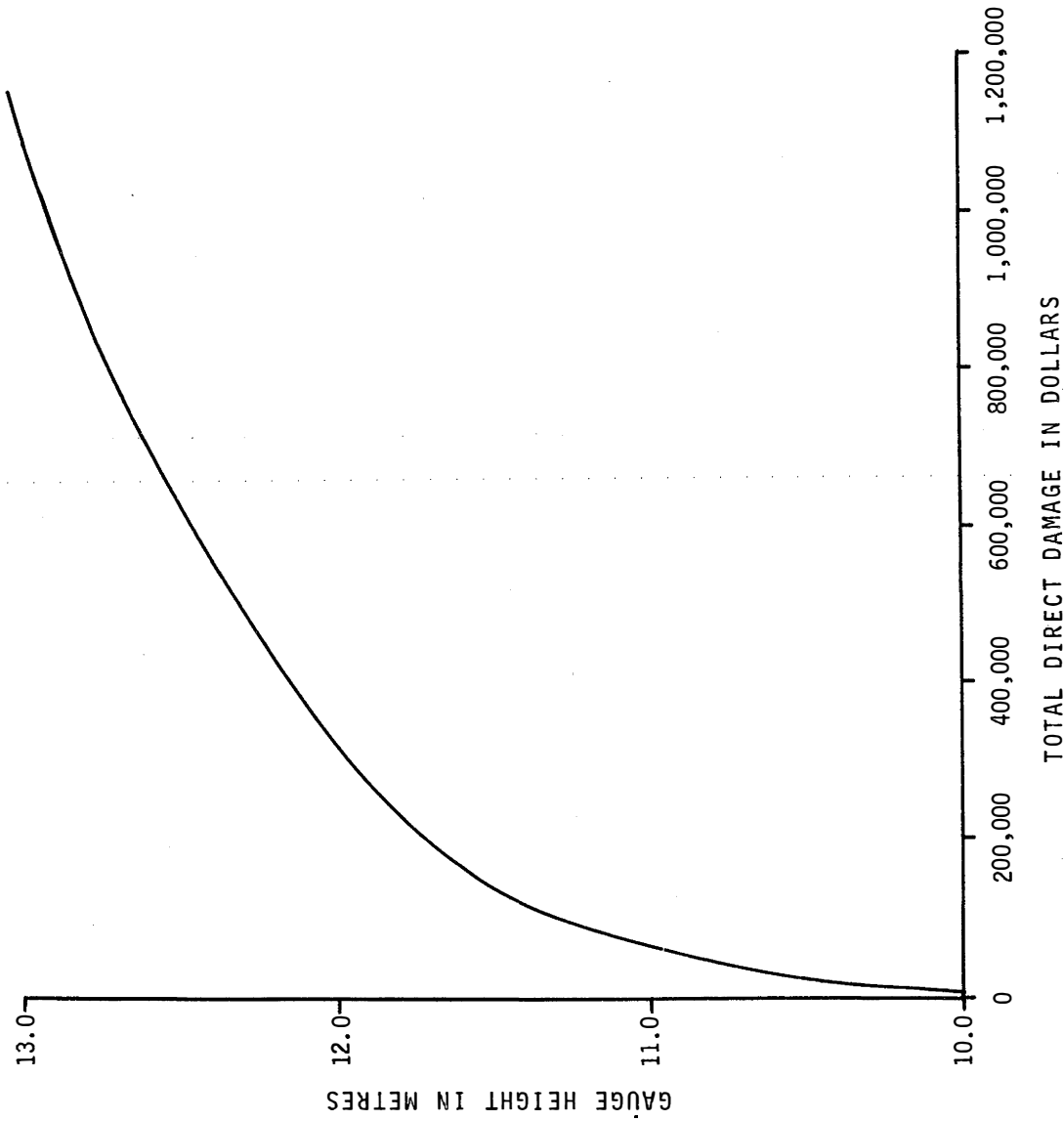


FIGURE 2.12
FLOOD PROBABILITIES FOR THE RICHMOND RIVER AT LISMORE

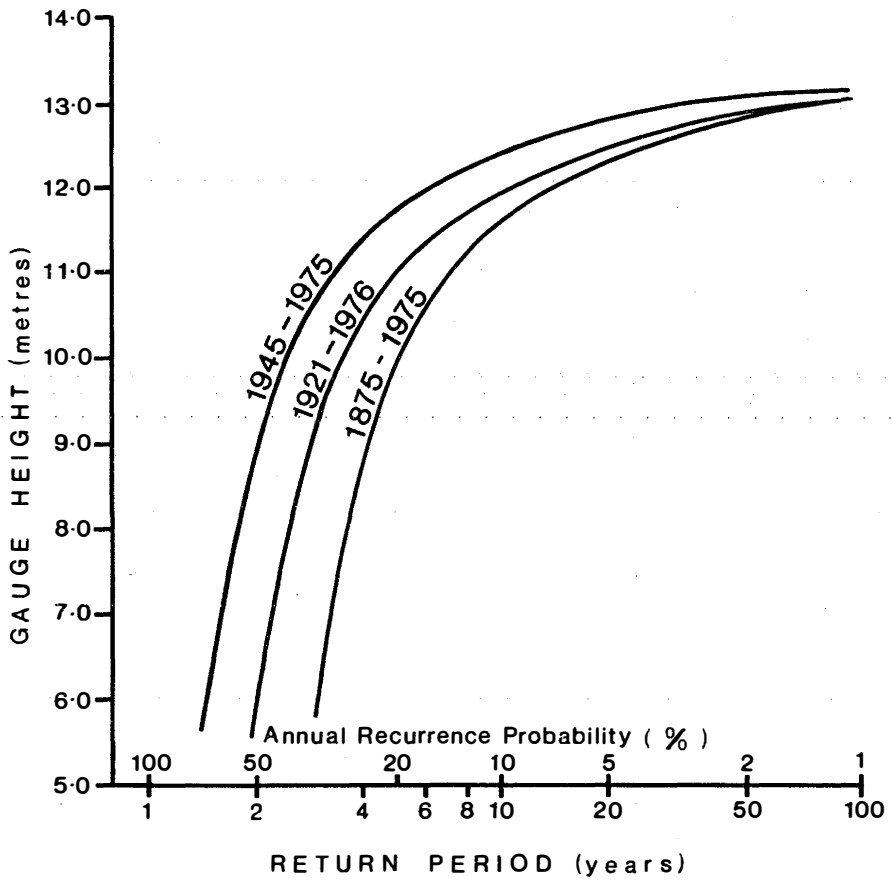


FIGURE 2.13
PROBABILITY OF RESIDENTIAL DIRECT DAMAGE USING THE
RECORD FOR 1921-1976

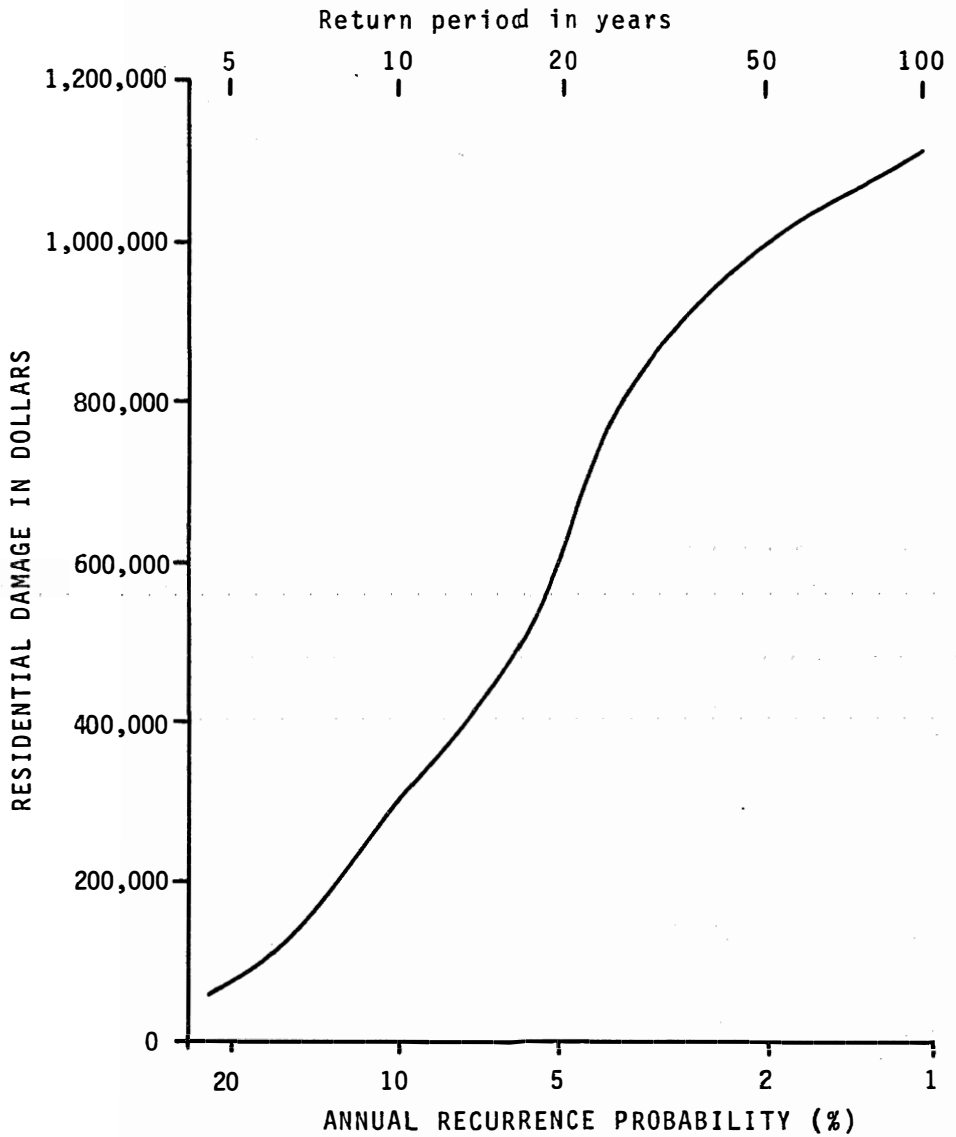


FIGURE 2.14
DISTRIBUTION OF FLOOR HEIGHT FOR THE COMMERCIAL SECTOR
IN RELATION TO GAUGE HEIGHT

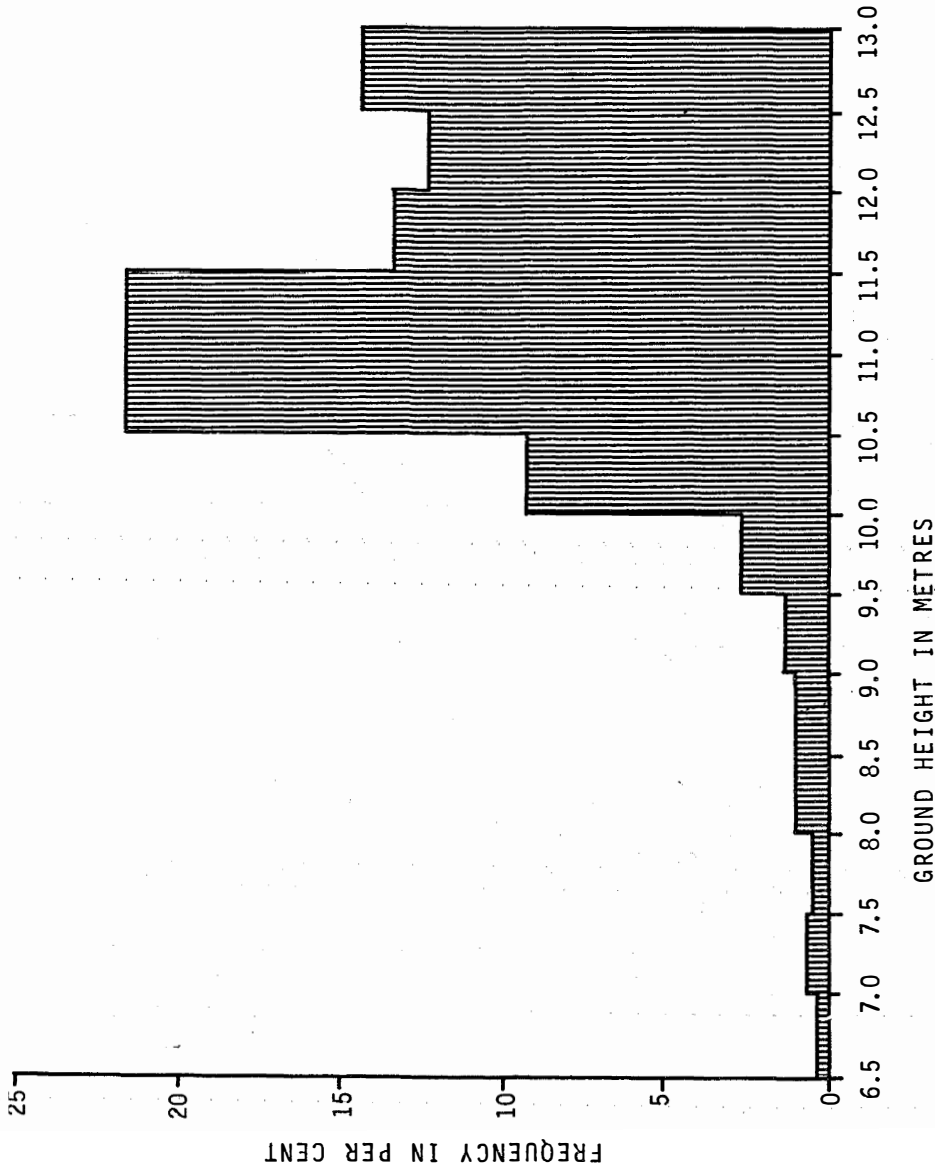
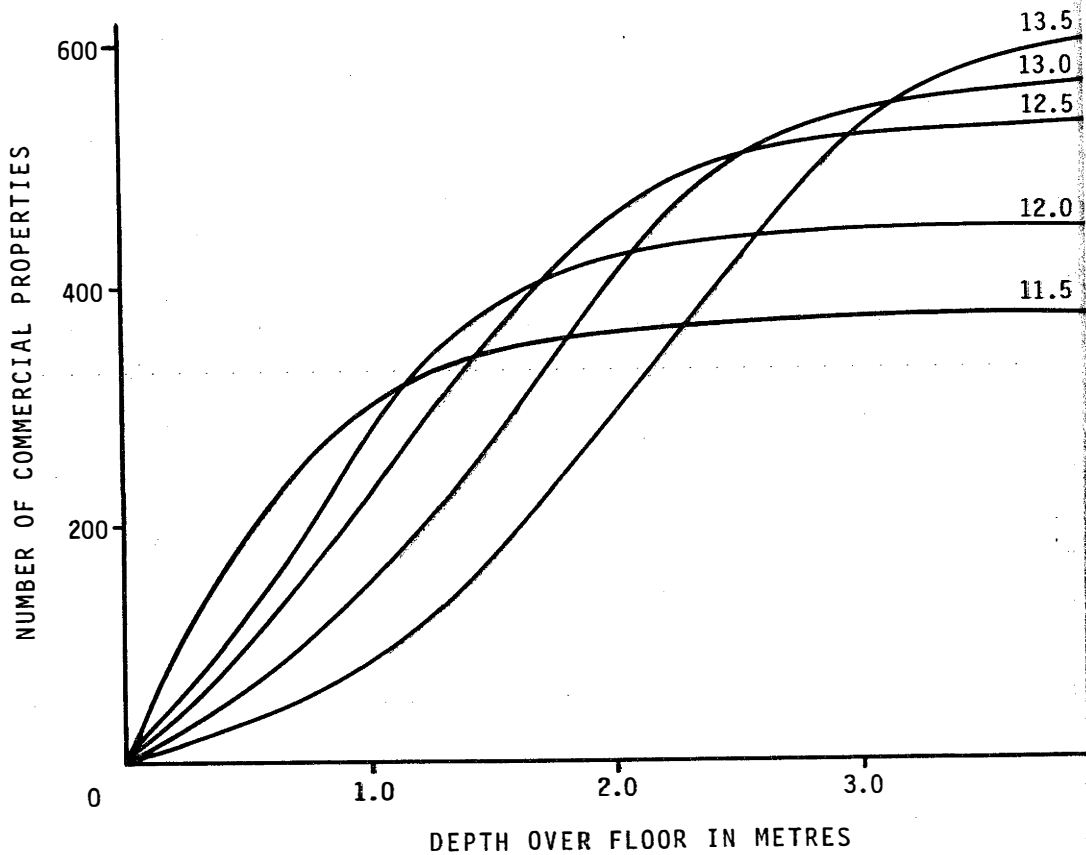


FIGURE 2.15

CUMULATIVE FREQUENCY OF COMMERCIAL PREMISES WITH DIFFERING
DEPTHS OF WATER OVER FLOOR LEVEL AT DIFFERING FLOOD
STAGES



NOTE: The use of this Figure is explained in a note at the foot of Figure 2.3.

FIGURE 2.16

DIRECT DAMAGE SUSTAINED BY COMMERCIAL PREMISES IN FLOOD
CATEGORIES 4 AND 10 IN RELATION TO DEPTH

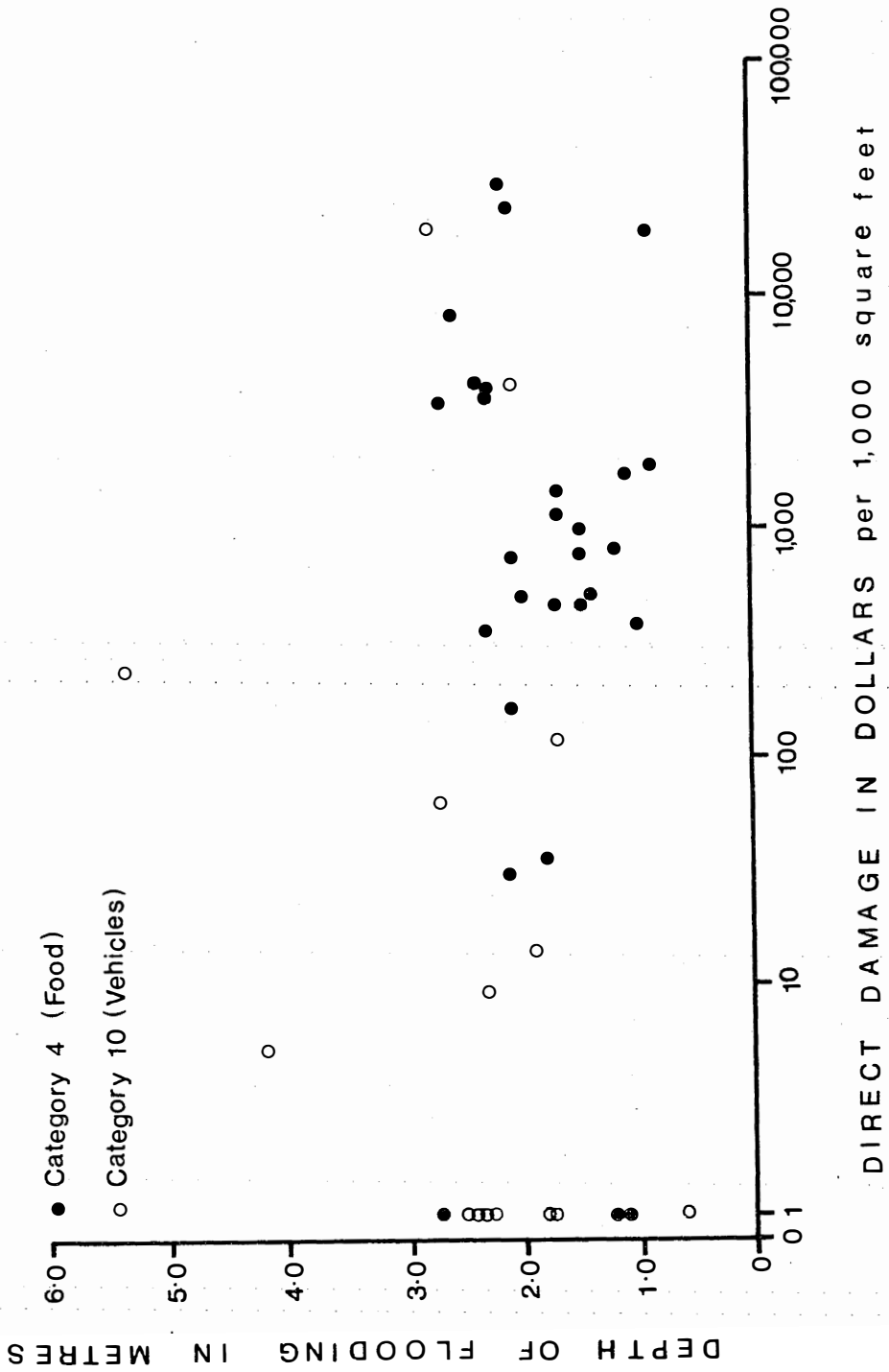


FIGURE 2.17
COMMERCIAL STAGE-DAMAGE CURVES FOR DIFFERING SIZE CLASSES

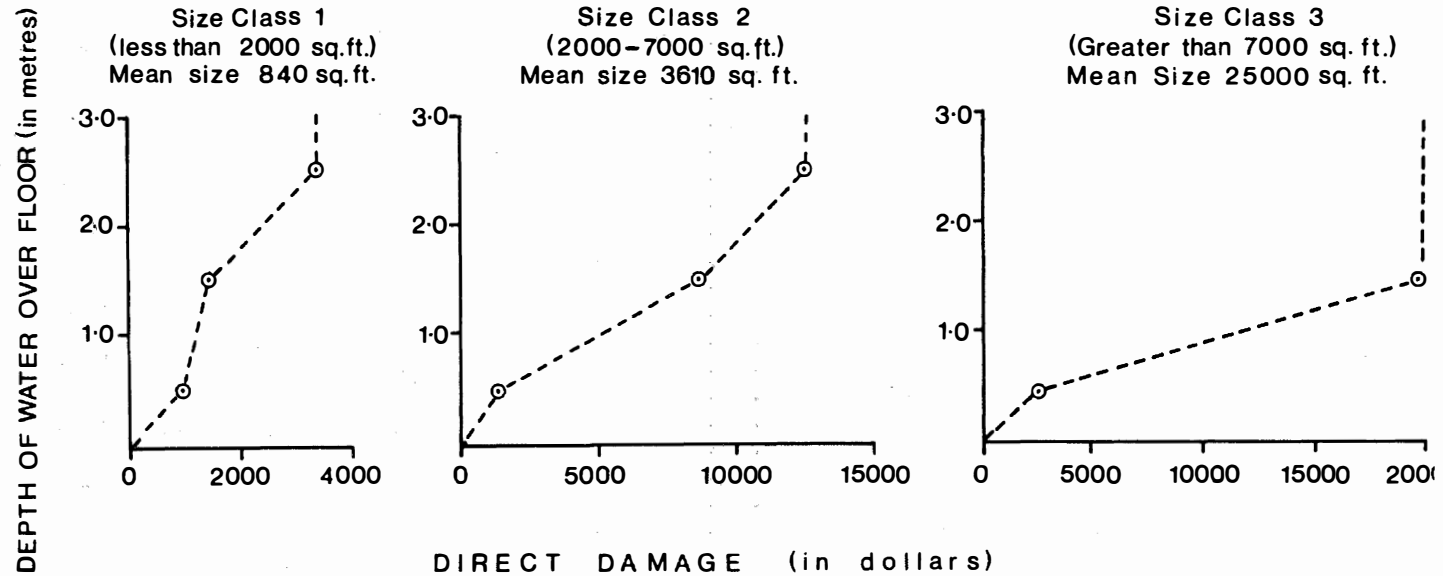


FIGURE 2.18
TOTAL COMMERCIAL DIRECT FLOOD DAMAGE IN RELATION TO
GAUGE HEIGHT

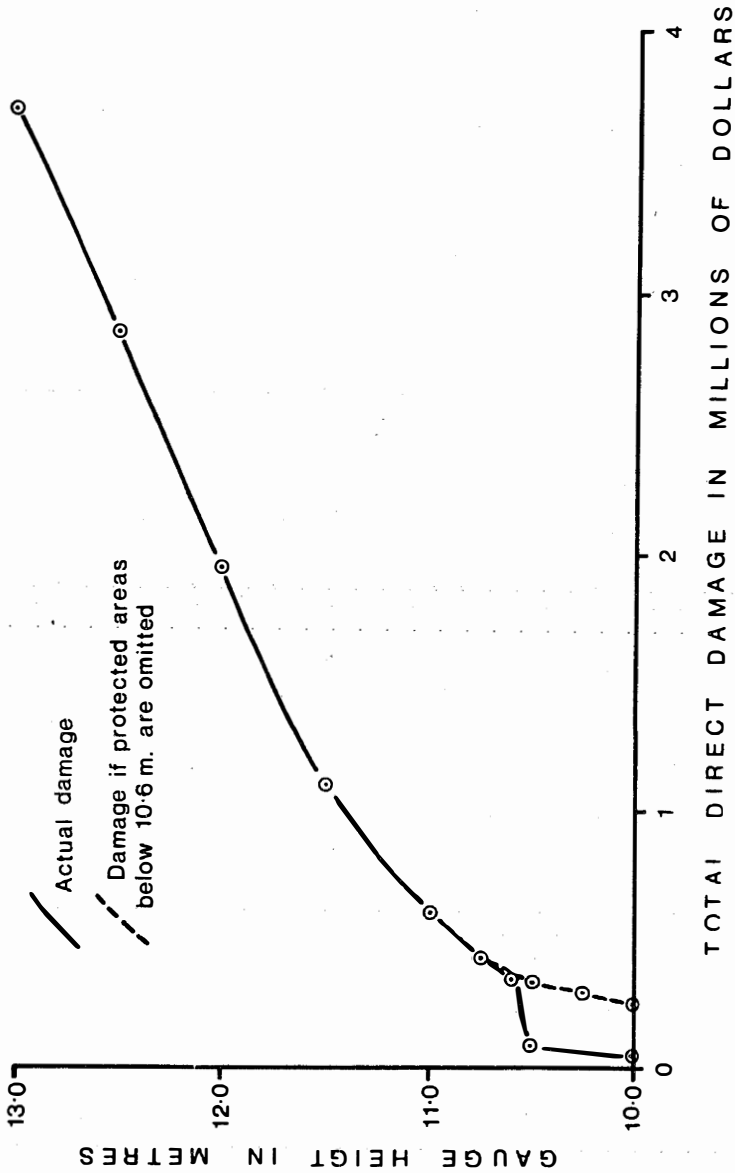


FIGURE 2.19
EXAMPLES OF TWO INDUSTRIAL STAGE-DAMAGE CURVES

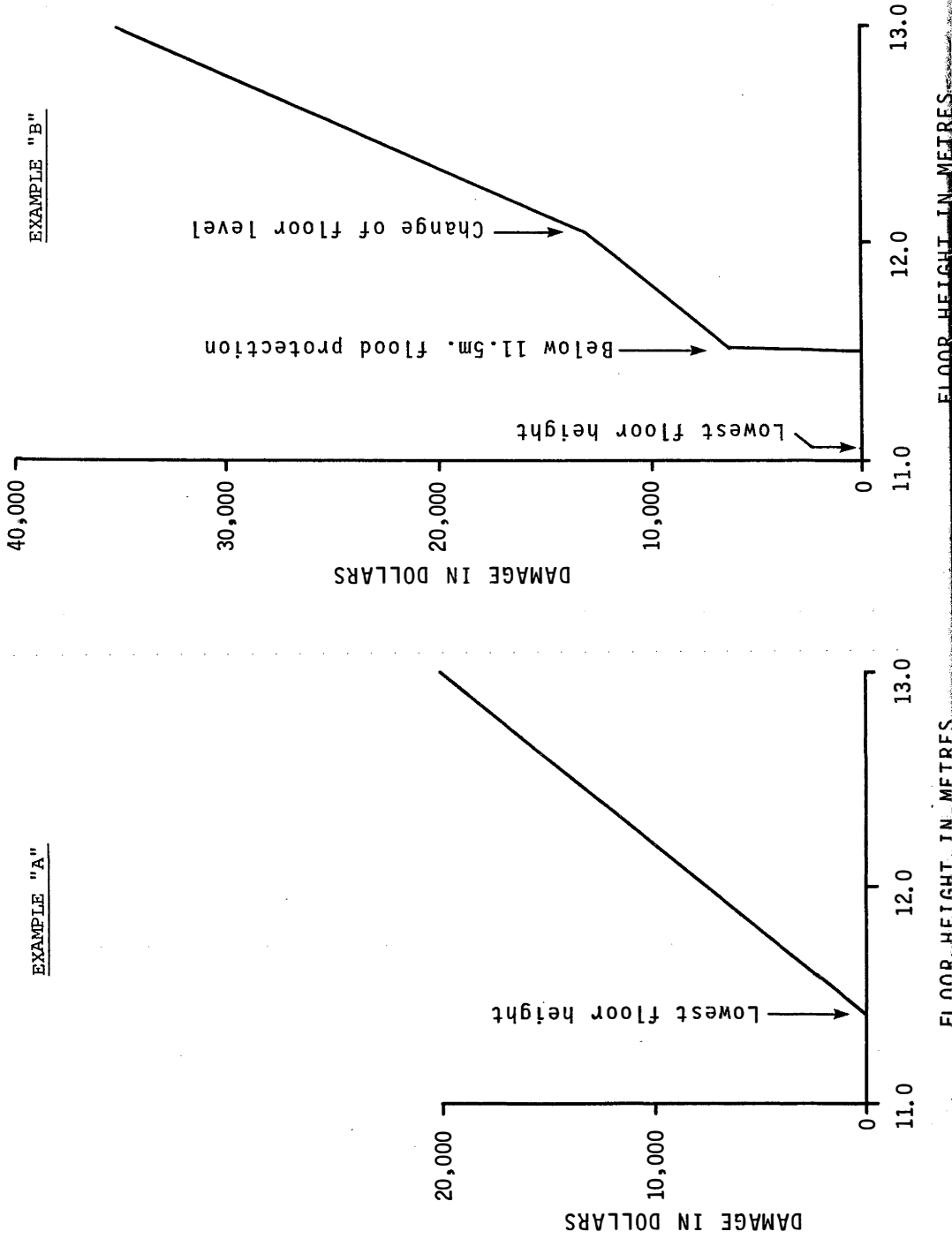


FIGURE 2.20
TOTAL INDUSTRIAL DIRECT FLOOD DAMAGE IN RELATION TO GAUGE HEIGHT

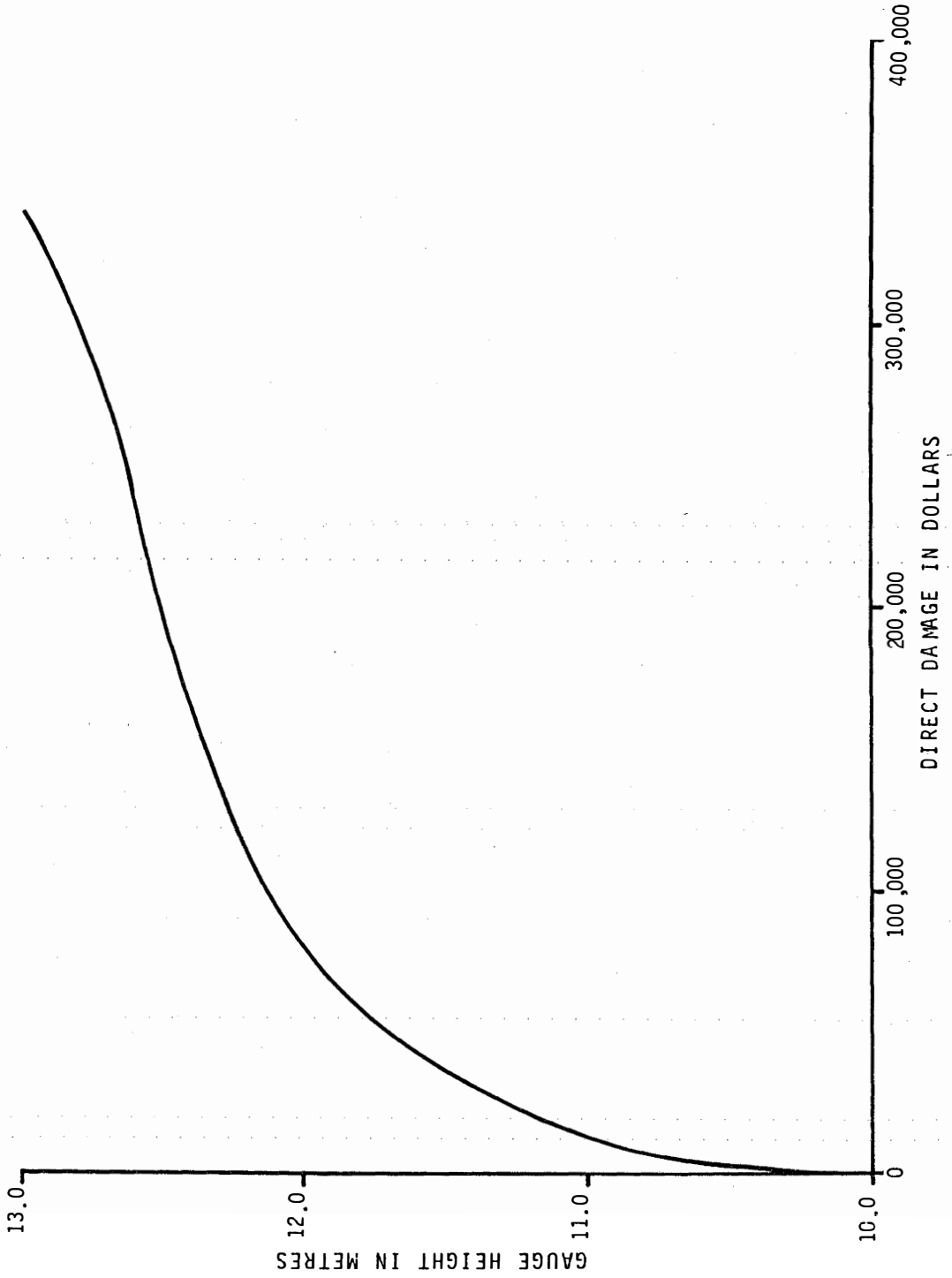


FIGURE 2.21

COMBINED DIRECT FLOOD DAMAGE FOR THE RESIDENTIAL, COMMERCIAL AND INDUSTRIAL SECTORS

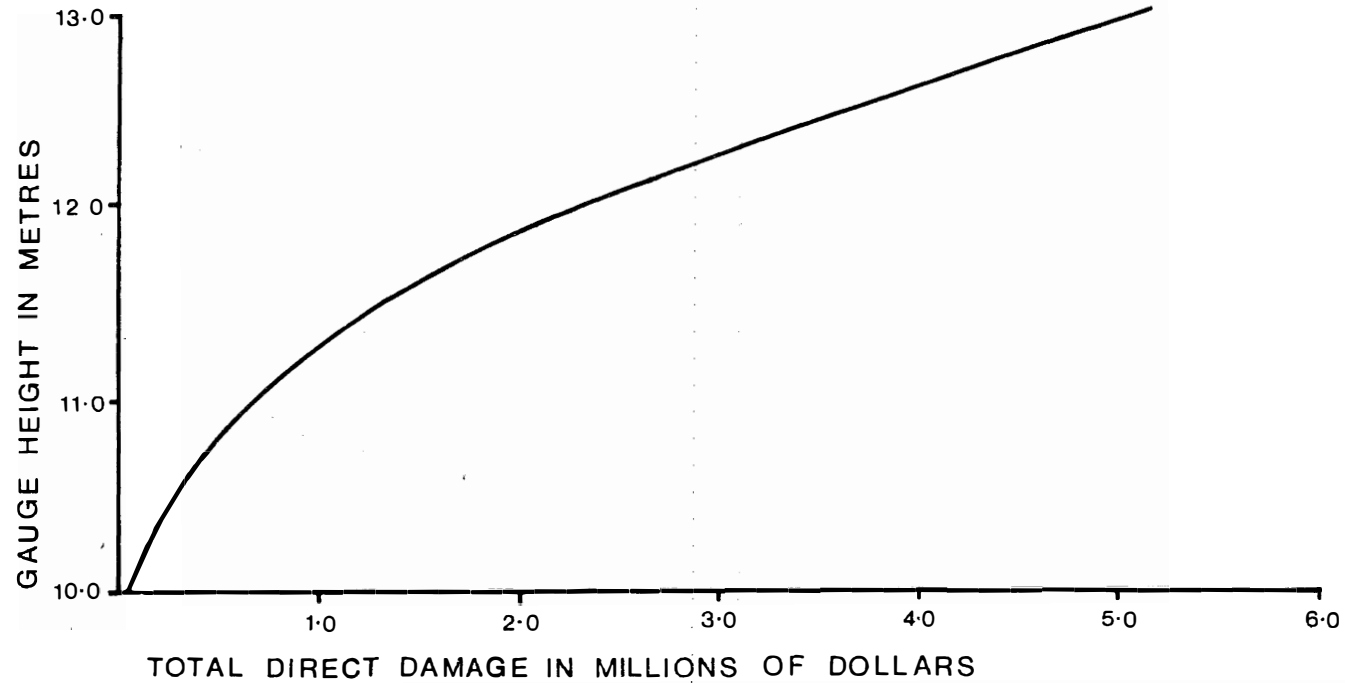


FIGURE 2.22
PROPORTIONS OF DIRECT FLOOD DAMAGE CONTRIBUTED BY RESIDENTIAL,
COMMERCIAL, AND INDUSTRIAL SECTORS

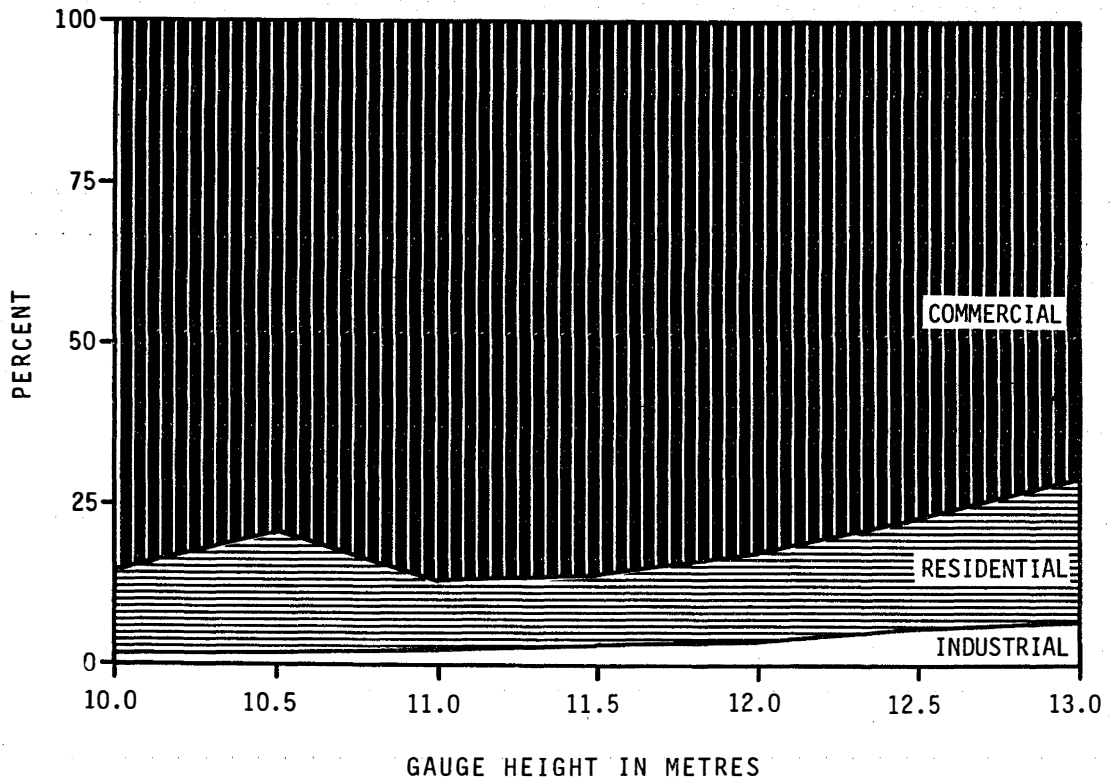


FIGURE 3.1
TIME REQUIRED FOR HOUSES AND GARDENS TO RETURN TO NORMAL AFTER
THE 1974 FLOOD

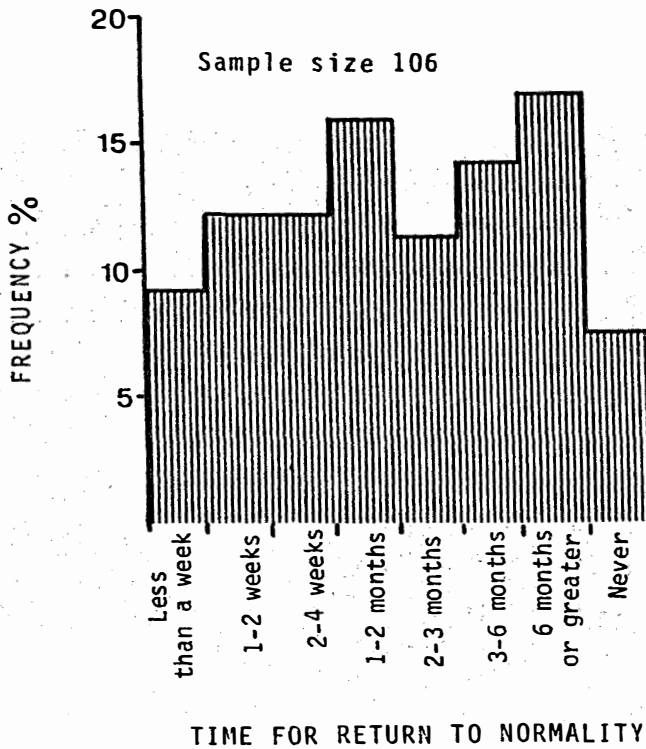


FIGURE 4.1

MAP OF THE RICHMOND RIVER VALLEY SHOWING LIMITS OF THE 1974 FLOOD,
DIVISIONS INTO UPPER AND LOWER VALLEY AND MAJOR AREAS OF CANE

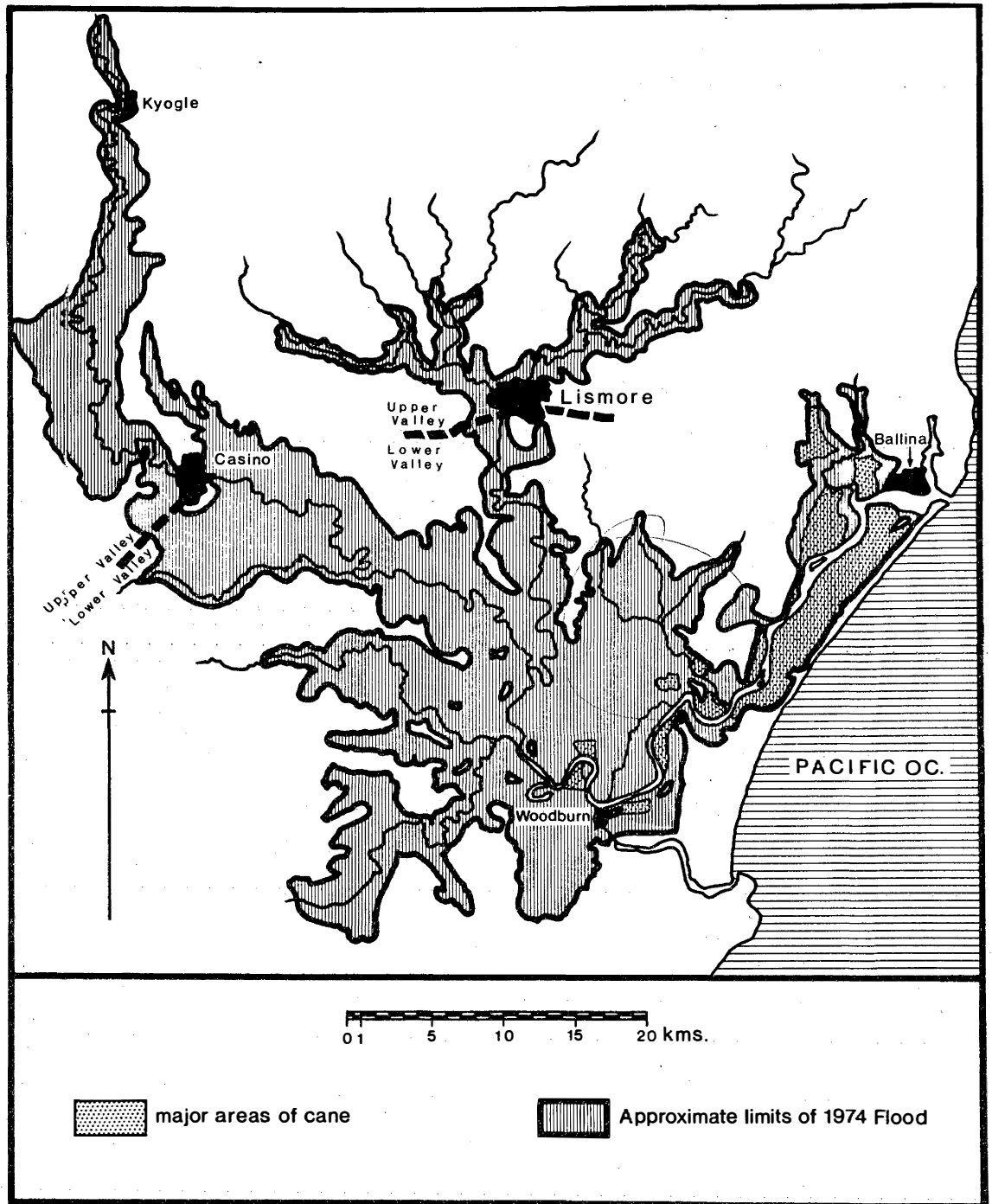


FIGURE 7.1
POTENTIAL STAGE-DAMAGE CURVE FOR RESIDENTIAL PROPERTY

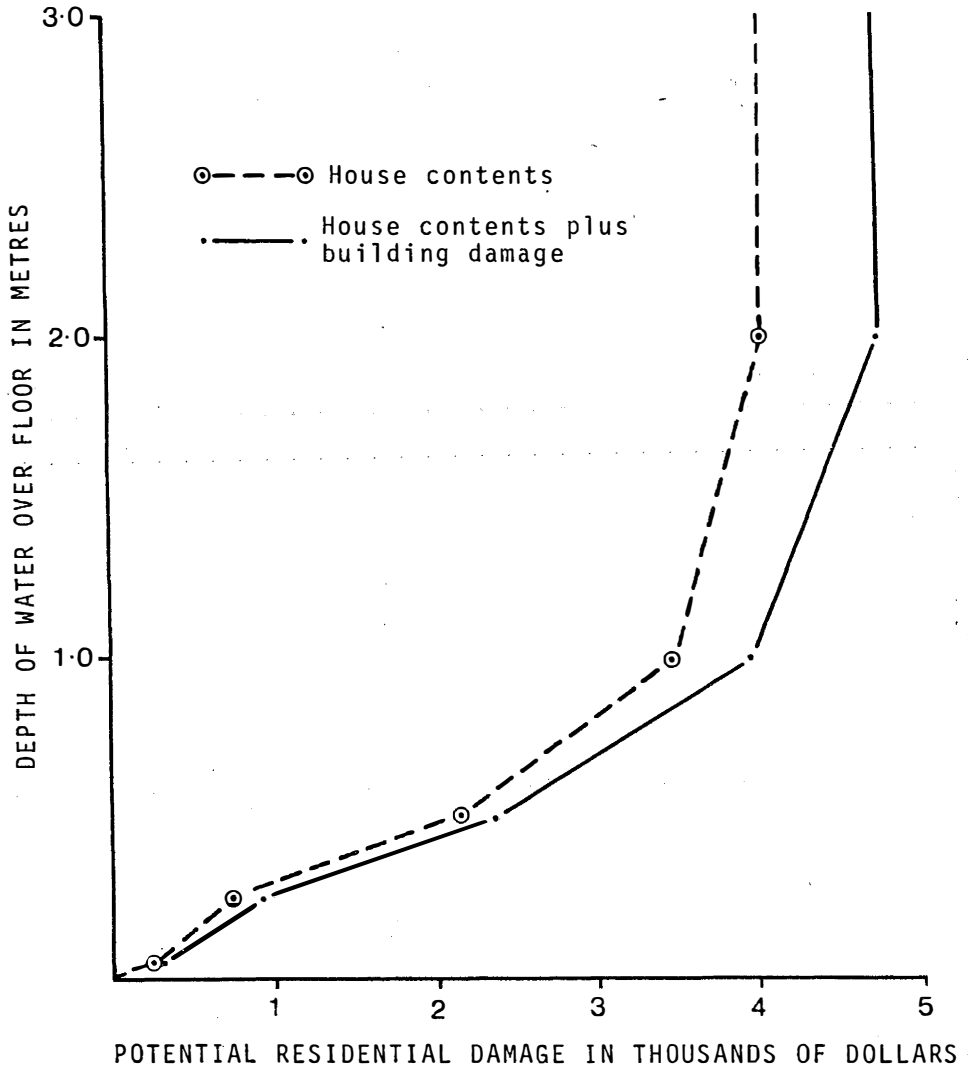


FIGURE 7.2

FREQUENCY OF VALUE FOR TOTAL HOUSE CONTENTS AT MARKET PRICE

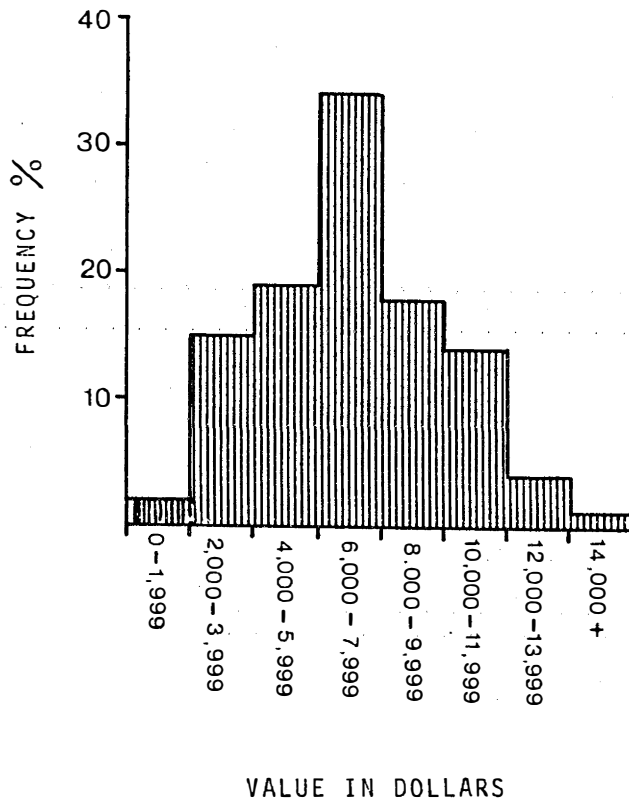


FIGURE 7.3

A COMPARISON OF POTENTIAL AND ACTUAL RESIDENTIAL DAMAGE

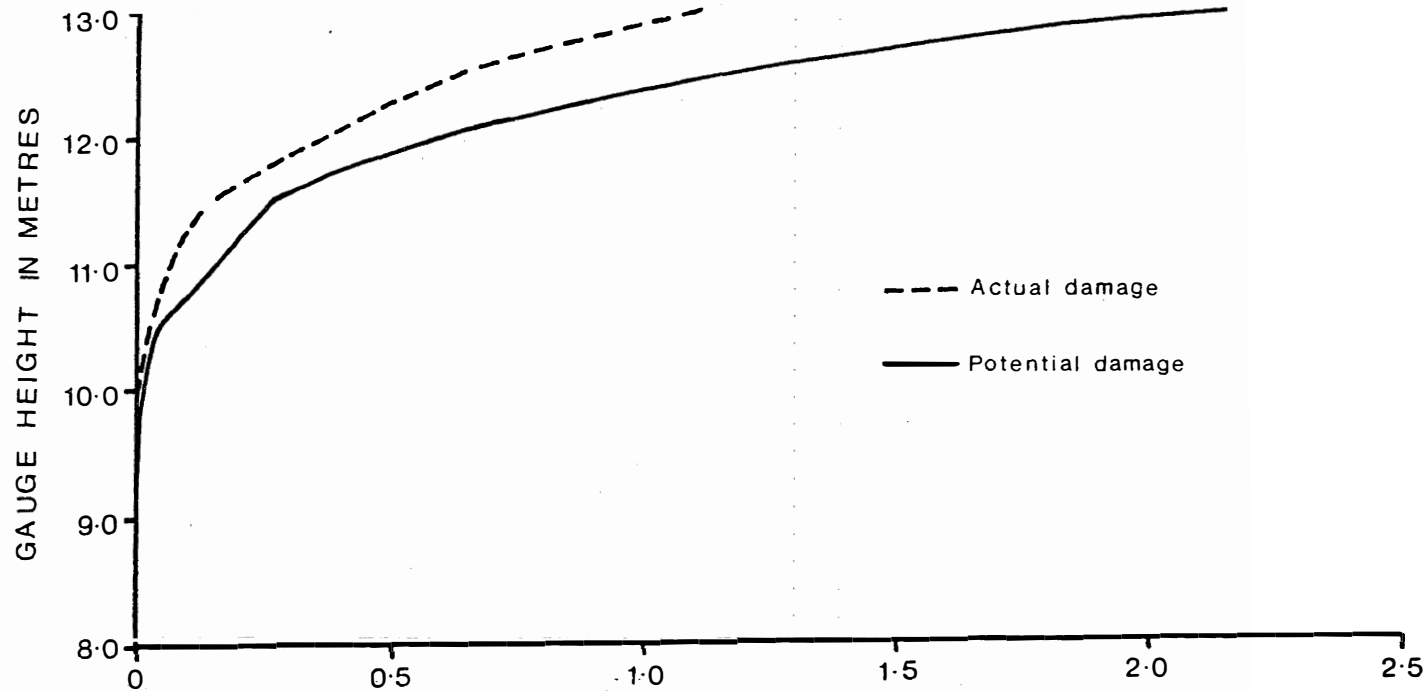


FIGURE 7.4
PROPORTIONS OF STOCK, BY VALUE, STORED AT DIFFERING HEIGHTS
ABOVE FLOOR LEVEL

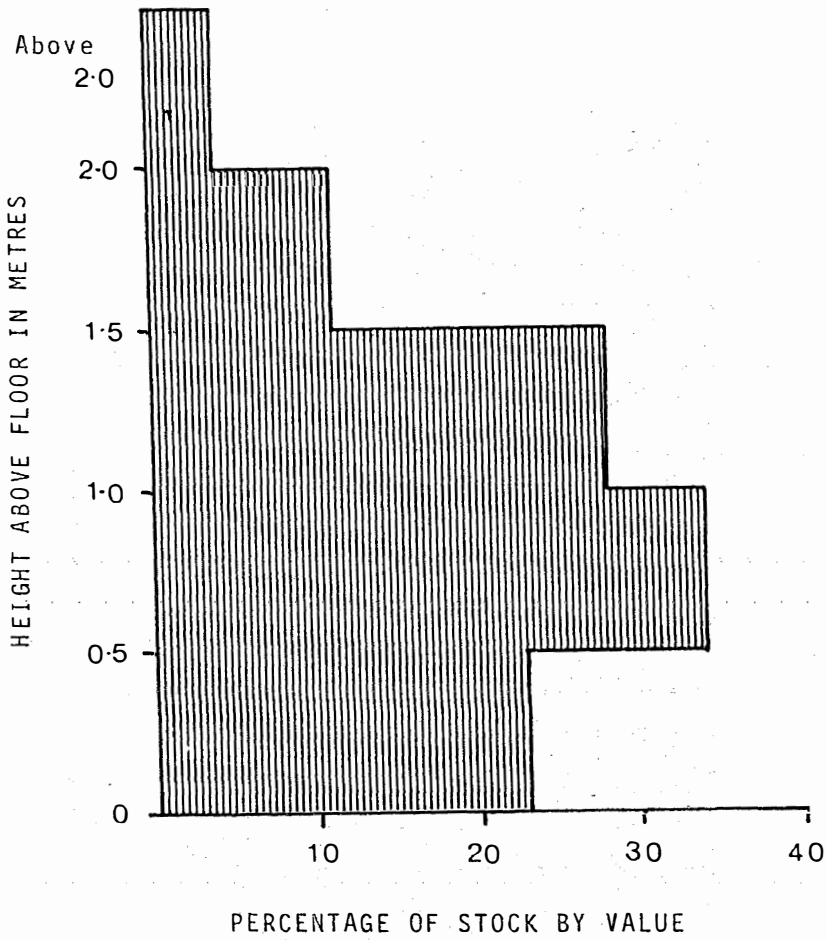


FIGURE 7.5
PROPORTIONS OF POTENTIAL FLOOD DAMAGE CONTRIBUTED BY
RESIDENTIAL, COMMERCIAL AND INDUSTRIAL SECTORS

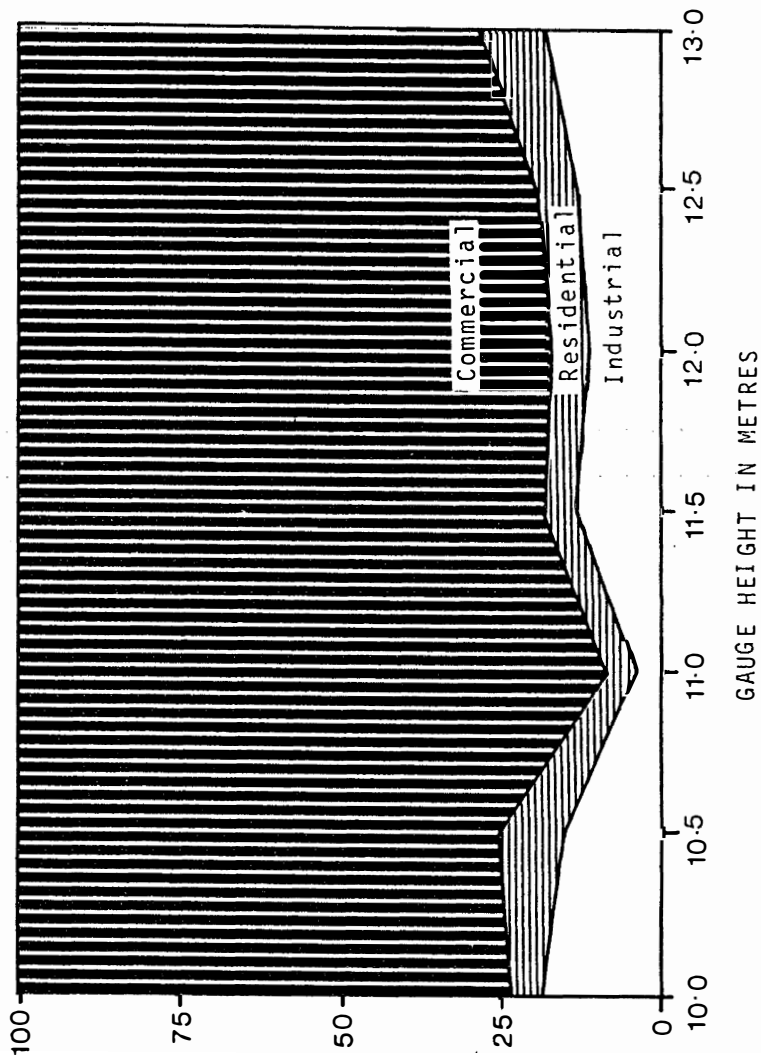


FIGURE 7.6

TOTAL POTENTIAL AND ACTUAL DAMAGE FOR URBAN LISMORE IN RELATION TO GAUGE
HEIGHT

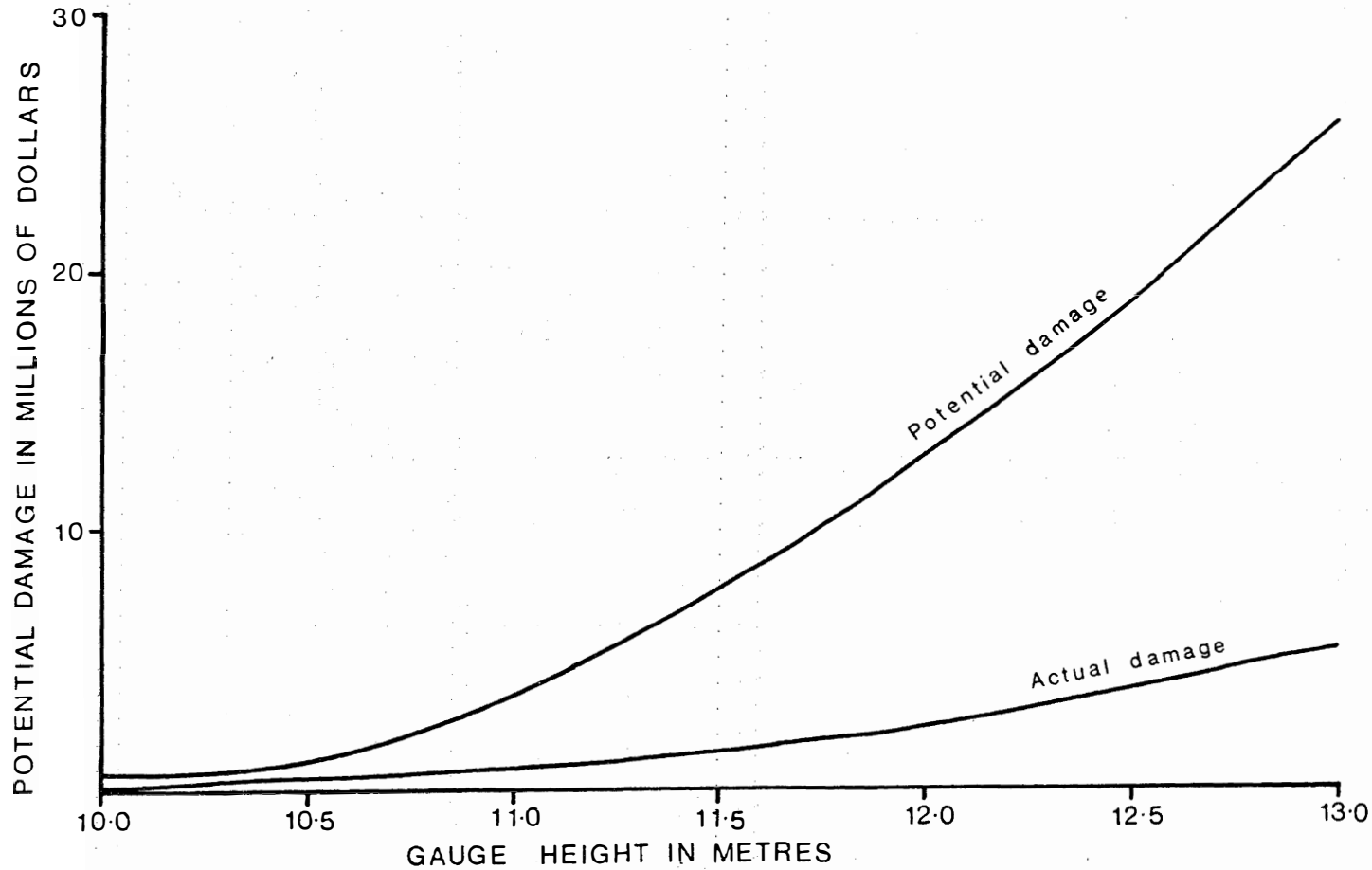
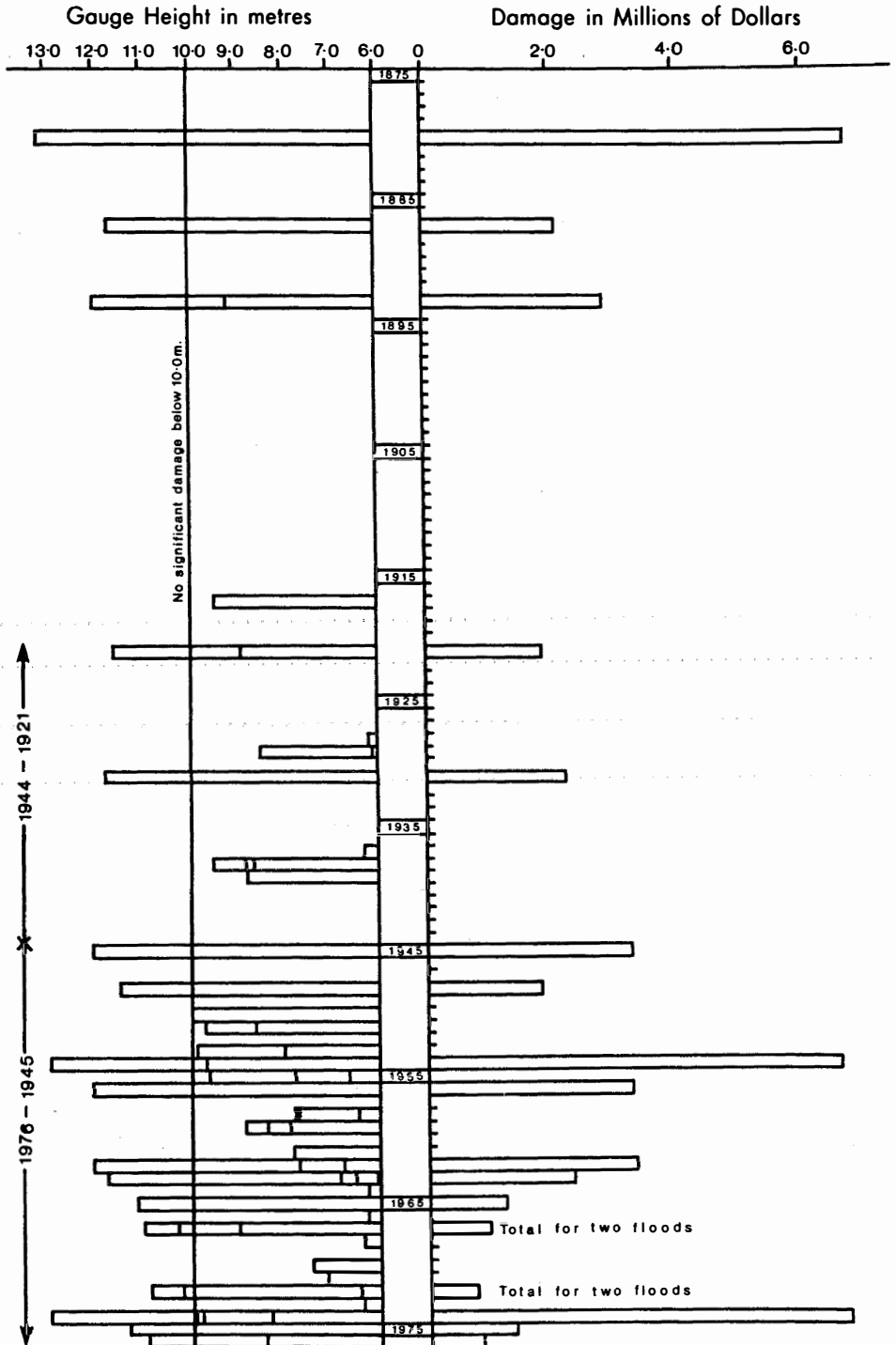


TABLE 9.1
 MAJOR FLOODS AND DAMAGE FOR URBAN LISMORE, 1875-1976
*(The damage is a total of direct and indirect for
 the present urban area at 1974 prices)*



APPENDIX 2.1

CLASSIFICATION OF RESIDENTIAL PROPERTY BY CONDITION AND SIZE

The criteria for the classification of residential properties by
condition and size are described in this appendix.

CLASSIFICATION OF RESIDENTIAL PROPERTY BY CONDITION AND SIZE

1. Condition

The classification used for exterior condition is intended for comparison within a single construction class, e.g., houses that have wooden construction. Comparisons between houses built of differing materials is more difficult. However, as well over 90% of the houses included in this survey had walls constructed of wood this difficulty is not considered to be a major limitation.

The condition was assessed from visual inspection of the outside of the buildings concerned.

a) Poor Condition

Advanced decay, perhaps aggravated by vandalism
 Little sign of recent maintenance
 Chipped wall paint, rusty roof, rusty and leaking guttering
 Floors or walls warped
 Crumbling brickwork
 Grounds unkempt and untidy

b) Fair Condition

Static maintenance condition, decaying naturally but not well advanced
 Wall paint ageing and dirty but still affording adequate protection
 Roof and gutters not leaking although patches of rust may be evident
 Grounds tidy

c) Good Condition

Natural decay reduced by good maintenance, obvious improvements
 Newly painted walls, roof and guttering
 Parts of building likely to have been renewed and possible new additions
 Grounds well kept

2. Size

Exterior assessment is not easy but reference was made to typical house-plans with linear measurements.

In general, the size categories of floor space were as follows:

<u>Small</u>	:	Less than 80 m ² . Generally 1 or 2 bedrooms
<u>Medium</u>	:	Greater than 80 m ² to 150 m ² . Three bedrooms
<u>Large</u>	:	Greater than 150 m ² . Four or more bedrooms

There was only a small number of flats and where this form of ownership was apparent from exterior inspection the size relates to the floor area of each individual unit.

APPENDIX 2.2

QUESTIONNAIRE FOR THE RESIDENTIAL SECTOR OF LISMORE

Details of the replies to some of the questions are given on the questionnaire form or as additional tables at the end of the form. Where the answers are more complex the information is either omitted or given in table form in the text of the report. In many cases answers that were 'don't know' or 'not applicable' were omitted from the totals presented in this appendix.

CONFIDENTIAL

APPENDIX 2.2

RICHMOND RIVER VALLEY FLOOD COST STUDY - RESIDENTIAL QUESTIONNAIRE

TOWN
 STREET
 NUMBER
 PHONE

NOTE: For our purposes we regard a residence as 'flooded' after water has risen level with or above the main floor of the lived in part of the residence.

1. * Please list in order of importance the main problems associated with living in this area. OFFICE USE
- (1)
 (2)
 (3)
- * (RESPONSES TO THIS QUESTION WERE UNSATISFACTORY.
 NO ANALYSIS WAS UNDERTAKEN)
2. How many years have you been in this building? Years
(see end of appendix 2.2)
3. How many times has this building been flooded while you have been the occupier? Times
(see end of appendix 2.2)
4. (a) What was the greatest depth of flood water that you have ever experienced in this building? Depth
(in metres)
(see end of appendix 2.2)
- (b) In what year did this occur?
5. Would you please indicate with a tick how much the biggest flood in this building cost you?
- | | | | | |
|-------------|-------------|-------------|---------------|---------------|
| 29
..... | 2
..... | 4
..... | 9
..... | 15
..... |
| \$0 - \$24 | \$25 - \$49 | \$50 - \$99 | \$100 - \$249 | \$250 - \$499 |
-
- | | | | |
|---------------|-----------------|-----------------|-----------------|
| 29
..... | 23
..... | 12
..... | 6
..... |
| \$500 - \$999 | \$1000 - \$1999 | \$2000 - \$4999 | \$5000 and over |

APPENDIX 2.2 (Contd.)

6. If you received compensation for this flood, from what source did it come and was it enough?
(If you did not receive compensation leave this question out).

	Amount received	Enough		
		Yes	No	Don't know
Council)			...	...
Government bodies)			74	...
Other sources (please state))			...	...

If you have always lived in this residence go to Question 10.

7. Did you consider the risk of flooding when you moved to this property?
 74
 ... Yes
 52
 ... No
 4
 ... Don't know
8. Were you ever flooded where you had your home before?
 58
 ... Yes
 72
 ... No
 1
 ... Don't know
9. When you moved here was this building already designed or modified to prevent flood water coming inside?
 73. Yes
 56. No
 0
 ... Don't know

If 'Yes' what were these modifications?

..... House raised 60
 Built own house 3

10. Please indicate in the boxes provided if you have undertaken any of the actions listed. If you have, please give the number of times used, the approximate cost and a statement of their effectiveness.

Action	Taken Yes/No	Approx. Cost	No. of Times Used	Was it Worthwhile?			
				Yes	Partly	No	Don't Know
Tried to keep out water by sandbags and other temporary measures	Yes 1 No 128	\$		1			
Taken out flood insurance other than as part of a general policy	Yes 2 No 144	(per year)	Claims	1			
Made permanent structural changes to this property to keep out flood water	Yes 39 No 144			20	1		
Moved valuables to higher level	Yes 144 No 28			42	5	1	
Made special arrangements to receive flood warnings	Yes 3 No 128			1			
Moved to temporary accommodation because of floods	Yes 72 No 73			19	2		
Other (Please state)	Yes 5			4			

11. Is there anything that you could do to further reduce the risk of flood damage to this building?

52
... Yes
93
... No
1
... Don't know

If 'yes' please give details including estimate of cost entailed.

.... Cost
(see end of appendix 2.2)

12. * Are public flood warnings given out in this neighbourhood?

... Yes
... No
... Don't know

*(THIS QUESTION WAS UNSATISFACTORY AND NO ANALYSIS WAS UNDERTAKEN)

13. Please tick the single most reliable source of information about danger from floods in this neighbourhood.

Police	7
Council	1
State Emergency Service (Old Civil Defence)	48
Radio and TV Broadcasts	108
Newspapers	1
Your own judgement	30
Others (please state)	6

14. If you suffered damage during the 1974 flood as a result of misinterpretation, or otherwise, of the warnings given, how much do you think you could have saved if the warnings had been understood and given in good time?

\$..... or %
(see end of appendix 2.2)

65
..... No difference

15. Please indicate in the boxes how many times you have received help from the following people during times of flooding and if it was useful.

	No. of times	Useful	Partly Useful	Not Useful	Don't Know
Police		13	3		
Church Organisations		11	2		
S.E.S. (Civil Defence)		16	1		
Neighbours		45			
Council		9		1	
Army		4			
Fire Brigade		2			
Family from outside flood zone		19			
Others (Please State)					

16. Is there more that any authority could do to further develop and co-ordinate evacuation and relief programs?

31
... Yes

41
... No

23
... Don't know

If 'yes' please give brief details:

..... (See end of appendix 2.2)

17. How many times do you think this building will be flooded in the next 20 years? Times
18. Do you think the risk of flooding is increasing or decreasing? .69 Increasing
 .41 Decreasing
 .13 No change
 .25 Don't know

Please tick the reason(s) that you think are important from the following list: NOTE: Respondents could select more than one reason.

- | | | | |
|---------------------------------------|----------------------------|----------------------------------|-----|
| 1) Changes in climate | .19 | 2) Highway construction | .11 |
| 3) Town building and sub-divisions | .15 | 4) Silting of rivers/ditches | .82 |
| 5) Building of river banks and levees | .48 | 6) Reservoir management upstream | .13 |
| 7) Forest felling | .21 | 8) Forest planting | .6 |
| 9) Other (Please State) | Changes to Brown's Creek 9 | | |

19. Is this residence rented or owned by you? Rented
 Owned

20. What are the ages and normal occupations of the people living here? (Give number in each age group and occupation)

Age	36	100	67	86	95	78
5 yrs & under	6 - 15	16 - 24	25-44	45-65	Over 65	
Occupation	13	14	44	31	76	
Manager/Professional	Clerical	Trademan	Manual	Domestic		
87	99	15	21	5		
Retired or Pensioner	School Student	Tertiary Student	Not Employed	Salesman		

21. Could you estimate the cost of damage today if
- a) Six inches of water entered this building after you were given six hours warning? \$.... Cost
- b) Three feet of water entered this building after you were given six hours warning? \$.... Cost

22. What is the minimum time it would take you to raise or move anything which would be damaged by flood? Hours

(see end of appendix 2.2)

23. How would you feel about each of the following possible schemes for the Richmond River?

Please state - 1) Strongly in favour
 2) Favour somewhat
 3) Oppose somewhat
 4) Strongly oppose

- a) Diversion of water from Wilson and Byron Creeks to the sea via tunnels at Nashua
 b) Other lower river diversion to the sea
 c) Construction of more and larger embankments or levees along the Richmond
 d) Construction of dam storage upstream of Lismore
 e) Deepen and widen the rivers through Lismore
 f) River straightening
 g) Preserve everything as it is and leave the river and its tributaries alone
 h) To pay for flood protection everybody should pay more in taxes
 i) The people who live in flood-prone areas should pay for their own protection
 j) The government should provide a grant or loan for people to protect themselves from flooding
 k) The government should give financial support for the re-housing of flood plain residents to safer areas

24. a) Has any member of this household suffered from ill health as a result of floods entering the home?
 26 Yes
 117 No
 1 Don't know

If 'no' go to Question 27

- b) Which description best fits this ill health? 5 Both
 Psychological (e.g., stress, family problems) 11
 Physical (e.g., broken limb, flu, bronchitis) 10

- c) Was it serious?
 20 Yes
 4 No

25. Did the effect of this ill health seriously disrupt the household?
 16 Yes
 9 No
 Don't know

26. What was the status in the household of the affected persons?

- | | | |
|----------------|----------------|-----------------|
| 1) Grandparent | 2) Young Adult | 3) Father |
| 4) Mother | 5) Young Child | 5) School Child |

27. Did members of your family visit the doctor for ailments more frequently for the 6-month period before the flood of 1974 than for the same period after, or vice versa?

Visited more before than after

Visited more after than before

No difference

28. Do you feel the people of Lismore psychologically:

1) Are well adjusted to the flood situation in Lismore?

2) Are only partly adjusted to the flood situation in Lismore?

3) Are poorly adjusted to the flood situation in Lismore?

4) Have not adjusted to the flood situation in Lismore?

29. During the 1974 flood did you help or aid anyone with evacuation or other relief operations? (Please tick the appropriate spaces)

No

Neighbours

Friends

Family

People you had never met before

30. Were you or your household helped by any of the following? (Please tick the appropriate spaces)

Neighbours

Friends

Family

People you had never met before

No one

31. Would you describe the community spirit as being - (Please tick the appropriate space)

Heightened

Lessened

Not changed

32. Do you enjoy or gain some form of satisfaction from helping with flood evacuation or relief operations?

Yes

No

Was too busy with own relief and evacuation to help

33. a) How long did clean-up operations take after the flood had subsided? (Please tick the appropriate space)

5	9	19	18
.....			
1 - 3 hrs	3 - 6 hrs	6 - 12 hrs	2 days

76
.....
More than 2 days 1 Week

- b) How long before the house and garden were back to normal?

34. Did the clean-up operation inconvenience you - (Please tick the appropriate space)

Personally	56
.....	
Financially	4
.....	
Both	44
.....	

Please estimate how much the clean-up operation cost, in personal expenditure only (not including own time) \$.....

35. Did you lose income through time taken off work to clean up the house and garden?

Yes	31
.....	
No	93
.....	

If 'yes' how much

\$.....

36. Did the flood experience disrupt any important events in the household? For example, were visits to or from relatives or friends, holidays, business trips or deals called off because of the floods? (Please give details below)

Sixteen varied responses

.....

.....

.....

DETAIL OF RESPONSES TO SPECIFIC QUESTIONS

Question 2: How many years have you been in this building?

Years	Less than 5	5-9	10-14	15-19	20-24	25-30	30-34	35-39	40-44	More than 45
Response	26	28	17	15	13	14	10	5	9	11

Question 3: How many times has this building been flooded while you have been the occupier?

Number of times	1	2	3	4	5	6	7	8
Response	40	22	16	6	2	4	2	3

Question 4(a): What is the greatest depth of flood water that you have experienced in this building?

Depth	0 m	0.1 - 1.0 m	1.1 - 2.0 m	2.1 - 2.9 m
Response	48	62	44	4

Question 4(b): In what year did this occur?

Year	1948	1954	1974	1975
Response	2	6	100	1

Question 11: Estimate of cost to raise house.

Cost	0 - 999	1000- 1999	2000- 2999	3000- 3999	4000- 4999	5000- 5999	6000- 6999	7000- 7999	8000- 8999	9000- 9999	More than 10,0
Response	2	2	7	8	8	7	3	1	1	0	3

Question 14: Misinterpretation of flood warning.

Only four respondents affected in this way, three claim 100% of damage could have been avoided and in one case 66%.

Question 15: Number of times help was received from differing organisations.

	0	1	2	3	4	5	6	7	8
Police	112	17	-	1	1	-	-	-	-
Church Organisation	111	10	1	2	2	-	-	-	-
SES	100	18	3	1	-	-	-	-	-
Council	118	9	2	1	-	-	-	-	-
Army	128	3	1	1	-	-	-	-	-
Fire Brigade	130	2	-	-	-	-	-	-	-
Family from outside flood zone	130	11	3	3	1	-	1	-	-

Question 16: Is there more that any authority could do to further develop and co-ordinate evacuation and relief programs?

Better organisation of evacuation boats	12
More assistance in North Lismore	3
Extend SES service	2
More assistance for pensioners	2
Better warnings	1

Question 22: What is the minimum time it would take you to raise or move anything which would be damaged by flood?

Time in hours	0	1-20	21-30	31-40	41-50	Impossible	Don't know
Response	20	106	4	0	2	6	4

APPENDIX 2.3

LISMORE FLOOD GAUGE RECORDS 1857-1976

These are the records on which all flood probability and average annual damage figures for Lismore are based.

APPENDIX 2.3

LISMORE FLOOD GAUGE RECORDS 1857-1976

The gauge heights are taken from an unpublished compilation made available by F. Barlow. The data was obtained from a number of sources and the gauge heights are reduced to LWOST at Ballina. Further investigation into the data and magnitude of some of the earlier records is being undertaken by F. Barlow and the Public Works Department. The listing below is based on the information available in late 1978.

Year	Month	Gauge height (in metres)	Comment
1857	-	-	A large flood, no height record
1870	March	-	
1870	March	-	
1879	May	-	Flooding, no height recorded
1880	February	13.11	
1884	May	-	
1887	January	11.68	
1889	January		
1889	July	-	No record of heights but estimated highest to date at Woodburn
1889	August	-	
1890	February	-	No record of heights
1890	March	-	
1892	April	-	
1893	January	9.14	
1893	February	11.98	
1893	March		
1894	January	-	No record of heights
1894	March	-	
1895	February	-	
1898	February	-	
1899	July	-	
1917	November	9.56	
1919	May		
1921	May	8.91	
1921	July	11.57	
1925	March	-	Lismore low parts under water
1927	January	-	No record of heights
1928	February	6.20	
1929	March	8.53	No record of heights
1929	June	6.10	Low areas of Lismore submerged
1930	February	11.74	
1937	March	6.31	
1938	January	8.85	
1938	April	8.67	
1938	May	9.49	
1939	March	8.74	
1940	December	-	No record of heights
1943	December	-	No record of heights

Year	Month	Gauge height (in metres)	Comment
1944	January	-	No record of heights
1945	June	12.07	
1946	March	-	
1948	May	-	
1948	June	11.52	
1950	March	-	
1950	June	9.95	
1951	January	9.65	
1951	March	8.59	
1953	February	9.91	
1953	March	7.99	
1954	February	12.95	
1954	July	9.63	
1955	March	9.61	
1955	April	6.60	
1955	December	7.76	
1956	February	12.07	
1956	May	-	
1958	June	6.45	
1958	July	7.81	
1958	August	7.75	
1959	January	8.82	
1959	February	8.44	
1959	November	7.91	
1962	January	6.81	
1962	April	7.70	
1962	July	12.08	
1963	January	6.52	
1963	March	6.89	
1963	April	6.07	
1963	May	11.77	
1964	March	6.29	
1965	July	11.15	
1966	June	6.29	
1967	March	10.99	
1967	June		
	(13/0300	8.98	
	14/1630)	10.27	
1968	January	6.4	
1970	December	7.47	
1971	February	7.19	
1972	March	6.46	
1972	April	5.85	
1972	October	10.87	
1973	February	6.40	
1974	March	12.95	
1974	April	9.75	
1974	June	8.30	
1975	March	11.31	
1976	February	8.40	
1976	February/ March	10.92	

APPENDIX 2.4

COMMERCIAL FLOOD CATEGORIES IN RELATION TO THE
BUNKER CODE CLASSIFICATION

The Bunker Code referred to in the text is based upon an unpublished classification system for urban land-use first proposed by Dr Raymond Bunker, now of the South Australian Institute of Technology. This provided to be a valuable field aid to the classification of the various residential and commercial properties. The detailed listing was used as a basis for the Flood Categories used in Chapter 2 and the commercial operations included within each Flood Category are listed in this Appendix.

COMMERCIAL FLOOD CATEGORIES IN RELATION TO THE BUNKER CODE CLASSIFICATION

New Code	Bunker Code	Comments
1	144	Motels
	167	Retirement Homes
	663	Sanitaria, convalescent and rest home services
2	412	Petroleum and fuel products - wholesale without substantial stocks
	422	Petroleum and fuel products - wholesale with substantial stocks
3	420	Wholesale trade - hardware
	476	China, glassware, kitchenware and domestic hardware
	479	Other household hardgoods
	481	Basic building materials, builders' hardware and supplies
	484	Paint
	548	Veterinary services
	596	Plumbing, draining services, heating, air conditioning equipment installation
	598	Painting, paperhanging and decorating services
	599	Other contract construction service
	589	Other repair services
	591	Building construction and repair
	594	Carpentry
	597	Electrical services
4	411	Farm products and supplies - wool, skin, hides, cereals, etc., stock and station agents, agricultural machinery
	425	Wholesale groceries, drinks, and tobacco
	442	General groceries/smallgoods store, delicatessen
	443	Meat (including frozen packaged meat)
	444	Fresh fruit and vegetables
	445	Fish and poultry, seafood, cooked fish, chips, hamburgers, etc.
	446	Confectionary, icecream, soft drinks, cut lunches
	447	Bread, cakes and pastry
	486	Grain, food and fertiliser supplies
	525	Men's hairdressing
	536	Restaurant/cafe
	566	Refrigerated storage/bond storage
5	417	Wholesale electrical appliances (domestic), domestic hardware, furniture and floor coverings - without substantial stocks
	427	Wholesale electrical appliances (domestic), domestic hardware, furniture and floor coverings - with substantial stocks
	471	Radios, radiograms, record players, television and accessories (including antennae)
	472	Stoves and heaters

New Code	Bunker Code	Comments
	473	Refrigerators, washing machines, vacuum cleaners, floor polishers, food mixers, fans, etc.
	474	Musical instruments
	467	Business and industrial machines and equipment
	494	Photographic equipment and supplies
	521	Laundering, dry cleaning and dyeing services, clothing repairs, alterations
	524	Beauty salons, ladies hairdressing
	569	Other business services
	583	Electrical repair services (except radio and television)
	584	Radio and television repairs
6	431	Department store
	439	Other extensive general retail
7	448	Beer, wine and spirits
	682	Social/entertainment clubs
8	451	Furniture (including mattresses)
	497	Antique and second-hand merchandise
	586	Reupholstery and furniture repair services
9	453	Drapery, softgoods, manchester, soft furnishings, haberdashery, etc.
	454	Mens' and boys' clothing
	455	Womens' clothing
	456	Childrens' and infants' clothing
	457	Footwear - mens' and boys'
	458	Footwear - womens', girls', and infants'
10	354	Motor freight terminals
	355	Motor freight garaging and equipment maintenance
	461	Tractors, farm machinery and implements including earthmoving equipment and parts
	462	New and used motor vehicles
	463	Used motor vehicles
	466	Marine craft and accessories
	469	Other automotive and marine equipment and accessories
	563	Plant equipment hire and leasing services
	616	Fire and Civil Defence
	666	Ambulance services
11	464	Motor parts, accessories, tyres, tubes, etc
	465	Petrol, oil and lubricants - including service stations
	581	Car repair services
12	475	Records and sheet music
	478	Sporting goods, bicycles and toys
	477	Watches, clocks and jewellery
	495	Sporting requisites and travel goods
	498	Gift shop

New Code	Bunker Code	Comments
13	485 496	Nurserymen, plants, shrubs Florists
14	489	Other basic supplies
15	491 544	Chemists goods - including dispensing Optician, optometrist
16	492 493	Books and stationery Newspapers and periodicals
17	384 511 512 515 517 518 519 527 528 553 557 572 574 476	Airport passenger and freight terminals Banking Hire purchase, instalment credit, and cash order companies Assurance and insurance (except medical) Building societies Real estate agents Other finance, insurance and real estate services Travel and tourist bureaux TAB and betting services Management consultant, development Commercial television and film production Surveying Accounting, auditing and book-keeping services Legal services
18	549	Other personal services - medical
19	651 652 653	Libraries and reading services Museums Art Galleries
20	215 217 218 231 232 241 263 269 280 281 282 294	Food manufacture - bakeries Food manufacture - other food products Beverage manufacture Manufacture - wood and wood products Manufacture - furniture (except sheet metal) and mattresses Publishing (including printing and publishing) Cement and concrete products - manufacture Manufacture - other non-metallic mineral products, e.g., plaster, stone Manufacture - fabricated metal products, transport equipment, industrial machinery and household appliances Manufacture - fabricated structural metal products Manufacture - sheet metal products (including furniture) Other manufacturing industries
21	940	Vacant floor area

APPENDIX 2.5

QUESTIONNAIRE FOR THE COMMERCIAL SECTOR OF LISMORE

Details of the replies to some of the questions are given on the questionnaire form or as additional tables at the end of the form. Where the answers are more complex the information is either omitted or given in table form in the text of the report. In many cases answers that were 'don't know' or 'not applicable' were omitted from the totals presented in this appendix.

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APPENDIX 2.5

RICHMOND RIVER VALLEY FLOOD COST : COMMERCIAL QUESTIONNAIRE

TOWN

STREET

NUMBER

PHONE

1. What is the total ground floor area of your business? sq.ft
2. Of this area how much is actual shop space and how much storage?

Shop space	- sq.ft	.....
Storage	- sq.ft	.....
3. What was the total wholesale value of your stock last stocktake (to the nearest \$1,000)? \$.....
4. Could you please estimate as accurately as possible the wholesale value of stock, at each of the following levels in your shop and in your ground floor storage area where applicable.

	<u>Level</u>	<u>Wholesale value</u>	
		<u>Shop</u>	<u>Storage</u>
(1)	0 cm to 50 cm (1' 8") above floor - bottoms of shelves.	\$.....	\$.....
(2)	51 cm to 1 metre (3' 3") above floor - middle of shelves.	\$.....	\$.....
(3)	1.01 m to 1.50 m (4' 11") above floor - middle of shelves.	\$.....	\$.....
(4)	1.51 m to 2.00 m (6' 7") above floor - tops of shelves.	\$.....	\$.....
(5)	2.01 m to ceiling height - high storage, display. Specify ceiling height - metres (.....ft).		

5. What proportion in wholesale \$ value of your stock would perish, be unsaleable, or lose resale value after immersion in water?

Please tick if appropriate	- All	.....
Please state if appropriate	- % of \$	.....
	None	.....
6. Do you hold insurance policies to cover damage and stock losses caused through flooding?

Yes	.....	17
No	.....	97

If 'yes' do these policies include loss of
furniture, floor coverings and plant equipment? Yes 13
No 6
Don't Know

If 'no' why not?

(1) Insurance for flood damage is too expensive. 61
(2) It is less trouble for me to risk losses and
just move out everything possible. 15
(3) (Other)..... 14

7. How many times has this building been flooded while
you have been the occupier? Times
(see end of appendix 2.5)

8. What was the greatest depth of water that you
have ever experienced in this building?
(Depth is height above floor level.) Ft. Ins.....

In what year did this flood occur?

IF YOUR BUSINESS WAS NOT IN OPERATION BEFORE MARCH 1974, GO TO
QUESTION 13.

9. How much did the 1974 or other higher flood,
cost you in losses through structural damage or
damage to stock, fittings and plant. (This does not
include clean-up costs and losses of business
contracts.)

	\$0-10	\$10-100	\$100-250	\$250-500	\$500-1000	\$1000-2500	\$2500 + (State)
1974	8	7	7	9	7	12	27
Other							

10. How long was the building flooded (underwater) during
the 1974 flood?

3 Hrs. 3 6 Hrs. 1 12 Hrs. 13
24 Hrs. 12 48 Hrs. 25 48 + Hrs. 22

11. Did you receive compensation after the 1974 flood?
(Note: NOT Insurance) Yes 2 No 78

12. If you received compensation or financial help
other than insurance, from what source did it
come?

.....
Was this compensation adequate? Yes 1 No 27
(see also end of appendix 2.5)

IF YOU HAVE ONLY BEEN INVOLVED IN BUSINESS ON THIS SITE, GO TO QUESTION 16.

13. Have you ever been flooded on other sites you may have been involved in business on?
- Yes 32
No 18
Don't Know
14. Did you consider the risk of flooding when you moved to this property?
- Yes 48
No 6
Don't Know
15. When you moved here, was this building already designed, or modified, to prevent flood water coming inside?
- Yes 4
No 52
Don't Know
16. Please indicate in the boxes provided if you have undertaken any of the actions listed. If you have, please give the number of times used, the approximate cost and a statement of their effectiveness.

Action	Taken Yes/No	Approx. Cost \$	No. of Times Used	Was it Worthwhile?			
				Yes	Partly	No	Don't Know
Tried to keep out water by sandbags and other temporary measures.	Yes 4 No 100			1		1	
Taken out flood insurance, other than as part of a general policy.	Yes 6 No 98	(per year)	Claims				
Made permanent structural changes to property to keep out flood water.	Yes 11 No 93		Year Done	4		1	
Moved valuables to higher level.	Yes 88 No 74			34		3	
Made special arrangements to receive flood warnings.	Yes 45 No 57			10		2	
Moved to temporary storage because of floods.	Yes 11 No 91			13		1	
Bought a boat primarily for use during floods.	Yes No			3		2	
Other, please state.							

17. How many years have you been in this building? Years
18. Is this building Rented 65.
Owned by you..... 48
19. Is flood free storage important for your particular business? Yes 100
No 2

IF "NO" GO TO QUESTION 25

20. Do you own or have access to flood free storage facilities capable of holding your entire flood susceptible stock?
- Own 58 No 17
Have access to 32 Don't Know
21. Do you have permanent arrangements to move stocks quickly to safe storage in the event of flood? Yes 79
No 26
Don't Know 3

IF "NO" GO TO QUESTION 24

22. If "yes" could you estimate how much this service cost you for the 1974 flood and for the same service - removal and storage of all possible - today? \$
1974 Flood
Today
23. Do these arrangements involve other organizations, e.g., truck or removal companies? Yes 19
No 56
Don't Know

Please state what organizations are involved.

Transport Company 13 Own Car 2
Norco 1 Star Court Theatre 1
SDA Community Services 1

24. Could you suggest any alternative methods of providing flood free storage for the commercial sector which would be more efficient to organize and operate?
(See end of appendix 2.5)

25. Did your business suffer any other costs or losses directly or indirectly related to floods which have not already been included as damage to stock, plant produce or site, clean-up costs or loss of business? Please state.

.....(See end of appendix 2.5).....

26. If a warning was given of a flood 6 hours before it eventuated, what proportion of the stock could be removed in the time allowed?

27. State the minimum warning time required before arrival of flood waters, to remove the entire stock threatened from the premises. Hrs

28. Is there anything that the Council or River Authority could do to further reduce the risk of flood damage to this building? Yes 43

If yes, please explain No 45

Don't Know..... 26

29. How do you feel about each of the following schemes which have been proposed at one time or other for the Richmond?

Please state whether you

1. Strongly oppose
2. Oppose somewhat
3. Favour somewhat
4. Strongly favour
5. Don't know

by placing the number of choice above (1-5) in the box provided.

- (1) The construction of diversion tunnels taking water from Wilson Creek and Byron Creek directly to the sea.
- (2) The construction of more and larger levees and embankments along the river especially around Lismore and other centres.
- (3) The construction of dams upstream from Lismore and the other centres.
- (4) Deepen and widen the rivers through Lismore.
- (5) Preserve everything as it is and leave the rivers alone.
- (6) Allow industrial development on the flood plain (more jobs and money) even if this aggravated the flooding situation.
- (7) To pay for flood protection everybody should pay more in taxes - not just those at risk from flooding.

- (8) The people who live in the flood prone areas should pay for their own protection.
- (9) The Government should provide a grant or loan for people to protect themselves from flooding.
30. Has the occurrence of flooding ever lead to cancellation of contracts, loss of business confidence, loss of supplies or other undesirable side effects for your business? If yes, please explain. Yes ³⁸.....
 No ⁷².....
 Don't Know ⁴.....

Please estimate the extent of financial losses involved for each flood this has occurred. This figure is other than losses from stock or plant damage.

Loss	\$	\$	\$	\$	\$
Year of flood	19	19	19	19	19

31. In what order of magnitude does the time and money lost cleaning up after floods fall?

Time	3 Hrs.	6 Hrs.	12 Hrs.	2 Days	2 Days+ (state)
	9	17	20	21	30

Cost	\$0-10	\$11-60	\$61-120	\$121-280	\$281-520	\$520+ (state)
	18	13	15	9	14	14

32. Does your business:- (1) Employ extra staff during clean-up? Yes 23
 No...80
 (2) Pay overtime rates to staff during clean-up? Yes 27
 No...76
 (3) Contract professional cleaners for clean-up operations? Yes 6
 No...21
 (Please tick all appropriate spaces) (4) Expect all staff to report to work immediately after floods to help with clean-up operations? Yes 21
 No...85
33. Does your business experience an increase in turnover after a flood has subsided? Yes
 No
 Don't Know.....

34. If your business was in operation before the 1974 flood
- (a) How long after the 1974 flood did it take before trading was back to normal? 28
- (b) How long after the 1974 flood did it take before business confidence returned to normal? 89
35. Have you considered shifting off the flood plain? Yes 28
- No 89
- Don't Know.....
- If "yes"
- (a) Where would you consider to be the best alternative location for your business? *(See end of appendix 2.)*
- (b) What main factor has prohibited this move?..... *(See end of appendix 2.)*
36. Do you think the Government should provide a scheme for re-settlement of businesses from the flood plain to a higher site? Yes 22
- No 84
- Don't Know.....
37. Do you feel the people of the business community of Lismore ...
- (1) are well adjusted to the flood situation in Lismore? 100
- (2) are partly adjusted to the flood situation in Lismore? 13
- (3) are poorly adjusted to the flood situation in Lismore? 1
- (4) have not adjusted to the flood situation in Lismore? 0
38. Please indicate below your average Gross Profits for the period of one week. This is before wages, taxes, rental etc. have been taken out. \$.....
39. Does your business pay full wages to staff in times of flood (when it is impossible for them to work)? Yes 7
- No 1
- If "no" what percentage of the full wage packet is paid in time of flood? Weekly 1
40. What is the normal average weekly wage bill for your business? \$.....

DETAIL OF RESPONSES TO SPECIFIC QUESTIONS

Question 7: How many times has this building been flooded while you have been the occupier?

Number of times	0	1	2	3	4	5	6	7	8 or more
Response	27	23	15	13	7	6	5	1	18

Question 12: If you have received compensation or financial help other than from insurance, from what source did it come?

Government Grant	2
TAB, NSW	1
Extended Credit	1
Harvester Corporation	1

Question 24: Could you suggest any alternative methods of providing floor-free storage for the commercial sector which would be more efficient to organise and operate?

High ground storage (halls, etc.)	5
Use second floor for storage with rent encouragement	4
Team of trained volunteers to move stock	2
Refrigerated coolrooms for perishables	2
Trailers for non-perishable goods	1
Hotels give storage	1
Sandbag Molesworth Street	1

Question 25: Did your business suffer any other costs and losses directly or indirectly related to floods which havenot already been included as damage to stock, plant, produce or site, clean-up or loss of business?

Papers and records destroyed	2
Delay in replacing stock	1
Phone out of order	1
Injury	1

Question 34(a): How long after the 1974 flood did it take before trading was back to normal?

Time	Response
No time	8
0 - 3 days	25
4 days - 1 week	29
8 days - 2 weeks	8
15 days - 1 month	10
30 days - 2 months	2
51 days - 3 months	2
Over 3 months	5

Question 34(b): How long after the 1974 flood did it take before business confidence returned to normal?

Time	Response
No time	8
0 - 3 days	25
4 days - 1 week	29
8 days - 2 weeks	8
15 days - 1 month	10
30 days - 2 months	2
51 days - 3 months	2
Over 3 months	5

Question 35(a): Where would you consider to be the best alternative location for your business?

Goonellabah	10
New shopping complex (Lismore Square)	4
Lismore-Ballina Road	1
East or South Lismore	1
'Anywhere out of flood'	6

Question 35(b): What main factor has prohibited this move?

More business at present site	14
Cost	7
New shopping complex unfinished	3
No premises available	3
Hope of flood mitigation	1
Lease obligations	1
Value of present premises	1

APPENDIX 2.6

SHORTENED COMMERCIAL QUESTIONNAIRE

The questionnaire is given without any detail of
replies. Replies are commented on in the text.

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APPENDIX 2.6

RICHMOND RIVER VALLEY FLOOD COST: COMMERCIAL QUESTIONNAIRE

NAME OF BUSINESS

ADDRESS

.....

CATEGORY

BUNKER CODE

1. What was the depth above floor level at the peak of the 1974 flood?

2. What is the area of shop space (ground floor) on this site? sq.ft

- What is the area of storage space (ground floor)? sq.ft

- IF THEY DO NOT KNOW ESTIMATE WHETHER SHOP IS SMALL, DOUBLE OR LARGE OR ESTIMATE FROM A NEARBY SHOP THE SAME SIZE

3. Total damage suffered as a result of the 1974 flood in \$ to:
 - (a) Stock \$.....
 - (b) Plant or equipment \$.....

APPENDIX 2.7

QUESTIONNAIRE FOR THE INDUSTRIAL SECTOR OF LISMORE

Details of the replies to some of the questions are given on the questionnaire form. Where the answers are more complex they are either omitted or given in table form in the text of the report.

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RICHMOND RIVER VALLEY FLOOD COST STUDY : LISMORE INDUSTRIAL SURVEY

NAME OF BUSINESS

CATEGORY OF INDUSTRY

NUMBER OF EMPLOYERS

ADDRESS

A. THE INDUSTRY

1. How many years have you been on this site? Years
2. Is this site² Rented
.....²⁴ Owned by you
3. What is the total ground floor area of your business? sq.ft
4. a) Is the ground floor divided into split levels? Yes
..... No
- b) If 'yes' what is the area of each level and the difference in height?

	<u>Area</u> <u>sq.ft</u>	<u>Height</u> <u>difference</u>
Level 1		
Level 2		
Level 3		
5. What is the height of the floor level of lowest floor levels? Metres
6. Of the total ground floor area, how much is workshop space,
how much is office space and how much is storage space?

Workshop space	.....	sq.ft
Storage space	.....	sq.ft
Office space	.....	sq.ft
7. What is the total present market value of your plant and machinery (to the nearest \$1000)? \$.....
8. What percentage of plant and equipment is kept at the following heights. (Above the lowest floor level)

.....	0-1 ft
.....	0-5 ft
.....	0-10 ft
9. What is the present value of the raw materials and unfinished goods stored on the premises? \$.....
10. What percentage of these are stored at the following

.....	0-1 ft
.....	0-5 ft
.....	0-10 ft

11. What is the present value of finished goods stored on the premises? \$.....
12. What percentage of these are stored at the following heights?
 0-1 ft
 0-5 ft
 0-10 ft
13. What is the average weekly output/turnover for this business on this site?
 \$.....

B. FLOODING

14. Did you consider the risk of flooding when you moved to this property?
²¹ Yes
² No
³ Don't know
15. How many times have these buildings been flooded while you have been the occupier?
 Times
16. What was the greatest depth of water that you have ever experienced in this building? (Depth is height above lowest floor level)
 In what year did this flood occur?
17. a) Have you ever been flooded on business sites other than this one?
¹³ Yes
¹² No
¹ Don't know
- b) If YES, was it before or after you became involved in the present site?
¹⁰ Before
² After
18. a) Have you had any experience, other than through your business, with flooding?
²⁰ Yes
⁶ No
- b) If YES, indicate nature of experience:
 Live in flood plain
 Other investments on flood plain in Lismore (indicate type)
 Own rural land in Richmond Valley that is flood
 Experience with SES
 Experience with flooding elsewhere (Give details)
 Any other experience (Give details)

APPENDIX 2.7 (Contd.)

C. FLOOD ADJUSTMENTS

19. When you moved here, was this building already designed, or modified, to prevent flood water coming inside?

..... 7 Yes
 18 No
 1 Don't know

20. Please indicate in the boxes provided if you have undertaken any of the actions listed. If you have, please give the number of times used, the approximate cost and a statement of their effectiveness.

Action	Taken (Yes/No)	No. of times used	Approx. cost	Further details of measure taken and effectiveness
Tried to keep out water by sandbags and other temporary measures	Yes 1 No 25			
Made permanent structural changes to this property to keep out flood water	Yes 4 No 22			
Moved valuables to higher level	Yes 26 No 0			
Made special arrangements to receive flood warnings	Yes 1 No 25			
Moved to temporary accommodation because of floods	Yes 4 No 22			
Machinery and equipment raised	Yes 22 No 4			
Greasing of machinery	Yes 8 No 14			

Other (Please specify)

21. a) Do you hold insurance policies to cover plant damage and stock or material losses caused through flooding? 4 Yes
 22 No
- If 'NO' why not
- i) Insurance for flood damage is too expensive 17
 5
- ii) This type of insurance does not exist 5
- iii) It is less trouble for me to risk losses and just move out everything possible 5
- iv) Others (please state)

22. a) Have you considered shifting off the flood plain? ⁹.... Yes
¹⁶.... No
.... Don't know
- b) If 'YES'
- i) Where would you consider to be the best alternative location for your business?
.....
- ii) What main factor has prohibited this move?
.....
23. a) Does your business pay full wages to staff in times of flood (when it is impossible for them to work)? ²¹.... Yes
⁵.... No
- If 'NO' what percentage of the full wage packet is paid in time of flood?%

D. FLOOD DAMAGE

24. How much (in \$ or %) of the total present market value of your plant and machinery (as shown in Question 7) is susceptible to flood damage after immersion of floor level to depth of:
- | | <u>0-1 ft</u> | <u>0-5 ft</u> | <u>0-10 ft</u> |
|--------------------|---------------|---------------|----------------|
| i) All | | | |
| ii) Some (% or \$) | | | |
| iii) None | | | |
25. What proportion in wholesale \$ value of your stock of unfinished goods and raw materials, stored at ground level would perish or lose resale value after immersion in water of depth:
- | | <u>0-1 ft</u> | <u>0-5 ft</u> | <u>0-10 ft</u> |
|--------------------|---------------|---------------|----------------|
| i) All | | | |
| ii) Some (% or \$) | | | |
| iii) None | | | |
26. What proportion in wholesale \$ value of your stock of finished and raw materials, stored at ground floor level would perish or lose resale value after immersion in water of depth:
- | | <u>0-1 ft</u> | <u>0-5 ft</u> | <u>0-10 ft</u> |
|--------------------|---------------|---------------|----------------|
| i) All | | | |
| ii) Some (% or \$) | | | |
| iii) None | | | |
27. Is flood-free storage important for your particular industry? ²².... Yes
⁴.... No
- If 'NO' go to Question 32.

28. a) Are flood-free storage facilities, capable of holding your entire stock of flood-susceptible produce, plant and raw materials available to you?
..... Yes
..... No
..... Don't know
- b) If 'YES' do you own these storage facilities, or have access to them?
..... Own
..... Have access to
- c) Can you indicate what the costs of maintaining these facilities -
Were in 1974 \$.....
Are today \$.....
29. a) Do you have permanent arrangements to move stocks quickly to safe storage in the event of flood?
20
..... Yes
3
..... No
3
..... Don't know
- If 'NO' go to Question 31.
- b) If 'YES' could you estimate how much this service cost you for the 1974 flood and how much removal of all possible stock would cost you today?
\$..... 1974
\$..... Today
30. Do these arrangements involve other organisations, e.g., truck or removal companies?
5
..... Yes
18
..... No
3
..... Don't know
- If 'YES' please state what organisations are involved:
.....
.....
31. Could you suggest any alternative methods of providing flood-free storage for the industrial sector which would be more efficient to organise and operate?
.....
.....
32. a) Do you have any arrangements other than moving and storage, to reduce losses to stock?
9
..... Yes
17
..... No
- b) If 'YES' please give details of method(s) and approximate costs incurred, if known. Details:
.....
.....

33. a) Has the occurrence of flooding ever led to cancellation of the contracts, loss of business confidence, loss of supplies or other undesirable side-effects for your business? ...⁷ Yes
...¹⁸ No
Please explain¹ Don't know
.....
33. b) If 'YES' please estimate the maximum financial losses incurred as a result of these causes over the past five years. This figure is above losses to stock or plant damage. Loss
..... Year of flood
34. Did your business suffer any other costs or losses directly or indirectly related to floods, not included as damage to stock, plant, clean-up costs or loss of business? Please give details.
.....
..... \$.....
35. Does your business experience an increase in turnover after a flood has subsided? ...¹¹ Yes
...¹⁵ No
.... Don't know
36. State the minimum warning time required before arrival of flood waters to remove the entire stock and raw materials threatened from the premises (i.e., for a major flood)
Minimum time Hours
37. If a warning was given of a flood six hours before such a flood eventuated, what proportion of the stock, raw materials and flood susceptible plant could be removed in the time allowed?
Stock
Raw materials
Plant

E. THE 1974 FLOOD

38. a) Was any part of these premises flooded during the 1974 flood? ...²⁶ Yes
...⁰ No
If 'NO' go to Question F (Question 45)
- b) i) For what period did flood waters remain in the building(s)? Hours
..... Days
- ii) What was the maximum height of flood water in the building(s)? Ft

39. a) Could you please estimate as accurately as possible the wholesale value of raw materials unfinished and finished products held in storage (to nearest \$1000) up to 1974 flood height level
- | | |
|---------------------|------|
| Raw material | .... |
| Unfinished products | .... |
| Finished products | .... |
- b) What proportion of these materials and products were moved out of the flood reach?
- | | |
|---------------------|------|
| Raw material | .... |
| Unfinished products | .... |
| Finished products | .... |
- c) What proportion of these materials and products not moved were damaged or lost during this flood?
- | | |
|---------------------|------|
| Raw material | .... |
| Unfinished products | .... |
| Finished products | .... |
40. How much did the 1974 flood cost you in loss through structural damage, damage to stock, plant and materials only. (Note: This does not include clean-up costs or loss of business contracts.)
- Please state figure to the nearest \$1000 \$1000
41. a) In what order of magnitude does the time and money lost cleaning up after floods fall?
- Time:
 3 hrs 6 hrs 12 hrs 2 days 2 days +
- Cost:
 \$0-10 \$11-100 \$100-500 \$500-1000 \$1000-2000 \$2000
- b) Is cleaning up performed by staff or by other labour?

42. a) How long after the 1974 flood did it take before production and trading were back to normal?
- | | |
|-------|------|
| Weeks | .... |
| Days | .... |
- b) How long after the 1974 flood did it take before business confidence returned to normal?
- | | |
|-------|------|
| Weeks | .... |
| Days | .... |
43. a) Did you receive compensation after the 1974 flood?
 (Note: Not insurance)
- | | |
|------------|------|
| Yes | .... |
| No | ..2 |
| Don't know | .... |
- b) Was this compensation adequate?
- | | |
|-----|------|
| Yes | .... |
| No | .... |

44. If you received compensation or financial help other than insurance, from what source did it come?
-

F. GENERAL ATTITUDE TO FLOODING

45. a) Is there anything that the Council or River Authority could do to further reduce the risk of flood damage to this industrial site?
- 13 Yes
- 11 No
- b) If 'YES', please give details:
- 2 Don't know
-
46. Do you feel the people of the industrial sector of Lismore:
- i) Are well-adjusted to the flood situation in Lismore? 25
- ii) Are partly adjusted to the flood situation in Lismore? 0
- iii) Are poorly adjusted to the flood situation in Lismore? 0
- iv) Have not adjusted to the flood situation in Lismore? 0
47. Do you think the government should provide a scheme for re-settlement of industries from the flood plain to a flood-free site?
- 10 Yes
- 15 No
- Don't know
48. How do you feel about each of the following schemes which have been proposed at one time or other for the Richmond?

Please state whether you:

- 1) strongly oppose
- 2) oppose somewhat
- 3) favour somewhat
- 4) strongly favour
- 5) don't know

by placing the number of choice above (1-5) in the space provided:

- i) The construction of diversion tunnels taking water from Wilson Creek and Byron Creek directly to the sea 0
- ii) The construction of more and larger levees and embankments along the river especially around Lismore and other centres 0
- iii) The construction of dams upstream from Lismore and the other centres 0
- iv) Deepen and widen the rivers through Lismore 0
- v) Preserve everything as it is and leave the rivers alone 0
- vi) Allow industrial development on the flood plain (more jobs and money) even if this aggravated the flooding situation 0
- vii) To pay for flood protection everybody should pay more in taxes - not just those at risk from flooding 0
- viii) The people who live in the flood-prone areas should pay for their own protection 0
- ix) The government should provide a grant or loan for people to protect themselves from flooding 0

G. GENERAL COMMENTS

Would you like to make any additional comments about flooding and Lismore?

APPENDIX 4.1

QUESTIONNAIRE FOR THE RURAL SECTOR OF THE RICHMOND RIVER VALLEY

Details of the replies to some of the questions are given to on the questionnaire form or as additional tables at the end of the form. Where the answers are more complex the information is either omitted or given in table form in the text of the report. In many cases answers that were 'don't knows' or 'not applicable' were omitted from the totals presented in this appendix.

CONFIDENTIAL

RICHMOND RIVER VALLEY FLOOD COST STUDY : LISMORE RURAL QUESTIONNAIRE

LOCATION

DISTRICT

.....

1. On the map provided please outline the height line of the flood of March 1974 plus (in another colour) the height of any other flood you can remember which was higher than the 1974 flood. (Please write on the line the year of that flood.)
2. Please mark on the map the height line of the 1975 flood as an example of a lesser flood (i.e., 1954 and 1974 are considered as major floods).

Also please check the boundary of your property /properties reproduced on the map is/are correct to date.

(NOTE: DETAILS OF FLOOD LIMITS, OTHER THAN FOR THAT OF 1974, WERE OF LIMITED VALUE)

3. Could you divide your property into land that falls into the following categories and estimate the areas of each type?

Type:	a) Land on the natural bank *	.....	Acres or hectares
	b) Backslope	.....	Acres or hectares
	c) Backswamp land	.....	Acres or hectares
	* Including abandoned levees marking former river channels		

4. What is the total area of your farm?
5. Do you lease, rent or own your land?

Lease	5	Lease and Own	2
Own	73	Share Farmer	1
- Comment:

6. In the following table please tick the forms of landuse practised on your farm and the areas presently utilised by each.

<u>Landuse</u>	<u>Acres/Hectares</u>
Grass	
Improved pasture	
Sugar cane	
Maize	
Other crops	

7. Could you briefly describe the history of landuse on this property as far as you can remember.

.....

.....

.....

8. At the peak of the 1974 flood what proportion of your land was out of production? %.....
Acres/hectares
9. How long after the 1974/5 floods before flood waters receded to cover half the area that was covered at the peak
1974: days
1975: days
10. How long after the 1974/75 flood before flood waters receded to normal river level?
1974: days
1975: days
11. Could you comment on long-term effects of flooding on your land, e.g., diseases, infestations (army worms), erosion, sediment deposition, noxious weeds, and land losses if greater than 1 acre?
.....
.....
.....
(See end of appendix 4.1)
12. How soon after a flood recedes is land suitable:
a) For stock again?
b) To put a tractor on it again?
13. Could you complete the following table of costs which may have occurred as a result of the 1974 flood.
This table includes damage or loss of:
a) Fencing, gates, etc. \$.....
b) Plant and equipment (pumps, tractors, etc.) \$.....
c) Stock: Number Type \$.....
d) Crops: Area Type \$.....
e) Pasture re-establishment costs \$.....
f) Number and type of stock sold prematurely because of the flood: Number Type
Estimated loss of possible market value \$.....
g) Costs of providing fodder during flood time \$.....
14. Could you estimate any loss in milk production which resulted from the 1974 flood in terms of lost income? \$....
Could you explain why this occurred? Indicate reason:
1) Pasture inundation 2) Flooded dairy
3) Inaccessibility 4) Milk collection services
How have you offset this loss: Please comment
.....

15. Do you have adequate flood free land to put stock on? 50
.... Yes
21
.... No

16. Do you have to agist stock to neighbouring farmland during flood periods? 27
.... Yes
44
.... No

\$.....

Could you explain these agistment arrangements:

.....
.....

What was the total cost in 1974?

17. For the financial year 1973/74 in which the 1974 flood occurred, if flood waters had not swept through the Richmond Valley, how much more could your property have made, given the number of stock and crops planted at that time, than was actually the figure for that period? i.e., from the annual accounts 1973/74, what was your loss resulting from the 1974 floods? \$.....

Could you enlarge on this?

.....
.....

18. Have you ever sought a carry-on loan to cover flood losses? 13
.... Yes
18
.... No
- Were you successful? 12
.... Yes
1
.... No

Have you received or sought aid from other sources? 8
.... Yes
73
.... No

Comment:
.....

19. Have you ever had flood waters enter buildings on this farm other than occupied dwellings? 48
.... Yes
33
.... No

If YES please tick those "OUT" buildings in the following table which have been flooded and include the maximum height reached above the floor level, in the 1974 flood. In the final column could you estimate the damage to these buildings from the 1974 flood

	Height	Damage (\$)
Dairy (bales)	... ft...ins	\$.....
Barn	... ft...ins	\$.....
Hay shed	... ft...ins	\$.....
Others, i.e., chook yard, piggery	... ft...ins	\$.....

20. During the 1974/5 floods were any of the following services cut for any period of time:
- | | Yes | No |
|--|-----|----|
| Electricity Please comment: (1974) | 14 | 67 |
| (1975) | 3 | 78 |
| Clean Water Please comment: (1974) | 3 | 78 |
| (1975) | 2 | 79 |
| Telephone (1974) | 34 | 48 |
| (1975) | 23 | 55 |
21. In the 1974/75 floods was road access to your farm cut?
- | | | |
|------------|----|-----|
| 1974: | 79 | Yes |
| ..... | 2 | No |
| 1975: | 67 | Yes |
| ..... | 11 | No |
22. Does your farm ever become completely isolated?
- | | | |
|-------|----|-----|
| ..... | 76 | Yes |
| ..... | 5 | No |
- If so, at what river height does this occur? ft
23. What is the longest time you have been isolated? Days
..... Hours
24. Do you feel state emergency services give adequate attention to the rural populace in your area in time of flood? Please comment:
- | | | |
|-------|----|-----|
| ..... | 67 | Yes |
| ..... | 13 | No |
25. Which source is the most reliable for information on the state of the flood?
- | | |
|--|----|
| Your own judgment | 66 |
| Judgment of friends upstream or in the neighbourhood | 13 |
| Radio | 58 |
| Other State media | 0 |
| SES | 26 |
| Police | 1 |
| Other | 2 |

IF YOUR HOME DWELLING OR ANY OTHER OCCUPIED DWELLING ON YOUR PROPERTY HAS EVER FLOODED (THAT IS, FLOOD WATERS HAVE GONE OVER THE FLOOR BOARDS) PLEASE ANSWER THE FOLLOWING QUESTIONS:

26. How many times has this been flooded while you have been the occupier? (See end of appendix 4.1) Times
- How many occupied dwellings on the property are in flood reach? Number
- Do you consider flood warnings to be accurate? Yes
..... No
..... Don't know

27. a) What was the greatest depth of flood water that you have ever experienced in this building? Depth

Other houses Depth

- b) In what year did this occur? Year

Other houses Year

28. Would you please indicate with a tick how much the biggest flood in this building cost you? (HOUSE ONLY)

.....11..... 0..... 0..... 2..... 6.....
\$0 - \$24 \$24 - \$49 \$50 - \$99 \$100 - \$249 \$250 - \$499

.....3..... 7..... 2..... 0.....
\$500 - \$999 \$1000 - \$1999 \$2000 - \$4999 \$5000 & over

29. If you received compensation for this flood, from what source did it come and was it enough? (If you did not receive compensation leave this question out)

	Amount received \$	Yes	No	Don't know
Council	2	.....	.....	.....
Government bodies	6	1	6	2
Other sources (Please state)	.....	.....	.....	.....
.....	1	.....	.....	.....
Don't know	.....	.....	.....	.....

30. Did you consider the risk of flooding when you moved to this property?

.57.. Yes

.12.. No

.12.. Born there

31. When you moved here was this building already designed or modified to prevent flood water coming inside?

.58.. Yes

.21.. No

..... Don't know

Comment:

.....

32. Please indicate in the spaces provided if you have undertaken any of the actions listed. If you have, please give the number of times and the approximate cost.

	Taken		Approx.	Number
	<u>Yes</u>	<u>No</u>	<u>cost</u>	<u>of</u>
				<u>times use</u>
Tried to keep out water by sandbags and other temporary measures	1	80	.....	.....
Taken out flood insurance, other than as part of a general policy	-	81	.....	.....
Made permanent structural changes to this property to keep out flood water	17	64	.....	.....
Moved valuables to higher level	30	50	.....	.....
Made special arrangements to receive flood warnings	5	76	.....	.....
Moved to temporary accommodation because of floods	16	65	.....	.....
Other: (Please state)				
.....				

33. Is there anything that you could do to further reduce the risk of flood damage to this building?

.... Yes

.... No

.... Don't know

If 'YES' please give details including estimate of cost entailed.

.....
 \$.....

34. Please indicate in the boxes how many times you have received help from the following people during times of flooding and if it was useful.

	No. of <u>times</u>	<u>Useful</u>	Partly <u>useful</u>	Not <u>useful</u>	Don't <u>know</u>
Police	9	.....	.....	.....	.....
Church organisations	4	.....	.....	.....	.....
SES (Civil Defence)	20	.....	.....	.....	.....
Neighbours	42	.....	.....	.....	.....
Council	5	.....	.....	.....	.....
Army	11	.....	.....	.....	.....
Fire Brigade	0	.....	.....	.....	.....
Family from outside flood zone	5	.....	.....	.....	.....
Others (Please state):					
.....					
.....					

35. Is there more that the SES can do to further develop and co-ordinate evacuation and relief programmes for rural people?

21. Yes
49
.... No
.... Don't know

If 'YES' please give brief details:

.....
.....

36. Do you think the risk of flooding is increasing or decreasing?

47.. Increasing
16.. Decreasing
9... No change

Please tick the reason(s) that you think are important from the following list: (as many as you wish)

- | | | | |
|---------------------------------------|----|-------------------------------|----|
| 1) Changes in climate | 12 | 2) Highway construction | 3 |
| 3) Towns, buildings & sub-divisions | 16 | 4) Silting of rivers, ditches | 36 |
| 5) Building of river banks and levees | 31 | 6) Reservoir management | 6 |
| 7) Forest felling | 33 | 8) Forest planting | 9 |
| 9) Flood mitigation | 33 | 10) Other (Please state): | |

37. Is this residence rented or owned by your?

Rented 3
Owned 78

38. What are the ages and normal occupations of the people living here?

AGE:	1) 23	2) 74	3) 48	4) 54	5) 91
	5 yrs & under	6 - 15	16 - 24	25 - 44	45 - 65

6) 22
.....
Over 65

OCCUPATION:	1) 87	2) 3	3) 4	4) 8	5) 8
	Farmer	Manager/Professional	Clerical	Tradesman	Manual
	6) 7	7) 95	8) 9	9) 4	10) 71
	Retired	School Student	Tertiary Student	Not Employed	Domestic

	Person 1	Person 2	Person 3	Person 4	Person 5	Person 6	Person 7
AGE							
OCCUPATION							

39. What is the minimum time it would take you to raise or move everything which would be damaged by flood?
- a) From the hosue (if susceptible) Hours
- b) From the whole farm (house included) if necessary? Hours
40. How would you feel about each of the following possible schemes for the Richmond River?
- Please state -
1. Strongly in favour
 2. Favour somewhat
 3. Oppose somewhat
 4. Strongly oppose
 5. Don't know
- a) Diversion of water from Wilson and Byron Creeks to sea via tunnels at Nashua
- b) Other lower river diversion to the sea
- c) Construction of more and larger embankments or levees along the Richmond
- d) Construction of dam storage upstream of Lismore
- e) Deepen and widen the rivers through Lismore
- f) River straightening
- g) Preserve everything as it is and leave the river and its tributaries alone
- h) To pay flood protection everybody should pay more in taxes
- i) The people who live in prone areas should pay for their own protection
- j) The government should provide a grant or loan for people to protect themselves from flooding
- k) The government should give financial support for the re-housing of flood plain residents to safer areas
41. Has any member of this household suffered from ill-health as a result of floods entering the home? Yes ...¹⁸...
- No ...⁶³...
- Don't know
- Number
- Sex
- Age at time of illness
42. Which description best fits this ill-health?
- Psychological (e.g., stress, family problems) ...⁸...
- Physical (e.g., broken limb, flu, bronchitis) ...⁴...
- Both ...⁶...
- Was it serious? Yes ...¹²...
- No ...⁵...
- In which year did this occur? Year

43. What was the status in the household of the affected person(s)?

1) Grandparent	 ¹	2) Young adult	 ¹	3) Head	 ¹¹
4) Mother	 ¹³	5) Young child	 ⁰	5) School child	 ⁰

44. Did members of your family visit the doctor for ailments more frequently for the six-month period before the flood of 1974 than for the same period after or vice versa?

Visited more before than after	....
Visited more after than before	....
Don't know	....

45. Do you feel the people of the Richmond flood plain psychologically:

1) Are well-adjusted to the flood situation?	 ⁷¹
2) Are only partly adjusted to the flood situation	 ⁷
3) Are poorly adjusted to the flood situation	 ¹
4) Have not adjusted to the flood situation	 ²

46. During the 1974 flood did you help or did anyone with evacuation or other relief operations? (Please tick the appropriate spaces.)

None	 ⁴²
Neighbours	 ³⁵
Friends	 ²¹
Family	 ¹⁵
People you had never met before	 ¹⁴

47. Were you or your household helped by any of the following? (Please tick the appropriate spaces.)

Neighbours	 ²⁷
Friends	 ¹⁵
Family	 ¹⁵
People you had never met before	 ⁵
	 ⁴⁸

48. Would you describe the community spirit as being: (Please tick the appropriate spaces.)

Heightened	 ⁵²
Lessened	 ⁴
Not changed	 ²⁵

49. How long did clean-up operations take after the flood had subsided? (Please tick appropriate spaces.)

	1-3 hours	3-6 hours	6-12 hours	2 days	Between 2 days and 1 week	More than 1 week	Never
Farm	3	2	4	8	22	30	1
House	4	1	2	7	8	3	0

50. Did the clean up operation inconvenience you? (Please tick appropriate space.)

Personally	52	Yes
	24	No

Financially	20	Yes
	57	No

Do you have any income from outside the farm?	25	Yes
	50	No

51. Did you lose income through time taken off work outside the farm to clean up the flood debris?
- | | | |
|--|----|-----|
| | 3 | Yes |
| | 77 | No |

\$.... How much?

COMMENT:

.....

DAIRY FARM SUPPLEMENT

- A. How long after the 1974-75 floods before
production returned to normal? 1975
..... 1974

- B. Can you carry on milking during flood time? Yes
..... No

Comment:
.....
.....

- C. Could you maintain your milk quota following a
1974 flood now? Yes
..... No
.....

- D. Could you keep your milk quota following a
1974 flood now? Yes
..... No
.....

DETAILS OF RESPONSE TO SPECIFIC QUESTIONS

Question 11: Could you comment on long-term effects of flooding on your land?

Army worm	48
Noxious weeds	41
Sediment deposition	16
Erosion deposition	16
Cane disease	3
Cattle disease	2
Dip over-flowed and poisoned stock	1

Question 26: How many times has this (the residential dwelling) been flooded while you have been the occupier?

Number of times	0	1	2	3	4	5	6	7	8 or more
Response	52	14	8	2	1	1	0	1	1

Question 27: How many occupied dwellings on the property are in flood reach?

Number	0	1	3	4	5
Response	47	27	1	0	1

APPENDIX 7.1

BOOKING FORM FOR MARKET VALUE OF HOUSE CONTENTS

The booking form was used for the assessment of the market value of house contents undertaken by Peter Robinson. Information obtained from an actual example has been presented in order that the use of the form can be illustrated. The combined information from the full sample was used in the assessment of potential residential damage.

Page 1

LEVELS MM	50	250				500				1000				2000			
DAMAGE \$		25	75	150		25	75	150		25	75	150		25	75	150	
<u>LOUNGE</u>																	
Carpet and floor coverings																	
Curtains and blinds							x										
Pictures & ornaments														x			
Lounge suite			x					x				x					
Buffet, book cases																	
Colour TV									300								
Heaters and coolers																	
Radios, records, tapes								x					300				
Tables																	
<u>BEDROOM 1</u>																	
Floor covering	100																
Curtains and blinds												x					
Pictures and ornaments																	
Suite		x					x				x			x			
Mattress and bedding								x									
Clothing				x				x				x					
Other furniture																	
<u>BEDROOM 2</u>																	
Floor covering	80																
Curtains and blinds												x					
Pictures and ornaments																	
Suite		x					x				x						
Mattress and bedding								x				x					
Clothing			x														
Personal effects						x											
Other furniture																	
TOTALS	280	350				1300				700				50			

Page 2

LEVELS	MM	50	250			500			1000			2000		
DAMAGE	\$		25	75	150	25	75	150	25	75	150	25	75	150
<u>BEDROOM 3</u>														
Floor covering	80													
Curtains and blinds													x	
Pictures and ornaments														
Suite						x				x				
Mattress and bedding								x						
Clothing			x				x			x			x	
Personal effects				x										
Other furniture														
<u>BEDROOM 4</u>														
Floor covering														
Curtains and blinds														
Pictures and ornaments														
Suite														
Mattress and bedding														
Clothing														
Personal effects														
Other furniture														
<u>ROOM 1</u>														
Floor coverings														
Curtains and blinds														
Pictures and ornaments														
Cupboards														
Tables														
Clothing														
<u>ROOM 2</u>														
Floor coverings														
Curtains and blinds														
Pictures and ornaments														
Cupboards														
Tables														
Clothing														
TOTALS		80	150			250			150			50		

APPENDIX 7.1 (Contd.)

Page 3

MM LEVELS	50	250				500				1000				2000			
DAMAGE \$		25	75	150		25	75	150		25	75	150		25	75	150	
<u>HALL</u>																	
Floor coverings	20																
Pictures and ornaments						x								x			
<u>KITCHEN</u>																	
Floor coverings																	
Curtains and blinds																	
Tables and chairs																	
Cupboards																	
Electric stove														x			
Refrigerator						x										x (food)	
Deep freeze						x											
Electrical items						x					x						
Cupboard hardware			x			x				x				x			
contents			x				x				x				x		
Food			x				x										
Dishwasher																	
<u>DINING ROOM</u>																	
Floor coverings																	
Curtains and blinds																	
Pictures and ornaments																	
Suite							x				x						
Contents						x					x						
TOTALS	20	75				375				325				350			

Page 4

LEVELS MM	50	250			500			1000			2000		
DAMAGE \$		25	75	150		25	75	150		25	75	150	
<u>VERANDAH</u>													
Furniture						x							
						x							
<u>BATHROOM</u>													
<u>LAUNDRY</u>													
Washing machine													
Fridge etc.								x					
<u>GARAGE</u>													
Motor Mower		General value of under house damage \$300											
<u>TOTAL</u>					300								
<u>OVERALL TOTAL</u>													
Page 1	280	350			1300			700			50		
Page 2	80	150			250			150			50		
Page 3	20	75			375			325			350		
Page 4	0	0			300			0			0		
<u>DAMAGE TOTALS</u>	380	575			2225			1175			450		
<u>VALUE OF CONTENTS</u>	380	955			2880			4055			4505		
<u>CONTENTS PRE-FLOOD</u>		\$12,000											
<u>BUILDING DAMAGE AT FLOOD LEVELS</u>	50	100			100			500			1000		

1974 Flood Height 3 ft to 3 ft 6 inside

Ceiling Height 11 ft

Floor Area 14 squares

Residents 4

Would you suffer any loss if you had sufficient time to prepare for
 1974 flood? No

APPENDIX 8.1

NOTES ON THE USE OF THE 1976 CENSUS

NOTES ON THE USE OF THE 1976 CENSUS

Section 8.2 uses data from the 1976 census for both Lismore and rural populations within the valley. The populations were defined in the following way:

(a) The Lismore population was taken as comprising census subdivisions 15, 16 and 17 of census division 4. This corresponds to the census local government area of Lismore. The map of collector's districts was then examined to estimate which districts were in the flood zone. Residents of collector's districts 3, 4, 5, 6, 7, 8 and 9, in subdivision 15; collector's districts 3, 4 and 5 in subdivision 16; and collector's districts 1, 2 and 4 in subdivision 17 were taken as being flood-prone. The remainder of the subdivisions were considered to be flood-free. Obviously these divisions are fairly crude, though the boundaries of the collector's districts coincided reasonably with the limit of the one in 100 year flood.

(b) The rural area presented many more problems. Most census collector's districts did not fall either totally within or totally outside the 1974 flood limit. Those actually chosen were ones in which the majority of residents would have been affected by flood waters. In a number of cases it was necessary simply to halve the figures for the collector's district since only about half the residents would have been affected by flood waters. It should also be noted that some very small towns are included in the collector's districts chosen. The population of the collector districts actually chosen therefore represents only a crude approximation to the population sampled by the rural questionnaire. The collector's districts used were (all are in census division 4): in census subdivision 2, collector's districts 1, 3,

APPENDIX 8.1 (Contd.)

5 and 6; in census subdivision 11, collector's districts 2, 4, 5 and 6; in census subdivision 12, collector's districts 5 and 9; in census subdivision 14, collector districts 1, 4 and 6 and half of collector's district 5; in census subdivision 18, collector's district 8, and half each of collector's districts 4, 7 and 9.

There are a number of points worth noting in relation to the use of census data in the tables of Chapter 8.

Table 8.1: Unfortunately the age groups used in available census data differ slightly from those used in the questionnaires. Therefore the census proportions shown in the less than or equal to 5 year age group are in fact those for the less than 5 year age group, or similarly those shown for the 6-15 year group are really for the 5-15 year group, those shown for the 45-65 year group are for the 45-64 year group and those shown for the over 65 year group are those for the over 64 year group.

Table 8.4: The census classification of occupation was equated to the one used in the questionnaires as follows: 'managerial/professional' was taken as group 0 (professional/technical) and group 1 (administrative etc.); 'clerical' was taken as group 2 (clerical workers) and group 10 (Armed Services); 'tradesmen' was taken as group 7-8 (Tradesman, Production Process workers) excluding the 'labourers' category; 'manual/farmer' was taken as groups 4, 5 and 6 (farmers, fishermen etc.; miners, quarrymen etc.; and transport, communication) and the 'labourers' category from group 7-8; and 'salesman' was taken as group 3 (sales workers).

Table 8.6: The percentages in this table are taken with the population normally resident at the address where they were enumerated in the census as a base. This excludes visitors, those temporarily away from home etc.

Table 8.8: The percentages in this table take the number of dwellings (not the population) as a base. In the 'owned' class 'owner', 'purchaser', and 'owner/purchaser undefined' were included; in the 'rented' class 'tenant-household authority' and 'tenant-other' were included.