BUSINESS IN THE MACLEAY

COMMERCIAL FLOOD DAMAGE KEMPSEY 2001.

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Abstract

The central business district of Kempsey was flooded on Saturday the 10th of March 2001, resulting in damage to 94 businesses. Total direct damage amounted to $2.5 million averaging $28,000 per business. Stage-damage analysis found damage data to be variable and uncertain. Fitted curves were different to previous loss estimation models and were log normal in shape indicating that marginal damage decreases as stage height increases. Coefficients of determination indicated a very weak relationship between direct damage and over floor depth.

The combination of direct and indirect damages resulted in prolonged hardship for 30% of businesses. Lost sales amounted to approximately $2 million and a net profit loss of $200,000.

Warning systems were effective in reducing tangible and intangible damage. Official warning coverage was mixed with radio stated as the most effective source of information about the flooding. Recipient satisfaction was low resulting from the perceived need by businesses for personal warnings, characterized by a high degree of clarity and accuracy.

Introduction

Investigations of commercial flood damage have long been neglected in favor of concerns about residential damage. The commercial sector is an essential part of the Australian economy and comprises about 12% of Australia's flood-prone buildings inundated by a 100 year Average Recurrence Interval flood (ARI) (Smith, 1996). Commercial sector flood losses have been greater than residential losses in numerous events, including Lismore (1974) and Brisbane (1974). Greater potential damage exists in the commercial sector, suggesting there may be greater loss reduction potential in commercial properties than residential (Smith, 1998). Previous research has been insufficient to enable accurate loss estimation for businesses, resulting in poor benefit-cost estimations.

Current research supports these ideas and has produced new insights into the complex nature of commercial flood damage. Flooding of numerous commercial areas in early 2001 provided terrific opportunities to analyze commercial damage. This paper discusses commercial flood damage suffered during the Kempsey 2001 flood and the effects of flood warnings upon Kempsey's business community.

Kempsey Overview

Kempsey is a small rural city situated on the lower Macleay River in the New South Wales Mid-North Coast region. Boasting a population of 10,000 residents, Kempsey's Central Business District (CBD) consists of approximately 200 businesses. Seasonal flooding is common, with the majority of floods occurring during late summer early autumn months. Ex-tropical cyclones and east coast lows are the dominant flood producing synoptic systems. Structural flood protection is provided by a series of levees that protect the CBD up to an ARI 10 year flood.

An ALERT[1] radio-telemetered flood warning network is in place for Kempsey. The system aims to provide residents 24 hours notice of an approaching major flood, however, for floods produced by heavy rainfall in the lower half of the catchment, only 15 hours will typically be available. The network consists of 12 automatic rain gauges and 12 automatic stream level gauges placed throughout the 11,500 square kilometre catchment. Additional data is available from an extra 7 rain gauges and 11 river gauges located predominately in the Armidale area (McKay, 2002).

Kempsey Flood 2001

Kempsey's commercial district was flooded on Saturday the 10th of March. Flooding resulted from an intense low-pressure system located offshore in the Tasman Sea. Heavy rainfall saw the river peak on Saturday night, recording a height of 7.43m AHD at the

[1] ALERT is the acronym for Automatic Local Evaluation in Real Time

Kempsey traffic bridge. The height was the 9th largest flood recorded with an estimated Average Recurrence Interval (ARI) of 12 years. Kempsey's largest flood recorded in 1949 peaked at 8.51m AHD, causing an estimated $200 million damage and taking 6 lives (Dutton, 2000). The most recent major flood prior to 2001 occurred in 1963; as a result flood experience and preparedness in 2001 were low.

Levees overtopped earlier than expected. Approximately 94 businesses were flooded within the Central Business District (CBD). Many more were without access. On average over floor flood heights reached 0.75 metres and persisted from a few hours to several days. Water velocities appear to have been low.

Total direct commercial damage was estimated at $2.5 million, averaging $28,000 per business. Damage to individual businesses ranged from several hundred dollars to almost half a million dollars. Plate 1 exhibits flooding in Belgrave St.

Plate 1.

Types of flood damage.

Two types of flood damage exist: tangible and intangible. Tangible damages are defined as losses to which monetary costs can be assigned. Intangible costs are societal costs and cannot be assigned financial values. Tangible damages can be separated into two sub-types: direct and indirect. Direct losses result from contact with floodwaters and are separated into internal, external and structural damage. Indirect damages are caused by the disruption of business and include cleanup costs, lost profits and opportunity costs.

Damage can also be defined as actual or potential. Actual damage refers to damage incurred during flood events. Potential damage is the amount of damage that would occur if no loss reduction measures were taken based upon synthetic estimates (Smith, 1992). The ratio of actual to potential damages is indicative of avoided damage.

Survey Methodology

Risk Frontiers conducted three surveys to assess damages incurred to commercial property. Responses were received from 88 of the 94 damaged businesses. An initial survey was performed one week after the event to measure water depths and document damage. Six weeks later a damage survey was performed to accurately determine commercial losses and assess other factors such as, flood preparation, flood warning, flood experience and community risk perception. A final survey was conducted six months after the flood to estimate business disruption and potential damage.

Damage estimates were made by respondents, resulting in some uncertainty. Uncertain estimates are attributed to the poor knowledge of losses experienced. An alternative methodology would be to employ loss assessors. While loss assessors have a wealth of experience, they are expensive and, as Nicholas et al. (2001) acknowledge, frequently gauge flood losses differently, also producing uncertainty in loss estimates.

Direct Flood Damage

Internal Damage

Internal damage refers to losses sustained to contents located within a building. In Kempsey 92% of damaged businesses reported internal damage, contributing 85% to total direct losses. Stock contributed 47%, equipment 33% and furniture and fittings 20%.

Damaged items varied depending upon the type of business damaged. Most vulnerable items were perishable, electrical, or stock contained in paper-based packaging. Frequently damaged equipment included white goods, computers, electrical tools, compressors, pumps, office equipment (phone, fax, etc.) and security alarms. Damaged furniture and fittings included lounges, office desks, chairs, counters, filing cabinets, curtains and miscellaneous shop fittings. The majority of damaged furniture and fitting items were made of particleboard that became swollen and lost strength.

It appeared that depth exerted little influence on internal losses (Figure 1), as suggested by Black and Evans (1999). The co-efficient of determination equal to 5%, indicates a weak relationship between over floor depth and internal damage. Flood preparations including the lifting or removal of internal items appeared to have an important influence on the relationship between depth and internal loss. Different degrees of flood preparation resulted in variable loss values. Lifting and removal of internal items distorted the positive accumulation of value, which the relationship is dependent upon. The inclusion of a wide variety of businesses added extra variability to the analysis, due to the heterogeneous nature of the commercial sector. Variability is also the result of the many variables that determine flood loss and surveying uncertainty.

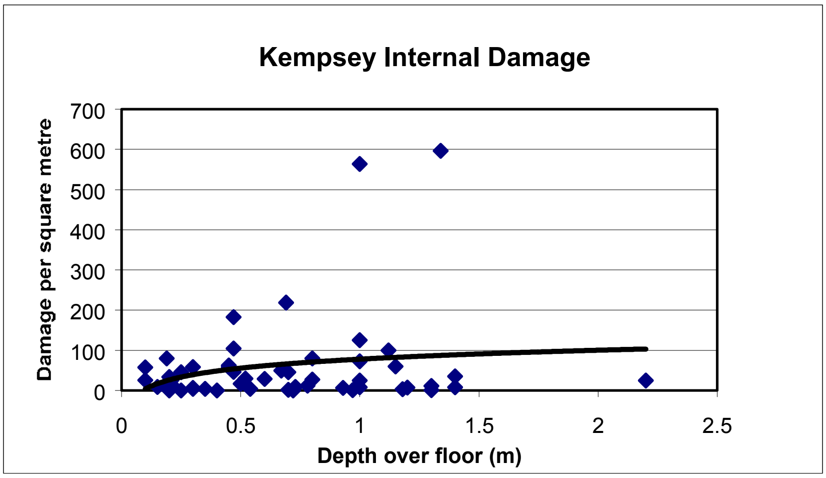

Figure 1. Internal damage vs. over floor depth

The majority of businesses suffered damage less than $100 per square metre, with mean internal damage equal to $87 per square metre. Loss values ranged from zero dollars to $1600 per square metre with a standard deviation of $240.

Structural Damage.

Structural damage refers to building fabric damage, including damage to items such as walls, carpets and built-in fittings. Structural damage was smaller than internal damage, contributing only 13% to total direct losses, with 68% of businesses reporting some form of structural damage. This result is similar to conclusions by Wright and Smith (1999) and Water Studies (1990) that state that structural losses are commonly lower than internal losses. Structural damage however is likely to be more prevalent during low probability events. The most common structural item damaged was carpets. Other damage was sustained to internal walls, paint, electrical connections and doors.

Total Direct Damage

Stage damage curves were constructed to establish a relationship between stage depth and damage (Figure 2). Curves were constructed using the ANUFLOOD method, involving classifying commercial enterprises by size and a value class, which represents a business's damage vulnerability. Three size categories exist, size one includes buildings smaller than 186 square metres, size two buildings between 186 to 650 square metres and size three buildings greater than 650 square metres. An alternate method would be to classify businesses into activity categories as suggested by White (1964) and Penning-Rowsell and Chatterton (1977). This method is not very suitable for this study due to the small sample size used.

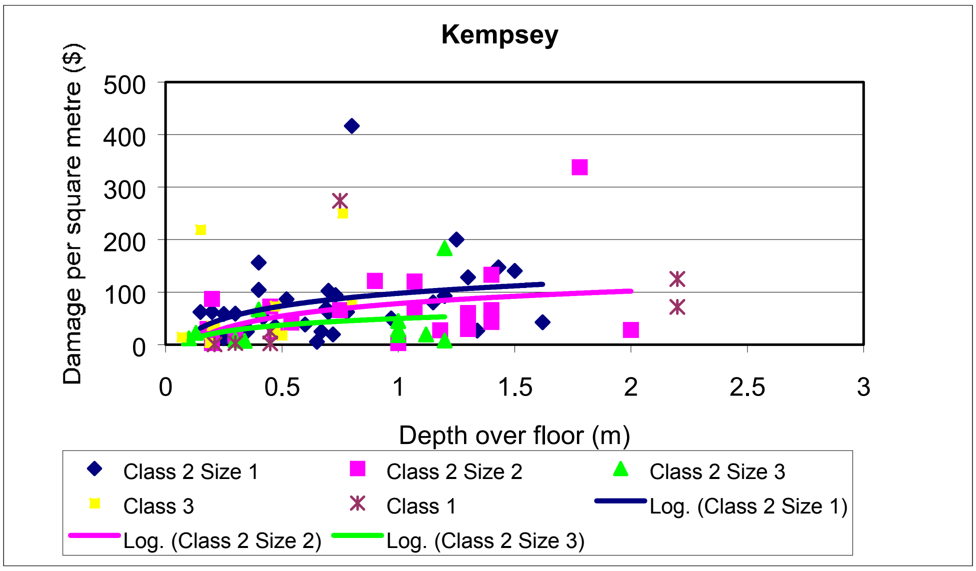

Figure 2. Kempsey stage damage curves value class 2.

The basis for commercial stage damage curves is the belief that a positive relationship exists between damage and stage height as has been suggested, though not convincingly proven, for the residential sector. It is logical that a relationship may exist for the commercial sector since in individual businesses the sum of value increases with height. The rate at which value accumulates is dependent upon the distribution of stock and equipment. Numerous studies including Penning-Rowsell and Chatterton (1977) and Smith et. al. (1979) have studied the distribution of accumulated stock value by height. Analysis of stock and equipment distribution in Kempsey showed that the majority of stock was contained between 0.3 metres and 1.6 metres. Stock and equipment distribution was found to vary between different types of retail outlets. The log normal shape of fitted curves displayed in Figure 2 indicates that marginal damage decreases as stage height increases.

Observations presented in Figure 2 display a high degree of variability and uncertainty. Variability results from the heterogeneous nature of the commercial sector and the wide array of variables that determine flood loss. Uncertainty is a result of errors in flood damage estimation. Variability in commercial damage has been suggested to be greater than residential damage by Higgins and Robbinson (1981), Smith (1992) and SMEC (1975).

Kempsey losses appear greater than predicted by various flood damage models. Damage appears greater than ANUFLOOD predicted values for small sized buildings ($<186\ m^2$) and shallow flood depths. Loss estimates are also greater than those suggested by the Rapid Assessment Method (RAM), developed by Read Sturgess and Associates (2000). The method allocates a potential damage value of $20,500 to flooded businesses less than $1000m^2$, not including cleanup costs (Branson, 2001). When adjusted to represent actual damage by multiplying by the actual to potential ratio (0.44) the RAM value is equal to about $9000. The average actual damage incurred by Kempsey businesses within this interval was significantly greater being equal to $24,000.

Coefficients of determination presented in Figure 2 indicate that a very weak relationship exists between over floor depth and direct damage. Clearly if over floor flood height is not correlated with loss value there is little point in using it as an estimator of future flood damage. However, no other determinant of flood damage has the qualities of over floor depth. As over floor depth is easy to measure, quantify and predict, it is also easy to link into emergency plans and risk analysis frameworks. Other determinants such as flood experience, velocity and duration of inundation are harder to measure and quantify, making it more difficult to analyze their impact upon losses.

An alternative to stage damage analysis may be to construct probability curves which can be used to ascertain the likelihood of certain loss magnitudes occurring to individual businesses. Such curves account for the variability and uncertainty within flood damage data. Using probability to estimate loss is not a new concept as SMEC (1975) used Monte Carlo simulation to predict flood damages.

Indirect Damage

Economic Effects

Flooding significantly affected trade flows within the Kempsey local economy. There existed both winners and losers as a result. The losers were far more prominent, losing an estimated two million dollars in gross sales and approximately $200,000 in net profits. Trade losses spread far further than floodwaters affecting many businesses that were not flooded. Approximately 150 businesses were closed for some period during the flood. Duration of business closure depended upon the time length of inundation, restoration of flood free access and the amount of time needed to either clean or restore a building. The majority of flooded businesses were closed for one week, while businesses that were not flooded closed for several days.

Most businesses were closed once the CBD was flooded, resulting in 90% of businesses recording no trade over the flood period. Businesses located in West Kempsey were fortunate to have flood free access and remained open serving approximately half of Kempsey's residents. Here retailers selling necessities such as newsagencies, supermarkets, pharmacies and take away food stores experienced trade well above average. Businesses such as dry cleaners and electrical appliance retailers experienced no trade increases. It was claimed by some business owners that trade increases had lasted for over six months as new customers attracted during the flood had remained as regular customers.

Trade experienced by all businesses after the flood was mixed as shown in Table 1. The majority of retailers experienced a decline in trade after the flood, whilst 21% experienced a rise in trade. Businesses that experienced trade decreases included retailers selling tyres, furniture, outdoor merchandise, music, antiques, holidays and jewelry. Businesses trading more necessary goods and services including builders, painters, electricians, electrical appliance retailers and repairers, opportunity shops, motels and clothing retailers experienced trade increases.

	Trade After
Nil	0%
Well Below Average	28%
Below Average	30%
Average	21%
Above Average	16%
Well Above Average	5%

Table 1. Trade after Kempsey 2001 flood.

The majority of businesses that suffered business disruption saw their trade levels recover to an average state within one month (Figure 3). Some businesses experienced prolonged hardship experiencing no recovery in trade figures by September 2001. Franchises were the fastest to recover due to the support given by businesses within their networks.

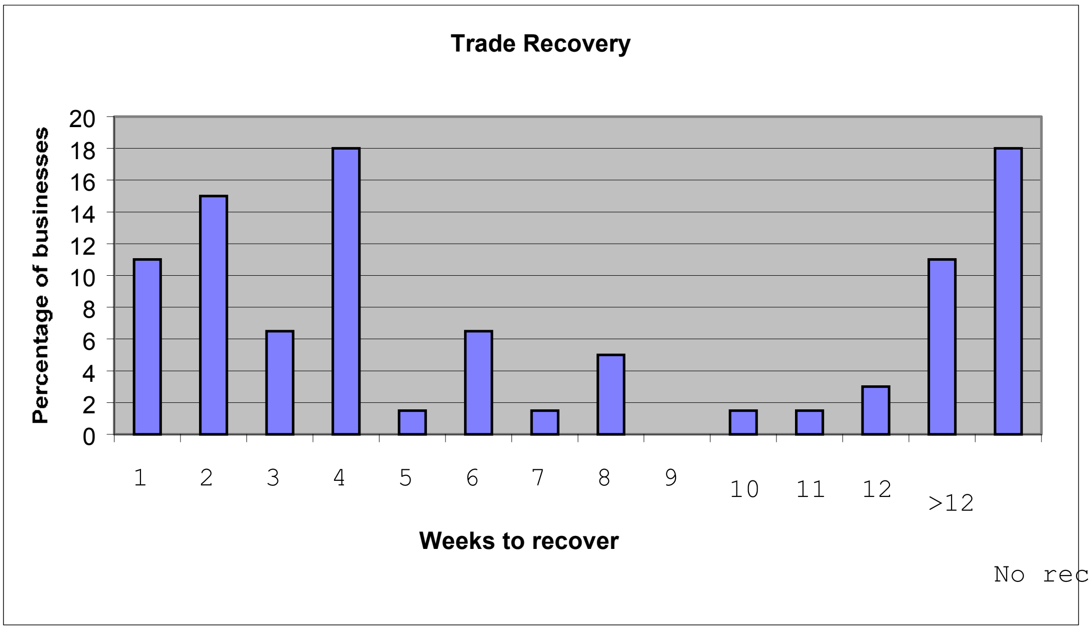

Figure 3. Recovery of trade after Kempsey 2001 flood.

Preparation costs

Preparation costs are those incurred in lifting or removing flood prone stock and equipment in anticipation of a flood. The value of preparation costs are estimated by multiplying person hours spent in preparing for a flood by an average hourly wage. In Kempsey 4900 person hours were used in preparations costing $100,000. Labour utilized consisted of business owners, employees, family, friends and volunteers.

Cleanup and Restoration costs

Cleanup and restoration costs are those involved in re-establishing a business to its pre-flood state, including material and labour costs. Where properties were not inundated businesses reported costs incurred in restoring their shops, referred to as restoration costs. The cleanup involved an estimated 67000 person hours, costing an estimated $1.3 million. Cleanup material costs were much less, equal to $27,000. Restoration costs were approximately equal to $85,000. In addition to those persons involved during preparations the SES, NSW Fire Brigade and RFS were heavily involved.

Flood Warning Effectiveness

Flood warnings aim to advise persons of approaching floods, so they can take actions to reduce the risk posed. The effectiveness of flood warnings can be evaluated by the extent of warning coverage, avoided losses, warning system failures and by evaluating recipient satisfaction (Parker and Neal, 1990).

Extent of warning coverage

Warning coverage was variable within the CBD, some businesses received more than one days notice, whilst others received only a few hours (Table 2). The majority of businesses received greater than 20 hours warning and 75% received 17 hours warning or more. Warnings were delivered by emergency services through door knocks and the media. Door knocks concentrated on warning businesses in Smith Street, many of whom were not flooded. Personal official warnings were received by only 40% of businesses. Radio was stated as the most effective source of information about the flooding, with local station Tank FM winning much praise. Once warned, 80% of businesses attempted to validate warnings, either by listening to the radio, contacting emergency services, talking to neighbours, or observing river levels.

Warning Time (Hours)	Obs	%
<4	13	16
>4 to 8	3	4
9 to 12	2	3
13 to 16	2	3
17 to 20	14	18
21 to 24	37	46
25 to 28	5	6
>28	4	5

Table 2 Warning time received by businesses.

Avoided losses

The actual to potential ratio was calculated at 0.44, indicating that approximately 56% of direct damage was averted through warning and emergency preparations. A maximum estimate of savings attributed to official warnings is estimated at $3.2 million. It is likely that the real amount is less than this figure since the majority of businesses did not receive official warning. Savings may therefore be attributed to the informal warnings as well as other measures such as pre-flood planning and flood education.

Savings tended to increase as warning time increased (Table 3). The initial four hour warning period was associated with the greatest savings, supporting Parker (1991) who stated that the majority of possible damage savings could be made within four hours. After four hours, savings appeared to diminish as warning time increased, signifying diminishing marginal returns. The existence of diminishing marginal returns places doubt over the cost effectiveness of measures to increase potential warning time, since it is unlikely that increases will lead to substantial savings.

Warning Time (Hours)	A/P	Obs
<4	0.61	11
>4 to 8	0.5	2
9 to 12	0.36	2
13 to 16	0.93	1
17 to 20	0.4	7
21 to 24	0.36	33
25 to 28	0.19	4
>28	0.39	3

Table 3. Losses avoided by businesses.

There appears to be room for improvement in Kempsey's flood response. It is recognized that given enough time all contents can be removed from a building. The extent to which internal losses dominate total direct losses is an indication of response effectiveness. In Kempsey internal damage comprised 85% of total direct damage, reflecting the potential to further reduce losses. Individual business flood action plans as proposed by Smith (1999) and Pryor (1999) may be an option when considering how to reduce losses further and hence increase the effectiveness of flood warnings.

Warning system failures

Twenty percent of businesses failed to respond or responded ineffectively to flood warnings. Reasons for poor response included: confusion about warnings, inadequate warning time and little flood experience or preparedness.

Automatic rainfall and stream level gauges failed. The Kempsey automatic stream gauge malfunctioned resulting in much higher flood height predictions than actual levels. A small number of rainfall gauges were also inoperable during the flood.

Recipient satisfaction

Businesses expressed unhappiness about warnings, with 85% of respondents indicating dissatisfaction. Complaints are listed in Table 4. Businesses were most unsatisfied about not personally receiving warnings from emergency services. Managers appeared to have an expectation that they should be individually warned by emergency services. Many businesses that received no official warning were located in the most hazardous areas.

Complaints about limited warning time were received from a variety of businesses ranging from those who only received several hours warning to others who received over 24 hours. Businesses tended to use only a fraction of the warning time available to them, on average taking only seven hours to prepare stores before evacuating. This meant that some businesses evacuated earlier than needed, whilst others conducted preparations after taking considerable time to evaluate the received warnings.

Confusion over warnings was the result of conflicting and inconsistent reports often communicated through informal channels. Confusion also occurred when persons were unable to relate gauge heights to their particular business. This problem is of critical importance since the underestimation of flood depth can lead to escalation in tangible and intangible damages. Some businesses were able to overcome this problem by relating forecast depths to flood markers representing 1949 flood heights, while others contacted emergency services for further information.

Warnings delivered by the media were criticized for containing inappropriate information. Such warnings often contained information about flooding in Grafton and other regions, tending to neglect Kempsey. The media was also criticized for delaying and confusing warnings.

Forecasts were criticized for inaccuracy, with predicted flood levels perceived as being higher than actual river levels. Inaccuracy was caused by the malfunctioning of the Kempsey gauge resulting in predictions up to 0.9 metres higher than actual levels.

Complaint	%
Warnings were inappropriate.	14
Warnings were inaccurate.	14
Warnings were confusing.	14
Other businesses were warned earlier.	7
Our business received no official warning.	30
Warnings gave little time to prepare.	21

Table 4. Warning satisfaction.

Conclusions

Commercial losses suffered during the Kempsey 2001 flood illustrate the significance of commercial flood damage. Commercial flood damage by its nature is uncertain and variable contributing to loss estimation difficulty.

Due to the infancy of commercial flood damage studies it is critical that a framework for estimating and analyzing commercial impacts is developed. This framework must not only allow proper comparison between floods but also comparisons with the impacts of different hazard types.

Businesses experiencing continued hardship as a result of flooding clearly need more generous government assistance than is currently offered. Increased relief in rural areas will provide a kick-start to struggling rural economies and promote rural sustainability.

The Kempsey 2001 flood experience proved that flood warnings are an effective means of reducing tangible and intangible damages. Room for further improvement has been identified particularly in areas of flood awareness, education and warning dissemination. Warning dissemination in Kempsey's CBD may be improved by the use of a public address system to alert persons of possible flooding and to seek further information from local radio.

Businesses have a perception that personal service should be delivered by emergency services during flood emergencies. This clearly has to change and businesses encouraged to become self-sufficient. Individual business flood action plans are a great way to achieve self-sufficiency.

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