EFFECTS OF DISCLOSURE OF FLOOD-LIABILITY ON RESIDENTIAL PROPERTY VALUES

Stephen Yeo
Risk Frontiers-NHRC
Macquarie University

Table of Contents

Floodplain mapping is regarded as an essential input for sensible flood risk management, through land use planning, warning systems and public education.[1] But the disclosure of flood risk information has led to opposition from those who perceive that such disclosure may reduce property values. This was clearly seen following the release of flood maps for Sydney's western suburbs in November 1982. A journalist suggested that to name a house as flood-prone would take an average of 30% off its value.[2] The Liberal opposition distributed a leaflet in the lead-up to the 1984 state election that claimed, 'Once the Labor Government has mapped your area … the value of your property could be reduced by up to 50%'.[3]

Is the media, are politicians, justified in claiming such effects? Does disclosure affect property value? Is the effect of disclosure more apparent than real? Does disclosure effect all flood-liable residential property or only dwellings with the greatest exposure? Is any effect on property value long-lasting or short-lived? Concerns about property values seem rational, but are they soundly-based?

In the Australian context we don't know the answers to these questions. Despite the continuing, widespread belief that residential property values are adversely affected by disclosure of flood liability, few Australian studies have examined the issue.

However, a wealth of international publications address the subject. Consideration of these global research results in an Australian context provides the opportunity to examine the implications of disclosure for Australian floodplain managers. This review allows managers, politicians and communities to be informed next time some 'authority' asserts that disclosure does (or does not) influence property values.

This review is structured according to a series of questions that serve to demonstrate the spatial and temporal effects of flood disclosure. Most studies come from the United States, with lesser numbers from Canada, New Zealand and Australia. Most of these deal with disclosure that results from an actual flood event rather than disclosure as a result of floodplain designation or mapping. In this review, more attention is given to the assessed rather than perceived influences of disclosure on residential property values. Seven key case studies are summarized in Boxes.

Outcomes

Does flooding affect residential property values?

A number of studies demonstrate that floods adversely affect residential property values. After flooding, average values fell by 19–26% at Oak Grove (Box 1), 30% at Wilkes-Barre (Box 3), 19% at Linda/ Olivehurst (Box 4), 9% at Te Aroha (Box 6) and 60% at Nyngan (Box 7). A slight decrease was observed for Sydney's Georges River district after the 1986 flood (Box 7).

There are several other examples, however, where flooding was not found to decrease residential property values. This was the case after the 1986 flood at Des Plaines (Box 2). After flooding at Cambridge in 1974 (Box 5) and at Paeroa and Thames in 1981 (Box 6), property values *increased*. No decrease occurred after flooding of Sydney's Georges River district in 1988 (Box 7). A study at Houston, Texas, found that flooding in 1979 had no direct impact on values of flooded houses, which declined only when flood insurance rates increased substantially.[4]

Does floodplain designation affect residential property values?

Many studies have found that properties situated in designated floodplains are valued less than comparable properties situated outside the floodplain (usually by 4–12%).[5] One study favored a figure of –11% for highly flood prone properties in Sydney's west, though flood prone properties in the largest data set (Toongabbie) were valued only 4% less than comparable properties situated above the 100-year flood level (Box 7).[6] Annual sales data revealed a 25% fall in floodplain property values in the Georges River catchment

in 1984, which was interpreted as a response to the release of floodplain maps (Box 7).[7] The data are of a coarse resolution, however, and show other downturns that presumably were not associated with disclosure. It is difficult to isolate the effects of disclosure due to the depressed state of most property markets in 1984.[8]

Other studies have found no significant difference between values of properties situated in and out of designated floodplains.[9] Several studies have found that floodplain designation or subsequent regulation have had no adverse effect on property values (e.g. at sites in Ontario, Box 5). Indeed, at Oak Grove (Box 1), Te Aroha (Box 6) and Bergen County, New Jersey,[10] properties so designated increased in value at rates *exceeding* those that were not designated. This may reflect extraneous influences such as the premium placed on waterfront property. A finding that floodplain designation has little effect on property values matches the finding of (some) research of earthquake hazards in California, where it was concluded that surface fault rupture zonation and its disclosure by real-estate agents had no negative impact on house price levels.[11]

A pervasive feature of global inquiry into the effect of flood disclosure on property values is the contradictory nature of the results, often acknowledged in the literature. Reasons for these contradictions are explored below. But one finding on which there appears to be little disagreement is this: a flood event, rather than floodplain designation, is likely to have a greater effect on property values. This is supported by the Oregon case study (Box 1). Even studies that demonstrate an adverse response to floodplain regulation have found that flood events trigger an even more adverse response.[12] This corresponds with a number of perceptual studies, which found that assessors, realtors and lenders thought flood events had more impact than floodplain regulations in determining property prices and lending decisions.[13]

How spatially extensive are the effects of disclosure?

Common lore has it that disclosure of flood-liability, whether by flooding or floodplain mapping, should result in a differentiation of market trends between flood-liable properties and those that are not. Research provides some support for this. At Oak Grove (Box 1), Wilkes-Barre (Box 3) and Linda/ Olivehurst (Box 4), non-flooded properties experienced less severe downturns. Houses that were not flooded experienced a greater overall increase in value at Des Plaines (Box 2). There is also a hint of spatial discrimination at Thames, where flooded properties failed to increase in value at statistically significant rates (Box 6).

However, rather more research indicates that flooding adversely affects whole communities, including properties that were not flooded. This occurred after the 1987 flood at Des Plaines (Box 2). It is particularly apparent following catastrophic flooding, when *proximity* to damaged property seems to affect property values almost as much as inundation (e.g. Oak Grove – Box 1, Wilkes-Barre – Box 3, Linda/ Olivehurst – Box 4, Te Aroha – Box 6). Publicity surrounding catastrophic floods probably colors perceptions of the entire locality.

What areas are most affected by disclosure?

Few studies have sufficient spatial precision to enable the assessment of areas most affected by disclosure. The degree of discounting in property values (5–14%) was found to correspond with intensity of flood risk in South Roanoke, Virginia.[14] Flood depth was directly associated with the magnitude of decline (%) and duration of recovery in property values at Wilkes-Barre (Box 3) and Linda/ Olivehurst (Box 4). Seemingly disparate findings that selling prices (Wilkes-Barre, Box 3) and rate of appreciation (Paeroa, Box 6) *increase* with flood depth are partly explained by the value added to properties by repairs and renovation.

Flooding at Des Plaines in 1986 and 1987 provided the opportunity to assess the effects of flood frequency on property values (Box 2). It was found that properties that were flooded twice experienced a greater decrease in prices and a longer recovery. At Thames, however, no significant differences in selling prices could be identified for properties with different flood experience – the second, larger flood did not adversely impact property values (Box 6). Similarly, no downturn in prices was apparent after the second flood in Sydney, though properties were apparently not demarcated according to flood frequency (Box 7). A study of the effects of flooding at New Orleans also implied that repeated flooding had no effect on flood insurance and hence no effect on property values.[15]

How prolonged are any effects of disclosure?

Deep, highly damaging floods have generated the longest recovery times – in excess of 10 years for parts of Linda/ Olivehurst, where abandoned houses acted as reminders of the damage (Box 4), and about 5–8 years for Oak Grove (Box 1). That property values recovered to their pre-flood levels within about two years at Wilkes-Barre (Box 3) and one year at Nyngan (Box 7) – despite severe floods – is thought to reflect the infusion of government relief funds, which speeded restoration. Adverse market effects of Te Aroha's flood and landslip had vanished after four years (Box 6). Twice-flooded houses at Des Plaines were still recovering after two years (Box 2). Any detrimental impacts of the floodplain mapping in Sydney's west had evaporated within a year (arguably, associated with the maps' removal), but the annual data are too coarse to allow confident interpretation (Box 7).

Interpretation

A review of the effect of flood disclosure on property values soon reveals the contradictory nature of much of the work. Some studies have concluded that flooding or floodplain designation negatively influences property values, while others have demonstrated the opposite. The magnitude, spatial extent and duration of any effects are also seen to vary substantially. Why are the research results so diverse?

1) Different purposes

One reason for diverse findings is the diversity of purpose. Some studies have an academic interest, others a very practical interest. Some approach the issue from a hazards framework, others from a real estate framework. Some seek to understand the interaction between people and their environment; others seek to develop more accurate means of appraising values of properties for sale.

2) Different data and methods

A second reason for diverse findings is the use of different data and methods. Most studies assess changes to developed residential property values; some focus on land values (e.g. Box 1).[16] Most studies use sales prices, some use assessed prices. Three broad methods of analysis have been used: changes in the mean value of properties, which are verified using common statistical tests; multivariate regression, where an attempt is made to isolate the influence of flooding or floodplain designation/ regulation on property values from other variables; and perceptual studies.[17] It is significant that a study using a number of methods to assess the effect of floodplain regulation at one site concluded that, 'The results are mixed, inconclusive and highly dependent on the specific analytical model'.[18]

3) Different quality

Another reason for different results is the varying quality of the studies. In part this reflects the quality of the property transaction data, which change over time even at the one site. Analysis of property values in the Sydney studies is limited by small sample sizes. The sale of a particularly high or low priced property can color substantially the monthly average when few properties are sold.[19]

An important reason why conclusions have differed is an inability to control for variables other than flooding.[20] The factors influencing residential property values are numerous (and to an extent, culturally dependent): lot size; building size; construction type; building age; state of deterioration; number of bedrooms; built-in wardrobes; ensuite bathrooms; carpets; standard of kitchen; garages; swimming pool; constraints on the owners' ability to develop their home; proximity to shops, transport, schools and work; exposure to air or vehicular traffic noise; local supply and demand; mortgage interest rates; etc.[21] For this reason it is important to analyze market trends within designated submarkets that hold constant as many variables as possible – failure to consider submarkets could lead to incorrect interpretations.[22] The moderate

R^2 derived for many of the studies using multiple regression is evidence for the difficulty of adequately modeling the many influences on property values.[23] A measure of the problem is obtained by realizing that a floodplain property has both negative (flood risk) and positive (possible water views) locational attributes, which are difficult to isolate.[24] No adverse effects may be detected where the positive obscures the negative.

Another reason for diverse findings is a lack of spatial precision, which masks the complexity within floodplains.[25] Studies also vary in temporal precision – the extent of data either side of a flood event or floodplain designation/ regulation and the frequency with which property values are assessed over that time vary markedly between studies.

4) Different contexts

Probably the most important reason for the diversity of research results, and related to the inability to exclude other influences on property values, is the site-specific nature of much of the work.[26] The depth and frequency of flood experience (or flood risk) varies from site to site. But little discussed in the literature are the implications of the nature of disclosure of flood-liability, which varies according to the detail of disclosure, the timing of disclosure, the degree of publicity about disclosure, the duration of disclosure (permanent vs. temporary), and the nature and scope of any regulations attached to disclosure.[27] Perhaps disclosure at Te Aroha had no effect (Box 6) because the flood and landslip risk had already been capitalized into property values as a result of the 1985 event.

A very important, variable factor affecting market response to flood disclosure is people's perception of risk. *Unexpected* flooding following the breaching or overtopping of levees caused substantial downturns in property values at Wilkes-Barre (Box 3), Linda/Olivehurst (Box 4), Nyngan (Box 7) and St Louis, Missouri.[28] Flooding at Des Plaines (Box 2), however, was not unexpected, resulting in little impact after the first flood. More substantial effects were recorded after the second flood, which may have changed perceptions.

Expectation is also important for understanding the effects of designation of flood-liable land. If a decline in flood-liable property values in western Sydney in 1984 is attributable to the release of floodplain maps, then a lack of flood experience and, therefore, expectation would have been influential. Here may be one example where radically changed perceptions led to an adverse market response. However, the rapid recovery of property values in 1985 (associated, perhaps, with the maps' removal) suggests that the downturn was associated more with frenzied media and political reporting than with real flood risk.

A related factor is the perceived *repeatability* of flooding. Impacts of disclosure on property values in Coromandel (Box 6) may be muted because of structural works that provide a (false) perception of security.

Extraneous factors have a variable influence. The role of relief funds in hastening recovery at Wilkes-Barre and Nyngan has been noted. Supply-demand considerations are important. The impact of flooding at Des Plaines (Box 2) may have been subdued by its situation as a suburb of Chicago, with a dynamic housing market. Flood experience had no depreciating impact at Thames (Box 6) because of strong demand from retirees moving into the community. Similarly in Sydney (Box 7), it was found that high population growth and consequent housing shortage resulted in 'a buoyant market remarkably resilient to external influence', which 'tended to obscure any serious, permanent impact upon the market'.[29] Related to supply-demand is the availability of flood-free housing. Where this is lacking, recovery of property values may be enhanced.[30]

A key study aptly summarizes the research results: residential property values reflect 'a complex interaction of spatial, temporal, economic, sociological and hydrologic variables'.[31]

(1) Oak Grove, Oregon, USA
(Muckleston et al., 1981; Muckleston, 1983)

A study of assessed land values over a 23-year period demonstrates the effects of (1) a major flood in 1964 and (2) the enforcement of floodplain regulations from 1971.

- The flood had a depressing effect on land values, particularly for waterfront lots (–19% to –26%), but also for lots that apparently were not flooded (–3%).
- This depressed effect lasted for 5–8 years.
- The enforcement of floodplain regulations had no dampening effect on residential land values; indeed, the mean appreciation rates for regulated river front lots increased significantly more rapidly than those for unregulated lots.

(2) Des Plaines, Illinois, USA
(Tobin & Montz, 1990, 1994)

A study of list and sold prices over a 4-year period reveals the influence of frequent, low-magnitude floods (in Oct 1986 and Aug 1987) on property values in a suburb of Chicago.

- The first flood had a minor effect on property values, with small increases (8%) in sold prices for flooded areas (perhaps due to the value added by repairs and renovation) and small decreases (–7%) for non-flooded areas.
- The second flood (which was less extensive) had a more pronounced effect on property values, with corresponding decreases in sold prices for both flooded and non-flooded property (–15% to –21% from the preceding quarter).
- Houses that were flooded twice experienced a slow recovery (> 2 years for sold prices to recover to pre-flood values), and houses that were not flooded at all experienced a greater overall increase in value than flooded houses.

(3) Wilkes-Barre, Pennsylvania, USA
(Montz & Tobin, 1990; Tobin & Montz, 1994)

A study of list and sold prices over a 5-year period reveals the influence of a catastrophic, levee-breaking flood in 1972. About two-thirds of the city was inundated, in places to depths of more than 4 metres.

- The flood caused an immediate decline in prices across the city, though the decline in sold prices for non-flooded property was neither as severe (–11%) nor as prolonged (6 months) as for flooded properties (–30%, 2 years).
- The most severe decline in values (almost –40% for the first 6 months) and the longest recovery (30 months) was experienced by properties flooded to the greatest depths (> 4 metres – sufficient to flood second storey).
- Flooded properties were worth more than non-flooded properties, before and after the flood, due to larger floor areas and the value of improvements from repairs and renovation.

(4) Linda and Olivehurst, California, USA
(Montz & Tobin, 1988; Tobin & Montz, 1988, 1994, 1997)

A study of list and sold prices over a 13-year period demonstrates the influence of a catastrophic, levee-breaking flood in 1986, which was characterized by depths of up to 3.5 metres, high initial velocities, and durations ranging from less than 2 days to more than 2 weeks.

- The flood caused an immediate decline in sold prices in flooded areas, by an average of –19% for the 6 months after the flood.
- Even sold prices for non-flooded areas showed a decline after 1 year.
- Those properties flooded to the greatest depths experienced the most severe downturns (–60% for the first quarter after the flood) and the slowest recovery (in excess of 10 years, partly due to abandoned houses serving as continuing visual reminders of the damage).
- Slightly flooded (0.5 metres) and non-flooded houses experienced less severe downturns (up to –20%) and a somewhat faster recovery (4–6 years).

(5) Ontario, Canada
(Babcock & Mitchell, 1980; Schaefer, 1990; Shrubsole et al., 1997)

A number of studies have investigated the influence of flooding and flood disclosure at sites in Ontario Province.

- Analysis of sales prices and assessment values revealed no significant differences between flooded and non-flooded areas either before or after a major flood at Cambridge in 1974. Sales prices were significantly higher after the flood. There was no significant difference in perceived property values between flooded and non-flooded areas in 1978.
- Modeling of influences on property values at North York identified no significant relationship between floodplain designation/regulations (from 1982) and selling price of homes situated within regional floodlines.
- Analysis of asking price, selling price, assessed value and days on market for houses in London between 1978 and 1989 found no significant difference between houses situated in and out of the designated floodplain. This corresponds with the perception of most interviewed residents that floodplain regulation had no economic impact.

(6) Coromandel, New Zealand
(Montz, 1992a, 1992b, 1993)

Sales data were used to assess the effects of record flooding at Paeroa in 1981, a severe landslip and flooding at Te Aroha in 1985 and flooding at Thames in both 1981 and 1985. The impacts of later disclosure via hazard maps at Te Aroha and Thames were also evaluated.

- For the non-flood area of Paeroa, prices after the flood were significantly higher than before, but this was not sustained beyond four years. Houses that were flooded to greater depths appreciated more after the flood due to their low pre-flood values and the value added by repairs and renovation.
- At Te Aroha, immediate post-event selling prices were significantly lower than pre-event prices (–9%) for all properties in the town – including non-hazard – for up to four years.
- At Thames, property values increased after the 1981 flood, though not significantly for flooded houses. There were no significant differences in before/after selling prices for the 1985 flood. There is little apparent difference in trends experienced in and out of the floodplain.
- Disclosure had little impact on the real estate markets in Te Aroha or Thames. No downturns are attributable to the release of flood hazard maps. Spatial patterns were the opposite of what might be expected – in Te Aroha, high-hazard houses sold for *more* after designation, and in Thames it was the houses that were *not* designated as flood prone that decreased in value.

(7) Sydney and Nyngan, NSW, Australia
(PRC, 1992; Lambley & Cordery, 1991, 1993, 1997)

The effect of flooding and flood disclosure on sales prices has been investigated by three Australian studies. One of these studies evaluated the impact of floodplain mapping and flood events in the Georges R. catchment, and another evaluated the impact of a levee-breaking flood at Nyngan in 1990.

- There is weak evidence to suggest that between 1987 and 1991, properties situated on highly flood-liable land in the Upper Parramatta R. catchment (separate to the Georges R. catchment) had reduced sale prices (–11%) when compared to properties situated above the 1 in 100 year flood level.
- There is some evidence to show that the prices of flood prone properties in the Georges R. catchment fell by 25% in 1984 but recovered in 1985. This has been linked to the release then withdrawal of floodplain maps, though the depressed state of property markets may have been influential.
- There is some evidence to show that prices of flood-liable property fell 2 or 3 months after the 1986 Georges R. flood, but this was not sustained. There was no decline after the 1988 flood.
- From 1984 to 1992, the average value of flood prone properties in the Georges R. catchment fell slightly, relative to a flood free control group.
- The average price for a house in Nyngan fell from $50,000 before the flood to $20,000 eight months after the flood (–60%), but recovered within a year.

Implications

Evidence for the effects of disclosure of flood-liability on residential property values is mixed. Opponents of disclosure find some support in the published research, particularly in the studies demonstrating that flood-liable properties are valued 4–12% less than comparable flood-free properties. It may be significant, however, that these studies are all taken from the USA, where the National Flood Insurance Program may act as a vehicle enhancing the capitalization of flood-liability. Studies in Canada and New Zealand (and others from the USA) have found no distinction in property values between floodplains and non-floodplains, and no distinction pre- and post- floodplain designation or regulation.

Advocates of disclosure find rather more support in the published research. Flood risk is just one of many characteristics influencing property values. House age, size and amenity – not flood hazard – explained differences in housing prices in towns in New Zealand. This compelling study concluded that, 'There are no market reasons to avoid disclosure'.[32] In fact, the evidence suggests that actual flooding is more likely to cause an adverse effect on property values than floodplain designation or regulation. Research indicates that the most severe downturns and the slowest recoveries typically are experienced by those properties flooded to the greatest depths, though even non-flooded properties are not immune from adverse effects. Again, however, flooding may have little impact where other factors dominate. In Sydney, where demand is strong, it was found that, 'The impact of flooding upon housing values … is not as apparent as popularly believed'.[33]

The balance of evidence suggests that the grounds for refusing disclosure are weak. Even if property values are adversely affected, a pragmatist sees that designation simply brings forward the inevitable decline that would occur after a future flood. This, however, is small comfort to the present generation who may sustain a loss. People may also have less tolerance for human disclosure (i.e. a floodplain map) than for 'natural' disclosure (i.e. a flood), and may express their anger at the polls.

The advantages of disclosed floodplain maps for flood risk reduction are, nevertheless, undeniable. Gaining a measure of public acceptance for disclosure is the key. This requires best-practice risk assessment – unreliable maps will do nothing for public confidence. Just as important is a well thought-out plan for risk communication. This review suggests that the *timing* of disclosure is significant. The potential for adverse impacts is minimized if flood awareness is already high (e.g. Te Aroha and Thames; cf. Sydney in 1982). Where no local floods have been experienced, remote events receiving substantial media coverage could be used (e.g. Wollongong floods as a surrogate for Sydney). Scheduling disclosure when the property market is strong would also minimize disruption (e.g. while the first-homeowner grant is available).

The *content* of disclosure is also significant. Risk needs to be communicated in precise, understandable, succinct language.[34] 'Probability' is likely to cause less fear and confusion than 'recurrence interval'. Photos of historic floods could be used to persuade sceptical residents. With careful explanation even difficult concepts can be understood. That the flood icon at Kempsey – marking the level of the Probable Maximum Flood – has not been cut down, suggests that as a result of effective communication this means of public disclosure of flood-liability has gained community acceptance.

Nonetheless, acceptance of disclosure is contingent upon responsible reporting. The impression from Sydney in 1982–84 (Box 7) is that adverse impacts were felt, less as a result of the floodplain maps, and more due to a fearful frenzy that was induced in part by irresponsible electioneering. Perceptions do exert an influence on property values. Those who influence perceptions ought to be co-opted as partners in risk communication.

Acknowledgement

This review was funded by the Floodplain Management Unit, Department of Natural Resources and Environment (Vic.), and Emergency Management Australia.

The project was an initiative of the Floodplain Managers Group of Victorian Catchment Management Authorities, and was managed on behalf of the Group by the East Gippsland CMA.

References

Askew, A.J. & Pilgrim, D.H. 1979. 'Identifying flood-plain hazards: a national programme of flood-plain mapping'. In: Heathcote, R.L. & Thom, B.G. (eds.) *Natural Hazards in Australia*, Australian Academy of Science, Canberra, pp.422–435.

Babcock, M. & Mitchell, B. 1980. 'Impact of flood hazard on residential property values in Galt (Cambridge), Ontario', *Water Resources Bulletin*, 16(3), 532–537.

Bernknopf, R.L., Brookshire, D.S. & Thayer, M.A. 1990. 'Earthquake and volcano hazard notices: an economic evaluation of changes in risk perceptions', *Journal of Environmental Economics and Management*, 18, 35–49.

Bialaszewski, D. & Newsome, B.A. 1990. 'Adjusting comparable sales for floodplain location: the case of Homewood, Alabama', *The Appraisal Journal*, 58(1), 114–118.

Brookshire, D.S., Thayer, M.A., Tschirhart, J. & Schulze, W.D. 1985. 'A test of the expected utility model: evidence from earthquake risks', *Journal of Political Economy*, 93(2), 369–389.

Damianos, D. 1975. *The Influence of Flood Hazards Upon Residential Property Values*, Unpublished PhD thesis, Department of Agricultural Economics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Donnelly, W.A. 1989. 'Hedonic price analysis of the effect of a floodplain on property values', *Water Resources Bulletin*, 25(3), 581–586.

Fridgen, P. & Shultz, S. 1999. 'The threat of flooding on housing values in Fargo/Moorhead'. In: Kendy, E. (ed.) *Science into Policy: Water in the Public Realm* (Proceedings, Specialty Conference, 30 June – 2 July 1999, Bozeman, Montana), American Water Resources Association, Herndon, Virginia, pp.77–82.

Handmer, J.W. 1985. 'Flood policy reversal in New South Wales, Australia', *Disasters*, 9, 279–285.

Holway, J.M. & Burby, R.J. 1990. 'The effects of floodplain development controls on residential land values', *Land Economics*, 66(3), 259–271.

Lambley D.B. & Cordery, I. 1991. 'Effects of floods on the housing market in Sydney'. In: *International Hydrology and Water Resources Symposium, Perth, WA, October 1991*, The Institution of Engineers Australia (National Conference Publication 91/19), Barton, pp.863–866.

Lambley, D. & Cordery, I. 1993. 'The housing market and urban flood control policy'. In: Chowdhury, R.N. & Sivakumar, M. (eds.) *Environmental Management: Geo-water and Engineering Aspects* (Proceedings of the International Conference on Environmental Management, Geo-water and Engineering Aspects, Wollongong, NSW, Australia, 8–11 February 1993), Balkema, Rotterdam, pp.447–453.

Lambley, D. & Cordery, I. 1997. 'The effects of catastrophic flooding at Nyngan and some implications for emergency management', *Australian Journal of Emergency Management*, 12(2), 5–9.

Montz, B.E. 1987. 'Floodplain delineation and housing submarkets', *Professional Geographer*, 39, 59–61.

Montz, B.E. 1992a. 'The effects of flooding on residential property values in three New Zealand communities', *Disasters*, 16(4), 283–298.

Montz, B.E. 1992b. *The Impact of Hazard Area Disclosure on Property Values in Three New Zealand Communities*, Natural Hazard Research Working Paper 76, Natural Hazards Research and Applications Information Center, University of Colorado, Boulder, Colorado.

Montz, B.E. 1993. 'Hazard area disclosure in New Zealand: the impacts on residential property values in two communities', *Applied Geography*, 13(3), 225–242.

Montz, B.E. & Tobin, G.A. 1988. 'The spatial and temporal variability of residential real estate values in response to flooding', *Disasters*, 12(4), 345–355.

Montz, B.E. & Tobin, G.A. 1990. 'The impacts of Tropical Storm Agnes on residential property values in Wilkes-Barre, Pennsylvania', *The Pennsylvania Geographer*, 28(2), 55–67.

Muckleston, K.W., Turner, M.F. & Brainerd, R.T. 1981. *Floodplain Regulations and Residential Land Values in Oregon*, Office of Water Resources Technology, Water Resources Research Institute, Oregon State University, Corvallis, Oregon.

Muckleston, K.W. 1983. 'The impact of floodplain regulations on residential land values in Oregon', *Water Resources Bulletin*, 19(1), 1–7.

Palm, R. 1982. 'Earthquake hazards information: the experience of mandated disclosure'. In: Herbert, D.T. & Johnston, R.J. (eds.) *Geography and the Urban Environment: Progress in Research and Applications, Volume V*, Wiley, Chichester, pp.241–277.

PRC (Property Research Centre) 1992. *Effect of Flooding on Residential Property Values* (Final Report to the Upper Parramatta River Catchment Trust). Faculty of Business & Land Economy, University of Western Sydney, Hawkesbury, Sydney.

Schaefer, K.A. 1990. 'The effect of floodplain designation/regulations on residential property values: a case study in North York, Ontario', *Canadian Water Resources Journal*, 15(4), 319–332.

Sheaffer, J.R. & Greenberg, L.S. 1981. *Evaluation of the Economic, Social and Environmental Effects of Floodplain Regulations*, US Department of Housing and Urban Development and the Federal Emergency Management Agency, Washington DC.

Shepard, R.C. 'Floodplain development: lessons learned from the Great Flood of 1993', *Urban Land*, 53(3), 19–24,42,44.

Shilling, J.D., Benjamin, J.D. & Sirmans, C.F. 1985. 'Adjusting comparable sales for floodplain location', *The Appraisal Journal*, 53 (July), 429–436.

Shilling, J.D., Sirmans, C.F. & Benjamin, J.D. 1989. 'Flood insurance, wealth redistribution, and urban property values', *Journal of Urban Economics*, 26, 43–53.

Shrubsole, D. & Scherer, J. 1996. 'Floodplain regulation and the perceptions of the real estate sector in Brantford and Cambridge, Ontario, Canada', *Geoforum*, 27(4), 509–525.

Shrubsole, D., Green, M. & Scherer, J. 1997. 'The actual and perceived effects of floodplain land-use regulations on residential property values in London, Ontario', *Canadian Geographer*, 41(2), 166–178.

Shultz, S.D. & Fridgen, P.M. 2001. 'Floodplains and housing values: implications for flood mitigation projects', *Journal of the American Water Resources Association*, 37(3), 595–603.

Skantz, T.R. & Strickland, T.H. 1987. 'House prices and a flood event: an empirical investigation of market efficiency', *The Journal of Real Estate Research*, 2(2), 75–83.

Speyrer, J.F. & Ragas, W.R. 1991. 'Housing prices and flood risk: an examination using spline regression', *Journal of Real Estate Finance and Economics*, 4, 395–407.

Tobin, G.A. & Montz, B.E. 1988. 'Catastrophic flooding and the response of the real estate market', *The Social Science Journal*, 25(2), 167–177.

Tobin, G.A. & Montz, B.E. 1990. 'Response of the real estate market to frequent flooding: the case of Des Plaines, Illinois', *Bulletin – Illinois Geographical Society*, Fall, 11–21.

Tobin, G.A. & Montz, B.E. 1994. 'The flood hazard and dynamics of the urban residential land market', *Water Resources Bulletin*, 30(4), 673–685.

Tobin, G.A. & Montz, B.E. 1997. *The Impacts of a Second Catastrophic Flood on Property Values in Linda and Olivehurst, California*, Quick Response Report #95, Natural Hazards Center, University of Colorado, Boulder, Colorado.

Tobin, G.A. & Newton, T.G. 1986. 'A theoretical framework of flood induced changes in urban land values', *Water Resources Bulletin*, 22(1), 67–71.

Warnick, L.J. 1977. *Analysis of Growth Rates of Residential Land Values On and Near the Regulated Flood Plain*, Department of Geography, Oregon State University, Corvallis, Oregon.

Zimmerman, R. 1979. 'The effect of flood plain location on property values: three towns in northeastern New Jersey', *Water Resources Bulletin*, 15(6), 1653–1665.

[1] Askew & Pilgrim, 1979
[2] Monaghan, 1984, cited in Lambley & Cordery, 1993
[3] Handmer, 1985, p.282
[4] Skantz & Strickland, 1987
[5] Damianos, 1975; Donnelly, 1989; Shilling et al., 1985, 1989; Speyrer & Ragas, 1991; Fridgen & Shultz, 1999; Shultz & Fridgen, 2001
[6] PRC, 1992
[7] Lambley & Cordery, 1991, 1993
[8] Handmer, 1985, p.281
[9] Zimmerman, 1979; Bialaszewski & Newsome, 1990
[10] Sheaffer & Greenberg, 1981, pp.118-121
[11] Palm, 1982, p.265; cf. Brookshire et al., 1985
[12] Warnick, 1977; Holway & Burby, 1990; Fridgen & Shultz, 1999; Shultz & Fridgen, 2001
[13] Sheaffer & Greenberg, 1981, p.114; Shrubsole & Scherer, 1996 (Table 3)
[14] Damanios, 1975, p.127
[15] Speyrer & Ragas, 1991
[16] Holway & Burby, 1990
[17] Shrubsole et al., 1997
[18] Schaefer, 1990, p.328
[19] Lambley & Cordery, 1993, p.450
[20] Tobin & Newton, 1986, p.67; Tobin & Montz, 1994, p.674
[21] Schaefer, 1990; PRC, 1992; Lambley & Cordery, 1993; Page & Rabinowitz, 1993, cited in Shrubsole et al., 1997

[22] Montz, 1987, 1992a, 1992b, 1993
[23] Schaefer, 1990, p.329
[24] Babcock & Mitchell, 1980, p.536
[25] Tobin & Montz, 1994, p.675; Shrubsole et al., 1997, p.170
[26] Donnelly, 1989, p.585; Schaefer, 1990, p.320
[27] Montz, 1992b, 1993
[28] Shepard, 1994, p.44
[29] Lambley & Cordery, 1997, p.6
[30] Tobin & Montz, 1994, p.684
[31] Tobin & Montz, 1994, p.684
[32] Montz, 1993, p.241
[33] Lambley & Cordery, 1991, p.863
[34] Bernknopf et al., 1990, p.48