COULD THE INSURANCE INDUSTRY HELP MAKE FLOODPLAIN MANAGEMENT SUSTAINABLE?

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1 Introduction

Floodplains are flat, easy to settle and productive, thus tending to attract pressures for intense development. From a strict monetary sense, this is quite rational, since the material benefits from exploiting these areas on average normally outweigh the material losses to a significant degree. Indeed, in the experience of most occupiers of floodplains, the losses from flooding are normally minor.

This impression is often reinforced by infrastructure such as levees and dams, designed to mitigate flood losses. However, most flood-mitigating works are generally designed to protect assets from floods only up to the level of the 1%AEP (annual exceedance probability) event, since it is rarely judged economical to install infrastructure that mitigates losses from higher floods. [Floods lower than the 1%AEP level will henceforth be referred to as 'Small Floods'.] Floods can have flows up to roughly ten times those of a 1% AEP flood, so the cost of protecting against floods higher than the 1%AEP level [hereafter 'Large Floods'] will often be substantial, and hard to justify for an event that people might never see in their lifetimes.

Yet when one estimates the monetary losses from floods on a floodplain, one finds that on average about half the losses from floods are from Large Floods, as illustrated in Figure 1, so that when flood-mitigating infrastructure is installed, it only eliminates the risk from Small Floods—addressing only half the problem. Yet the reduction in risk encourages renewed development in the floodplain, and when the inevitable Large Flood does come, the losses will be greater than before, so that installing flood-mitigating infrastructure need not result in significant long-term reductions in flood losses. Thus while it is correct that only a small proportion of homes are exposed to high or very high risk, it does not follow that losses from Large Floods are of less consequence to the community—and hence to the insurers—than those from Small Floods.

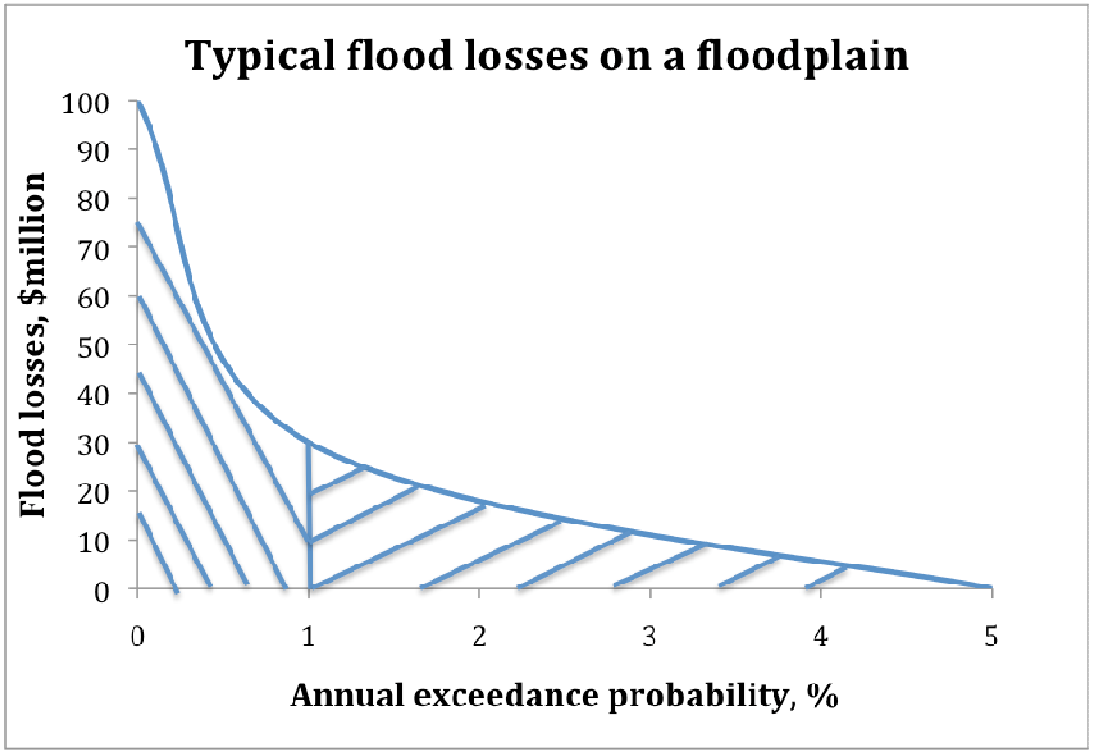

Figure 1 Typical plot of flood losses against AEP. Average annual losses are proportional

to the area under the curve. The area for floods lower than the 1% level (on the left) is about the same as for floods greater than the 1% level (on the right).

It falls then to other techniques for mitigating losses from Large Floods, such as improving communal preparedness and warning systems and insurance. However as will be explained below, improving preparedness is inherently difficult to sustain, particularly for floods above the 1%AEP level. If flood insurance does become more accessible, its design will need to take as much account of Large Floods as Small Floods, since it will be a major mechanism for addressing these losses.

It might be noted that Figure 1, which is consistent with the results of all studies that I have been involved with, is quite different from what is depicted in Andrews et al (2008: Figure 2.2). I have put their results into the same format in Figure 2 together with the curve from Figure 1 for comparison. It can be seen that the curves are very different. There may be several reasons for this. One is that the data for that paper was taken from records and reports of the Insurance Council of Australia. This data was for floods between 1970 and 2006, and it is quite likely that there were few floods higher than the 1%AEP level during that time. As well, the report relies on the work of Leigh and Gissing (2006), which largely considered only properties below the 1% level. Finally, as will be discussed below, many of the properties that were flooded would have been paid under storm and not recorded as flood.

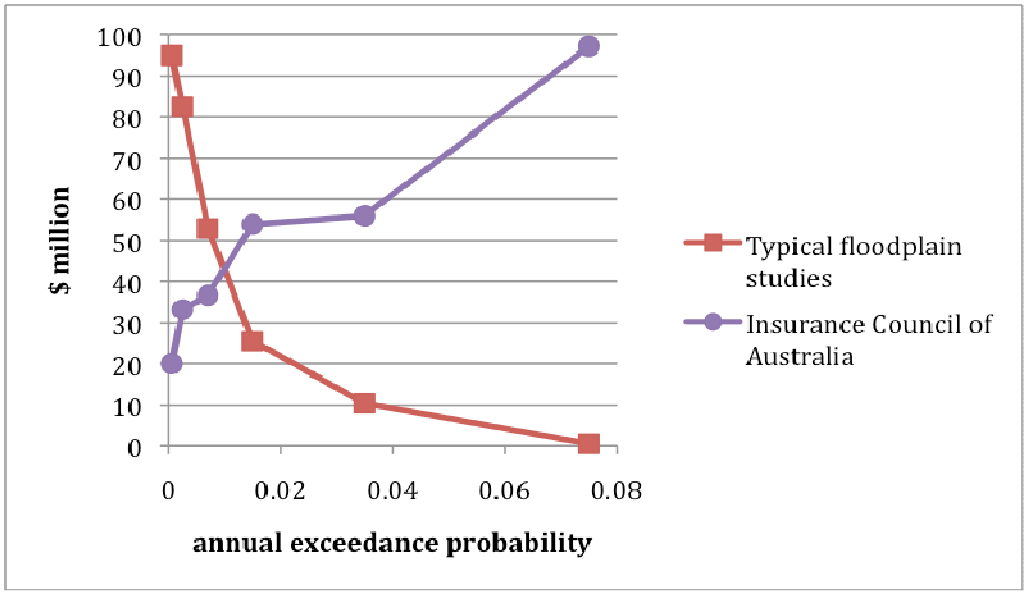

Figure 2 Damage-probability curve as perceived by Insurance Council of Australia, compared with Figure 1.

2 The economics of flood insurance

Even where insurance companies have stated that they do not cover flood damages, I have observed over the years that they can end up paying for a significant proportion of the household losses. In 1989, we estimated from our company's own experience that insurance companies paid as much as half the losses to households, three-quarters of the losses to industry and 90% of floods from urban drains (Lustig and Haeusler, 1989: 14). Since then, the policies of some major insurers have been amended to include most urban flooding, and some rural riverine flooding (Irish, 2002: 114), and with one insurer all household flooding (Owide, 2002: 114), so that these proportions are now higher. The Insurance Council of Australia estimates that in 2006, only 3% of the policies covered flood. This rose to 54% in 2010, and in 2013, it is estimated that the level will be 84%. The insurance industry is not aware of how much it covers flood already. I estimate that the true figure today is about 75%, and in 2013, it will rise to over 90%. It is difficult to understand how amending policies to include all flood losses might not be financially feasible.

It is instructive to compare what happens with Australia's household insurance with the situation in New Zealand, where flood cover is available to households and flooding conditions are not all that different. Bewick and Lustig (1989: 143) found that the flood losses per household in New Zealand were two to three times those in NSW. Part of the reason for this was that the NZ policies covered replacement of lost possessions rather than the indemnity value. Whatever the cause, full cover was clearly affordable by the New Zealand community.

It is arguable that flood insurance is also socially necessary. When one compares the social effects of flooding after the Sydney floods of 1986 and 1988 (Lustig and Haeusler, 1989: 7) with those in Invercargill, New Zealand (Luketina, 1986), the economic importance of flood insurance becomes clear. Sydney people suffered emotional stress, infections, arthritis, heart trouble, marriage breakups, alienation, disturbed behaviour and even premature death. Invercargill residents mostly experienced only stress from disruption to their normal lives.

The social impacts are economically substantial. Our surveys following the 1988 Sydney floods showed that the householders usually regarded the social effects as worse than the financial losses they incurred. This implies that the economic cost of the social effects exceeded the economic costs of the financial losses. In addition, there are substantial monetary costs arising from the effects on health and the cohesion of the family. In other words, the economic cost of flood losses to households is significantly more than double the direct monetary cost of losses to property, and it is reasonable to posit a factor of three. Any suggestion that it may be easy to recover from uninsured losses to contents for other than low income tenants is not readily supported by the known facts.

If flood insurance were universally available, this would substantially reduce the economic costs of the social affects. Thus, while non-financial social costs are monetarily uninsurable, the substantial reduction in social losses when there is flood cover means, in effect, that the most important social losses are insurable indirectly.

An objection to universal flood insurance has been the problem of moral hazard, that flood insurance will remove many incentives for mitigating the losses. It is felt that this is no more an issue than with any other event covered by a home insurance policy. As it is, we found in our social surveys that householders normally respond emotionally to the entry of floodwaters as with an unlawful entry, an event that is covered by household policies. Moreover, a proportion of the potential losses would be of household items that have sentimental value, so even if there were discounted premiums through government assistance to make flood insurance affordable for the most at risk from flooding, there would remain incentives to mitigate losses. A far greater problem is that the resident may simply fail to take such steps through denial of the hazard, as will be discussed below.

The main reason insurers underestimate their flood losses is that they tend to misclassify flood losses suffered high up the floodplain as 'storm'. There are several reasons for this.

- I have frequently encountered situations where, even though I would normally have classified an inundation as caused by 'flood' rather than by 'storm', I could not rule out the small chance that it was otherwise, and so had to give the client the benefit of the doubt. I am obliged to do this under the Insurance Contracts Act 1984, which requires the insurer to show utmost good faith.

- Most flood-prone residences are in areas of low to moderate flood risk, and these are where flash flooding or stormwater runoff are liable to be the proximate (or first) cause of the losses. This is because storm runoff arrives quickly at a site, while with these higher properties, floods take time to rise to the level that causes inundation. By this time the storm will have done some damage, and it can then be assumed that all subsequent losses were caused by the storm as well.

- A further complication is that flooding from short-duration meteorological events is often classified by the insurer as storm. Most urban catchments are small, and their floods would normally result from short-duration events, however defined. Thus properties upstream would be covered under storm, while properties downstream subject to the same flood may not. (As an aside, because it is difficult to underpin such an outcome with logic, insurers who reject claims for flood losses in such situations may be in

breach of the requirements in Secs 35(2) and 37 of the Insurance Contracts Act to explain clearly why they do not provide flood cover.)

- One can rarely know how intense the rainfall was at the site after the event, since the nearest pluviometer (an instrument for recording rainfall intensity) will normally be kilometres away, where the pattern of rainfall will have been different. So it is entirely possible—albeit unlikely—that there was a period of very intense local precipitation—much larger than what was recorded at the pluviometer—resulting in so much runoff that it was able to enter the client's house.

- Finally, the proposed arbitrary distinction between 'flood' and 'storm' can have perverse effects. Stormwater runoff is more likely to enter a house that is low on the ground than one next door where the floor is raised. In such a case, the stormwater could enter the low house before the floodwaters arrived, and the losses should be covered by an insurance policy. The raised house would escape the stormwater, but could then be inundated by the flood, and the losses may not be covered under the same form of insurance policy. Such outcomes defy common sense.

To sum up, the current arrangements may end up with a result that might not be all that different financially from universal flood cover, but it would have a larger social cost. It may also lead to some insurers having difficulties with conforming to Sections 13, 35 and 37 of the Insurance Contracts Act.

3 Enhancing the role of the insurance industry in sustaining the flood-risk management system

It could be beneficial to the insurance industry were it to become more pro-active in ensuring a sustainable floodplain management system. This would be particularly beneficial if universal flood cover were adopted. This is because a sustainable flood-risk management system would need to be designed in recognition of the following trends and features: -

- *Insurance companies have a large and growing stake in having a sustainable emergency management system*.

- *The awareness of the flood risk in a community inevitably declines with time since the last flood*, and flood-prone households are liable to be unprepared for the next big flood, if they are only passive recipients of information on the hazard (Dufty, 2008: 6, Attorney-General's Department, 2009: 57). Insurance companies providing flood cover could help provide incentives to residents of the floodplain to prepare for the flood hazard.

- *The decline in flood awareness results in reduced political pressures for maintaining the preparedness of the flood-prone community*. There is thus an appreciable risk that public resources available for sustaining communal resilience will be small by the time of the next large flood. To counter this, the insurance industry could be empowered to apply countervailing political pressures for funding to maintain the emergency management network. It may even be feasible for the insurance industry—the sector with the greatest financial stake—to provide some of the modest funding needed for the secretariats of the local Flood Risk Management Committees. In this way, it could be assured of having a large and continuing say in the sustainability and enhancement of the local emergency management systems.

These points will be now be explained in more detail.

The awareness of the flood risk in a community inevitably declines with time since the last flood

Flood-prone communities tend to become less prepared for a flood over time following the previous event. If people or those close to them have experienced a flood, they are far more

likely to prepare for the next one, and studies have shown that their losses are less than before (Schiff, 1977: 233, Lustig and Haeusler, 1989: 5). But as they die or move out, their replacements will mostly be unprepared for—if not unaware of—the hazard. Consequently, a first estimate of the decrease of communal awareness over time might be given by the turnover of the population. This is taken to be as illustrated in Figure 3, based on Equation A.2 in Appendix A. It allows for an average population turnover for Australia of 23% over 5 years (ABS, 2010), where people changed to a residence in a different suburb or region. It ignores those people who may have moved into or out of a floodplain within the same suburb or region. Even with this conservative assumption, only about half the population who experienced the last flood will still be there 10 years later.

Figure 3 First estimate of decline in awareness of the flood hazard in an Australian community.

Even if people do observe a flood in their area but are unaffected because the flood does not reach them, they will tend to assume that they are likely to be safe from floods. This is because people tend to attribute favourable outcomes from risky circumstances to skill, and unfavourable outcomes to bad luck (Langer, 1975). Therefore, many of those who are flood prone, yet have been above a previous flood, may convince themselves that they are clever enough to have acquired a house above "the flood level". Typically, people may say that "floods come up to here", and resist the idea that larger floods will come (Slovic et al., 1984: 184). Thus, the expected communal awareness of large floods is likely to be small, as illustrated in Figure 4. This curve is a plot of Equation A.5 of Appendix A, calculated for Australia's turnover of population mentioned above. This indicates, for example, that on average perhaps no more than 14% of households would remain aware of the risks posed by a 1%AEP flood when it arrives. For larger floods, the likely percentage would be lower. While the interest in flood insurance would rise immediately after a flood, it would fall to a negligible amount a short period later.

This low perception of the risk from Large Floods results in the political pressures for flood-risk management efforts being directed towards Small Floods. It is rare for resources to be allocated in an economically efficient manner, so that communal resources directed to managing the risk from Large Floods are equal to those for Small Floods. One cause of this is that few flood-risk management studies undertake economic evaluations of strategies for mitigating the losses from these large floods.

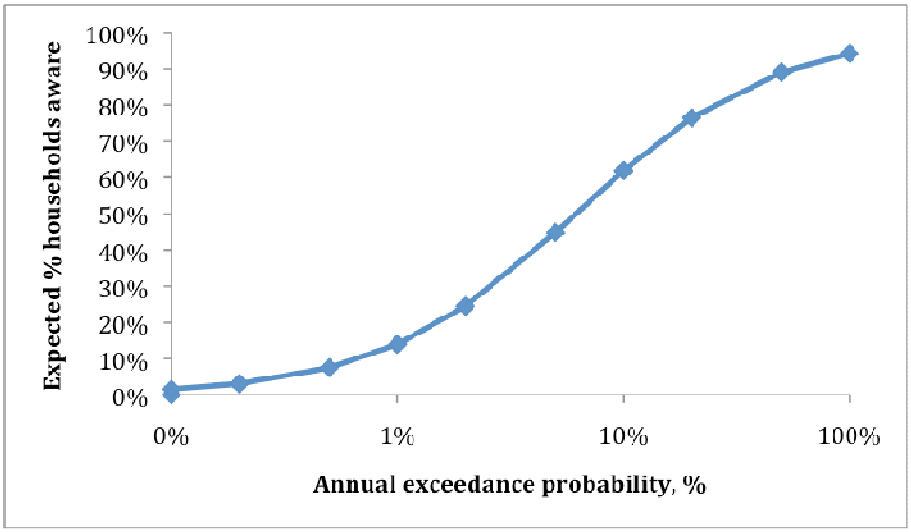

Figure 4 Expected awareness of community versus AEP

A further reason that Figure 3 is too conservative is that there are powerful psychological barriers that make it difficult to maintain resilience in a floodplain. These stem from the fact that it is important for mental health that we feel in control of our lives (Langer, 1977). Feeling helpless can be debilitating, and can even lead to death (Rodin and Langer, 1977: 900-2). Studies show that mental and physical stress can be more readily coped with if the subjects have a sense of control (Langer, 1983). This does not mean that they *are* in control, merely that they *perceive* they are in control.

For example, if people are simply informed that their house it is in a hazardous location, this may threaten their sense of control, if they feel they cannot eliminate the hazard. The only way they might then feel they can retain a sense of control is to deny the problem. [To appreciate how we might behave in such a situation, let us envisage that we have almost completed a large project. Then a newly recruited young graduate points out a fatal flaw. What is our reaction?]

I have frequently observed—immediately after a flood—people telling themselves that it couldn't happen again. It is a source of frustration for floodplain managers who provide the community with information about a hazard to see it mostly ignored. This is one reason that the preparedness of a community will often decline even more rapidly than shown in Figure 3. To illustrate, following the 1974 floods in Brisbane, the price of houses on the floodplain dropped. They were back to "normal" two years later. Among people purchasing a home, there are not just those who are unaware of the flood risk, there are also many who, for a range of psychological imperatives will deny or rationalise away the flood risk. An analogous example of this can be seen from the findings of Miransky and Langer (1978: 404), that people in New York apartments who believed their neighbourhood was unsafe used their locks *less* than those who perceived their neighbourhoods as safe. The writers suggested that the more apprehensive subjects might be trying to distance themselves from negative events. It is not always appreciated that people act not so much to minimise losses, but to minimise distress (Green, 1990: 46). This means that they will only start to reduce losses if they *perceive* that this is the most effective strategy for minimising distress and restoring control.

To sum up, there is only a weak correlation between awareness and behaviour. People may be aware of a hazard, but they can underestimate the risk (Saarinen, 1990: 281). This tendency can be found among floodplain-management experts, not just lay people (1990: 283). [The proportion of flood experts living in flood-prone areas may be an interesting number.]

In light of these considerations, it is suggested that an indicative curve such as in Figure 5 may be more realistic than that taken from Figure 3. [A more "accurate" depiction would depend on the hydrological and topographic characteristics of a particular floodplain, the geographic distribution of housing, the floor levels, and the population turnover.] Likewise, the curve of Figure 4 is probably too optimistic. It follows too, that if equity is an important criterion in the

design of a national disaster insurance scheme, there should be no option for people to decline flood cover. Many people will find it psychologically challenging to appreciate that flood insurance is an important strategy for reducing future distress, and they may choose to opt out of flood cover in order to reduce their present distress.

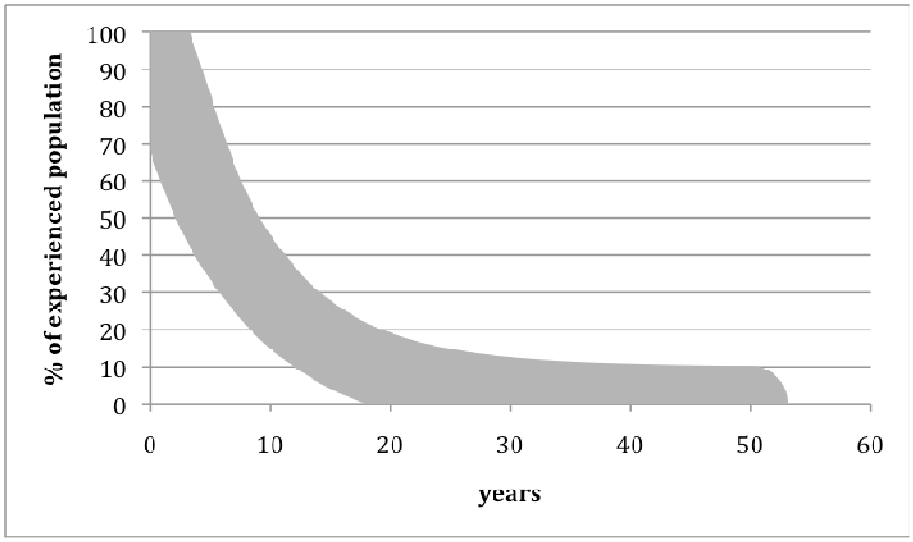

Figure 5 Modified estimate of decline of communal awareness of the flood hazard in an Australian community.

The decline in flood awareness results in reduced political pressures for maintaining the preparedness of the flood-prone community

One of the few strategies for mitigating losses from Large Floods is through emergency services. However, it would be prudent for insurers not to rely heavily on their effectiveness when setting premiums. Emergency-management systems are invariably made up of several government and non-government organizations.

As well, the people in an agency turn over through promotions, transfers and resignations, so that the experiences gained during the last disastrous event become less readily available. The longer the period, the less will be the appreciation by the emergency workers of the pitfalls in carrying out their duties and liaising with other organizations on a particular floodplain. For example, during investigations of the effectiveness of flood warning systems in northeast Victoria in the 1993 flood, I was told that the role of the SES was to combat floods, but not to warn (SKM, 1995: 31).

Unless there is very thorough training, the inexperienced replacements are unlikely to appreciate fully how they should work with others within the particular floodplain-management system. As a result, two inexperienced members of two cooperating organisations may have different understandings of who should do what, so that some tasks may be done inappropriately or left undone before, during and after the next flood. For example, a council flood-mitigation engineer may carefully design a retarding basin to reduce the flooding downstream, and then a council road engineer may carefully build a road above the flood level, restricting the flow of water into the retarding basin.

Figure 6 indicates that with an average 5-year turnover of staff and only four organisations in a flood-warning system (there can be more), the chances of coordination without too many mistakes could become small within a few years. Three curves are shown, labelled Optimistic, Moderate and Pessimistic. The assumptions made in deriving this figure were that an experienced member of staff would have a 95%, 90% or 85% chance respectively of not making a serious error, while a trained but inexperienced person would have an 85%, 80% or 75% chance; and that at time zero, all key personnel were experienced. The equation used for these

curves is B.2 from Appendix B. A spreadsheet computing the graphs in this submission (other than Figure 1) can be provided, to allow the effects of alternative assumptions to be checked.

As it is, since it is unlikely for Large Floods to recur in less than 10 years, it can be expected that there will be negligibly few key personnel who will be experienced at the next event. This difficulty is compounded by the problems of coordination of government agencies even at the best of times. Yet coordination during an emergency is highly likely to encounter situations with little time for delicacy and subtlety.

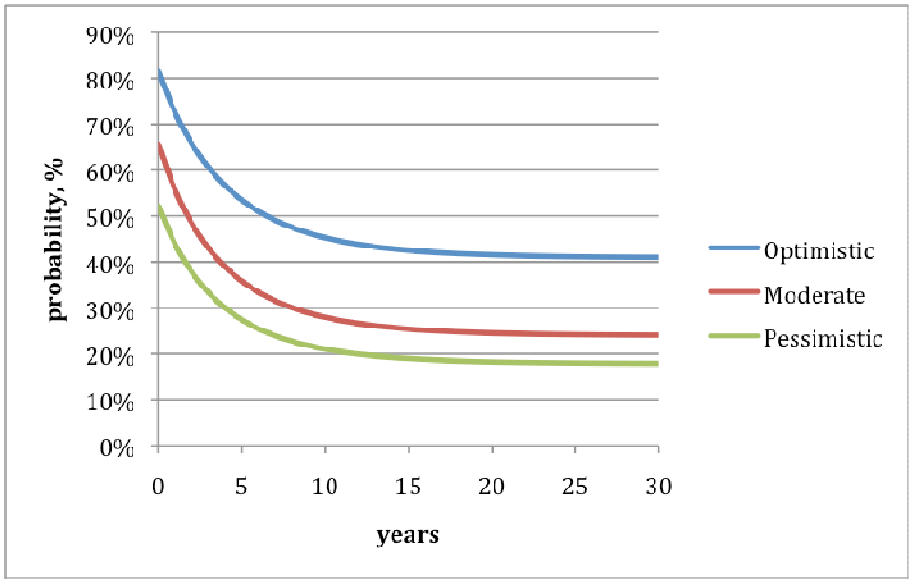

Figure 6 Theoretical decrease in probability of no serious errors within a local emergency management network

As time lengthens since the last event, the risk of an emergency agency being diverted from preparing for the next event increases, and funding diverts to areas where political pressures are greater. If this tendency cannot be resisted—and key emergency-management agencies are rarely politically powerful—the capacity of the agency declines. It is suggested that while strong efforts should be made to improve communication and coordination, we would do well to recognise, in designing a sustainable floodplain-management system, that coordination of flood-risk management has an appreciable risk of breaking down.

For these reasons, it is in the interests of insurers of flood-prone properties that there is continuing pressure to ensure that the various agencies in the emergency-management system remain prepared and coordinated. If the source of this pressure were the insurance industry, it would have the advantage that it was independent of government and that it had a continuing interest in sustaining its effectiveness.

4 Preparedness of commercial, industrial enterprises and government agencies

Commercial, industrial enterprises and public agencies are far less inhibited psychologically from preparing for flooding than households when informed of the hazard. Some support for this was found following the Sydney floods of 1986 (Smith et al., 1990: 21). This is because businesses and public bodies tend to be less emotionally involved. Their decisions to locate on the floodplain stem mainly from financial considerations, and when businesses are aware of the risks of flood losses, these are generally treated as simply an additional financial consideration, possibly addressed by taking out flood insurance.

Since the financial losses from these sectors of the community are often greater than those suffered by households, it would make good economic sense to ensure that businesses are

regularly informed of the risks and advised of strategies for reducing losses, particularly if flood insurance for business is to become more accessible.

Conclusions

- The insurance industry may not fully appreciate that its liability for losses from flooding is large and growing, and that it already pays for most of it.

- Having universal flood cover is an economically more efficient option than the present arrangements.

- The benefits of universally available household flood insurance could be twofold: a substantial reduction in the economic cost of social losses; and enlisting a powerful group, insurers, with a continuing stake in sustaining communal resilience: in return for requiring the insurance industry to make flood insurance universally available to households, it should be invited to become a member of all flood-risk management committees. To enhance its interests and influence, the industry could be asked to fund the modest cost of the secretariats of these committees.

- The monetary losses to commerce and industry often exceed those incurred by households. As this is often covered by insurance, emergency management systems should be designed to facilitate insurers providing incentives to their clients to reduce their potential losses.

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APPENDIX A Decrease in community awareness of hazard with time

(I am indebted to Jim Irish, of the North China University of Water Engineering and Hydropower for this derivation. A version of this derivation was presented in SKM (1995).)

It is assumed that, unless there are sustainable measures to maintain preparedness, people will only apprehend the severity of the hazard if they have experienced it. Thus as people move out of the hazardous zone or die, their replacements will tend not to keep alive the communal awareness of the possible disaster.

Let m be the annual proportion of the community, which does not move out of the hazardous zone. Then if M is given by

$$m = e^{-M} \quad \text{or}$$

$$M = -\ln m \qquad \text{(A.1)}$$

and t is the time since the last disaster, then the proportion of the community that remains aware after time t is

$$m = e^{-Mt} \qquad \text{(A.2)}$$

Let t_D be the time from one disaster to the next. The proportion of aware members of the community that remain a year later is, on average

$$\frac{e^{-Mt_D}}{t_D} \qquad \text{(A.3)}$$

The probability of the period between disasters being t_D is

$$pe^{-pt_D}.\Delta t_D \qquad \text{(A.4)}$$

where p is the annual exceedance probability (AEP) of the hazardous event in any one year, and Δt_D is a convenient time interval. So the expected proportion of the community remaining aware for a given AEP is

$$\lim_{\Delta t_D \to 0} \sum_{t_D=0}^{\infty} \frac{e^{-Mt_D}}{t_D}.t_D.pe^{-pt_D}.\Delta t_D$$

As $\Delta t_D \to 0$, this expression becomes

$$\int_0^{\infty} e^{-Mt_D} pe^{-pt_D}.dt_D$$

$$= \frac{p}{p+M} \qquad \text{(A.5)}$$

APPENDIX B Decrease in effectiveness of a multi-agency emergency management network with time

(I am indebted to Jim Irish, of the North China University of Water Engineering and Hydropower for this derivation. A version of this derivation was presented in SKM (1995).)

Assume that an organisation involved in disaster mitigation turns its key personnel over on average every T_p years.

Assume too, that if a key person is experienced, their chance of not making a crucial error is M_e. Alternatively, if the officer is trained but inexperienced for a flood of this magnitude, the probability becomes M_{tr}.

Then if t_D is the time from the last to the next disaster, the probability P of there being an experienced person in charge is

$$e^{\frac{-t_D}{T_p}}$$

Likewise, the probability of there being only a trained, inexperienced person in charge is

$$1 - e^{\frac{-t_D}{T_p}}$$

So the probability of there being no serious mistake during an event at time t_D is

$$M_e.e^{\frac{-t_D}{T_p}} + M_{tr}(1 - e^{\frac{-t_D}{T_p}})$$

$$= M_{tr} + (M_e - M_{tr})e^{\frac{-t_D}{T_p}} \qquad \text{(B.1)}$$

If there are n such organisations with similar characteristics, the probability of no serious error becomes

$$P_n = \left\{ M_{tr} + (M_e - M_{tr})e^{\frac{-t_D}{T_p}} \right\}^n \qquad \text{(B.2)}$$