Submission to Queensland Floods Commission of Inquiry

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I am an environmental and water engineer with a doctorate in ecological economics. I have been in professional life for 47 years, working mainly in the Asia-Pacific Region, in government, private and academic roles. My consultancy has specialised in, among other matters, advising on strategies for optimally reducing the social and economic losses on floodplains. More recently, I have been undertaking research into mediaeval water systems in South East Asia to see if their histories can provide lessons today.

The issues that will be addressed in this submission concern mainly the first two items of the Commission's list, namely,

- preparation and planning by federal, state and local governments, emergency services and the community; and
- private insurers and their responsibilities.

The two issues shall be dealt with together. I shall discuss the economic and psychological imperatives for flood losses, the tendency for communal preparedness to decline, the factors that continually threaten to reduce the preparedness of emergency systems, and finally positive roles currently being played by the community, commercial, industrial and public entities on the floodplain, and insurers. I shall conclude by recommending some strategies for reducing economic and social losses from floods.

The economic imperative for flood losses

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 can have flows up to roughly ten times those of a 1% AEP flood, so the cost of protecting against large, rare 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 those greater than the 1%AEP level, as illustrated in Figure 1. Further, when flood-mitigating infrastructure is installed (e.g. Wivenhoe Dam), the reduction in risk encourages further development in the floodplain, so that when the inevitable large flood does come, the losses will be even greater.

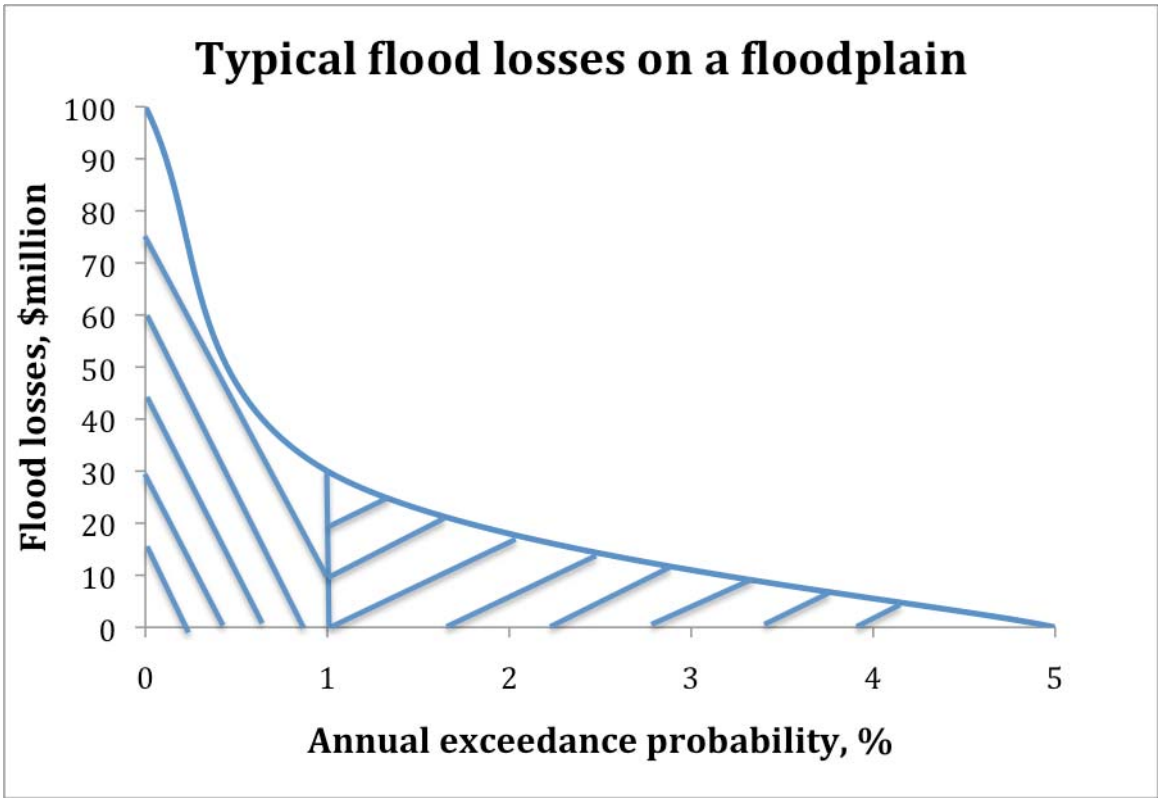

Figure 1 Typical plot of flood losses against AEP. Average annual losses are proportional to the area under the curve. The area for floods lower than the 1% level (on the left) is about the same as for floods greater than the 1% level (on the right).

It falls then to other techniques for mitigating losses from large floods, such as improving communal preparedness and insurance. However, improving preparedness is inherently difficult to sustain—particularly for floods above the 1%AEP level—and flood insurance is not universally available.

Preparedness of householders

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 (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 2, based on Equation A.2 in Appendix A.

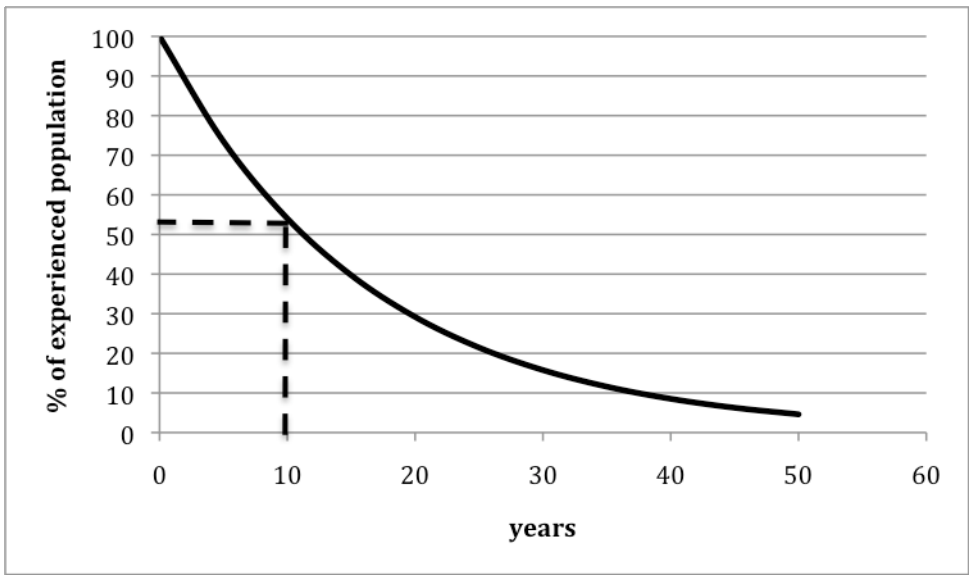

Figure 2 First estimate of decline in awareness of a Queensland community.

However, this curve does not account for psychological impediments such as denial, discussed below. It allows for an average population turnover for Queensland of 26.5% over 5 years (ABS, 2010), where people changed to a residence in a different 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.

Moreover, 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 3. This curve is a plot of Equation A.5 of Appendix A, calculated for Queensland'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 percentage would likely be lower.

This low perception of the risk from large floods results in the political pressures for flood-risk management efforts being directed towards small, frequent floods. It is rare for resources to be allocated in an economically efficient manner, so that communal resources directed to managing the risk from floods greater than the 1%AEP level are equal to those for smaller 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.

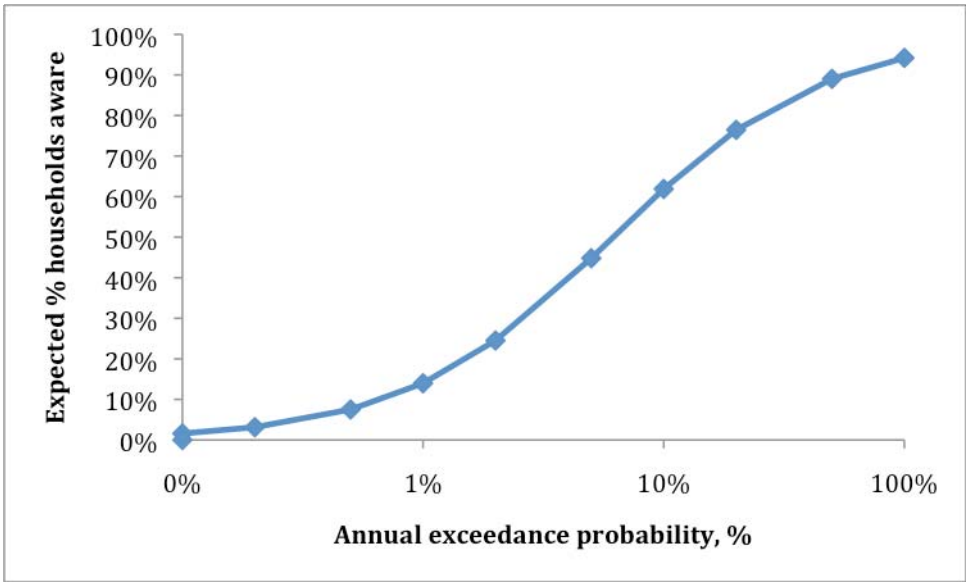

Figure 3 Expected awareness of community versus AEP

The psychological imperative for flood losses

There are powerful psychological barriers that make it difficult to enforce proper maintenance of floodplain-management systems. 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 (Langer, 1975). 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.

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.] It is not always apreciated 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.

Taking all these issues into account, it is considered that the preparedness of a community will often decline even more rapidly than shown in Figure 2. To illustrate, following the 1974 floods in Brisbane, the price of houses on the floodplain dropped. They were back to "normal" two years later.

Preparedness of commercial, industrial enterprises and government agencies

Commercial, industrial enterprises and public agencies are far less inhibited 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 tend to be less emotionally involved. Their decisions to locate on the floodplain stem mainly from financial considerations, and flood losses are generally treated as simply an additional financial consideration, often 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 they are regularly reminded of the hazards and advised of strategies for reducing losses.

Risk of decline in preparedness of emergency systems

Emergency-management systems are invariably made up of several government and non-government organizations. For several quite intractable reasons, it can be difficult to coordinate their activities so that they function smoothly, both when there is an emergency and before the next event. Part of the problem is that many of these organizations will be busy with other priorities during times when there is no emergency, and as time lengthens since the last event, the risk of 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.

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 left undone before, during and after the next flood.

Figure 4 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, rare floods to recur in less than 10 years, it can be expected that there will not be many 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. By their very nature, bureaucracies have to take care not to offend their counterparts. Yet coordination during an emergency is highly likely to encounter situations with little time for delicacy and subtlety.

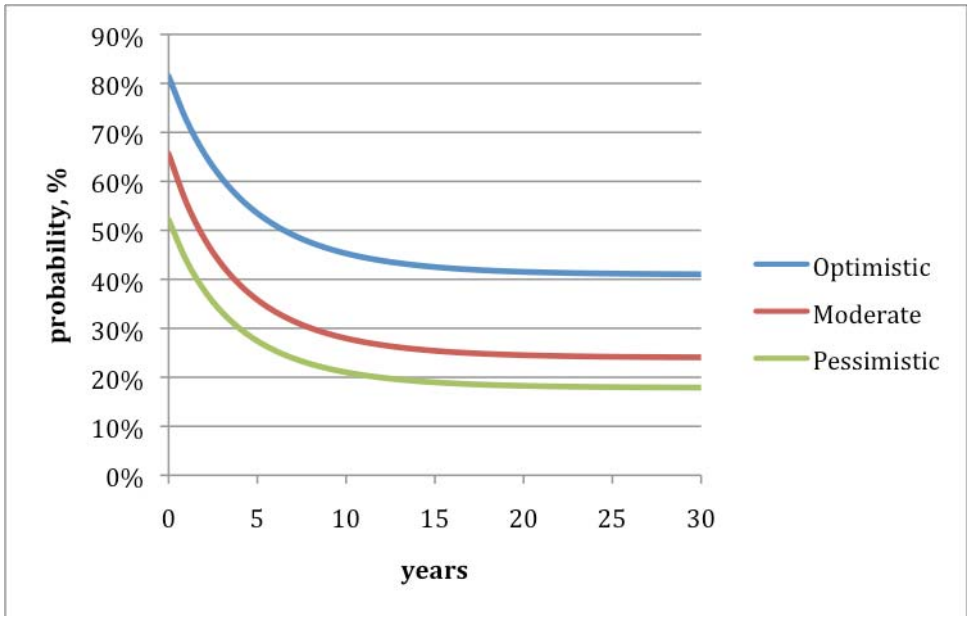

Figure 4 Theoretical decrease in probability of no serious errors within a local emergency management network

It has been a frequent experience to find examples of declining coordination in the period leading up to 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. We would suggest 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; and secondly that inter- and intra-agency rivalry is endemic.

The most effective component of a warning system?

Emergency management services often assume that it is they who are the most important component of a warning system. It was instructive to find during the investigation of the flood-warning system for northeast Victoria that the least trained, least prepared, yet arguably the most effective components of the warning system were family members and friends (SKM, 1995: 29). In these days of even greater personal communication capacity, this appears to be proving even more so, where the first news of disaster come from tweets and SMSs.

Personal warnings are also important for the warning to establish credibility (Saarinen, 1990: 280). Irish and Falconer (1979: 323) describe how during a moderate flood in the Logan River, residents sought to confirm warnings received from official sources by contacting others. The information from these other people might have come from the same source, but this still helped in satisfying the reliability of the warning.

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. Curiously, flood insurance is available for commerce and industry, often at low or even zero premiums. 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 would be higher. 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 insurance is available to households and flooding conditions are not all that different (Bewick and Lustig, 1989: 143). The flood losses per house in New Zealand were two to three times those in NSW. Part of the reason for this is that the NZ policies cover replacement of lost possessions rather than the indemnity value—the depreciated value of the goods lost or damaged. Whatever the cause, it is clearly affordable by the New Zealand community.

It is considered 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 (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. These social impacts are economically substantial. Our surveys following the Sydney floods of 1988 showed that the householders usually regarded the social effects as worse than the financial losses they incurred. This means that the economic cost of the social effects exceeds 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 monetary cost, and it is reasonable to posit a factor of three. If flood insurance were universally available, this would substantially reduce the economic cost of flooding.

Economic evaluations of emergency management strategies

One impediment to giving proper consideration to emergency management for floods higher than the 1%AEP level is that the main strategies for reducing these losses are non-structural, such as improving communal preparedness, enhancing warning systems and insurance. Unfortunately, their benefits appear to have been evaluated economically on only a few occasions when preparing flood risk management strategies. Relationships for evaluating the benefits of improved warning times were developed by Smith et al. (1990: Appendix 7), and Lustig and Haeusler (1989: 5-6) presented relationships to help assess the benefits of improved communal preparedness.

Although the accuracy of these relationships could be enhanced with further studies, they are sufficient for demonstrating that the benefits can be substantially greater than the costs (e.g. Environmental Management, 1995). It would thus help decision-makers justify directing more resources to such strategies if they were evaluated economically as a matter of course. This in turn would provide incentives to improve the information and procedures for such assessments.

Recommendations for sustaining the flood-risk management system

A sustainable flood-risk management system should be designed in recognition of the following trends and features: -

- 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).

- Emergency management networks are likely to be staffed by people who may have experienced a moderate flood in the area, but are unlikely to have experienced an event significantly greater than the 1%AEP flood.

- As the awareness of the flood risk declines, the political pressures for maintaining the preparedness of the flood-prone community lessen. There is an appreciable risk that public resources available for sustaining communal resilience will be small by the time of the next large flood.

- Non-residential occupants of the floodplain are inherently more receptive to advice on the flood hazard than residents.

- Residents are a major component of the flood-warning network.

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

- Inter- and intra-agency rivalry is endemic.

It is suggested that in order to sustain the preparedness of an emergency-management system, it should be designed to provide a strong voice to those with a continuing stake in its efficiency, perhaps through a floodplain management committee. An Emergency Management Committee, with oversight of the emergency management system, could include: -

- insurance companies

- flood-prone commerce and industry

- flood-prone residents

- the SES

- council(s)

- Bureau of Meteorology

- River Improvement Trust(s)

- Department of Environment and Resource Management

The first three groups should be less subject to changing political priorities than the other agencies, and to them could fall the task of applying the necessary political pressures for funding to maintain the emergency management network. It may even be feasible for the insurance companies—the sector with the greatest financial stake—to provide some of the modest funding needed for the secretariat of the Committee, perhaps through the Insurance Council of Australia (ICA). In this way, it could be assured of having a large and continuing say in the sustainability and enhancement of the local system.

A prime focus of the Committee should be to enhance the resilience of the community to flooding (Attorney-General's Department, 2009: Chapter 6, Dufty, 2008). In this way, it could counter the pressures continually threatening communal preparedness. A particular difficulty will be to sustain communal resilience in areas above the level of the 1%AEP flood, even though half the average annual damages are from floods above this level. It may fall to the insurance representative, as the member of the Committee with the greatest stake in reducing the losses, to sustain the pressure for these areas of the floodplain to be kept prepared. Some strategies, adapted from Lustig and Maher (1997: Appendix 1) and set out in Appendix C, may help with this. A further aid would be to

mandate that all flood-risk management studies evaluate the economic benefits of strategies for improving communal resilience.

Conclusions

- The greatest threat to an emergency management network is the declining of political pressure for sustaining it.

- The effort devoted to emergency preparedness is not allocated in an economically efficient manner, being devoted mainly to about half of the problem, floods less than the 1%AEP level.

- 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, this industry could be asked to fund the secretariat 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.

- It should be mandated that all flood-risk management studies evaluate the economic benefits of strategies for improving communal preparedness.

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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

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

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

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

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

APPENDIX C Suggested strategies for sustaining communal preparedness and enhancing a sense of control

- Permanent marks in public places indicating the severity of the worst historical flood, and that of the Probable Maximum Flood;
- photos in public buildings showing previous floods;
- flood drills and advice kits containing simple strategies for protecting property on receiving the warning and for preparing for the next hazardous event;
- advising on ways of safeguarding very important personal property such as memorabilia;
- kits for schools to teach aspects of the hazard in topics such as science, geography, social studies *etc*.;
- school and village plays;
- articles in the local newspapers;
- videos on previous floods and on flood preparedness which are available for a nominal fee;
- programs on local radio stations;
- use as a topic for talk-back radio;
- information leaflets in relevant public offices;
- data personalised for each household, relating the effects of the hazard on the property;
- as a topic for information drama on radio and television;
- incorporating into radio quizzes.

Strategies for developing a sense of control and motivating people to prepare for the next hazardous event:-

- flood-preparedness advice desks at evacuation centres during and after a flood;
- flood -preparedness advice stands at fairs, festivals and other public occasions;
- competitions between villages as part of hazard drills;
- well-publicised subsidies for flood-proofing strategies.