

# Towards a consistent approach to disaster loss assessment across Australia

*Handmer, Abrahams, Betts and Dawson consider some implications of disaster economics*

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## Abstract

This paper sets out the case for a nationally consistent approach to disaster loss assessment in Australia. Advantages of a consistent approach include the provision of a basis for analysing and comparing disaster events and for evaluating alternative risk management and mitigation proposals. Guides exist but are generally not based on economic principles. Economics in this context is not limited to goods and services conventionally valued in dollars. It includes items of social and environmental value which are not normally bought and sold. The Queensland Department of Emergency Services, other Queensland agencies, Emergency Management Australia (EMA) and the Bureau of Meteorology collaborated with the Centre for Risk and Community Safety at RMIT to produce a set of guidelines and an illustrative case study on loss assessment. The *Guidelines* are being implemented in Queensland and agencies in some other states are examining their utility. Originally developed for inundation hazards within a generic framework, they are now being extended to cover other hazards such as bushfires. The paper describes the *Guidelines*, experience with initial implementation, some issues raised by bushfire loss assessment in Victoria, and suggestions for further development of an approach based on economics.

## Disaster loss assessment

Disaster loss assessment is the estimation of losses that have occurred or that could occur as a result of some specified event defined in space and time. It is a critical element of disaster management, as the techniques and estimates of loss assessment support the risk management process. They do this by evaluating risk management strategies and determining relief and recovery needs. Assessment enables a better

understanding of the impact of disasters and the type and extent of losses that communities experience. Understanding the causal factors that underlie losses allows synthesis of losses for given risks and assists in evaluation of alternative mitigation strategies. Another important aim is to support the process of resource allocation between places, communities, hazards, and approaches to management. Resource allocation and comparisons across Australia have been hampered by the absence of a standard, agreed approach. As interest in a national approach to disaster mitigation grows – demonstrated by the recent COAG (Council of Australian Governments) agreement on natural disaster management in Australia (COAG 2003) – the need for consistency in loss assessment becomes more urgent.

This paper sets out the limitations of existing guides, and therefore the requirements that a new guide needs to satisfy to constitute a significant improvement. Special attention is given to the importance of an approach based on economics. Economics is not limited to goods and services conventionally valued in dollars; it includes items of social and environmental value which are not normally bought and sold. These requirements form the basis of flood loss assessment guidelines developed in Queensland with a view to wider application across Australia (Queensland Government, 2002a). The development and contents of these *Guidelines* are outlined. Initial reactions by potential users to the *Guidelines* are analysed. To highlight some of the issues that arise in extending the assessment principles to bushfire losses, the 2002–03 Victorian bushfires are examined. Suggestions for further development and extending the application of a nationally consistent approach to loss assessment conclude the paper.

## Existing loss assessment guides

There are many guides and approaches to loss assessments in use worldwide but they generally have a number of limitations. In particular, most ignore economic principles, and with some exceptions, are weak on comparability (some commercially available and in-house approaches to assessment may satisfy the comparability requirements). In this context

comparability means that assessments for one location, hazard or mitigation strategy are based on similar assumptions, methodology, data quality and effort.

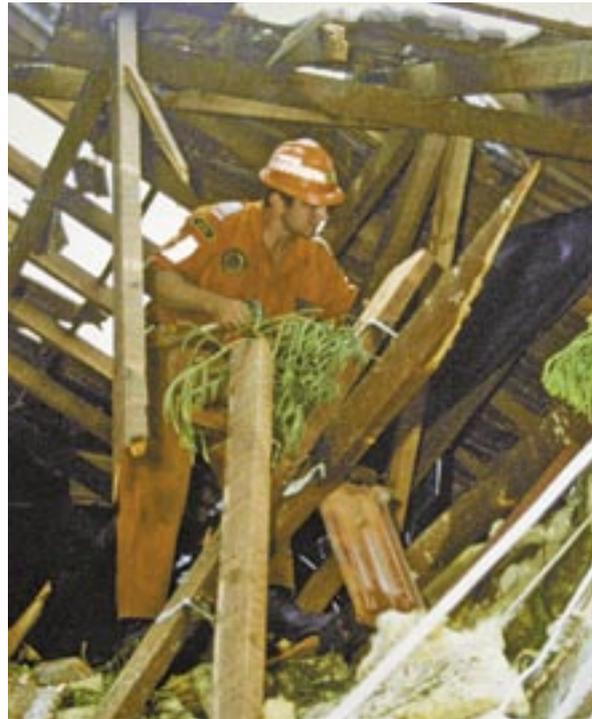
Existing guides:

- focus on measurement issues only—ignoring the overall process of loss assessment;
- focus on a single hazard;
- often don't consider data quality;
- often ignore intangibles (items not normally bought and sold) and may ignore important losses. Such losses are occasionally the losses of greatest concern to many people. Items which are normally bought and sold and have market prices are known as “tangibles”;
- require a high level of specialist knowledge to use;
- usually ignore the principles of economics; and
- are – where they are based on economics – concerned with national rather than sub-national regional and local economies (in this paper “regional” refers to sub-national areas determined by the needs of a particular loss assessment analysis). This becomes important when we are concerned with areas other than the nation, and State and local governments are usually concerned with sub-national areas.

Any new guide needs to address these shortcomings to ensure that it presents a clear improvement.

There is not the space here to examine the principles of risk management or the details of flood loss assessment and how these differ from appropriate practice for other hazards. The key issues with risk management from our perspective are the emphasis on transparency, replicability, consistency, participation and documentation (EMA, 2000; Zamecka and Buchanan, 1999). The relevant distinguishing features of flood loss assessment are set out in the *Guidelines* as well as the two recent BTE<sup>1</sup> reports (BTE, 2001; BTRE, 2002) and are the subject of a vast literature, much of it published by the engineering industry (for example, the US Corps of Engineers), development banks and the project appraisal sector. Flood loss assessment manuals include those by Parker et al., 1987, Penning-Rowell et al., 1992 and 2003, Thompson and Handmer, 1996, FEMA through HAZUS in the United States, and UK government departments like DEFRA (formerly MAFF). Reviews and critiques include Cochrane (1995), and for developing countries Benson and Clay (2004). Here we comment only on economics and consistency.

In loss assessments *economics* is frequently confused with any analysis based on money. However, an economic analysis is based on a particular set of principles. In defining economics we follow long



*Damage to buildings and infrastructures are only a part of disaster loss assessment*

established UK practice and include intangible losses, such as social or environmental items.

An economic analysis is concerned with the impact of an event on the economy of the area selected for analysis (see the references on flood loss assessment listed above)—also sometimes referred to as a macro economic analysis. Defining this economy in space and time is a key step. For example, we might want to know the impact of a cyclone on the economy of North Queensland. After initial analysis the study area could be defined by a number of local government areas and we would examine the impact on the economy in these areas for the year after the cyclone hit (see Queensland Government, 2002b). (However, in some circumstances we may be concerned with the performance of a sector of the economy which may not be as well defined). A macro economic analysis is not about distributional effects; nor is it about commercial profit and loss.

In contrast a *financial* analysis is usually undertaken to assess the loss from the perspective of a group of enterprises and households—this is sometimes also referred to as a micro-economic analysis. Note that assessments made on the basis of insurance data or assumptions may be higher for tangible losses than those prepared using economic principles. This is because household insurance policies value many damaged items as new ones, rather than at their market

1. Acronyms in this paragraph: BTE/BTRE = Bureau of Transport Economics/Bureau of Transport and Regional Economics (Australia); FEMA = Federal Emergency Management Agency (US); HAZUS = a US loss assessment methodology; EMA = Emergency Management Australia; DEFRA/MAFF = Dept of Environment, Fisheries, Resources and Agriculture/Ministry of Agriculture, Fisheries and Food. UK;

value which would normally be much less. In the work at the London Flood Hazard Research Centre, new (or replacement) value has been assumed to be around double the depreciated or market value. It is unclear whether such assumptions hold in modern households with much high value electronic equipment. Loss assessments do not generally include the “underground” or “black” economy, nor do they include the household or domestic economy. The importance of these parts of the economy in comparison to the formal economy will vary greatly, providing a challenge for precise comparable loss assessments (eg see Syrett et al, 2004).

In summary economic assessment is about:

- losses and gains for all members of a defined economy, rather than individual commercial entities or households;
- changes to economic activity in the defined economy, rather than to components within it. The defined economy would normally be the economy of a specified region;
- counting all impacts on this defined economy, both positive and negative (based on the principles of cost-benefit analysis);
- depreciated rather than replacement values. The interest here is on the market value of the asset or activity damaged by the disaster, not what it might cost to replace it with a new asset. This is in contrast to some insurance policies that offer new for old.



Use of case studies provided practical information to assess economic impact

## The Guidelines developed in Queensland

Loss assessment guidelines recently developed in Queensland (Queensland Government 2002a; EMA 2002) are designed to overcome the major limitations of existing approaches, while being generally consistent with existing guides based on economic principles (e.g. BTE, 2001). To do this they:

- deal with the whole process of loss assessment through step by step procedures from identifying the purpose of the assessment through to presenting the results;
- can be applied by people without in-depth specialist training or extensive experience in loss assessment;
- support contemporary emergency management by providing an input to the risk management process;
- are based on economic principles;
- cover all types of loss, including direct, indirect and intangibles;
- are applicable to sub-national (or regional) areas as required, not simply to state or the national economies; and
- can be used for loss assessment after an actual event, as well as for estimating losses for disaster scenarios.

While many guides cover some of these features, a combination of three major features makes the Queensland *Guidelines* distinctive:

- the comprehensive step-by-step process of assessment (Figure 1, page 14);
- the focus on sub-national economies, rather than national economies; and
- the emphasis on producing results which are comparable across space and different mitigation strategies, rather than focusing on accuracy for one specific circumstance.

The last emphasis means that the *Guidelines* favour an “averaging” approach where possible rather than pursuing precision – which may be an illusion in any case (Handmer, 2002; Blong, 2002). Not all existing approaches concentrate on precision; the Victorian RAM (Read, Sturgess and Associates, 2000) approach for flood losses is based on an averaging method.

Unique or unusual to the *Guidelines* are:

- its three approaches to assessment;
- its discussion of the actual to potential issue;
- the acknowledgement of the importance of the time dimension in assessment; and
- its option of an analysis fully based on economic principles. All other guides neglect the full implications of economics at the sub-national level (see following “Critical issues and initial feedback”).

The *Guidelines* are accompanied by a case study of inundation losses associated with *Cyclone Sid* (January



*The principles of economics includes items of social and environmental value not normally bought and sold*

1998) in North Queensland (Queensland Government, 2002b). This study was undertaken to assist with the development of the *Guidelines*, to provide a practical example, and to assess the economic impact of the floods on the economy and people of the coastal region from Townsville to Cairns.

### **The process of developing the *Guidelines***

The development of the *Guidelines* and accompanying case study were supervised by a Project Management Board which represented a range of stakeholder viewpoints including the Queensland Department of Emergency Services, Emergency Management Australia, Queensland Departments of Natural Resources and Mines, Main Roads, Transport, Treasury, and State Development, and the Bureau of Meteorology. The Disaster Mitigation Unit of the Queensland Department of Emergency Services maintained close supervision of all aspects of the project. As the *Guidelines* developed draft manuscripts were examined twice by several external reviewers with specialist expertise. The case study involved extensive consultation with government and non-government stakeholders throughout Queensland.

### **The principles underlying the *Guidelines***

To satisfy the requirements set out above, the *Guidelines* are underpinned by the following:

- the context is set by the principles of risk management adopted by contemporary disaster management in Australia (EMA, 2000; Zamecka and Buchanan, 1999);
- the principles of economics, including those from cost-benefit analysis where comparisons are to be made, underpin the loss assessment process;
- the *Guidelines* are consistent with other disaster loss assessment guides based on economic principles; and

- the step-by-step procedures in the *Guidelines* are for flood loss assessment. But the economic and other principles of assessment are generic and can be applied to most rapid onset hazards. However, there are important differences between hazards that need to be addressed before the method can be extended to other hazards with confidence.

As far as possible the *Guidelines* are consistent with other disaster loss assessment guides and reports based on economic principles, including the BTE report (2001) *Economic Costs of Natural Disasters in Australia*, and the manuals from the UK's Flood Hazard Research Centre at Middlesex University. The *Guidelines* are generally consistent with, and in places draw on, the Victorian Rapid Appraisal Method (RAM) (Read, Sturgess and Associates, 2000). This approach forms the basis of the "averaging method" set out in the *Guidelines*. They are broadly compatible with the HAZUS methodologies being developed by the US Federal Emergency Management Agency and they can be used in conjunction with computer-based methodologies such as ANUFLOOD (now superseded).

### **The contents of the *Guidelines***

In addition to much supporting material – some of which are outlined above – the *Guidelines* set out the process of flood loss assessment in 12 steps (Figure 1, page14), with aims and procedures for each step. These steps can be thought of in terms of five broad tasks:

1. Define the purpose, identify the stakeholders and resources available, define the area and time frame (Steps 1–3);
2. Select the type of assessment – averaging, synthetic or survey (Step 4);
3. Establish the information base about the hazard, people, assets and activities, and types of loss (Steps 5–7);
4. Measure the loss (Step 8); and

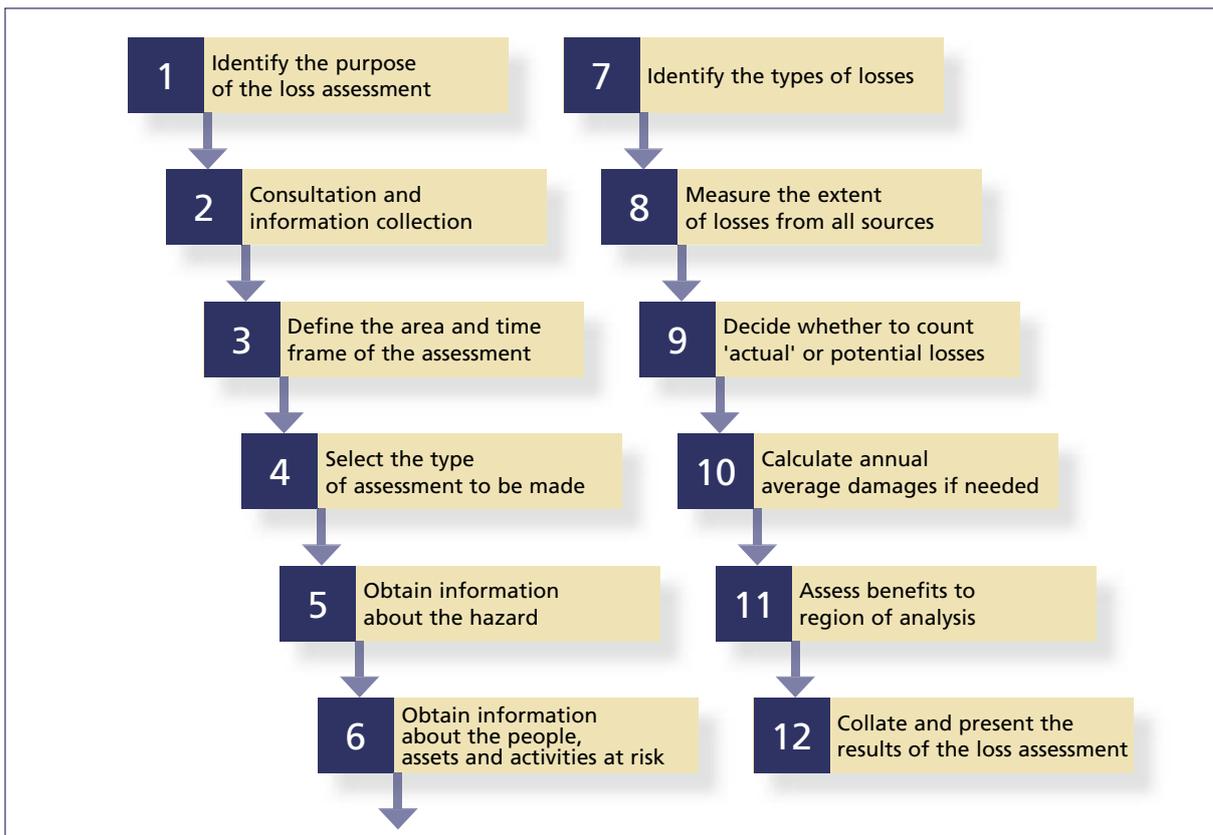


Figure 1. Step-by-step loss assessment process. (From Queensland Government 2002a.)

5. Analyse and present the results to be consistent with the purpose of the assessment. As appropriate consider actual and potential losses, average annual losses, and net economic loss (Steps 9–12).

An additional step not included in the published *Guidelines*, which should be added, is that of dataset improvement and methodological enhancement.

Three general approaches to measurement are set out:

- The *averaging approach*, based largely on pre-existing average data on losses for example an average loss per flooded property is the least expensive and quickest method (e.g. Read Sturgess and Associates, 2000);
- The *synthetic approach*, a detailed assessment based on pre-existing databases covering a range of average building types and contents. Loss tables are often developed theoretically or synthetically as opposed to being based on experience (eg the UK approach as set out in Penning-Rowsell et al., 1992; or the ANUFLOOD computer program); and
- The *survey or historical approach*, based on detailed surveys of a recent event to establish the actual loss. A characteristic of this approach is that it incorporates all the unique attributes of the event in question including the details of the response and people's preparedness which includes the time of day etc, making it less suited for comparisons. It is also very sensitive to the resources and expertise used to collect the data. This approach is difficult to use without a recent disaster to generate losses.

The details of applying the approaches are set out in the *Guidelines* which recommend the use of an averaging approach for reasons of comparability, cost and the limited expertise needed to use the approach well. A key issue is obtaining the needed data. For the averaging approach the *Guidelines* set out some data (which may now require updating), and suggest sources for other data. For example, information on Natural Disaster Relief Arrangements (NDRA) payments and insurance payouts provide useful data on certain types of losses provided the limitations of these sources are recognised.

### An assessment of the 2003 Victorian bushfires on regional economic activity

A whole-of-government project managed by the Office of the Emergency Services Commissioner (OESC) was tasked with identifying the economic impact of the 2003 north-east Victorian bushfires on regional areas. Calculating a total economic cost should document the magnitude of such a major emergency, which in this case led to 1.3 million hectares being burnt over 59 days (Esplin, 2003). Initial discussions with State and local government personnel showed that the process to provide a final economic loss assessment would be complex. This complexity was due to the varied quality and quantity of available cost and impact assessment data, and to the size and nature of the fire itself. What we discuss here, however, are the processes and

activities involved in the loss and impact assessment itself. The assessment process has the potential for evaluating the mitigation, preparedness and recovery measures undertaken within the event.

The Victorian State Government has a range of financial assistance packages within the State Emergency Recovery Plan for both municipal councils and the public. The Australian Government assists the State Government to provide approved financial assistance to eligible persons and organisations following natural disasters. This arrangement is known as the Natural Disaster Relief Arrangement (NDRA) and is administered through the State Department of Treasury and Finance. While the NDRA has reporting requirements it does not currently provide a framework that would enable an economic impact of a bushfire to be calculated.

Initial reports of the losses resulting from the Victorian bushfires were based on the compilation of cost receipts associated with tangible losses and the cost of services provided within the response and recovery phases. The damage to environmental elements has been measured by the cost attributed to clean-up or recovery rather than on their value to the region's economy.

In each of the local government districts affected directly by the bushfires, the economic value of livestock losses and of tourism activities varied according to the importance of that particular element within a district. Research has documented the negative effects of bushfire smoke on the viticulture industry and local

information suggests that tourists who had to change their holiday destinations because of the bushfire have not made a decision to return. The recovery process, which has included the use of available financial grants and support, appears to have relied on the knowledge and preparedness of small business and farm owners. There has been only anecdotal information about the impact of intangible losses such as community event sponsorship, family lifestyle and health.

The nature of the bushfire in certain areas also influenced the type of impact. The slow path of the bushfire toward the east of the State meant that the community, businesses, and industry were on 'stand-by' for lengthy periods of time. During this time the business and agriculture activities of some townships just stopped, waiting for the bushfire to arrive. It appears that the mitigation measures used by emergency services managed to reduce losses significantly in the agriculture sector (fencing, grazing land, livestock and commercial timber).

When the bushfire arrived at a town, most of the economic activity of the town was put on hold while small business and farming personnel took up the tasks of fire fighting. Some businesses continued to operate, particularly those servicing the welfare and accommodation requirements of the emergency service organisations.

The *Disaster Loss Assessment Guidelines* (EMA, 2002) were used to assemble the data and information



Many local businesses and farming activities come to a standstill to allow people to respond to the emergency



*The Guidelines suggest that flood loss assessments are not adjusted for local circumstances*

submitted to the Victorian Ministerial Task Force on Bushfire Recovery 2003. A sector map has been developed to identify both the tangible and intangible economic losses resulting from the bushfire. This map aims to clarify at which level of government, community and agency the impact might be experienced. A whole-of-government approach to this project has also provided access to the loss assessment data collected to date, and has helped the identification of gaps and questions still to be resolved.

The continuing challenge in the development of an economic methodology for bushfire loss assessment which incorporates a cost/benefit analysis, is the inclusion of the following factors:

- the 'recovery over time' influence;
- the simultaneous impact of events such as drought and soil erosion;
- the State and Australian Government provision of funding and services; and
- the insurance claims made by householders, businesses and farmers.

### **Critical issues and initial feedback on the *Guidelines***

Feedback and comments on the *Guidelines* have been primarily in two areas:

- the methodology, and
- apparent gaps in assessment knowledge.

Some aspects of the methodology are challenging in the sense that they challenge usual practice. These aspects include the full application of economic principles, the recommended approach to "actual" losses and use of an averaging approach. Any criticisms of the *Guidelines*

should be seen in the context of the inherent limitations of all loss assessments (Handmer, 2002).

Full economic loss assessment involves measurement of the net change in the economy under consideration. So an assessment should count the losses to the local economy as well as the benefits from the event being assessed. Benefits to the economy would include insurance and disaster relief funds that flow into the economy from outside. (Note this type of assessment is not interested in benefits and losses to individual firms and households. The interest is on the economy as a whole). To obtain "net economic loss", any benefits to the economy need to be subtracted from the assessed losses. This is the full economic measure of the regional impact of disaster. Also important distributional issues might be ignored. The US General Accounting Office (GAO) examined studies of the economic cost of the September 11 attacks in New York. The GAO endorsed a report that estimated the loss to New York City at about US\$83 billion, offset by US\$67 billion of benefits, for a net loss of about US\$16 billion (US General Accounting Office 2003). This study included amounts for loss of life.

However, care is needed in the application of net economic loss and it may not be appropriate as an indicator of what should be spent on mitigation. For example, even though the losses from an event may be very large, the net losses may be small, suggesting that mitigation might not be worthwhile and highlighting that economics should be only one component of decision-making. Another issue is that the jurisdiction from which some of the benefits come may be meeting part of the cost of the mitigation. Note that the *Guidelines* do not include intangible losses and benefits as part of the calculation of "net economic loss". This is because the current state of knowledge about

intangibles does not support the level of quantification necessary for this calculation. We suggest that any assessment should calculate the total and net economic losses and then set out why one approach is selected for use. This transparency would highlight local economic circumstances and assist with comparability.

In Australia flood loss assessments are often adjusted for specific local circumstances. The resultant estimates are termed “actual losses” as opposed to “potential” losses. The use of “actual” losses is not recommended by the *Guidelines* in general loss assessments, as they may discriminate against certain groups, and because of a range of methodological issues. However, where the mitigation measure being assessed is a warning system, preparedness, education programs and the like, at the current state of knowledge, the techniques used for assessment may be similar to those for “actual” losses.

Loss assessment methodologies are weakest when grappling with the “intangible” losses of anxiety, health, heritage and cultural losses, environmental damage and so on. Even though the *Guidelines* set out approaches for assessing intangibles where possible, there are many gaps. Filling these gaps is a long-term aim by drawing on relevant research and practice across areas such as health, heritage and transport.

Another important lesson from the Queensland case study concerns the quality and availability of data. Data quality is a universal issue so it is not surprising that some problems were identified. Some information was not located in space making it difficult to be sure that it was tied to particular events or waterways. Data sets held by different groups sometimes used quite different start and end dates for the same flood event. Some losses were presented for an event as a lump sum, making it impossible to determine the components of loss or to verify the loss estimates. Some loss estimates provided to us used doubtful assumptions and procedures. Improved documentation of data sources and calculations would help this situation.

## Conclusions—broadening the application of the *Guidelines* across Australia

The disaster loss assessment *Guidelines* are designed to help achieve consistency, comparability, rigour in terms of economics, and accessibility. They have been drawn up to be consistent with – while being quite different from – the main existing or emerging loss assessment approaches based on economic principles in Australia, the UK and the USA. As a whole they set out a distinctive approach in attempting to overcome the main shortcomings of existing guides. However, they are far from fully developed.

Further progress with loss assessment in Australia depends on developments in three main areas:

- *Extending the methodology to other hazards.* Although the published *Guidelines* are based on principles which are generic across most hazards, they deal primarily with flood loss assessment. To make the approach useful across Australia, hazards important in different parts of the country need to be included. Work has started on extending the approach to bushfires through the Bushfire CRC (www.bushfirecrc.com), as well as through the work of the Victorian OESC and other organisations.
- *Filling in the knowledge gaps for intangible losses.* Proper inclusion and assessment of intangibles depends on their identification and estimation. Improvements in assessment will require research in the areas of health, environment, heritage and so on. Work on other types of hazards such as wildfire, may help with some areas of intangibles.
- *Achieving consistency across Australia.* This does not mean achieving a detailed uniform approach, but one that produces comparable results. Most effort however needs to be directed at working with authorities across Australia to gain acceptance of the idea of loss assessment based on economic principles, and on the need to collect appropriate data.

Other issues are also important such as attention to data quality, consistency and availability—but these are subsidiary to the areas listed above in that much can be done now through the averaging approach. One important cross-cutting issue concerns a perception by some officials that application of the *Guidelines* and other approaches to disaster loss assessment based on economics is unnecessarily complex, difficult and resource intensive. This may argue for a more straightforward approach that preserves the essence of the principles set out here, while work continues on the development of more comprehensive loss assessment procedures.

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## References

- Benson, C. and Clay, E. (2004) *Understanding the economic and financial impacts of natural disasters*. Washington DC: World Bank.
- Blong, R. (2002) Estimating residential flood damage. In Smith, D.I. and Handmer, J. (eds) *Residential flood insurance: the implications for floodplain management policy*. Canberra: Water Research Foundation: 175–200.
- BTE (Bureau of Transport Economics) (2001) *Economic Costs of Natural Disasters in Australia*. Report 103. Canberra: Bureau of Transport Economics (Now BTRE).
- BTRE (Bureau of Transport and Regional Economics) (2002) *Benefits of flood mitigation in Australia*. Report 106. Canberra: Bureau of Transport and Regional Economics.
- COAG (Council of Australian Governments) (2003) *Natural Disasters in Australia: reforming mitigation, relief and recovery*. Canberra: Department of Transport and Regional Services.
- Cochrane, H. (1995) *The Economic Impact of Earthquake Disasters*. Presented at the conference: *Wellington After the Quake: The Challenge of Rebuilding Cities*. Wellington, New Zealand. March 27-29.
- EMA (Emergency Management Australia) (2000) *The Australian Emergency Risk Management Applications Guide, Part II, Approaches to Emergency Management, Volume I, Risk Management*, Emergency Management Australia, Canberra
- EMA (2002) *Australian Emergency Manuals Series. Part III Emergency Management Practice. Volume 2 – Guidelines. Guide 11. Disaster loss assessment Guidelines*. Qld-Department of Emergency Services and Emergency Management Australia. (Written by Handmer, J. Read, C. and Percovich, O.)
- Esplin, B. (2003) *Report of the inquiry into the 2002–2003 Victorian bushfires*. Department of Premier and Cabinet, Victoria.
- FEMA - HAZUS, Natural Hazard Loss Estimation Methodology, Federal Emergency Management Agency, URL <http://www.fema.gov/hazus/hazus4a.htm> (last accessed 6/5/02)
- Handmer, J. (2002) The chimera of precision. *International Journal of Mass Emergencies and Disasters*. 20(3): 325-346.
- Parker, D.J., Green, C.H., and Thompson, P.M. (1987) *Urban Flood Protection Benefits: A Project Appraisal Guide*, Gower Technical Press, Aldershot.
- Penning-Rowsell, E.C., Green, C.H., Thompson, P.M., Coker, A.M., Tunstall, S.M., Richards, C., and Parker, D.J. (1992) *The Economics of Coastal Management: A manual of assessment techniques*. Gower Technical Press, Farnborough
- Penning-Rowsell, E.C., Johnson, C., Tunstall, S.M., Tapsell, S., Morris, J., Chatterton, J., Coker, A.M., Green, C.H. (2003) *The benefits of coastal defence: techniques and data for 2003*. Flood Hazard Research Centre, Middlesex University.
- Queensland Government (2002a) *Disaster loss assessment Guidelines*. Qld-Department of Emergency Services and Emergency Management Australia. (Written by Handmer, J. Read, C. and Percovich, O.)
- Queensland Government (2002b) *Disaster loss assessment case study*. Qld-Department of Emergency Services and Emergency Management Australia. (Written by Percovich, O. and Handmer, J.)
- Read, Sturgess and Associates (2000) *Victorian Rapid Appraisal Method (RAM)*.
- Syrett S, Evans M, and Williams C. (2004) Report on the black economy for the UK Office of the Deputy Prime Minister. Reported on 19 August 2004 in [http://news.bbc.co.uk/go/pr/fr/-/1/hi/uk\\_politics](http://news.bbc.co.uk/go/pr/fr/-/1/hi/uk_politics)
- Thompson, P. and Handmer J. (1996) *Economic Assessment of Disaster Mitigation: An Australian Guide*, Centre for Resource Environmental Studies, ANU and Flood Hazard Research Centre, Middlesex University, for the Australian IDNDR Committee
- US GAO (General Accounting Office) (2003) *Review of Sept 11 loss assessments*. Washington DC: US GAO.
- Zamecka, A. and Buchanan, G. (1999) *Disaster risk management*. Brisbane: Department of Emergency Services.

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