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NATIONAL CATALOGUE OF FLOOD STUDIES

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Abstract

Following the acceptance in 2003 by the Council of Australian Governments of the twelve reform commitments into natural disaster mitigation, relief and recovery arrangements; the Department of Transport and Regional Services engaged Geoscience Australia to act as its technical advisor in a national program of natural hazard risk assessment. One step in this process was the development of a catalogue of riverine flood studies completed in Australia between 1980 and mid 2004. The catalogue is the first attempt at assembling information on existing flood studies at a national level. It provides the foundation from which to identify and prioritise areas for future flood studies and improve our knowledge of national flood risk. Attributes stored in the database are described; several conclusions are drawn from the data, and a number of recommendations are made relating to the future development of a comprehensive national flood risk assessment.

Key Words: flood, risk, damage, database, national

Introduction

In December 2003, the Council of Australian Governments (COAG) gave in-principle approval to the twelve reform commitments in the report *Natural disasters in Australia: Reforming mitigation, relief and recovery* (DOTARS, 2004). The report was developed in 2002 by representatives from Commonwealth, State and Territory Governments and the Australian Local Government Association. The development of a national catalogue of flood studies was identified by Geoscience Australia as the initial step in meeting the following reform commitments:

- To develop and implement a five year national program of systematic and rigorous disaster risk assessments; and
- To establish a nationally consistent system of data collection, research and analysis to ensure a sound knowledge base on natural disasters and disaster mitigation.

The three elements of a risk assessment involve the hazard, exposure and vulnerability. The hazard is an event characterised by a certain magnitude and likelihood of occurrence. Exposure refers to elements that are subject to the impact of a specific hazard. Vulnerability is the degree to which exposed elements will suffer a loss from the impact of a hazard event. In the past, flood studies have tended to concentrate on the hazard. It is only recently that the importance of undertaking more rigorous risk assessments has been identified as a priority issue. The report *Best Practice Principles and Guidelines for Floodplain Management in Australia* (SCARM, 2000), for example, recommends a risk management approach to floodplain management and

mitigation that looks essentially at each of these three elements and includes mitigation options as part of a Floodplain Management Plan.

Flood studies are usually undertaken to: i) assess flood risk to new developments, ii) assess the impact from changes in the catchment, and iii) establish the benefits of flood mitigation strategies. The work is largely commissioned by Local Councils, State Government agencies, catchment authorities or by private parties. However, despite vast amounts of resources spent on flood modelling, no systematic catalogue of these studies is kept on a national or state level.

The development of a catalogue will help a user to see what studies have been undertaken for a particular area, what techniques were used, and where available, what data has been used and its' custodian. It will enable organisations wishing to commission a flood study (particularly small Councils with little experience in flooding or risk assessment) to learn from the work that has been undertaken in other areas. It can also be used to establish trends in flood studies, for example, the trend towards the use of unsteady flow models rather than steady state models.

At a national and a regional level a catalogue can be used as a tool to assist in determining the areas of high flood hazard and risk, and to aid comparisons of relative risk between urban centres. It may also be used to identify areas where further research needs to be undertaken, for example, where future studies should have a greater focus on risk assessment. The catalogue is the first attempt at assembling information on existing flood studies at a national level, and may be used as another tool with which flood funding organisations like the Department of Transport and Regional Services (DOTARS) prioritise applications for funding.

Scope of the Database

The catalogue is limited to riverine flood studies in existing developed areas. Therefore, the catalogue does not capture information on studies into flooding primarily caused by storm surge, tsunami, dam failure or stormwater. Flood studies for proposed developments have also been excluded as potential damages cannot be assessed. Data was collected for the full range of annual exceedence probabilities available, up to, and including, the probable maximum flood (PMF).

Gaps in the data are inevitable as this is the first attempt at producing an inventory of flood studies nationally. The studies included were independently checked in a number of the states. Therefore the amount of studies likely to be missing is small relative to the total number now listed in the national catalogue.

Data Collection

Information on riverine flood studies undertaken in Australia was collected by Geoscience Australia, with assistance from engineering consultants Sinclair Knight Merz and Patterson Britton and Partners over an eight month period. The primary source(s) of the data varied between the states. In Victoria, for example, data was collected from the State Government agency responsible for flooding and from Melbourne Water. The list of studies was then sent to each Catchment Management Authority for checking and a number of additional studies added. In Queensland, however, studies were sourced almost exclusively from local Councils, making the data collection exercise more difficult. Table 1 shows the primary source(s) of data for each State and Territory.

There were a number of attributes in the database that were mandatory. These attributes covered general information available for all flood studies, including the name of the study, the state, the commissioning organisation, the lead consultant, and the date of the study. Additional attributes were collected that fell into a number of non mandatory categories. The non mandatory categories could not be filled in for all studies, reflecting the different purposes of the flood studies, for example, whether it was a study of the hydrology or

hydraulic modelling of a particular floodplain. There were nine categories of non mandatory information including i) terrain surveys, ii) floor level survey, iii) hydrology, iv) hydraulic modelling, v) flood inundation mapping, vi) flood hazard mapping, vii) damage assessment, viii) historical flood events, and ix) post-flood information.

Table 1: Primary source(s) of data by State/Territory.

State or Territory	Predominant source(s) of studies
ACT	ACT Department of Urban Services
Northern Territory	NT Government Department of Infrastructure, Planning & Environment
NSW	Department of Infrastructure, Planning and Natural Resources
	Local Councils
Queensland	Local Councils
South Australia	Transport SA
Tasmania	Local Councils
Victoria	Department of Sustainability and Environment
	Melbourne Water
Western Australia	Department of Environment

The design of the database was ambitious. Even where information for one of the non-mandatory categories was available, data for all the attributes within that category were not necessarily available. For instance, the horizontal and vertical accuracy for the terrain survey was not listed in the majority of reports, even where a survey had been undertaken.

The Database

Information on approximately 1020 riverine flood studies has been entered into the catalogue. Of these, half the studies were undertaken in NSW and just under a quarter in Victoria (Figure 1).

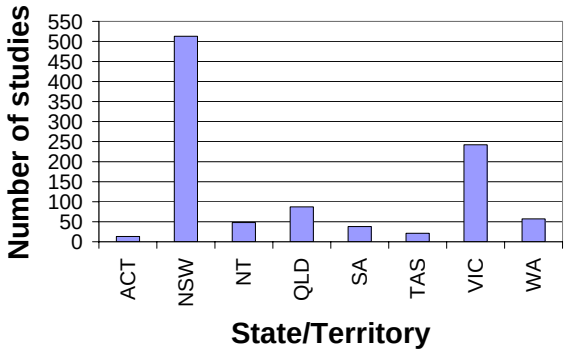

Figure 1: Number of studies completed by State and Territory between 1980 and mid 2004.

The number of flood studies with information in each of the non-mandatory categories is shown in Figure 2.

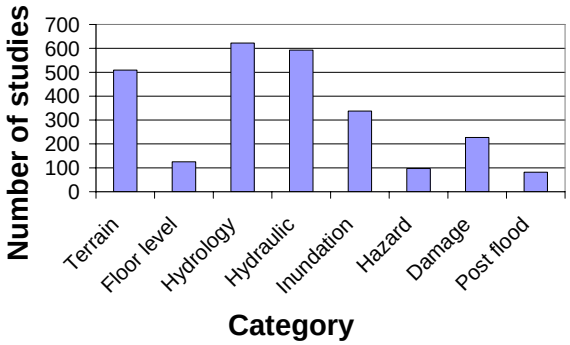

Figure 2: Number of studies by category.

A number of conclusions can be drawn from Figure 2, of which a few are mentioned below:

- Studies generally concentrated on the hydrology or hydraulic aspect of flood modelling.
- The number of studies with hydraulic scenario information exceeded the number of studies with terrain survey information. As hydraulic models require survey information, this suggests that the survey information associated with some of these studies is not documented, and might be difficult to source for future studies.
- There were twice as many studies that included information on damages than information on a floor level survey. For a rigorous damage assessment, the depth

of water overfloor needs to be known as losses increase significantly as soon as water enters a building. This means that one of the key components in undertaking a rigorous damage assessment has not been collected for use in half the damage studies.

- Less than a third of studies that mapped the area of inundation developed hazard maps. For the development of emergency evacuation plans however, information on velocity and depth of inundation, and the change of these through time is critical.

The most frequently modelled average recurrence intervals (ARIs) are shown in Figure 3. The 100 year ARI event was modelled in 80% of studies, followed by the 20 year ARI at 51%. A large range of flood probabilities were modelled, most of which were equal to, or less than the 100 year ARI event. The 100 year ARI event dominates as it has been traditionally used for flood planning and mitigation in Australia. The wide range of scenarios considered in the database makes it difficult to draw comparisons of flood risk between different study areas.

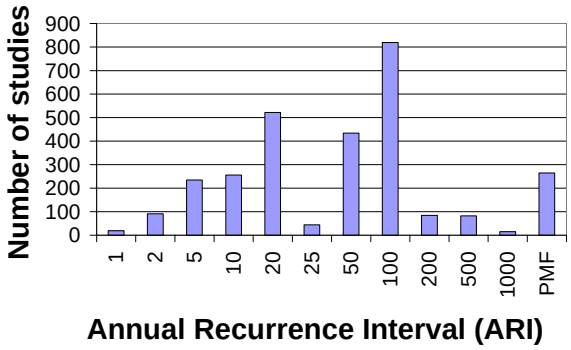

Figure 3: Most frequently modelled ARIs.

The SCARM (2000) report recommends consideration of the consequences of flooding from a range of flood events up to and including the PMF. The Guidelines recommend three sequential levels of flood investigation. These include i) the Flood Study (equivalent to the hazard), ii) the Floodplain Management Study (reflecting the exposure and vulnerability elements of a risk assessment), and iii) the Floodplain Management Plan (which looks at mitigation strategies). The database includes records of all three types of studies recommended in the report, combinations of the three types, and studies that don't fit into any of the three categories.

Under the Guidelines, Floodplain Management Studies should include an assessment of the economic costs of flooding under existing conditions, taking into account the full range of flood events up to and including the PMF. Adoption of the approach recommended in the Guidelines should go towards the Floodplain Management Study element of the sequence addressing the COAG reform commitment of developing and implementing nationally consistent risk assessments for different hazards.

The most frequently used hydrology and hydraulic models are shown in Figures 4 and 5 respectively.

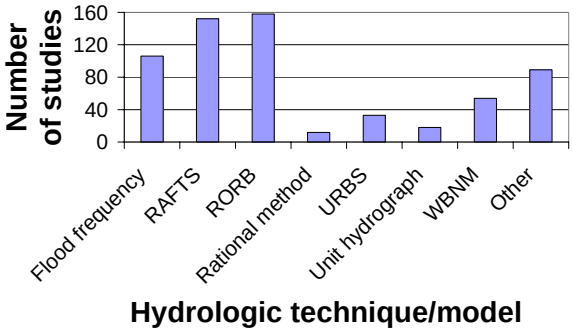

Figure 4: Hydrological techniques and models.

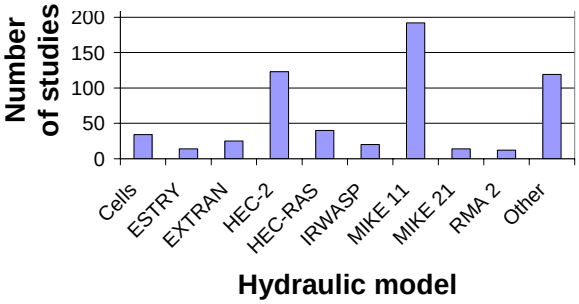

Figure 5: Hydraulic models.

The models of RORB (Laurenson & Mein, 1997) and RAFTS (WP Software, 1994) were used in half of the studies that undertook

hydrological modelling (Figure 4). Flood frequency analysis (Pilgrim and Doran, 1987) was the third most frequently performed analysis at 17%. MIKE 11 (DHI, 2004) was the most frequently used hydraulic model at 32%, followed by HEC-2 (US Army Corps of Engineers, 1982) at 21% and HEC-RAS (US Army Corps of Engineers, 2002) at 7% (Figure 5). Hydraulic models included in the 'other' category were university or in-house developed models which had been used in ten studies or less.

Less than a tenth of studies had information regarding mitigation. Of those that did, 57% stated that there had been modifications to a planning scheme in response to the flood study. The most frequently implemented flood mitigation types are shown in Figure 6. A number of studies adopted more than one mitigation strategy, for example, improving channel maintenance while also increasing channel capacity; or adopting a system of property acquisition while also amending the planning scheme. By far the most frequently implemented mitigation strategy however, was the construction of levees.

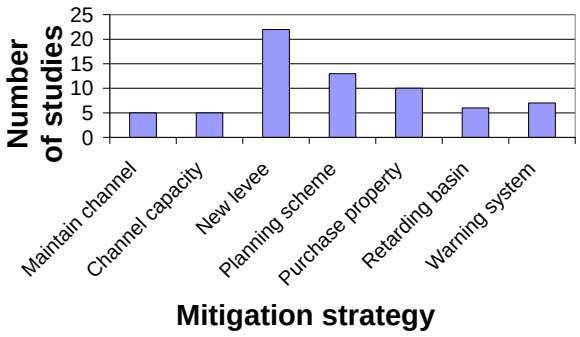

Figure 6: Dominant flood mitigation strategies.

Some other interesting conclusions can be drawn from interrogating the database, some of which are listed below:

- The development of hazard maps has become more frequent in recent years. Eighty two percent of the hazard maps have been produced over the past ten years and 66% over the last five years. In comparison, only 58% of inundation maps have been produced over the last ten years and 34% over the last five years. The recent trend towards producing hazard maps suggests that there is an increased awareness in the industry of the importance of these maps and the greater availability of digital elevation models which assist in their production.

- Only 11% of damage assessments used velocity and inundation in assessing damages, and none mentioned the use of duration of inundation when assessing damage. To undertake a rigorous risk assessment, the depth and duration of inundation and velocity are required.

- More than 40% of the damage assessments fail to indicate what model was used. Of those models listed, ANUFLOOD (Taylor, Greenway and Smith, 1983) was the most frequently used, being used in a quarter of damage studies. The next most frequently used models were FLDAMAGE (Water Studies, 1992) and the Rapid Appraisal Method (Department of Natural Resources and Environment, 2000) at 4% and 3% respectively. The remaining damage assessments were derived largely from historical information, other studies and post disaster interviews. This makes it difficult to compare loss assessments as the model used can significantly influence the economic analysis.

- Fifty percent of the studies that included a damage assessment gave the number of buildings with overfloor inundation, and about a third gave the number of properties with water at least on the property. Only 23% of damage assessments gave both. Forty percent of damage assessments gave neither, however, listed either a damage cost or an average annual damage. The lack of consistency in the method applied to assess damage makes it difficult to compare risk between studies and areas.

Limitations

The usefulness of the database is limited by the information contained in the flood study

reports. In particular, not all studies provided the detail required for all the attributes in all survey categories. The number of studies with inundation or hazard maps could also potentially exceed that recorded in the database, where no reference was made to the mapping in any flood study report.

Maintenance of the Database

The maintenance of the database requires the willingness and input from the flood study commissioning organisations to provide timely information free of charge either during, or on completion of a flood study. One method for facilitating this could be for the government agency responsible for flooding in each state to take responsibility for entering the data into the catalogue. In order for this to work effectively, it would require those groups that commission or undertake flood studies, for example, local governments, to be proactive in supplying the information to the data enterer in each state. Alternatively, those commissioning the flood study could make it a requirement of the consultancy to fill in the data. Geoscience Australia could provide the services of data custodian and maintain quality assurance.

Geoscience Australia is beginning the slow process of redeveloping the database as a relational database on Oracle. Following this, some, if not all the fields may become available on the internet for general viewing. Data input would however be restricted in order to maintain quality assurance. Obviously sufficient caveats would have to be attached with the use of the database regarding its completeness and accuracy.

Recommendations

Following this review of flood studies, a number of key recommendations have been formulated, as follows.

1. Work with the States and Territories to ensure that Floodplain Management Studies are undertaken in accordance with current Best Practice Principles and Guidelines to include consideration of the full range of events up to, and including the PMF.

2. Develop and encourage nationwide adoption of a consistent methodology for undertaking future flood risk assessments.

3. Develop metadata standards in cooperation with the States. Develop closer working relationships between agencies to get them adopted as standard practice.

4. Update and maintain the database on an annual basis. Obtain the agreement of the States and Territories to assume responsibility for collecting and entering data on new flood studies completed in their State/Territory.

Conclusion

In response to the COAG review of natural disasters, a national catalogue of riverine flood studies was developed. This catalogue is an attempt to address some of the issues identified in the report relating to obtaining consistency in data collection and risk assessment. It is also used to identify gaps in our current knowledge base which are then used to formulate a number of recommendations.

During 2004 information on over a thousand riverine flood studies was collected nationally, of which half of the studies were from NSW. While a large range of ARIs were modelled in the studies, the 100 year ARI was the most frequently modelled scenario. Studies generally focussed on either the hydrological or hydraulic aspects of flooding. RORB and RAFTS were the most frequently used hydrological models; with MIKE 11 and the HEC products the most frequently used hydraulic models. Levee construction has been the most frequently adopted mitigation strategy.

The last ten years has seen a trend towards the production of hazard maps and more comprehensive damage assessments. However, the majority of damage

assessments fall significantly short of undertaking a full scale flood risk assessment, largely ignoring velocity and duration of inundation, and in about half of damage assessments also depth of inundation. The lack of national consistency in flood hazard and damage assessment makes it difficult to compare the results between studies; therefore work needs to be undertaken to develop and adopt consistent methodologies on a national scale. The success of these may be reflected in reviewing the entries in the database again in the future. However, this isn't achievable unless effort is made to update and maintain the database.

Acknowledgments

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