Lessons from Cyclone Larry in co-ordinated earthquake post-disaster surveys

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Abstract

Natural disasters provide an invaluable opportunity to capture data for improving our understanding of risk. Observed damage types and their predominance provide useful insights into the factors contributing to building vulnerability and consequential community risk. They also facilitate the appraisal of mitigation measures directed at reducing that risk where it is found to be high. Survey activities that followed the impact of Tropical Cyclone Larry have highlighted the benefits of a co-ordinated survey response to natural hazard impacts. The response to this event involved liaison with local emergency management and the broad participation of recognised wind engineering experts. Survey techniques were refined to achieve a more efficient and comprehensive approach that ensured consistency, utility and transferability of the data for all collaborators. The refined approach proved very successful and may provide a useful model for similar post-disaster exercises directed at earthquake damage. The sudden nature by which earthquakes inflict damage without warning points to having arrangements already established beforehand for the best survey outcomes. Proposals for advancing such preplanning are presented.

Introduction

The risk natural hazards pose to Australian communities is not precisely known. The review of natural disaster management presented to the Council of Australian Governments (COAG 2002) included recommendations on improving this understanding of natural hazard risk. The subsequently funded Disaster Mitigation Australia Package (DMAP) is directed at addressing these recommendations to COAG and requires an improved understanding of infrastructure vulnerability. Initial wind risk studies of selected Australian communities (Nadimpalli et al, 2006) have highlighted the significant wind risk posed by tropical cyclones to coastal North Queensland. Consequently efforts have been expended to better understand the vulnerability of the infrastructure in the associated communities as a key component of any improved understanding of this risk. Post-disaster surveys are an important part of advancing this work and the response to Cyclone Larry's impact on North Queensland constituted a major effort to advance this work. In a relatively short time a team of 14 comprised of both specialists and experts was mobilised leading to the capture of a substantial infrastructure damage dataset. Many aspects of this approach are transferable to equivalent surveys of earthquake damage. These are identified for consideration in developing a parallel approach to earthquake damage surveys.

Background

The effective development of vulnerability models involves the engagement of recognised experts in the respective hazard areas. Two wind risk related workshops were organised by Geoscience Australia and funded by DOTARS to engage researchers in the wind field. The first of these was held in Canberra on the 1st Dec 2005 (JDH Consulting 2006). It was entitled "Severe Wind Risk Research Workshop" and the content was equally divided between the assessment of wind hazard and the quantification of wind risk. Of the 10 recommendations advanced by the expert group, two were directed at improved post-disaster activity:-

- A clear strategy for damage surveys after a severe wind event should be prepared. This should involve non-GA personnel.

- Damage surveys should be conducted and reported jointly.

This was followed by a subsequent workshop on the 14th and 15th March 2006 which focussed on wind vulnerability alone and was hosted by the Cyclone Testing Station at James Cook University's Townsville campus (TimberEd 2006). The import of post-disaster surveys also featured prominently in the discussions. The workshop further recommended to:-

- Develop a damage report template for use in wind damage assessment. This would include estimation of local wind speeds in the damaged area.
- Form a team of experts and an engagement process for immediately assessing wind damage from both major and minor events, for calibration of models.

Representatives from key New Zealand research agencies attended both workshops with a view to trans-Tasman participation in severe wind event surveys.

In summary, both workshops identified the need for co-ordinated post-disaster surveys in which field observations were consistently recorded. The opportunity to implement these presented itself much sooner than anticipated when Tropical Cyclone Larry crossed the Queensland coast just five days after the close of the second workshop, impacting Innisfail and several neighbouring communities.

Tropical Cyclone Larry

Tropical Cyclone Larry crossed the North Queensland coast at 7:10 am on the 20th March 2006. While of a devastating Category V intensity close to landfall, the cyclone lost intensity close to the coast and crossed as a mid Category IV (Figure 1). Post-impact survey activities gave evidence of this loss of intensity. Road signage damage was the subject of detailed study and suggested that the local wind speeds as observed at a 10 m elevation in level open country were in the range 50 to 65 m/s. These speeds indicate that the event was more severe that Cyclone Winifred (1986) and that the wind speeds were marginally lower than the design wind speeds for ordinary structures.

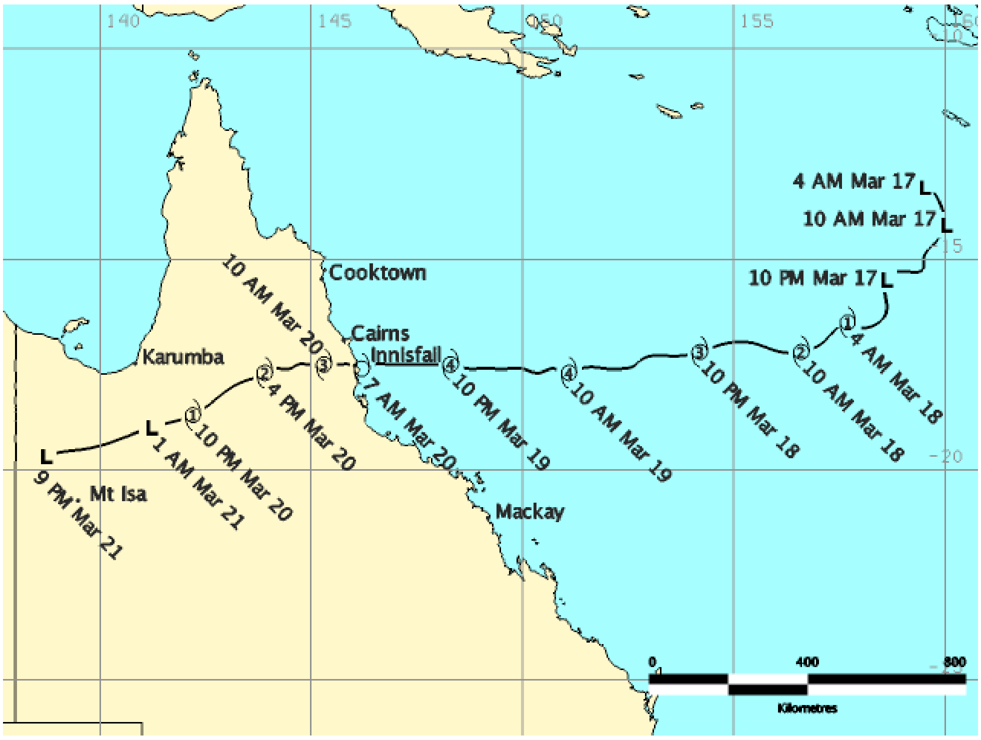

Figure 1: Tropical Cyclone Larry track (Bureau of Meteorology, 2006)

Survey activities

Protocols

Any activity in an area of severe impact needs to be conducted with the approval and co-ordination of emergency services. The existing protocols GA has with Australian emergency management were used in which the duty officer of EMA was contacted who then made contact with the State Emergency Services (SES). The local emergency managers then provided a contact person in the SES for co-ordination of activities. Once in the area the local emergency co-ordination centre in Innisfail was visited to advise of the team's arrival in the area and to be briefed by the SES on any matters that may affect the survey activity.

In parallel with this, previously identified key wind researchers were contacted and a survey team assembled. In the limited time prior to mobilisation efforts were also made to align the survey templates for consistent logging of data. A simple 10 point damage scale was used by all collaborators while GA used in addition a detailed damage logging template on hand-held computers which was refined prior to departure through survey team review.

Team composition

Within 48 hours a forward reconnaissance party departed for Innisfail with the main survey party joining them 3 days later. The combined team comprised:-

Cyclone Testing Station, James Cook University	3
Australian Building Codes Board	1
TimberEd Services	2
JDH Consulting (John Holmes)	1
Risk Frontiers, Macquarie University	1
Geoscience Australia	6
	14

Collaborative field work also took place between GA and the Bureau of Meteorology in the assessment of wind speeds in standard conditions. Both hazard specialists and wind engineers were included in the team as damage severity is meaningless if it cannot be associated with a degree of hazard exposure.

Infrastructure scope

The combined team surveyed in a systematic way almost 2,700 buildings. The composition of the surveyed building stock is summarised in Table 1. Separately Geoscience Australia carried out a non-comprehensive study of critical infrastructure. This included power transmission and distribution along with State Rail radio communication tower assets.

Tools and techniques

Historically post-disaster surveys have tended to focus on damaged infrastructure and their failure types. Novel structural behaviour has been the subject of keen interest as it may give insight into building vulnerabilities and aid the identification of building code deficiencies requiring address. Predominance in the population is approximately considered and the cost of repair is not addressed in detail. Population surveys of all structures (including undamaged) is needed for surveyed damage to be used in a risk process. Further, the level of damage detail captured needs to be greater for reparation costs to be reliably assessed to each structure. Both approaches are needed and were used in the Cyclone Larry survey process.

The building population surveys were undertaken on selected suburbs and communities. GA made use of hand-held computers, GPS equipment and digital cameras whereas the balance of the team surveyed using paper templates. The advantage of the hand-held computers was the ability to control data entry quality through customised predetermined dropdown menus, using aerial imagery, street locality maps as a backdrop and the straightforward input of address and cadastre information from the national database Geocoded National Address File (PSMA 2006 G-NAF). Disadvantages are associated with the cost of the equipment ($2500 per unit), the time involved in overnight data download/upload and the need for some basic training. The equipment utilised is pictured in Figure 2 and the data fields captured are shown in a Geographic Information System (GIS) Figure 3. Assessed overall levels of damage for several suburbs/communities are summarised in Figure 4. The damage to modern residential structures was found to be half that of the older building stock built prior to 1986.

Table 1:- Composition of surveyed building stock following Tropical Cyclone Larry

Building Type	Age	Number Surveyed
Commercial and Industrial	All	177
Government, Community, Education and Other	All	44
Residential	1914 to 1945	413
	1946 to 1959	368
	1960 to 1979	844
	1980 to 1989	239
	1990 to 2006	601
	Total	2,686

Data gathering and collation extended after the field activity. Building portfolio information was obtained from the Queensland Department of Housing which provided data on when their homes were built and roofs were replaced. Building permit data was obtained from the Local Government Authority (LGA) and the high resolution satellite images of the surveyed structures were foot-printed to obtain floor areas. Repair cost modules have been developed for seven building types through a quantity surveying consultancy (Turner and Townsend Rawlinsons, 2006) and are being implemented to turn damage observations into repair cost. Claim data is presently being sought from collaboratiing insurance companies. As a final phase, arrangements are being put in place to survey the residents of surveyed homes to refine and supplement information on retrofitting, building age, window breakage and degree of water ingress.

Figure 2: Field survey equipment used for detailed damage survey activity

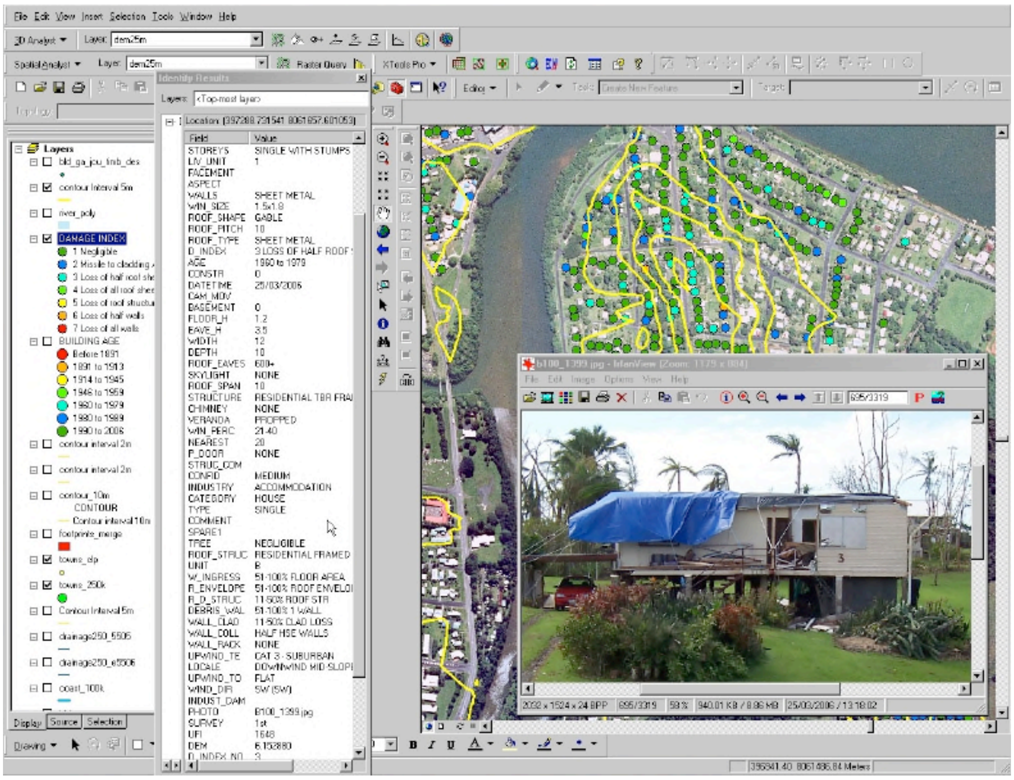

Figure 3: Sample of data captured using field survey equipment in a GIS

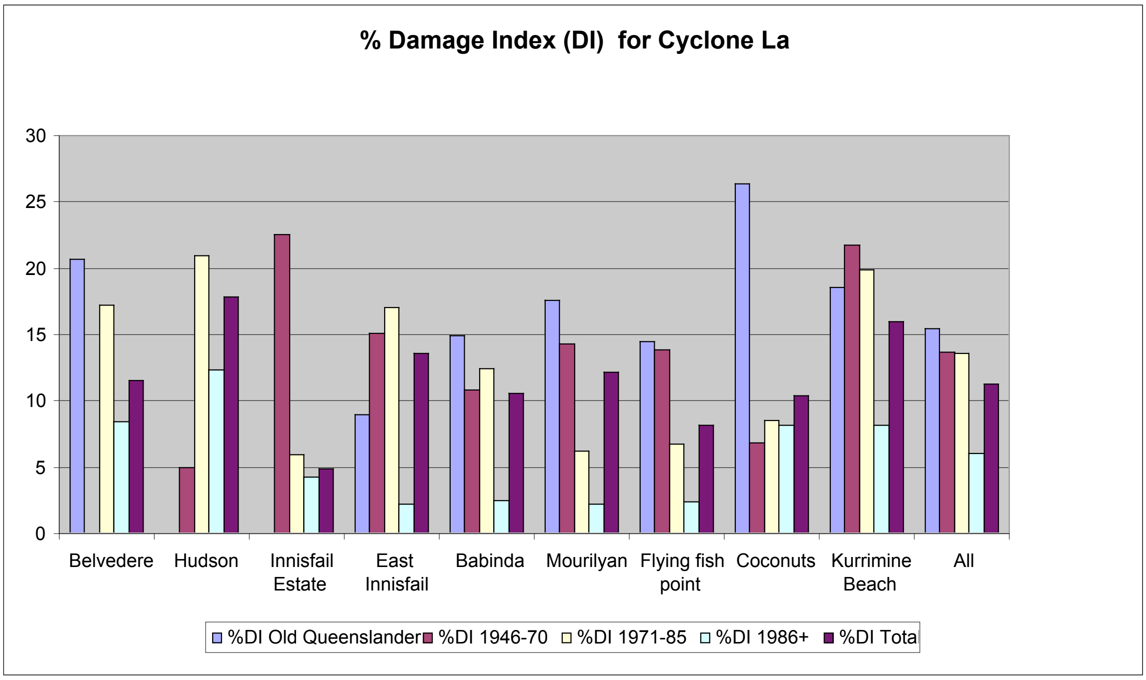

Figure 4: Damage sustained by residential structures for surveyed suburbs and communities separated by age and expressed as a proportion of the cost of complete house rebuild.

Future survey developments

Survey templates for wind damage will be reviewed and refined as part of a third wind workshop scheduled for late February 2007. Geoscience Australia has also acquired field equipment that will permit overall damage as observed from the street to be captured using multiple roof mounted cameras.

Tranferable elements

In the context of equivalent activities the following transferable elements have been identified:-

- The need to seek the input of key specialists in earthquake hazard and vulnerability to resolve the best approach to post-disaster surveys. Workshop activities were found to be an effective way of advancing this for severe wind.
- The value of a regional approach which includes New Zealand researchers. Great value would be derived from participating in damage surveys of both countries infrastructure.
- The establishment of clear protocols with Australian (and New Zealand?) emergency management to permit efficient mobilisation with limited disruption to the first priority management of the immediate event consequences.
- The development of an agreed survey template that captures the data interests of all collaborators. If hand-held computer / GPS data capture is to be used some basic training of all potential collaborators is needed. This could be carried out in conjunction with a workshop activity.
- The inclusion of a broader range of infrastructure. Critical infrastructure needs systematic and comprehensive surveyed.
- The value of early mobilisation. Damage cleanup that quickly follows an event can lead to a corresponding loss on survey information.
- The systematic sourcing of supplementary datasets following an event.

Summary

This survey activity has been the largest and most extensive damage survey undertaken by GA and its other collaborators. It has also drawn upon the broadest group of wind experts ranging from the hazard specialist through to those with a detailed knowledge of structural behaviour. Research outcomes from this activity are expected to become available over the coming months that will permit a better assignment for vulnerability to the North Queensland building stock. Many wind damage survey elements transferable to earthquake damage surveys have been identified which could effectively be incorporated into a coordinated response to the next damaging earthquake in the region.

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