Severe wind hazard/vulnerability modelling workshop, Geoscience Australia, Canberra, December 1st 2005

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Introduction

Severe wind is one of the major natural hazards in Australia. These winds are chiefly produced by cyclones in the north and cold fronts or thunderstorms in the south. In August 2002 the Council of Australian Governments (COAG) published a review of natural disaster relief and mitigation arrangements in Australia (COAG, 2002). One of the recommendations from this review included a commitment by COAG to "develop and implement a five-year national program of systematic and rigorous disaster risk assessments". As part of a response to this commitment, the Commonwealth Department of Transport and Regional Services (DOTARS) enlisted the assistance of Geoscience Australia to undertake the development of a risk assessment methodology for peak wind gusts. This work will form part of Geoscience Australia's wider aim to develop comprehensive methodologies, models and tools, to address natural hazard risk across Australia in a consistent way, primarily for the use of the Federal and State Governments.

The initial research has considered four urban area case studies in three of the four wind regions defined in the Australian/New Zealand wind loadings standard (AS/NZS 1170.2, 2002); Perth (Region A), Brisbane (Region B), Gold Coast (Region B) and Cairns (Region C). This first-order methodology is described in Nadimpalli *et al.* (2006), in the proceedings of this conference (12th AWES conference). The methodology was applied to the four study regions to assess their return period wind losses and risk both collectively and spatially across them, using a GIS-based approach. The approach utilised the statistically derived hazard in the current Australia/New Zealand wind loadings standard and attempted to remove, where possible, the conservatism of this design focused document.

These "first steps" by Geoscience Australia towards a national risk assessment approach were initially reviewed by the Technical Risk Assessment Advisory Committee (TRAAC), setup by the Department of Transport and Regional Services to oversee the implementation of the national risk assessment methodology. The committee queried both the spatial hazard assessment and the structural vulnerability assessment, particularly in relation to the applicability of the damage curves used for structures in the regions considered. Geoscience Australia has been aware that the initial approach has limitations and this has been reinforced by the feedback received from others. Some members of TRAAC proposed that we consult with the principal Australian and New Zealand wind researchers to obtain directions and recommendations on how this work might be advanced to provide more reliable estimates of community risk. The National Risk Assessments Project (NRAP) of Geoscience Australia consequently funded a workshop, convened by Geoscience Australia, with Dr John Holmes (chairperson of the Aust/NZ wind loadings standard) engaged to chair and report on the findings. This event was held on December 1st 2005, at Geoscience Australia in Canberra.

Structure of the workshop

Geoscience Australia consulted with TRAAC and other stakeholders such as Emergency Management Australia (EMA) the Bureau of Meteorology (BoM) to draw up a list of experts in wind hazard and vulnerability (government, research and private consultants), both atmospheric scientists and engineers, to discuss the objectives of the Geoscience Australia severe wind project. Frank and open discussions were encouraged to assist in defining some clear pathways, and in particular, to help develop a strategy for progressive model refinement that could be practically implemented and resourced. Geoscience Australia's preliminary work showed that regional losses are very sensitive to the hazard definition adopted, and that a similar sensitivity

is associated with the choice of building vulnerability models. The workshop primarily focussed on these two areas; severe wind hazard and damage models. The list of 15 attendees, their affiliation and skill-set are listed in Table 1.

Attendee	Affiliation	G/R/C	H	V
Keith Ayotte	Windlab Systems	C	Y	
Geoff Boughton	Timber*Ed* Services	C		Y
Bob Cechet	Geoscience Australia (Risk Research Group)	G/R	Y	
Peter Coppin	CSIRO (Wind Energy Research Unit)	R	Y	
Mark Edwards	Geoscience Australia (Risk Research Group)	G/R		Y
John Ginger	Cyclone Testing Station, James Cook University	R		Y
Bruce Harper	Systems Engineering Australia (SEA)	C	Y	
John Holmes	JDH Consulting	C	Y	Y
Jeff Kepert	Bureau of Meteorology (Research Centre)	G/R	Y	
Andrew King	Geohazards Solutions, IGNS, NZ	C		Y
Yuriy Kuleshov	Bureau of Meteorology (National Climate Centre)	G	Y	
Ian Muirhead	Bureau of Meteorology (National Climate Centre)	G	Y	
Stephen Oliver	Global Environmental Modelling Systems (GEMS)	C	Y	
George Walker	Aon *Re*	C	Y	Y
Kevin Walsh	Melbourne University (Earth Sciences)	R	Y	

Table 1. Workshop attendees (G/R/C, Government/Research/Consultant; H, hazard expertise; V, vulnerability expertise)

Prior to the workshop, attendees were provided with two background papers:

1. summarised Geoscience Australia's work-to-date and detailed the methodologies used.
2. outlined Geoscience Australia's proposed wind risk program of work (3-5 years).

Dr. John Holmes was engaged as the independent chairperson for the workshop. He noted that "there had been very few occasions in the last thirty years that meteorologists and wind engineers had met together on a 50-50 basis; there should be more meetings of this kind". The workshop consisted of a general introduction to the wind risk work being undertaken by Geoscience Australia, and a morning session with short invited technical presentations related to wind hazard aspects, each followed by focussed discussion sessions. The afternoon session consisted primarily of short technical presentations and discussion of vulnerability curves plus general aspects of risk modelling. A list of the workshop technical presentations is shown in Table 2.

recorded downburst events

Presenter	Title
Ian Muirhead	Local wind speeds (Observations; means and peak gusts)
Peter Coppin	Extreme peak gusts
John Holmes	Regional wind speeds in Aust/NZ wind loadings standard
Bruce Harper	"Event catalogue" based modelling
Keith Ayotte	Modelling approach for non-cyclonic Australia
John Ginger	Vulnerability (available models and model development)
George Walker	Role of insurance data in engineering vulnerability modelling
John Holmes	Capturing debris damage in engineering vulnerability models
Stephen Oliver	Risk modelling for transmission line systems

Table 2. Summary of workshop technical presentations

Workshop outcomes

The workshop aimed to provide a series of recommendations to assist Geoscience Australia with the planned 3-5 year program for national scale severe wind risk assessment. The summary of the recommendations are listed below:

1. Sampling and other errors (siting, instrument etc.) represent significant uncertainties and should be considered in the overall variability of the damage estimates.
2. Thunderstorm downbursts should be treated as a separate event type with different multipliers for terrain and topography.
3. Uncertainties about climate change and long-term cycles should be included in the standard deviations of gust speed in hazard models.
4. While a long-term engineering-based vulnerability model is under development (e.g. damage scenario prediction with restitution cost evaluation, windborne debris included more explicitly), Geoscience Australia should proceed with a simpler empirical model based on expert opinions and adjusted to known damage scenarios.
5. Damage surveys from Cyclone 'Vance' (Exmouth, 1999) as well as earlier cyclones, should be considered for calibration purposes.
6. Damage surveys should be conducted and reported jointly (Geoscience Australia, Bureau of Meteorology, Emergency Management Australia, Cyclone Testing Station [James Cook University] and relevant state authorities).
7. A clear strategy for damage surveys after a severe wind event should be prepared. This should involve non-Geoscience Australia personnel.
8. Collaboration with the insurance industry should be pursued in order to obtain access to damage data.
9. Damage predictions by Geoscience Australia should be given as a *confidence range*.
10. A sub-committee should be setup under TRAAC to provide ongoing technical guidance for wind risk methodology development.

The general recommendations from the workshop were:

1. As a national priority, funding should be made available to the Bureau of Meteorology/National Climate Centre to improve recorded anemometer data (e.g. introduce regular calibrations, strengthen AWS installations in cyclonic areas), the severe storm database, and the historical cyclone database (retrospective re-analysis).
2. Support should be given to improve known deficiencies in the wind models in the Australian/New Zealand Standard AS/NZS1170.2

The workshop summary will be published by Geoscience Australia and will be available as a public document on the Geoscience Australia website (www.ga.gov.au). We are also endeavouring to make all the workshop PowerPoint presentations available. There will also be links to recent Geoscience Australia papers and publications in the severe wind risk area. The workshop report is currently being reviewed by the attendees, and the document is expected to be finalised by the end of February.

Summary and Directions for Future Research

The workshop assessed Geoscience Australia's first step in the development of a national methodology for severe wind risk. It included a review of the 3-5 year plan for developing a robust methodology and concentrated on regional hazard assessment and building vulnerability assessment. Geoscience Australia's efforts to date were considered professional and more than adequate for the "maturity" of the approach. However, the work-to-date received criticism with regard to quantifying the uncertainty associated with both the regional hazard and the applicability of the building vulnerability curves utilised. It was generally agreed that the Geoscience Australia risk assessments should follow a probabilistic approach and that reports presented to government and administrators should include an explanation of the uncertainty

inherent in the predictions. A brief report on the workshop was given to TRAAC by George Walker (both a TRAAC member and invited workshop attendee) at the December 6th TRAAC meeting.

The current severe wind risk assessment of the regions associated with four city areas contains considerable uncertainty in the assessed risks due to both incomplete data and the modelling assumptions made. The methodology will be progressively refined and improved over the next 3-5 years until the goal of reliably estimating the risk posed by peak wind gusts is achieved.

One of the recommendations of the workshop is being acted upon presently. Geoscience Australia is arranging a follow up workshop to develop an initial suite of vulnerability curves applicable to Australian structures. The workshop to be attended by wind engineers is proposed for March 2006 and the heuristically derived wind curves produced will be progressively refined in the future. To this end, Geoscience Australia is continuing collaborative research with the Cyclone Testing Station of James Cook University to develop residential vulnerability models for a wide range of construction types.

The workshop allowed Geoscience Australia to strengthen relations and collaboration with the BoM, CSIRO and other as wind engineering researchers and consultants. Clearly improved assessments of regional wind speed are required. Geoscience Australia will be working with the BoM and CSIRO to assess the spatial variation of regional wind speed in the Australian region. Geoscience Australia will also be working with wind engineers and consultants to better specify the statistical assessment of return-period wind hazard, and the local factors which greatly influence the local wind. The most significant local factor is the topographic multiplier, and over the following year Geoscience Australia will be engaging Windlab Systems Pty. Ltd (www.windlabsystems.com) to evaluate the topographic multiplier, M_t , using 3D analysis (an upgrade from current 2D analysis), that will capture complex terrain and topographic shielding not addressed by current wind loading standards methodologies.

Finally, the statistical hazard assessment approach, based on a climatology of hazard, has limitations and studies of other hazards have shown (Patchett *et al.*, 2005) that this approach tends to over-estimate risk. Over the next few years Geoscience Australia's methodology will move from the current hazard map approach to one which is event based. This will involve the use of both a tropical cyclone wind model and a general synoptic scale wind model for the Australian region. Stochastic "event-based" modelling of the assumed climatology will then follow using a Monte Carlo sampling technique to allow the full range of environmental parameters to be explored.

References

AS/NZS 1170.2 (2002) Structural design actions, Part 2: Wind actions, *Australian/New Zealand Standard, 2002.*

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Patchett, A., Robinson, D., Dhu, T., and Sanabria, A. (2005) *Investigating Earthquake Risk Models & Uncertainty in Probabilistic Seismic Risk Analyses*, Geoscience Australia Record 2005/02, Geoscience Australia, Canberra.