RISK MANAGEMENT OF EXTREME WEATHER EVENTS: A CASE STUDY OF COFFS HARBOUR BASE HOSPITAL, AUSTRALIA

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In Australia climate change is expected to generate more extreme weather events such as heat waves, bushfires, storms and floods. Given Australia's relatively high exposure to climate extremes, many hospital facilities are exposed to such events. Using a single case study research the risks of flooding to a major tertiary hospital in Australia are explored. The results identify five key areas of risk which include: the availability of essential (building) services; the physical integrity of the hospital; continuity of service delivery; effective inter-agency communication and access to and from the hospital for staff and patients.

Keywords: adaptation, climate change, extreme weather events, hospitals, risk management.

INTRODUCTION

Scientists have controversially argued that there is a connection between global warming and patterns of extreme weather events such as floods, storms and heat waves (Steffen, Love *et al.* 2006; Intergovernmental Panel on Climate Change 2007; Garnaut 2008; Solomon, Plattner *et al.* 2009; Stern 2009). While the changing healthcare risks posed by such events are increasingly understood (higher incidences of heat stroke, respiratory diseases and tropical vector diseases such as malaria etc., little is known about the adaptive capacity of hospital facilities to support continuity of health service delivery. As DEWR (2007) found, new buildings are reasonably resilient to climate change but there is considerable scope to improve the resilience of existing building stock through new adaptation strategies.

While many types of healthcare facilities provide community health needs during extreme weather events (clinics, day centres, outposts etc., hospitals provide the majority of the community's acute health care needs, the majority of patients will likely present to these facilities and it is from here that responses to health disasters are generally coordinated. However, given the age of Australian and NZ health care

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infrastructure, extreme weather events are likely to create unique physical and patient demand challenges which were not envisaged in original designs. An assessment of the adaptive capacity of hospitals to cope with extreme weather events is thus urgently needed. Yet there has been very little research into the adaptive capacity of Australian and New Zealand hospitals to cope with such events and the extent to which current hospitals represent a risk to effective health care provision is not well understood. This gap represents a major weakness in Australia's ability to respond to the potential impacts of climate change and in addressing this challenge it makes sense to develop a regional response that encompasses the needs of two traditional neighbours and collaborators – Australia and New Zealand. This reflects common regional climate challenges and represents an extension of the ongoing partnership between these countries that is already manifest in the development of Australasian Health Facility Guidelines through joint funding of the Centre for Health Assets Australasia (CHAA) at the University of New South Wales (UNSW). In this context, this research focuses on climate change adaptation strategies for hospitals in Australia and NZ. More specifically, using Coffs Harbour Base Hospital as a case study, this research assessed the risks to infrastructure and services posed by flooding events.

METHOD

Case Study

A case study approach which focuses on a single hospital is an ideal way to investigate how hospitals more generally respond to extreme weather events. It enables a focus on the ways that various stakeholders respond collectively to a single event and the reasons for and effects of these responses over time. Coffs Harbour Base Hospital was selected as a case study in consultation with the New South Wales (NSW) Health Authority, supported by research into: past records of extreme weather events that have had a significant impact on the hospital facility and its services and the frequency of these events; size and age of the hospital and total population dependencies; and future climate projections. A survey of key stakeholders in the NSW health service was also undertaken to incorporate their experiences and perceptions of vulnerable facilities in the choice of the hospital case study.

Coffs Harbour Base Hospital is the largest hospital in the North Coast Area of NSW. Situated on the mid North Coast of NSW, Coffs Harbour city has a population of 68,000 although the Coffs Harbour Base hospital serves a population of 100,000. Coffs Harbour is classified as a sub-tropical area with warm to hot summers and mild winters. The average annual rainfall is 1700mm mostly during late summer and early autumn (Coffs Harbour City Council 2010). Due to its geographical location, flooding and storms are relatively common. However the intensity of severe storms and flooding events has increased in the recent years with six major flooding events in 2009 alone. In November 1996 a flood affected 800 properties with 300 people evacuated. In 2001 floods caused significant damage to adjoining hospital services putting extra pressure on acute services and in 2007 a severe hail storm damaged the hospital building causing roofs and ceiling to collapse. As Coffs Harbour Base hospital is the major referral hospital in the region, other hospitals depend on its services and critically ill patients are moved to Coffs Harbour hospital during an emergency event. For example, in 2008 patients were evacuated from residential age care facilities which put more pressure on the hospital that already had limited numbers of beds. In February 2009, flooding affected five dependent hospital facilities in the region. In March 2009 a one-in-one-hundred year flood inundated the Coffs Harbour Based Hospital site, the CBD area and surrounding streets cutting off all

access to the hospital and causing disruptions to the essential services such as food and waste. In addition hospital service delivery was disrupted by staff absenteeism either due to road closures or school and day care closures. In May 2009 more floods resulted in the evacuation of 148 residents from aged care facilities and on 5 November 2009, Coffs Harbour was again declared a natural disaster area following the flooding which caused damaged to local infrastructure (NSW Government 2009).

Data Collection

Data was collected in a focus group of key stakeholders from a broad cross section of design, health, science, and facility management professionals who work in and around Coffs Harbour hospital, and at NSW Health Department level. The stakeholders were selected using a well established stakeholder analysis framework developed by Freeman (1984) – see Figure 1 below.

Ability to implement project objectives

Objectives affected by project outcomes

	Low	High
Low	Minor Stakeholders All Support Services (e.g. Cleaners, Kitchen, etc. Trade Services Other Government Department Laboratories / pathology	Important Stakeholders Utility (essential) services – power, water, gas Civil Defence and emergency service – (SES) Public Works Dept (State level government dept) Security Patients and community (indigenous, socially disadvantaged, aged, disabled, young, LSE) Staff / Services
High	Major Stakeholders Local Government Designers Union	Key Stakeholders Director Corporate Services Director of Nursing Facilities Manager including IT Emergency Management Personnel Director of Medical Services Ambulance / emergency services Corporate Asset Manager Quality and Safety Management Public Relations Personnel

Figure 1: Stakeholder Analysis

The focus group approach enabled interaction among all stakeholders in a focused and non-judgmental environment. It also enabled in depth exploration of the different ways in which stakeholders perceive an event and how they interacted before, during and after it. Focus group discussions were stimulated by a highly probable extreme weather event scenario which included anticipated implications for health care needs (flash flooding of the Coffs Harbour site). This scenario was generated from past records of extreme weather events in the region and from climate modelling research conducted by our partners at the UNSW Climate Research Centre. In accordance with recommendations made by the UNFCCC (2006), the Australian Greenhouse Office (2005), CSIRO (2006) and UK CIP (Willows and Connell 2003), the focus group discussions were managed using a risk and opportunity management framework.

The framework used is called ROMS (www.risk-opportunity.com). ROMS provided a systematic framework and process to help the key stakeholders collectively identify common goals in responding to the presented climate change scenario, risks and opportunities to those goals and to assess and prioritize those risks and opportunities

in light of existing controls (adaptive facility-related strategies). Risks were defined as facility characteristics that could impact negatively on health care continuity and quality during an extreme weather event (e.g. failure of critical equipment, infrastructure and building fabric). Opportunities were defined as facility characteristics that could impact positively on health care continuity and quality during an extreme weather event (e.g. new technologies, flexible space allowing change of use, sustainable energy sources not vulnerable to energy outages etc..

RESULTS

The ROMS process involves eight steps which are described below. In the first stage of this research (reported here) steps one to five were completed. The next phase of the research will cover steps six to eight.

Step one – Project information
A ROMS record was created for each hospital case study for future monitoring, learning and compliance purposes. The interface from step one shows the key stakeholders involved and the focus of the workshop discussion which was agreed to be 'How to ensure that our facilities do not represent a risk to our response to climate change related extreme weather events'.

Step two – Analysis complexity
Step two involved selecting a level of analysis from level 1 (simple qualitative analysis) to level 4 (probabilistic analysis). Level 3 was chosen for this research project based on past project experience (See: www.risk-opportunity.com for more information).

Step three – Stakeholder consultation
Key stakeholders were required to identify their objectives in responding to the climate change scenario and then rank and weight five common objectives. Common objectives create a sense of collective responsibility between the key stakeholders, avoiding the silo mentality which afflicts many hospital and similarly structured organizations. Figure 1 illustrates the final list of objectives as the output from step three.

Common Objectives	Weighting
To ensure staff and patient safety (including vulnerable patients within the community)	40%
Maintain essential services and physical fabric (water, electricity, gas, communications (IT), sewerage and sufficient supplies).	20%
To ensure continuity of service delivery (core clinical services – theatres, emergency, maturity, ICU and ensuring adequate staff resources to deliver health services – senior management and health staff)	20%
To ensure timely access in and out of facilities for staff, patients and emergency vehicles (to ensure we maintain adequate resources and staff available to cope, patients can get treatment etc. – including wider access in catchment area	10%
Effective internal and external communications.	10%

Figure 2: Output from Step Three of ROMS – Common Objectives

Step four – Identify risks and opportunities
Key stakeholders identified both risks and opportunities which could adversely or beneficially affect the project objectives. Stakeholders were required to identify at least one opportunity for each common objective, enabling them to generate innovative solutions that could use the scenario advantageously to improve health

outcomes. ROMS provides a range of techniques which correspond to the level of complexity chosen in step 2. At the simplest level, simple checklists and work

Common Objective (Ranked)	**Risks**	**Opportunities**
To ensure staff and patient safety (including vulnerable patients within the community)	Flooding into clinical areas Roads being cut Inability to respond to speed of event Lack of disaster procedures for vulnerable patients Lack of ability to cope with surge of demand Unpredictability of pattern of event (intensity, nature/pattern/location of impact, etc. Not having leadership available ON SITE causing poor coordination during event Adequacy of community age care facilities BCM plans and capacity to implement those plans	Develop and implement flood mitigation strategy for the site (e.g. Coffs Harbour bypass may present opportunity, engage with urban planning controls) Build a multi-storey car park
Maintain essential services and physical fabric (water, electricity, gas, communications (IT), sewerage and sufficient supplies)	Flooding into essential services (usually in the basement) Inability of key maintenance staff to get to work Inadequate building design (e.g. Low pitch roof design, drains, essential services located in flood-prone areas – at low levels etc. No back-up essential services (due to cost savings etc. Just-in-time models for logistics resulting in reduced on-site stock External service providers – cessation of services such as food, linen, waste etc Not having an adequate minimum level of supplies maintained (fuel, food, etc. Capacity of emergency services to get necessary resources to site	Increase self-sufficiency (utilize roof space for water collection, solar – use of new technologies etc. Revize HFG and other regulations and guidelines re. Design and planning of critical infrastructure
To ensure continuity of service delivery (core clinical services – theatres, emergency, maturity, ICU and ensuring adequate staff resources to deliver health services – senior management and health staff)	Specialist staff themselves being affected by the flood (can't get to work – their priority will be their family and property) Lack of new growing population's knowledge of flood events Being regional we have a limited pool of casual staff and specialized staff to draw on and no back-up supply of staff (e.g. Intensive care nurses) Timing of the event – if occurs after hours increased risk Lack of availability of staff over an extended period – replacement of fatigued staff	Adapting other facilities to accommodate staff during an emergency
To ensure timely access in and out of facilities for staff, patients and emergency vehicles (to ensure we maintain adequate resources and staff available to cope, patients can get treatment etc. – including wider access in catchment area	Hub and spoke model of service delivery can be compromised by loss of access in wider catchment area Singular access to the site and potential secondary access is also flood-prone Availability of appropriate vehicles to cross flooded areas (e.g. Water police, boats, large 4WD etc. Co-location of ambulance means cannot get out during a flood Inability to air lift critically ill patients to tertiary care – rotary unable to fly	Create a flood-free access to the hospital Further develop our telehealth facilities
Effective internal and external communications. EXTERNAL (Horizontal – SES, police, council, community services, power/energy – all LEMC members; Vertical – Department of Health, HSFAC) INTERNAL – onsite services, staff, etc.	Location of emergency operating centre in town preventing management staff working there Inadequate phone access – swamping of mobile and landline and control centres Inadequate early warning system Inadequacy of communication systems for campus population – staff and public (e.g. PA system etc. Inadequate numbers of senior staff to attend to all areas and other staff stepping in inappropriately Controlling large volumes of conflicting information from numerous sources to avoid misunderstanding Clarity of communications – to ensure people respond appropriately – need to withstand scrutiny People not following protocols/directions	Ability to control from one single source all communications to entire campus via designated screens/TV system override/emergency channel etc Coffs Council can make their emergency operating centre flood free

Figure 3: Output from Step Four of ROMS

breakdown statements are used to identify risks whereas at higher levels techniques such as soft systems analysis and simulation are used to identify potential risks and opportunities. Figure 5 illustrates the output from step four. It is important to note that

opportunities were deliberately not defined as counterpoints (controls) to risks but as separate ideas to enhance objectives. This is a common error made when thinking about opportunities. Therefore they do not align with risks in Figure 3.

Step five – Assess and prioritize

Key stakeholders collaboratively assessed the magnitude of each risk and opportunity associated with the project objectives, in order to be able to allocate resources most efficiently to manage them. ROMS provides a unique three-dimensional ranking process on "risk level", "urgency" and "controllability". Risk level is a function of probability and consequence, urgency reflects the imminence of the event and controllability reflects the degree to which it is within the control of key stakeholders. The rank is calculated as a product of these three. Figure 4 illustrates output from step five with graphical information which illustrates the risk profile of this hospital.

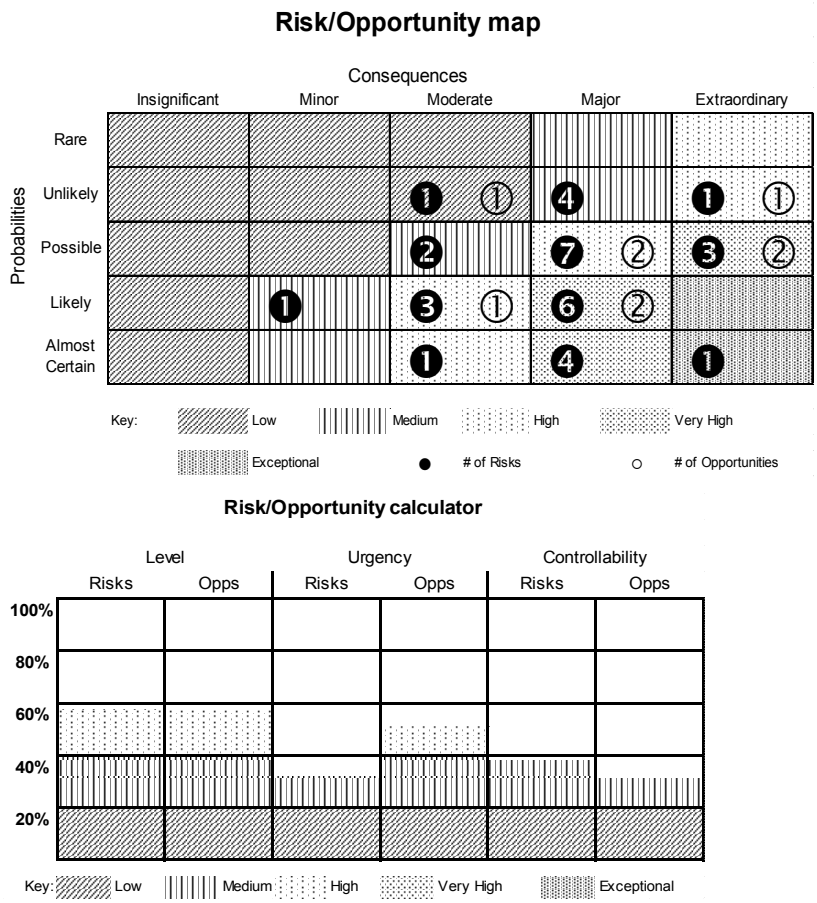

Figure 4: Output from Step Five of ROMS – Development of Risk Profile

Figure 4 show s that the scenario risk profile for this hospital is quite high. Most of the squares coded as "exceptional" risk in the Risk/Opportunity map are in the lower right hand corner with the level of overall risk shown as 58% of what it could be (if all risks were catastrophic); the risk profile is also skewed to the right. Interestingly, as shown in the Risk/Opportunity calculator above the opportunities are also high at 57%, the opportunity profile is also skewed to the right and the matrix shows all opportunities focused in the right hand corner of the matrix. This shows that although floods are a major risk for this hospital in terms of the existing controls it has in place to deal with them, it also presents the hospital with opportunities to take advantage of creative solutions not yet explored to improve health outcomes.

Step six – Action plan
In the next stage of the project, the ranked list of risks and opportunities will be addressed in an "action plan" where control strategies to mitigate risk and maximize opportunities will be identified and selected via cost/benefit analysis. The impact of different combinations of strategies will be compared graphically using a variety of tools to optimize the risk and opportunity profile (see Figure 5) of this hospital. The aim will be to alter the risk profile by shifting all risks into the top left of the risk map and to skew the risk profile to the left. The opposite will apply to opportunities.

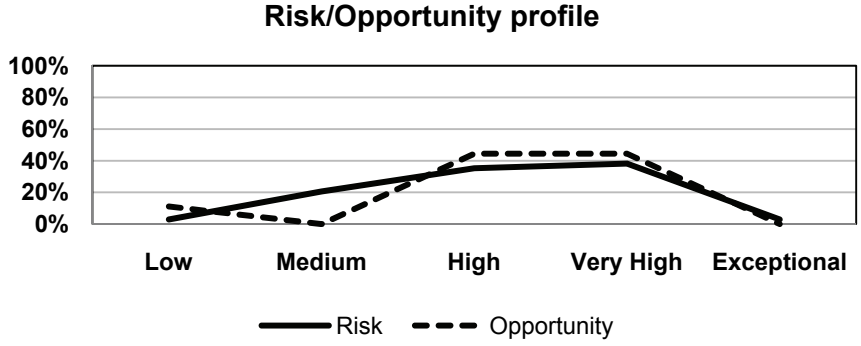

Figure 5: Output from Step Five of ROMS – Risk/Opportunity Profile

CONCLUSIONS

The research identified four key areas associated with the vulnerability and adaptive capacity of the Coffs Harbour Base Hospital facilities in terms of the overall goal of maintaining the continuity of service delivery during an extreme weather event. These included: availability of essential (building) services supported by ensuring the physical integrity of the hospital; effective inter-agency communication; and maintaining access to and from the hospital for staff and patients. The major hospitals in an area such as Coffs Harbour Base are part of the local emergency management plan with other agencies in the local area such as the local council, Emergency Management Australia and emergency services such as fire authorities and police. A more collaborative approach is necessary to ensure the roles and responsibilities of individual authorities are well defined and to encourage a coordinated approached in disaster management during an event.

The next phase of the research will further explore these areas of vulnerability and adaptive capacity in another workshop with the intention of developing an action plan to address the issues identified. These will be further extrapolated to continue development of an evidence base regarding suitable design and facilities management adaptation strategies for hospitals faced with increasing exposure to floods and other extreme weather events.

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