ADAPTING NSW HEALTH FACILITIES TO CLIMATE CHANGE – A RISK MANAGEMENT APPROACH

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Abstract:

With incontrovertible evidence that anthropogenic climate change is occurring worldwide, the need to safeguard critical community infrastructure in the face of increasing incidences of extreme weather events must be addressed. This paper will report on the outcomes of a risk management workshop conducted early in 2007 for the NSW Health Environmental Health Branch that considered possible risks to human health and impacts on healthcare infrastructure likely to be associated with these types of events in NSW, Australia. The findings from this study are generalisable to other communities and indicate a range of available controls to address and manage the identified risks and opportunities generated by climate change for critical healthcare infrastructure.

Key words: Climate change, healthcare infrastructure, risk management, asset management

Background

This study was undertaken at the request of the NSW Health Environmental Health Branch as part of the *Human Health Impacts of Climate Change Adaptation Project* funded by the NSW Greenhouse Office, NSW, Australia. The NSW Greenhouse Office project was designed to provide research evidence and develop policies and programs that will enable NSW government service providers to adapt to the potential impacts of climate change.

The intent of the study was to undertake a preliminary investigation of the adaptive capacity of NSW Health infrastructure to increasing incidences of extreme weather events likely to be generated climate change. For the purposes of the study, the IPCC definition was adopted, whereby 'adaptive capacity' is 'the ability of a system to adjust to climate change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences'. (McCarthy et al., 2001, 982)

Various studies of climate change contend that both mitigation and adaptation strategies are required to cope with the effects of climate change which now appear inevitable no matter the degree to which mitigation either becomes a higher priority or is in fact pursued. For example, the 2006 UNFCCC Adaptation Framework notes that 'Until recently, policy makers concentrated on mitigation, partly because of worries that highlighting adaptation options might reduce the urgency for mitigation…mitigation and adaptation are not alternatives; both need to be pursued actively and in parallel. Mitigation is essential and adaptation is inevitable.' (UNFCCC, 2006) This study has necessarily considered both of these approaches in the background research and in conduct of the risk management workshop. However the primary focus is on adaptation strategies required to safeguard essential healthcare infrastructure so as to protect the current and future health status of the NSW population.

The risk management approach towards adaptation strategies adopted by this study was developed in accordance with recommendations made by the UNFCCC (2006), the Australian Greenhouse Office (2005), CSIRO (2006) UK CIP (Willows & Connell, 2003) and other authorities. For example a Norwegian study noted that: 'Reducing the potential for defects or damage through the development of technical and organizational preventive measures (a risk management strategy) while at the same time applying the precautionary principle and discursive strategies in the design, construction and geographical localization of buildings, is likely to increase the robustness of the built environment in the light of the unknown risks of future climate change.' (Lisø, 2006)

Introduction

As a developed country, Australia is well placed to protect its healthcare and other community infrastructure from the anticipated additional demands likely to be placed on it by increasing

incidences of extreme weather events likely to be associated with climate change. However, although these demands may place only incremental additional loads on systems already designed to cope with disasters and other emergency situations, they require recognition, anticipation and responses to be identified within existing health asset management frameworks. This will ensure that should the predicted demands arise, appropriate responses will have been determined well in advance and incorporated into health asset management practices so that healthcare infrastructure will be able to cope with the increased load and stresses likely to be imposed. If not considered in advance, such responses will become reactionary without guarantee of success or adequacy, and possibly of much greater cost to the community in terms of damage to infrastructure and potential reduction in health status of the population.

It must also be recognized that climate change will affect the built environment in many and diverse ways. However, it is a problem that can be addressed with proper identification and planning, as supported by the comment made by the IPCC Report that:

'Climate change will affect human settlements against a very dynamic background of other environmental and socioeconomic factors. Human settlements are expected to be among the sectors that could be most easily adapted to climate change, given appropriate planning and foresight and appropriate technical, institutional, and political capacity.' (Scott & Gupta, 2001, 402)

Methodology

Aims and Objectives

The *parameters* of the study were deliberately restricted to focus on the facility-related impacts of climate-related extreme weather events such as heatwaves (and bushfires), floods, storm surges, and tsunamis. It is anticipated that appropriate planning for health facility infrastructure will help reduce the potential adverse impacts of extreme weather events on the health of the community.

The overall *objective* of the study was to identify a range of potential adaptation strategies for NSW healthcare facilities in coping with extreme weather events. More specifically it aimed to:

1. Explore the impacts that extreme weather events may have on healthcare buildings specifically in the context of the NSW climate (but with reference to the wider Australian context), focusing on the differing requirements by location.
2. Investigate the suitability and applicability of the suggested responses (gleaned from the existing literature) from a healthcare infrastructure perspective
3. Assess the "adaptive capacity" of health infrastructure in the light of healthcare, social, financial, technological, and political impacts in Australia resulting from climate change
4. Where possible, align potential strategies with existing disaster planning strategies

Finally it aimed at developing an Action Plan that summarises identified key risks and opportunities, and a strategy in dealing with each of these. In doing so, it also determined where further research and investigation are required in order to develop a cohesive NSW strategy for dealing with the impact of extreme weather events on healthcare infrastructure. (Carthey et al., 2007)

Method

The study commenced with the identification of key stakeholders who were subsequently invited to a Risk and Opportunity Management (ROMS)[1] Workshop held over two days that was facilitated by Professor Martin Loosemore of UNSW. Key stakeholders were determined through a process undertaken by the authors of the study in conjunction with representatives of the NSW Health Environmental Health Branch. Clearly many stakeholders could be identified for a study such as this. However, it was agreed that in order to ensure an outcome from the workshop, a

[1] The ROMS Methodology was originally developed for Multiplex Facilities Management and subsequently developed and used by many major public and private sector organisations throughout Australia and Asia. ROMS complies with AS/NZS 4360:2004; is internationally benchmarked; is currently used by 2008 Beijing Olympic Organising Committee and; received an innovation award from UK's Chartered Institute of Building in 2006. The principles underlying ROMS have been published in LOOSEMORE, M., et al. (2006) *Risk management in projects,* Abingdon, [U.K.] ; New York, N.Y., Tayor & Francis.

selected group of up to ten people would be invited to participate in the workshop. These people were to be selected initially on the basis of their professional backgrounds and current occupations in roles of influence in the healthcare and community sectors. Other criteria for selection then became their likely concern with the effects of climate change related extreme weather events on healthcare infrastructure (their objectives affected by project outcomes) coupled with their perceived abilities in determining effective adaptive responses and possible subsequent involvement in the implementation of these (their ability to implement the project objectives).

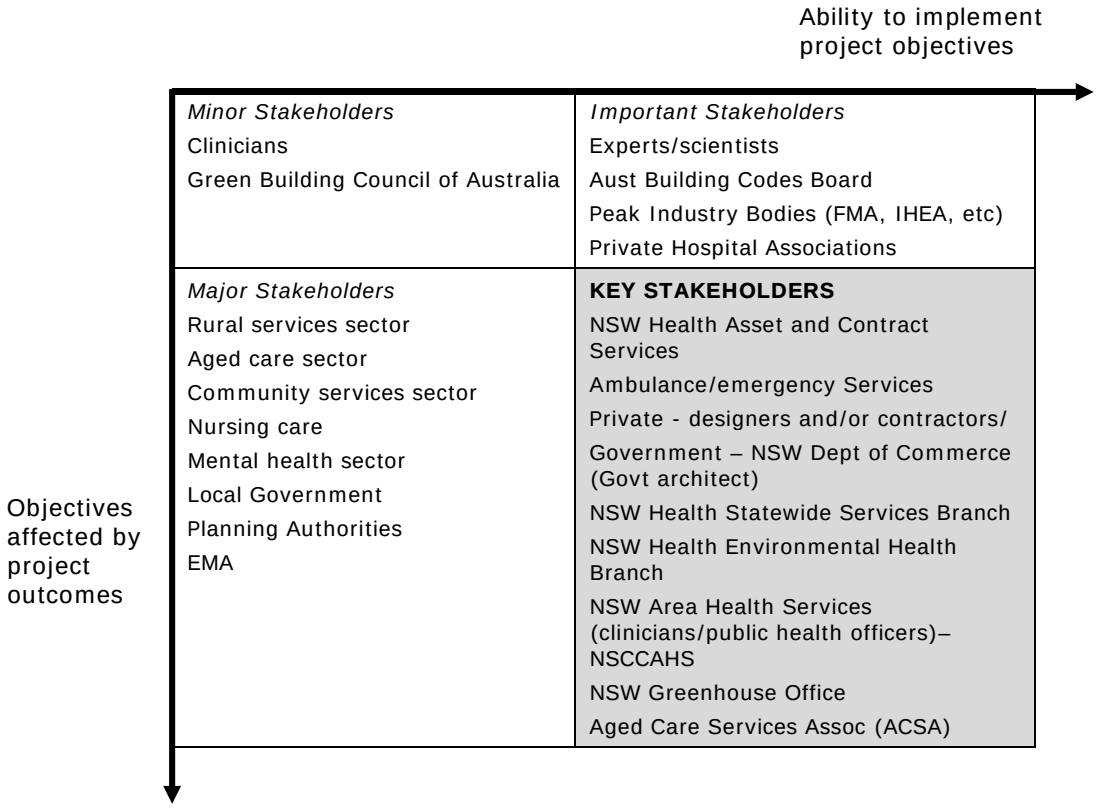

Figure 1: Selection matrix for workshop participants

The identified key stakeholders were invited to participate in the ROMS workshop which following a background briefing for participants, was conducted in accordance with the structured process set out below:

Workshop 1

Step 1 : Stakeholder analysis and common objectives

Step 2 : Identify risks and opportunities to those objectives

Step 3 : Assess their magnitude and prioritise them

Workshop 2

Step 4 : Develop an action plan to minimise risks and maximise opportunities

Workshop proceedings and outcomes were documented in the ROMS format, and an accompanying report written to highlight the analysis of the findings and the key themes that emerged. In the first step of the first workshop, participants identified the following common objectives for the study:

1. *Quantifying impacts*

To develop a research program to identify, analyse and assess impacts of extreme weather events on health infrastructure.

2. *Evidence-based practice*

To identify a range of potential facility-related responses to the health-care challenges posed by climate change, that may assist in influencing potential funders of climate change research.

To ensure practitioner/researcher engagement to facilitate evidence-based practice by operationalising research, ensuring research is relevant, practical and disseminated in a usable format.

3. *Asset management planning*

To ensure procurement, design, FM, urban planning and asset management planning strategies enable effective health-care responses to climate change and do not exacerbate problems in event of a crisis.

4. *Ensuring behavioural change*

To raise awareness of climate change including changing public expectations and behaviours, securing buy-in from industry stakeholders by means of communication and education.

5. *Integrated planning*

To ensure a coordinated cross jurisdictional response to climate change at internal, local and society level involving: disaster planning; emergency services, private health care sector, and other non-health care community services.

These common objectives were then aligned with the initial project objectives identified by the NSW Health Environmental Health Branch for the study, and are discussed further in the results below.

Results

The outcomes of both workshops are summarised in the final report for the project. In the report itself, they are summarised in terms of their relationship to the objectives of the project sponsor, NSW Health and a draft Action Plan is then proposed for review and discussion by project stakeholders. I

Risks to the Healthcare System due to Climate Change Extreme Weather events – Impacts on Human Health and Health Facilities

It was beyond the scope of the study (and not included in the objectives of the risk management workshops) to undertake specific or detailed investigations into the predicted effects of climate change generated extreme weather events on human health or the associated changing demands for healthcare services. This work is either being undertaken by others or more properly demands the skills of public health specialists and epidemiologists. However, the background briefing for the workshop and introductory remarks by NSW Health noted outline findings documented by other parties from journals and government reports.

The change in weather patterns, including increased variability and extremes, suggest that patterns of disease will alter both within NSW and Australia generally. Healthcare infrastructure may come under pressure as a result of those seeking refuge from extreme events (heat, storms, etc) and it may also be subject to increased demands by those suffering injury or ill health as a result of such events (e.g. elderly or vulnerable populations suffering from heat stress related to extended periods of higher than normal temperatures).

Public health expects such as McMichael, Woodruff and others (McMichael et al, 2003, 2006; McMichael & Butler, 2006) have written on the likely impact of climate change on human health needs in the worldwide and Australian context. The UNFCCC (2006, 28) report noted that 'the IPCC has concluded that climate change is likely to undermine health mainly within tropical and subtropical countries and predominantly in lower-income populations'. In discussing developed countries, it acknowledges that these will be in a stronger position and likely to be able to use existing public health strategies, augmenting or improving these as necessary to cope with increased risks. However, the report does note that even developed countries have pockets of at-risk populations who will require protection during incidences of extreme weather events such as heatwaves – as demonstrated by events in Europe in 2003.

The following predictions have been made in regard to the effects of climate change on the Australian (McCarthy, et al, 2006) climate:

- Increased annual average temperature of 0.4-2.0°C by the year 2030
- More heatwaves and fewer frosts
- Prolonged drought and heavy rains

- More severe wind speed in cyclones and storm surges
- More frequent storms and bushfires
- Changing ocean currents which affect coastal waters

The current literature on climate projections for NSW suggests an increase of 0.4-2.0°C on average temperatures by 2070, with the following climatic impacts (Preston & Jones, 2005; CSIRO, 2006; AGO, 2003)

- Warmer average annual temperature
- 50-100% more hot days 35°C and fewer cold nights. Sydney may average 4 days over 40°C per year and Canberra 10 days. It is also projected that there will be 100-200% more hot days over 40°C at Cobar, Walgett, and Wilcannia
- More frequent heatwaves
- 70% increase in droughts
- 10-20% increase in the intensity of extreme daily rainfall

Most research has focussed on developing predictions based on an expected increasing average number of events, rather than the increasing unpredictability of the number, severity and impact of these. This type of analysis provides little insight into how climate-related extreme weather events will affect specific geographic locations. Until recently, the finest level of detail for predicted events was available at a geographic scale consistent with assessment at whole of State level and so it has not been possible to predict how different regions and health facilities within NSW will be impacted with any degree of accuracy. We do know however that there is an increased likelihood of more frequent rainstorms and strong winds (and greater fire risks) are also noted. The variability of the incidence, severity and impact of these events will also be likely to increase.

While much of NSW will be drier, heavy rainstorms may be more frequent in central and south-east NSW, and in the far north-east, particularly in summer. In autumn and winter, heavy rainstorms are likely to increase in the centre and north-west of the State, and decrease on the coast. Increased average wind speed and extreme winds are expected in spring (greatest across central NSW). Along with these climate projections, it is also noted that the “loss of life, and the impact on hospital and emergency services, through extreme weather events is likely although not predictable” (Allen Consulting Group, 2005, 77). Consequently, “a major challenge in Australia is how to protect and improve public health systems…” (AGO, 2003, 156-7)

This may require changes in the adaptive capacity of healthcare facilities in NSW as a direct result of changes to the climate of NSW, but also possibly resulting from changes in other States (or indeed countries), that may trigger changes in the pattern of migration that will impact on the use of NSW health services. The aftermath of Cyclone Tracey, in Darwin in 1973, and of the Bali Bombings in 2002, demonstrates the impact that events in other locations may have on NSW health facilities. Healthcare infrastructure must be able to respond to such events, and in doing so possess sufficient capacity to be able to moderate the influences of extreme weather (and other catastrophic events) on human health.

The following table lists a range of extreme weather events that may be experienced more frequently or more severely as a result of climate change and, based on actual examples, indicates possible health impacts and associated facility impacts that have resulted and that may potentially occur again in the future.

Events	Health impacts	Facility impacts
Heatwaves (and Bushfires)	In Australia and other countries, heatwaves are responsible for more deaths than any other natural hazard but are mostly underrated because they are viewed as a 'passive' hazard in contrast to the more catastrophic hazards such as tropical cyclones or bushfires (Emergency Management Australia, 1998, Bureau of Meteorology, 2006). Heatwaves are likely to affect the elderly and other vulnerable populations (very young, dependent on alcohol or other drugs, chronically ill, etc) causing them to seek admission to health facilities due to increased incidence of CVD and other ailments.	Sydney heatwaves in 2005 "one hospital has been swamped by people not needing medical treatment - simply looking to take advantage of its spacious air conditioned reception area" (Mercer, 2001). The 7-day heatwave in Adelaide in February 1997 caused hospital computers to overheat and fail (Emergency Management Australia, 1998). Water shortages and water supply failures may also become a problem during prolonged heatwaves as demand for water may increase dramatically. Transport systems may also suffer from problems and interruption due to possible heat-related expansion of railway lines and steel bridges, and other associated damage to roadways (Emergency Management Australia, 1998).
Floods	The flooding of the river Elbe in 2002 in Saxony/ Germany required immediate public health action in order to ensure a proper public hygiene response (Meusel et al., 2004). Floods are significantly likely to result in degradation of human health and loss of life, high financial cost, trauma and associated human misery (Schreider et al., 2000, Meusel et al., 2004, Kundzewicz, 2002)	Where healthcare facilities are flooded, electrical power outages may be unavoidable. In the UK in June 2005, Warwick Hospital evacuated emergency patients by ambulance and helicopters to other facilities (BBC News, 2005). Flooding may also create an access problems for physicians and other staff travelling to and from the hospital (Cocanour et al., 2002)
Storm surges	93 hospitals were adversely impacted Hurricane Katrina in the Southern USA in 2005, with 19 hospitals being evacuated and another 18 being closed (Planning 2.0, 2005). Numerous deaths were attributed to transportation shortages, although evacuation measures were aided by helicopters, buses, and ambulances. In March 2006, Tropical Cyclone Larry crossed the tropical north Queensland coast near Innisfail, giving pressure to medical services (Emergency Management Australia, 1998, Queensland Government, 2006), although at a much smaller scale than Hurricane Katrina.	Water pushing several kilometres inland where land is low lying may potentially knock down healthcare facilities and wash away roads (Commonwealth of Australia, 2006, Meusel et al., 2004, Joint Commission on Accreditation of Healthcare Organizations, 2006). In March 2006, Cyclone Larry in north Queensland, the Innisfail Hospital was forced to close, thus requiring medical support from Townsville and Cairns Base Hospitals. Herberton hospital was without power until a generator was provided and leaking roofs resulted in emergency evacuation (Emergency Management Australia, 1998, Queensland Government, 2006).
Tsunamis	The South Asian tsunami in 2004 was one of the largest flooding disasters in recent history, causing about 280,000 fatalities in eight countries from Asia to Africa (Morgan et al., 2005). Post-traumatic stress disorders and problems of hygiene and infectious diseases were also noted, which caused many fatalities including a large number of suicides (Morgan et al., 2005).	During the 2004 tsunami in Indonesia, 1 main referral hospital, 4 district hospitals, and 41 out of 240 clinics were destroyed (International Centre for Migration and Health, 2005). In the Maldives, where most healthcare facilities escaped major structural damage, some facilities such as Mulee hospital lost all their medical records and equipment. Access difficulties were also noted, hindering the provision of health services following the disaster.

Table 1: Health and Facility Impacts associated with Extreme Weather Events (Carthey & Chandra, 2007)

Possible Infrastructure Responses (from the literature)

While calls for responses to extreme weather events are evident within the literature, the workshop identified that a key barrier to moving forward with adapting to extreme weather events was the lack of understanding of the likely quantum and nature of the impacts of such events on health infrastructure. In particular, prior to any attempts at adaptation, the quantification of the impacts of climate change and the resulting extreme weather events was considered key to reinforcing understanding of the immediacy and severity of problem.

Table Two lists some potential adaptation responses by health and other authorities that may assist health services and infrastructure to cope with extreme weather events - these have been identified from existing research. They include immediate responses such as evacuations, as well as long-term facility responses to help mitigate the risk of facility failures. However the ability to translate these responses into facility planning policies and design are yet to be assessed in terms of the current adaptive capacity of existing health services and infrastructure.

POSSIBLE INFRASTRUCTURAL RESPONSES TO EXTREME WEATHER EVENTS	
Immediate	• Increased public awareness • Warning procedures for the community especially those at highest risk • Thermal control – airconditioning, close blinds, windows, etc (heatwaves/bushfires) • Environmental control (to filter out smoke and dust, etc) • Emergency fire fighting response • Evacuation of those in immediate danger to safer facilities, surge hospitals, etc.
Long-term	<u>Urban planning</u> • Regulations – such as the Australian Standards, Building Codes, Health Facility Guidelines, Engineering Services guidelines – to ensure appropriate ventilation, air quality, thermal condition • Urban Design (e.g. land use, green spaces, water bodies) • Environmental management of high risk areas adjacent to urban areas or health facilities • Improved communication networks among urban planners • Redundancy built into road and transport networks to avoid isolation of facilities and emergency services • Availability of safe and environmentally controlled gathering spaces for the community to seek relief e.g. shopping centres, public libraries, etc, and to avoid unnecessary burdens being placed on health care facilities by those not in need of healthcare interventions. <u>Health System Responses</u> • Coordinated disaster responses – emergency services – ambulance, fire, police, etc that work with facilities to ensure healthcare delivery is uninterrupted • Relief plan: surge hospitals, counselling, etc <u>Facility Management</u> • Site selection and utilisation • Facility design, detailing, and construction • Maintenance of equipment, e.g. airconditioning and facility fabric such as roofs and downpipes, so that structural failure is avoided in a disaster situation • Backup and spare capacity for building services e.g. electricity, water, ensuring uninterrupted supply

Table Two: Summary of possible infrastructure responses for managing the risks associated with extreme weather events impacting on healthcare facilities (Carthey & Chandra, 2007)

The ROMS workshops indicated that an evidence-based approach must underpin adaptation strategies that are intended to respond to the threats posed by climate-related extreme weather events. However, the need to include adaptive strategies in the current health infrastructural processes has not yet been considered (i.e. design documentation and tender processes do not yet incorporate this requirement). Other difficulties in adopting this approach included the lack of

evidence regarding the translation of adaptation strategies into facility requirements and designs, and the likely costs associated with these.

It should also be recognised that the current health infrastructural processes are predicated on the commercial realities associated with competitive tendering processes, and exist in a political climate faced with increasing expenditure needs for healthcare service delivery and infrastructure. Thus the need for greater apparent 'efficiency' in the expending of public monies often becomes the highest priority, and this usually involves reductions in capital costs.

Should the need to incorporate adaptation strategies into healthcare design and facility maintenance become required, this may increase initial capital costs for health projects. This may conflict with current project delivery and funding processes which do not always recognise the link between capital and operational costs, and result in a backlash of resistance in those funding health capital projects to the incorporation of specific adaptation requirements.

Adaptive Capacity – existing and required

Research efforts to understand the impacts of extreme weather events on health services and health infrastructure are few and to date have not provided a comprehensive understanding of effective response strategies. Table One showed potential facility impacts already demonstrated to be associated with the health impacts generated by the identified list of extreme weather events. However, it is still difficult to find adequate examples of research, or indeed examples from real life projects for translation into a more generalisable and effective response strategy that would guide the asset and facility management processes for healthcare infrastructure.

In addition, comprehensive identification of the impacts on the social, financial, technology and the political climate are still at a relatively early stage. The workshop identified the lack of certainty around how climate change will impact the Australian community, and that a sense of urgency was beginning to become apparent but was yet to be translated into policy and adaptation strategies. However, the ROMS workshop did confirm that changing attitudes towards adaptation and then "ensuring behavioural change" is an important factor in enhancing the "adaptive capacity" of health infrastructure to cope with extreme weather events.

In the workshops, the attitude of those managing and funding health infrastructure projects was identified as one impediment to the implementation of adaptation responses for health services and infrastructure. It was suggested that this might be partly be a result of the lack of understanding and certainty surrounding the likely additional impacts of extreme weather events on health services and infrastructure. In addition there may be a perception that inappropriate triggers / impractical targets may be set in response to current research efforts, and this would mitigate against longer term behavioural changes.

It was suggested that research is needed to provide more evidence (including practical examples and case studies) to improve community and health system understanding regarding the likely effect of increasing incidences of extreme weather events on health services and infrastructure, and the adaptation of these to cope with the predicted impacts. This is necessary to effectively influence community leaders and health system managers to ensure that their political influence is applied to implementation of strategies that will ensure "behavioural change" - in particular promotion of the climate change adaptation agenda.

A "bottom-up" approach is an alternative strategy and could be pursued simultaneously. Those working in and using facilities could promote an adaptation strategy at facility level and seek endorsement from those at higher levels of the organisation. These local efforts are also more likely to be successful when underpinned by an understanding of the impacts and potential benefits of committing to an adaptation strategy. However it was recognised that such efforts ultimately require great levels of stakeholder perseverance and commitment to participation in the process.

However at a practical level, it was noted at the second workshop that asset planning strategies currently undertaken by NSW Health would be a suitable existing mechanism for assessing the adaptive capacity of health care infrastructure. NSW Government policy requires that all NSW Health facilities are developed in accordance with an asset management strategy, and the condition of existing facilities regularly appraised to enable update of that strategy. Imposing an incremental additional work load to those assessing facilities would result in ongoing assessment of the adaptive capacity of all health infrastructure. Specific building related data is gathered from such an assessment in addition to site-related data, plus the condition of building services

such as electrical and mechanical systems, integrity of the building fabric, etc, could be assessed as required at an appropriate level of detail.

Incorporation of a climate change adaptation focus into current asset strategic planning processes would commence the process of "behavioural change". This would be further developed by educating those undertaking asset condition surveys regarding the need to consider this additional requirement in determining the future value and suitability of healthcare infrastructure.

In identifying the health service demands to be supported by both new and existing healthcare infrastructure the need for "spare" or "surge" capacity to be provided to cope with the increasing demands associated with a greater number of extreme weather events should also be identified. This should be addressed in conjunction with those developing and implementing disaster management strategies, and this is discussed in more detail below.

Integration with current disaster management strategies and other community responses

Currently, adaptation strategies to cope with extreme weather events are considered under the banner of disaster management and emergency planning in countries such as the US, UK, and Australia. However, such efforts do not embrace clear adaptation strategies nor do they often address practical implications for infrastructure in order to safeguard critical service functions such as healthcare delivery. Existing disaster management and planning strategies must be considered in conjunction with a framework of climate change adaptation initiatives for healthcare infrastructure. This will then enable the development of a comprehensive and practical response strategy for health infrastructure exposed to extreme weather events, whether these occur naturally, or are generated increasingly by climate change.

Disaster planning strategies are already being considered in regard to the need to cope with terrorist attacks or outbreaks of infectious diseases within the Australasian community. There is concern being expressed regarding the ability of current healthcare infrastructure to cope with these threats particularly in terms of assessment of the existing capacity of emergency departments within Australasian health facilities (Traub, et al, 2007). Given this opinion that does not yet consider additional burdens likely to be placed on health services by increased incidence of extreme weather events, it seems likely that existing healthcare infrastructure would not be considered adequate should this additional response scenario be added to disaster response requirements.

The quantum of additional facility requirements or indeed the location of these facility resources is not yet identified, partly because the science surrounding the additional burdens on human health that may be associated with climate change has not yet been robustly investigated for the Australian situation, as noted previously. Disaster planning needs to be expanded to include this scenario and its likely impacts on healthcare facilities. In addition, health service authorities must consider this as part of the spectrum of community healthcare delivery needs, and this will likely fall within their areas of responsibility within the near future. Therefore, those responsible for guiding health asset strategies and planning processes must be encouraged to ensure that facilities of the future are capable of responding to this need.

One of the key impediments to understanding this issue that emerged from the ROMS workshop was the current lack of focus on the issue of climate change adaptation strategies within NSW Health itself. Adequate responses to the issue require firstly acknowledgement of its existence, then a willingness to consider and to support development of appropriate responses, all requiring a heightened sense of urgency from those in NSW Health responsible for planning and funding the development of health facilities. The reasons behind this current lack of focus were thought to include a lack of understanding of the nature of climate change for Australia (particularly for NSW) and how it may impact on health and health infrastructure by both the government and its agency.

Once the importance of the issue is recognised at a more strategic level, another barrier to the development of suitable responses, as previously noted, is the lack of integration (or recognition of the essential interrelationship) of Capital Expenditure and Operational Expenditure budgets. This interrelationship is not always apparent during the planning phases of healthcare projects, with short term decisions sometimes made that cut capital costs in the shorter term, but often significantly increase operational costs over the longer term.

In addition, at a more strategic level, difficulties resolving planning issues are not uncommon due to the myriad different government authorities currently involved in planning the NSW urban environment. Therefore, this could also be expected to be a factor in creating difficulties in

addressing the potential impacts of increasing incidences of extreme weather events on all community infrastructure, not solely that for healthcare. Appropriate governance structures and high level coordination of efforts to overcome these difficulties were perceived to be lacking in many instances. This problem tends to be exacerbated by the inconsistencies in process and efforts between the different responsible authorities, plus the lack of continuity in the government bodies representing the different sectors due to their frequent changes in personnel, shifting areas of responsibility and thus their effective realms of influence.

Research Required

Impacts of Climate Change extreme weather events on Health and Facilities

Although awareness of climate change has permeated through the Australian government system and other funding bodies, many were still uncertain about its impact on Australia and the health of its community, its health services and infrastructure. It was also noted that there was uncertainty (and confusion) surrounding the government's commitment to pursuing the adaptation route for health infrastructure as opposed to mitigation strategies. The lack of research in this area and other competing priorities in funding allocations further discouraged any attempts to explore health infrastructure adaptation to extreme weather events. In addition, although some research has been undertaken in the NSW context, it remains difficult to specifically determine or even to estimate the likely impact of climate change on human health, especially in terms of the effect that increasing incidences of extreme weather events may have on the utilisation of healthcare infrastructure.

Current research is now focusing on climate change related impacts on human health on a regional basis, including consideration of Oceania and the specific Australian context. For example, Campbell-Lendrum and Woodruff (2006) highlight the need for a risk assessment framework approach to be applied to this issue that would use both traditional epidemiological methods in conjunction with consideration of the specific characteristics of climate change on a region by region basis. However, this study also notes that 'The attempt to carry out a full accounting of the health impacts of climate change rapidly clarifies significant knowledge gaps', which require further research to obtain more useful predictions of these impacts. (Campbell-Lendrum & Woodruff, 2006, 1935)

The use of GIS[2] mapping, LIDAR[3] and other technologies to examine the impact on real locations of the predicted increasing incidence and variability of extreme weather events are feasible techniques already being used. These could be used to assist in modelling the impact of the impacts of climate change on existing health care infrastructure and to assess the suitability of proposed locations (or necessary re-locations) of future facilities.

Infrastructure Responses and Adaptive Capacity

Several strategies were identified by the workshop to encourage a better understanding of the suitability and applicability of adaptive responses through evidence-based practice. These included the development of innovative strategies through multi disciplinary research that should include accurate forecasting of implementation costs. To maximise the likelihood of implementation of these strategies, they should where possible align with current government policies and practices. Where possible, they should become an extension of existing processes and procedures and require minimal additional staff or equipment for implementation.

Integration with Current Disaster Management Strategies and other Community Responses

NSW Health should continue to work with existing disaster planning agencies to ensure that all strategies relying on healthcare infrastructure capacity for implementation are able to respond to the additional challenges likely to be imposed by increasing incidences of the extreme weather events associated with climate change. Once these strategies acknowledge the additional likely threat to the community and its infrastructure, the assessment of health infrastructure and its adaptive capacity becomes more meaningful and targeted. The role of health care infrastructure

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[2] ***G****eographic* ***I****nformation* ***S****ystems*, tools used to gather, transform, manipulate, analyze, and produce information related to the surface of the Earth. This data may exist as maps, 3D virtual models, tables, and/or lists (webopedia.com, accessed 05 June 2007)

[3] 'Lidar' or laser radar is a method for detecting distant objects and determining their position, velocity, or other characteristics by analysis of pulsed laser light reflected from their surfaces. (Answers.com, accessed 05 June 2007)

should be to support health system responses in disaster situations and so must be planned to assist in this response by not failing when placed under such additional pressure.

Suggestions made at the workshop to address this requirement included the need for applied research to be more prescriptive in its outcomes specifications and to include the prioritisation of efforts to respond to disaster planning strategies within agreed adaptation frameworks. As part of an expanded disaster response strategy, healthcare infrastructure becomes even more critically important to the community, and this fact should assist those asserting the importance of adapting health infrastructure to cope more effectively with extreme weather events. In practical terms, this provides an extremely robust argument for influencing the Asset Management Planning policies and processes of NSW Health.

As noted previously, to assist in the implementation of adaptation measures, costs and operational benefits must be identified by those advocating climate change adaptation strategies. These benefits should be identified and tested against performance measures specifically developed for health services and health infrastructure. These may include business continuity issues in disaster situations, with health services required to maintain current, or even increased, levels of health service delivery within a community in disaster situations. To develop performance measures of this type would require engagement with building industry experts (contractors and facility managers) in an arena set apart from the prevailing contract arrangements in place for current projects.

Communication of Research Findings

Developing a greater understanding of the impact of extreme weather events on health infrastructure requires a range of strategies, particularly those emphasising clear and effective communication with stakeholders. One strategy proposed the invitation of influential or credible bodies of researchers to provide scientific information and evidence to point out the potential immediacy and severity of the likely impacts of extreme weather events on human health and health infrastructure in NSW. In particular, it was also noted that it will be important to communicate clearly and effectively any early assessment of gains from pursuing the adaptation route. Other suggested strategies included:

- Releasing research publications reporting findings from influential forums and respected research bodies via those who can influence the community's climate change adaptation agenda. This may include seeking endorsement and dissemination of information through organisations such as the Australian Medical Association, insurance bodies, hospitals, local government, etc
- Maintaining the relationship of project objectives to a wider national research agenda
- Continuing to engage with leading and/or credible researchers in the area (particularly in terms of applied research)
- Clarifying the extent of problems and costs that may be associated with neglecting the necessary adaptation efforts
- Identifying a range of possible adaptation strategies for health facilities in terms of suggested future projects, costs, programmes, actions and demonstrable outcomes.

Influencing clinical and asset management practices could be achieved by means of demonstration projects showing the implementation of health infrastructural adaptation strategies and ongoing evaluation of these. In addition, practices could also be influenced directly through development and implementation of government policy. In particular, future efforts should include:

- Translating research into a practical, applied format
- Disseminating information through appropriate sources, demonstration projects, etc
- Providing evidence of cost, safety, social benefits (including reduced operational costs, etc)
- Where possible developing strategies that require incremental adjustments to existing processes and procedures, rather than imposing new or additional burdens
- Influencing health care project procurement processes to ensure those assessing project tenders recognise and reward the value embodied in innovative adaptation strategies for healthcare infrastructure.

Collaboration with key stakeholders in the development of adaptation strategies for health infrastructure is needed. This must include the alignment of business continuity and other risk management strategies with existing planning strategies, including disaster management plans developed by others. To do this, it was noted that it may be useful to:

- Keep the dialogue simple
- Establish a mechanism to facilitate cross sectional communications
- Encourage health services to be proactive in accelerating change and being brokers in determination of action agendas.

Discussion and Recommendations

This study has found that the current lack of understanding of the problems (nature, frequency, severity, and relevance) associated with extreme weather events in Australia (including NSW) has led to perceived uncertainty surrounding the need for adaptive strategies for health services and infrastructure in response to the increasing incidence of extreme weather events likely to be associated with climate change. Consequently, further research is needed to increase the understanding of the impacts of extreme weather events on both healthcare service needs and health infrastructure to ensure uninterrupted delivery of these services. This involves the quantification of such impacts, including the risks associated with ignoring them and not acting, as well as the benefits associated with a prompt response. The information should be made available and communicated in a form that may be clearly understood by the community. Results from this undertaking should then be distributed in seminars and forums and through other influential bodies that endorse climate change adaptation agendas.

Finally, as further research is undertaken and adaptation strategies implemented, an education and communication strategy should be developed to inform key stakeholders regarding:

- The likely impacts of climate change on the demands for health services in NSW health facilities
- The adequacy of current NSW health infrastructure capacity to cope with the additional demands likely to be imposed
- Implementation strategies for reconfiguring or augmenting capacity to cope with the identified demands
- The costs associated with this reconfiguration or augmentation, and assurances given that these will be met in order to ensure business continuity within the health sector in the event of natural disasters now and into the future
- Confidence that an integrated disaster planning and management strategy is in place that will ensure the continuity of operation of health facilities in the event of natural disasters associated with the increasing incidence of extreme weather events likely to be generated by climate change.

Conclusion

Although this study focused on a specific geographic region and health system (NSW Health) many of the findings are clearly generalisable to other settings and locations. The study demonstrates the need for a systems approach to developing adaptive capacity in healthcare infrastructure to cope with climate change. This includes the requirement to determine not only the impact of increasing incidences of extreme weather events on the health of the community that may increase the demands of the customers for healthcare services, but also to consider how to prevent health facilities failing under the demands placed on the building fabric due to these same events.

Working with existing systems appears to offer the greatest chance of success in achieving both these aims. For example, where possible, tapping into existing disaster management frameworks will ensure more effective community responses and greater pressure for the development of adaptive capacity for healthcare infrastructure. This approach will thus also be more responsive to the existing political, social, technological and institutional capacity, wherever the healthcare system may be located.

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