Climate Change Adaptation Research Grants Program
- Emergency Management Projects

Project title:
Adaptation of Built Environment to Climate Change Induced Increased Intensity of Natural Hazards

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Objectives:
This project will examine the likely impacts on the built environment of increased intensities in weather-related natural hazard events, and will identify the possibilities for the adaptation of regulatory mechanisms in building construction, housing and planning.

An analysis of the impacts of climate change on the built environment, and a review of the existing regulatory mechanisms and their effectiveness, will be followed by further modelling of industry best practices and policy recommendations that provide for improved emergency management preparations and response capabilities across a wide range of agencies and organisations.

Project design and methods:
Adaptation of built environment to climate change induced increased intensity of natural hazards is a cooperative research project of the Centre for Disaster Studies and the Cyclone Testing Station, both of James Cook University and the School of Geography and Environmental Studies at the University of Tasmania. Industry and institutional partners that will be involved in aspects of the research projects and to whom research results will be reported include Emergency Management Australia, EMQ, PIA, AHURI, Local Governments the Tasmanian Fire Service, Tasmanian SES, and the Bushfire CRC as well as the housing, construction and insurance sectors.

The project will focus on the built environment specifically housing, institutional and commercial buildings and infrastructure. Each of the three participating research organisations will take responsibility for specific areas of building codes, housing and land use planning. Research will examine current best practice and regulatory mechanisms against the background analysis of scenarios for climate change induced increased intensities and occurrence of tropical cyclones, floods and bushfires. Analysis of adaptive capacity to predicted changes that will impact the built environment will identify areas of existing best practice and the capacity of regulatory mechanisms to deal with future scenarios. Identification of gaps between scenarios of change and existing practice will generate models for future response.

Building Codes
Buildings and other infrastructure are generally designed and built to codes and standards aligned with the Building Code of Australia (BCA). These structures are built to a specific "Iifespan" with an acceptable level of risk based on data available at the time. In many regions of Australia, wind load is the critical environmental design load criterion and most regular structures are built to withstand a 500yr return period wind speed. Significant levels of damage can be expected in situations where the design load is exceeded (such as from a severe windstorm where wind speeds exceeding the value used in design). Furthermore, older houses are built with limited engineering input, during periods when the regulatory framework did not require the use of standards. Such structures could be highly susceptible to extensive damage and hence are prime candidates for adaptation measures especially for climate change scenarios that predict increases in wind speed. Parts of Australia are subjected to different types of windstorms and are classified as either noncyclonic or cyclonic wind regions in the wind load design standard AS/NZS 1170.2. Townships comprise a range of house types, with differences in shape, size, cladding type, window size, roof shape and slope, material and method of construction and age. Each of these features influences the vulnerability of a house to wind damage. Houses also have varying degrees of exposure to wind, with those located in a suburban environment

sheltered by surrounding structures as opposed to houses near the sea or open terrain. Topographic features such as hills can also speed-up or slow-down the wind flow.

Findings from damage surveys and full-scale house tests by the CTS have been used to assess the vulnerability of a range of house types to windstorms. House frames are complex structures consisting of multiple building elements and connections that cannot be easily analysed using simple structural analysis techniques. The roof of a house is generally subjected to the largest wind load and is most vulnerable to wind damage. Probabilistic models developed by the CTS have been used to assess the vulnerability of a range of house types to wind damage. The CTS has developed engineering tools that are able to assess the vulnerability to a given wind hazard. These techniques can be applied to a given population of buildings (Le. house stock in a city) to assess its vulnerability to any predicted changes in wind intensity or frequency, and use this to recommend adaptation strategies (building retrofit, decommissioning etc).

The CTS has surveyed houses around Australia assessing the potential extend of vulnerable housing and will also assess the database of house types collected by Australian Bureau of Statistics. The vulnerability of each house type to wind hazard can then be studied by defining the structural form of each house type. Data on house structural elements and connection type and strength and critical components and connections that are associated with failure will be assessed.

In addition, the strength distribution of critical components for the building population will be assessed along with the wind loads on components and their variability for increasing wind speeds. The CTS model predictions will be verified using house damage data available at the CTS. Results obtained from this analysis will be applied to the mix of houses in a particular region (Le. selected postcodes within a township) to estimate the extent of damage and also the type of damage for specified events (Le. spatial and temporal variation of wind speed). Such an analysis will also take account of the track of the storm event and progressive damage to the housing stock with respect to the track. These results can be used by Emergency Services to assess the vulnerability of the hosing stock to a range of predicted wind speed events (including those resulting from climate change) and determine effective adaptation strategies.

Land Use Planning

Emergency managers have traditionally had relatively little direct influence upon land use planners, although most states have adopted hazard overlays and hazard planning policies as mechanisms to guide appropriate locations for new developments. There are however, significant variations between states and between approaches to different hazards. Additionally the emphasis on hazard zone planning at the state and local government level is a relatively new requirement that is undergoing a process of adoption into planning schemes. Hazard overlays and planning policies are structured on existing knowledge of return events. Research will identify hazard planning processes and attitudes of land use planners and developers to both the known hazard zones and perceptions of climate change impacts and uncertainty in general. Research will employ tools such as Delphi techniques to elicit attitudes to hazard planning, climate change, uncertainty and regulation. An outcome of the project will be the identification of acceptable and feasible regulatory features within planning legislation that can enhance adaptation to future threats and uncertainties.

Land use planning is framed within the context of sustainability. Research will examine attitudes amongst planners towards sustainability in a changing future. Scenarios of failed sustainability where settlements encounter decline or closure will be examined in relation to the idea of the decommissioning and relocation of suburbs and even towns. Land use planning has traditionally been designed to deal with growth. Hazard zone controls, decommissioning of settlements, relocation and buyouts, withdrawal of services and consolidation are new directions for land use planning which will be a focus of this research project.

Housing
Housing comprises a significant component of the infrastructure damaged and/or destroyed each year by natural disasters. Procedures of evacuation and the provision of emergency shelter and longer term accommodation can be essential when such events occur, but affected areas also need to be assessed, dangerous buildings secured, toxic or hazardous wastes cleaned up, debris removed and then subsequent repairs and reconstruction conducted. Planning and preparedness around housing is therefore important in the management of any threats posed by natural hazards, and regulatory mechanisms such as insurance have a critical role here in disaster mitigation as well as our adaptation to future uncertainties under climate change.

The housing research has two sections. First, an international literature review will be undertaken to identify and evaluate key regulatory mechanisms for disaster mitigation in housing provision. One of the main areas of interest will be insurance in its varying forms and with roles across new construction, retrofitting or renovation, and greenfield and brownfield developments, and with differences noted across public and private sectors, for rental and owner-occupant properties, and in the types of housing stock and materials used. Second, the researchers will then conduct interviews with key informants from government departments, housing, state emergency services, the property and insurance councils, and the construction and insurance industries, and they will examine specific case studies in relation to the different hazard types.

The research will thus identify the most effective statutory, market and policy instruments (including insurance amongst other mechanisms), configured for the successful strategic implementation of natural hazard mitigation for housing and climate change adaptation, with emphasis on the drivers and barriers to their uptake in policy and practice. Key deliverables will be in line with the overall project but also include a seminar/workshop for key stakeholders on best practice.

Outputs
The primary aim of outputs is an integrated view of the acceptability and feasibility of processes of adaptation to climate change of housing stock and infrastructure. Key outputs will include the presentation of findings through reports and meetings and specifically a workshop directed at government personnel and agency staff, facilitating networks between researchers and practitioners. The workshop will contribute directly to the production of a monograph structured as a guide for good practice. The workshop will bring together all project stakeholders involved with the three components of the research, so that not only will specific findings and recommendations be communicated, but the crossover and connections between these sectors will be made clear in order to enhance adaptive capacities and policy and regulatory directions. Each research component will present its own findings and all researchers will be integrate these into an overview report. Reports will be published and disseminated to all stakeholders every 6 months as part of the communication process. Additionally researchers in the three centres will write several peer reviewed papers.

Stakeholder Involvement
Emergency Management Queensland, the Planning Institute of Australia, Australian Housing and Urban Research Institute, Architects Institute of Australia, state/federal Housing Authorities, the Bureau of Meteorology, state Emergency Management department representatives, Emergency Management Australia and Department of Climate Change will participate as stakeholders and respondents. The research organisations making this application already have close working relationships with these organisations.