



Australian Climate Change Adaptation Research Network for Settlements and Infrastructure

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THE UNIVERSITY OF
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Abstracts

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Research Area: Coastal Settlements

Title: NSW Sea Level Rise Policy: Challenges, Needs and Opportunities

The coastal zone of NSW is threatened by sea level rise. Changes in extreme weather events such as more severe storms, intensified beach erosion and flooding create greater magnitude and immediate impacts than gradual inundation. These changes expose coastal settlement and infrastructures to widespread risks and physical damages. Meanwhile 'sea change', rapidly increasing population inland, rising temperature and frequent heatwaves, make coastal locations progressively attractive destinations for settlement and tourism. The objectives of this paper are to examine the three broad approaches of adaptation to sea-level rise - namely protection, accommodation and retreat - and evaluate possible approaches or mix of approaches to sea level rise. The NSW Department of Environment and Climate Change drafted the Sea Level Rise Policy Statement which aims to minimize the social disruption, economic costs and environmental impacts resulting from long-term sea level rise. This policy is crucial in providing decision-makers with sea level rise benchmarks for a responsive and flexible approach to the threats associated with sea level rise. Because the magnitudes and effects of sea level rise are somewhat vague for some and still characterized by uncertainty, decision makers will inevitably confront those who prefer adaptive responses that delay major restrictions on private property until the effects of sea level rise are imminent. In determining effective response to sea level rise, policy approach must consider the dynamics of potentially conflicting factors in coastal zone, including private property rights, public expenditure, duty of care and ecological sustainability.

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Research Area: Coastal Settlements

Title: Complex Adaptive Systems - Local Governments, Communities and Coastal Erosion

Climate change adaptation is a relatively recent addition to the agenda of multiple levels of government, though institutions, communities and individuals have a history of adapting to biophysical change in the coastal environment. Strategies to adapt to climate change will interact with routine responses to short and long-term biophysical changes, such as shoreline recession and storm-related erosion. The routine process of adaptation emerges from the interacting strategies of different actors, influenced by the evolving scientific, policy and legal environment.

Complex Adaptive Systems (CAS) theory provides a useful framework for understanding and articulating how adaptation emerges from the interactions of different human and biophysical agents at a chosen scale. In my research, I used it to guide a preliminary desk-based review of adaptation to Coastal Erosion in Byron Shire, in northern New South Wales. In 1988, Byron Shire Council adopted a strategy of “planned retreat” to guide erosion response in vulnerable areas of the shire, and has expressed an intention to uphold it as an adaptation strategy to coastal zone climate change impacts. However, “planned retreat” has come into direct conflict with the strategies adopted by private property owners to protect their assets, and its effectiveness is inhibited by the policy and legal environment in NSW.

The study raises some topical issues, including the potential for conflict between public and private adaptation strategies, the use and interpretation of climate science by actors at a local level, and understanding how knowledge of past experience can guide effective adaptation policy.

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Research Area: Coastal Settlements

Title: Social Vulnerability and Community Adaptation: perceptions of, and willingness to adapt to, climate change in non-metropolitan coastal communities in Australia

Climate change and risks are projected to render a vast number of human settlements in coastal areas vulnerable. As it stands, the majority of discourse on vulnerability analysis internationally has tended to focus on the biophysical elements at risk, with these studies primarily focused on Least Developed Countries. Studies have tended to concentrate on climate change impacts and mitigation, rather than climate change adaptation, and have largely ignored the social aspects of vulnerability.

Local Government, and particularly those in non-metropolitan coastal areas that typically lack financial capabilities and expertise, will most likely bear much of the costs and responsibility for responding to impacts of climate change, coastal development and population growth/change. In Australia, there has been a growing body of literature on the risks climate change presents to society; however, there has not been sufficient debate on how society perceives risk and whether or not they are capable of adapting or in fact willing to adapt to climate change, which will assist in the development of more appropriate adaptation policy. Consequently, as per the goals of integrated coastal zone management (ICZM), a greater emphasis is needed regarding the social aspects of vulnerability including perceptions of risk and willingness to adapt to climate change, to inform a much more holistic approach to coastal vulnerability assessment.

This paper presents a discussion on the factors of social vulnerability assessment, to complement more prevalent biophysical analyses, with an emphasis on Australian non-metropolitan coastal communities under the influence of ‘sea change’.

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Research Area: Coastal Settlements

Title: Methods for non-stationary hydrologic extremes and joint probability interactions

The majority of Australia's population is concentrated along its coastline and is vulnerable to flooding exacerbated by potential climate change. At the turn of the century the annual average cost of flood damage in Australia was estimated as \$300M and the recent 2008 Newcastle flood caused \$1.5B worth of insurance damages alone. Estimating the risk of flooding is a major ongoing challenge and the recent Mackay flood in February, 2008 highlights this: a monsoonal trough over central Queensland caused 625 mm of rainfall to fall on the city, the resulting floodwaters were met by a high tide that kept levee gates shut, and since the storm water could not drain to the sea, the town was flooded. This is referred to as a joint-probability problem since the flooding event depends jointly on the ocean water levels and on the occurrence of freshwater flooding. This problem is challenging because it implies that aspects of flooding cannot be considered independently.

Whereas current hydrological practices depend on the notion of a stationary climate, there is the likelihood that the future ocean levels as well as rainfall and runoff amounts will change over time. The ability of our coastal communities to respond to climate change depends in part on our ability to estimate flood levels in a non-stationary setting. Monte Carlo simulation models have potential to address these issues however numerous limitations remain regarding their application: their ability to incorporate joint saltwater-freshwater flooding, their uncertainty of climate scenarios and trends, and their high computational burden.

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Research Area: Infrastructure

Title: Wellington Working Farms Project: A small rural community's approach to adapting to the changing climate

Small communities in the Murray Darling Basin face considerable challenges in adapting to climate change. On top of existing trends such as declining agricultural profitability, diminishing services, rural to urban drift and increasing indigenous birth rates; climate change will bring declining irrigation water entitlements, marginalization of existing land uses, restriction of domestic water supplies and many other additional burdens with their associated social, economic and ecological impacts.

The Wellington (NSW) community is taking a pro-active approach to these challenges through the 'Wellington Working Farms Project' – a developing partnership between government (local and state), industry (grazing, cropping and horticulture), education (schools, TAFE and tertiary), social services, Indigenous agencies and conservation groups. This paper reports on the role that UNSW Wellington Field Station, including the establishment of the station as a key site for the National Centre for Groundwater Research and Training.

A number of commercial and other activities on the UNSW field station and on properties managed by the Conservation and No-till Farming Association (CaNFA) are being instigated that will link with research (e.g. the hydrological, social and ecological impact of alternative land uses), training (future hydrologists, trades people, natural resource managers and workers), social programs and business with adaptation to a changing climate.

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Research Area: Infrastructure

Title: Design, manufacture and analysis of a durable beam for infrastructure applications

In Australia there are more than 20000 timber bridges, most of which are 60 plus Years old and need major rehabilitation or replacement. Fiber Reinforced polymer (FRP) composites can be thought of as a better solution to this problem due to their numerous advantages such as high stiffness to weight ratio, corrosion resistance, ease of transportation and low maintenance cost. However, the use of FRP composites in highway structures is making limited progress due to their high initial cost. This cost can be reduced with large a volume automated process like" pultrusion".

However, when pultruded profiles are used as primary structural elements i.e. beam, they suffer from secondary modes of failure such as web buckling, compression face buckling and usually give catastrophic failure without warning. In this innovative approach High Strength Concrete (HSC) block and Carbon Fiber Reinforced Polymer (CFRP) laminate are bonded with Glass Fiber Reinforced Polymer (GFRP) pultruded profile at its top and bottom flange. The role of HSC block is to alleviate the compression of face buckling of the GFRP profile and CFRP laminate to increase the overall stiffness of the beam. The whole system is then wrapped with GFRP laminate to eliminate the debonding of GFRP-concrete interface and to have a full complete composite action. In the design, concrete element is allowed to fail first. This result in a most desired pseudo ductile behaviour of the beam for civil structures. Experimental investigation have shown that with this approach a successful design of a durable, economical and light weight beam for infrastructure application is possible.

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Research Area: Infrastructure

Title: Correcting GCM rainfall across Australia for future water availability assessments

Australian rainfall and streamflows are affected by variability at a range of time scales. This is particularly relevant for the design of water supply infrastructure, for example water supply dams. To understand future water availability for our major population centres and to assess if existing infrastructure is appropriate, we need estimates of rainfall and streamflow variability for the future.

The rainfall outputs of General Circulation Models (GCMs) are biased at daily, seasonal, annual and interannual timescales. If the outputs of GCMs are to be used for climate change impact assessments these biases need to be removed.

A nesting bias correction methodology has been developed that addresses biases in the GCM outputs compared to observations. The method corrects biases at seasonal and annual levels, and also improves the modelling of interannual variability.

Prediction errors are reduced compared to those obtained using a seasonal bias correction model. The methodology was applied to the outputs from six GCMs for the SRESA2 scenario. The bias corrected results were then used to calculate the percentage change in rainfall for the future compared to current conditions.

The bias corrected precipitation simulations were also used to estimating future drought frequencies over Australia. The Standardised Precipitation Index (SPI) was used to estimate current and future drought conditions. For the future projections, the SPI values were calculated using parameter values calibrated for the current conditions. This allows the changes in rainfall and hence drought conditions to be compared to what is typical for current conditions at each location.

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Research Area: Infrastructure

Title: Natural climate variability and implications for infrastructure

Natural climate processes are known to impact greatly on Australian rainfall and streamflow. The main climate mechanisms known to impact Australia are the El Nino/Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), the Southern Annular Mode (SAM) and the Interdecadal Pacific Oscillation (IPO) which can modulate the impacts of ENSO. These mechanisms have been shown to influence rainfall across Australia. In particular the SAM influences the southern half of the continent and ENSO the north east of the continent. The extreme states of these climate modes are associated with drought (El Nino conditions) and floods (La Nina conditions).

The aim of this study is to develop an Australia-wide model of these natural climate processes which can be used for short and long term prediction of rainfall. This will include assessing the role and importance of the different climate modes across Australia. The knowledge gained will help with prediction of temperature and streamflow associated with rainfall. Prediction of future climate states will allow for improved management practices and development of policies concerning water infrastructure (e.g. upgrade of or development of new dams and pipe networks, drainage and flood control systems such as levees) and transport infrastructure (e.g. maintenance of roads, culverts and retaining walls) to improve drought security, reduce the impact of floods and to increase protection of infrastructure in times of elevated fire risk associated with El Nino conditions.

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Research Area: Infrastructure

Title: Climate Change and Agricultural Adaptation in the Yellow River Basin China: the Potential for Adaptive Policy and Management

The Yellow River Basin covers 9 provinces and regions in Qing-hai Tibetan Plateau and North China and is experiencing vital challenges from climate change and global warming. Incorporating 15% of China's farmland, the basin contributes to more than 160 million people's livelihood. Its agricultural production has been pivotal to China for hundreds of years. Increasing temperatures and decreasing rainfall, as well as melting glaciers, have been observed in the basin over the past 50 years. A trend to become warmer and dryer will have significant effects on the local agricultural sustainability and farmers' livelihood. Local communities rely mostly on the agricultural production are facing huge impacts from climate change. Irrigated agriculture, the biggest consumer of the water in Yellow River Basin, will be greatly affected by increased water scarcity driven by the two key factors of increased human use and climate change.

This presentation will outline some of the arising hard realities for the Yellow River Basin. It will also consider the potential to engage farmers and decision makers in changing adaptive behaviours and governmental policy instruments respectively, as potential strategies to ameliorate impacts on agricultural sustainability in the basin.

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Research Area: Urban Management, Transport and Inclusion

Title: Australian Rainfall Trends and Adaptive Urban Water Management

Rainfall is the key climate variable that governs the spatial and temporal availability of water. In the changing climate, presence of significant trends in observed rainfall plays an important role in decision making on urban water management such as Water Sensitive Urban Design (WSUD) and Water Supply Engineering. In this study we identified monthly rainfall trends and their relation to the southern oscillation index at ten rainfall stations across Australia covering all state capital cities. The non-parametric Mann-Kendall test was used for identifying significant trends. The trend free pre-whitening approach was used to remove the effects of serial correlation in the data set. The trend beginning year was approximated using the cumulative summation technique and the influence of the southern oscillation index was identified using graphical representations of the wavelet power spectrum. Decreasing trends of rainfall depth were observed at two stations, namely Perth airport for June and July rainfall starting in the 1970s and Sydney Observatory Hill for July rainfall starting in the 1930s. No significant trends were found in the Melbourne, Alice Springs and Townsville rainfall data. The remaining five stations showed increasing trends of monthly rainfall depth. The southern oscillation index was found to explain qualitatively the increasing trends for the Adelaide (June) and Cairns (April) rainfall data and the decreasing trends for Sydney (July) rainfall. Other possible climatic factors affecting Australian rainfall are also discussed. Adaptive urban water management strategies in presence of significant rainfall trends are explained in this study.

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Research Area: Urban Management, Transport and Inclusion

Title: Modelling of Australian road transport greenhouse emissions in carbon constrained economy

This paper outlines a proposed methodology for development of model for projection of future road transport GHG emissions in carbon constrained Australian economy. The methodology is based on three milestones: a) determining the emissions rates for all essential vehicle classes in all necessary year categories; b) determining future composition of Australian vehicle fleet – that is what are the classes and years of manufacture that vehicles belong to; c) estimating future vehicle-km-travelled for all essential vehicle classes and year of manufacture categories. The methodology utilises an iterative approach that capture the social economical realities and therefore will provide accurate predictions. In the iterative methods all parameters are used as inputs and outputs to the model in search of equilibrium. Central stage in this research is played by the concept of rebound effect. The paper presents a framework for verification of hypothesis that road transport activities are closed to saturation and therefore more affordable transportation will cause limited increase of vehicle-km-travelled. To the knowledge of the author there is no available statistics for rebound effect in Australia or at least the published vehicle-km-travelled data has not been analysed in such manner. Therefore, the conclusions for rebound effect from this research could have significant assistance for future policies discussions. The proposed modelling will assist in decisions for important policy problems such as role of vehicles fuel economy standards and emissions trading in the effective mitigation of current Australian vehicle fleet to sustainable one.

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Research Area: Urban Management, Transport and Inclusion

Title: Biosolids and Pine Plantations – a carbon sink?

The land application of biosolids is increasingly becoming popular worldwide as it provides an avenue for wastewater treatment plants (WWTP) to beneficially use a waste product. Biosolids are produced during the continuous treatment of domestic sewerage and their disposal is governed by legislation due to the potential health issues associated with their use. In Western Australia the application of biosolids to pine plantations has proved a successful activity. In plantations where biosolids have been applied, the growth and productivity of the trees has been significant. The increase in tree growth converts to increased levels of carbon sequestration than previously observed. This coupled with the high demand for timber may result in a potential long-term strategy for the use of biosolids a product from settlements. Due to the long life-cycle of wood products sourced from these plantations there is the potential for the plantations to increase their ability as carbon sinks. The ability of biosolids to increase the carbon sequestering capabilities of the plantations means that the WWTP producing the biosolids have developed a system to offset their carbon emissions. Utilising this strategy along with carbon reduction activities at the WWTP could increase the potential of the plantations and the sewerage industry to become carbon positive. This study will assess the economical, social and environmental benefits of applying biosolids to pine plantations leading towards increased carbon sequestration; a key step in the progress towards climate change adaptation. The significance of the study would be quantifying the climate adaptation process from the application of organic waste stream from settlements after treatment and risk assessment for revegetation or in plantations. This research will be conducted in association with Water Corporation.

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Research Area: Built environment, innovation, institutional reform

Title: Visualising Carbon

The focus internationally on climate change adaptation has undoubtedly centred on carbon emissions reductions. Much has been made of carbon neutral cities (also known as zero-carbon or carbon constrained cities) and yet, as one report on the Abu Dhabi Masdar development states: “the goal is actually best described as zero net carbon dioxide emissions: to reach the zero-emissions target, the developers will turn to a system of carbon credits.” (Technology Review, March-April 09)

Thus such cities and the future ‘carbon-constrained world’ are likely to give rise to increasing demands on land - for (renewable) energy generation and carbon offset generation – which will exist in competition with land resources required for food generation, settlements and national parks. Increasing interactions between carbon interests and environmental/social interests will occur with growing infrastructural and abatement needs – straining the increasingly unsuitable ‘bundle of rights’ system that serves to determine property rights.

This paper contends that a holistic approach to carbon management – and indeed the field of property rights - by authorities is required. Such an approach requires clearly defined property rights and interests alongside integrated data management – essentially a single point of access for decision making and risk assessment. Such a system would further enable the development of regulations in the carbon environment - specifically those surrounding bio- and geo-sequestration, where projects currently exist in Australia without a fully defined regulatory environment.

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Research Area: Institutional reform

Title: Transcending the Past: Renovating Climate Change Policy in Small Pacific Island States, Tonga

The Kingdom of Tonga historically is a class structured society. The 1875 Constitution confirmed the King's liberation of commoners from chiefly authority, as well as legalising private land tenure. The following Land Act of 1927 then prescribed strict rules for land acquisition through the Minister for Lands who is the sole representative of the Crown in all matters concerning land and sea in the Kingdom. Tonga's current environmental and resource management framework as a consequence is founded in the 1875 Constitution and the Land Act. This basically sets out the constitutional and administrative structure that established the modern land and marine tenure as practiced today. More importantly, political perceptions, the supporting institutions, and the resource management structure that was initially formulated were a reflection of this past and of priorities at the time. Consistent with deductions of 'Environment and Development' theory, elevation of the economy and raising the standard of living to a more affluent level was of utmost priority.

The complication created here is that the country's priorities have shifted with time, assisted by the increasing global focus on sustainable development and the environment. However in light of overwhelming economic pressures to develop, the current environmental framework with its inherent legacies although evolving through recent national reform can be deemed inept and still lacking the capacity to adequately address arising environmental issues. Successful research will fundamentally contribute to the reform process and aid the Tongan Government in ensuring that potential development initiatives are provided the proper sustainable vision, direction and guidelines in light of a changing paradigm. The framework developed will more importantly be knowledgeable in objectively integrating information from all disciplines into enhancing management of the environment from a critical and rational perspective.

Name: Cathryn Hamilton

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Research Area: Built environment, innovation, institutional reform

Title: Local government initiatives to support carbon neutral households

Although climate change is a global issue the contributing factors arise through local action, particularly the use of energy from fossil fuels. While state planning strategies dictate the direction and priorities for planning communities into the future, these are then implemented by local agencies. In 2008 a questionnaire was sent to Chief Executives of local government in metropolitan South Australia (SA) and Victoria (Vic) seeking information about their organizations commitment to address climate change and reduce greenhouse gas (carbon) emissions and what actions had been taken or were proposed to assist residents to reduce their carbon emissions. The responses to questions about ideal processes or measures that local government could implement to make a positive impact on climate change and the barriers that would prevent local government from implementing these will be presented. The responses from each state indicate differences in the idea approaches to address climate change and the barriers that would need to be overcome. The SA Councils most frequently identified 'leading by example' followed by reducing energy used for 'street lighting' while the Vic Councils most frequently nominated 'planning policy' followed providing 'information and education'. The main barrier for SA Councils was clearly insufficient funding. The Vic Councils also mentioned insufficient funding as a major barrier, but equally nominated the lack of political will or support from higher levels of government. The barriers to addressing climate change at the local level are generally not technological but are mainly financial, political, institutional, infrastructural or social.

Name: Melchior Mataki

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Research Area: Infrastructure and institutional reform

Title: Intertwining Adaptation and mitigation: the case of solid waste management

Most of the published studies on solid waste management (SWM) and its linkage to climate change have focused on the connection between SWM and green house gases (GHGs) emission and mitigation. Some of these studies have been captured in the analysis by Bogner et al. (2007) for the IPCC 4th Assessment Report.

However, the potential impacts of climate change on SWM have not been flagged out clearly in the literature (Bebb and Kersey 2003), and even the IPCC 4th assessment report fell short of the mark. This paper explores two pertinent questions to contribute to alleviating the lacunae described above: (i) how can SWM infrastructure (e.g. landfills, material recovery facilities) be made resilient to changing climate regimes? (ii) How can SWM options (e.g. organic material recovery and reuse) reinforce adaptation and mitigation objectives?

Name: Supriya Mathew

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Research Area: Built environment, innovation, institutional reform

Title: Development of a Decision Making Tool for Local-scale Adaptation to Future Climate Risk

This paper focuses on local scale climate adaptation decision-making process that could be utilised by local government agencies. The tool avoids making decisions under pressure and necessity and hence reduces the likelihood of detrimental consequences of adaptation decisions. The method offers an objective record of adaptation options for each council recognising their different dynamics during a period of approximately 10-30 years. It also helps identify benefits from adaptation options before decisions are taken. Future climate impacts not only cause financial loss, but social and environmental losses and hence are ranked separately within a Triple Bottom Line (social, environmental and financial) framework.

A 3D virtual environment tool is to be used to encourage groups to ‘see’ the interactions between adaptation choices and community impacts. The simulation of climate adaptable neighbourhoods in 3D virtual environments focuses on the consumption behaviour and adaptive capacity of more vulnerable groups (young and elderly people) and helps in prioritising the social aspects of climate impacts. The ranking process is carried against well-defined objectives to reduce the differences in opinions while considering social and environmental impacts. Bayesian inference, exploiting expert views, is used for valuing market impacts with practical discount rates considering the fiscal situation of councils.

Ku-ring-gai council, Sydney is our first case study with a plan to extend our method to Cochin Municipality, Kerala, India and thereby to develop an internationally useful tool to support climate adaptation decision-making.

Name: Trevor Nottle**Email:** trevor.nottle@adelaide.edu.au**Organisation:** University of Adelaide, Arch./Land arch./Urban Design**Research Area:** Built environment - innovation**Title:** The impact of climate change on hoe gardens on the Adelaide Plains

This paper summarises a 3yr research project into the likely impacts of climate change on home gardens of the Adelaide Plains. Results show:

Participants believe climate change will have moderate to extreme impacts.

Participants, by and large, follow water use restrictions.

Participants are aware of the soil types of their locations i.e. they understand their 'terroir'.

Participants are still, to a large extent, dependant on tap water to water their gardens.

The use of rain-water tanks is growing despite there being no government subsidy for this usage.

Participants employ a range of short term strategies.

Few participants are highly discouraged by water restrictions.

No participants are considering utilizing high-end irrigation technology in the short term.

Short term strategies focus strongly on changes in plant selection, placement and applying criteria for drought hardy/tolerant plants.

Participants have a range of long term strategies to manage the impacts of climate change on gardens.

Significant strategies are partial revamping of gardens, gradual change, and installation of rain-water tanks.

Priority also being given to reduced areas of garden, tighter zoning of plants according to water needs, and constructing/creating more shade.

No respondents plan wholesale change.

Significantly no participants contemplate increasing hard-scaped areas.

Participants will look to themselves and friends, local nurseries and print media to gather ideas.

Radio talk-back gardening programmes have some credibility among participants.

Few participants will turn to garden designers, landscape architects.

Travel and TV gardening programmes are not seen as source for ideas.

Transformational change is proposed as the way forward for home gardeners managing the impacts of climate change and some simple strategies are outlined.

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Research Area: Built environment, innovation, institutional reform

Title: Adaption to climate change through enhanced energy performance of housing

The background to this research which is at an early stage of progress (year one, PhD) is that housing in Australia consumes huge resources and contributes significantly to climate change effects through greenhouse gas emissions. There are however major anomalies surrounding the question of environmental performance, cost and affordability in modern housing in Australia:

- The effectiveness of initiatives aimed at reducing the environmental impacts of housing, yet reducing the capital and longer term costs are not fully understood.
- Cost effective design and procurement of housing currently is difficult to achieve without a more rapid response and adaption to newer climate change realities.
- Housing economic life span prediction is problematic, as maintenance issues, technological developments and adaption or suitability to future occupancy must account for evolving climate change scenarios.

The essential aim of the research presented to the ACCARNSI forum surrounds the question of how can we measure and predict the costs and/or benefits of building more energy efficient homes in Australia? together with an underlying examination of the general volume housing industries capability and role in providing sufficient and cost effective housing product variation. The research seeks to develop a greater understanding of both the construction cost implications and downstream impacts on housing cost and affordability of measures to improve housing energy efficiency across climate regions of Australia

The research presented, examines both house building design/construction and regulatory processes that impact on costs to build more energy efficient housing. The presentation includes some discussion and early prototyping of comparative and parametric analyses of housing options with the aim of developing a robust model of cost evaluation of energy efficiency measures.

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Research Area: Built environment, innovation, institutional reform

Title: Sustainable urban design using Information Technologies: Building Information Modelling and Geographical Information System

There is an increasing pressure on architects, urban designers and planners to redefine design processes to

- reduce green house gas emissions caused by the built environment
- create buildings and cities so they are adaptable and/or resilient to the consequences of climate change.

The consensus among experts is to leverage Information Technologies (IT) for design analysis as a prerequisite to achieving sustainable design outcomes. During the last few years two new IT concepts with a spatial focus have emerged: Building Information Modelling (BIM) and Geographical information System (GIS).

Urban sustainability and climate change issues have traditionally been looked at from various perspectives such as economic, social, ecological, and conceptual models like DPSIR (Drivers-Pressure-State-Impact- Response). This research is based on the premise that the spatial element is fundamental to all these perspectives; and that the assessment of the performance of the built environment is an indispensable step in the pursuit of sustainability, and adapting to climate change.

This research therefore approaches urban sustainability and the consequences of climate change from a spatial view point and aims to:

- understand the synergies between BIM and GIS to evaluate and analyse performance of buildings and urban settlements for sustainability. This analysis includes a range of sustainability indicators with a focus on energy consumption
- propose strategies for implementing these sustainability analysis practices using BIM and GIS in the current industry scenario.

The method involves identifying suitable sustainability indicators, developing a BIM and GIS based methodology for their analysis, document their strengths and weaknesses; and propose strategies for existing practices to incorporate such analyses in their operations. The expected outcome of the research will be to establish a practical methodology for current architectural design industry to employ BIM and GIS for sustainable urban design.