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Climate change adaptation in Australia

Introduction

5.1 In chapter two, the Committee noted that some climate change has already occurred, and that, regardless of the extent and timing of mitigation efforts, climate change will continue to occur for some time.

5.2 This chapter focuses on an aspect of the climate change debate that will become increasingly important as the climate change already in train starts to take hold: how to adapt to the effects of climate change.

5.3 During the inquiry, the Committee heard evidence about two mechanisms for adapting to climate change. One is the more energy efficient design of buildings, and the other is the moderating effect revegetation can have on climate change at a local level.

Energy efficiency in buildings

5.4 The energy used in new and existing buildings forms a significant part of the total energy use in Australia. According to the Australian Bureau of Statistics' *Year Book Australia 2008* Australian households alone account for about 11 percent of total energy use in Australia.[1] Improving energy efficiency in new and existing buildings will thus form an integral part of Australia's response to climate change.

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1 Australian Bureau of Statistics, *Year Book Australia 2008*, 2008, cat. no. 1301.0, ABS, Canberra.

Energy efficiency in new buildings

5.5 In warmer regions of Australia, a mixture of standardised regulation and an ill-informed consensus as to what constitutes an energy efficient house is driving climatically inappropriate design.

5.6 Currently all construction in the states and territories is regulated by the Building Code of Australia (the BCA). The BCA is administered by the Australian Building Codes Board on behalf of the Australian Government and state and territory governments. The BCA governs a range of factors relating to structure, fire safety, access, equipment, health and sustainability.

5.7 One of the objectives of the BCA is to reduce greenhouse gas emissions by ensuring the efficient use of energy in newly constructed buildings. This is achieved through a verification process where all proposed designs for new buildings must achieve an 'efficiency star rating' or equivalent level of efficiency.

5.8 This efficiency star rating takes into account design features such as geographical location, energy source, heating and cooling, and placement of windows. These factors are then used to model the energy efficiency of the building either through a computer programme or an equivalent modelling method.[2]

5.9 During the inquiry the Committee was informed that the nation-wide character of the BCA, far from encouraging efficient design, may in fact be driving inefficient design in some regions of Australia.

5.10 Mr Ross Conolly, from the Darwin Chapter of the Institute of Architects, had the following to say about the effect of BCA regulations on energy efficient design in Darwin:

> The typical thrust has been to use computer based modelling to assess the energy efficiency of, particularly, domestic dwellings. [The modelling] is often based on the effect of sealing small windows, minimisation of heat loss and gain, which can be very good if you live in Melbourne or wherever, but in Darwin you want to get rid of the heat.[3]

5.11 In regards to housing design in Darwin, Mr Connolly advocated housing that is elevated, long and thin with through-ventilation. Mr Connolly stated that this form of housing, whilst significantly more energy efficient

2 BCA Illustrated, *The Building Code of Australia*, 2009, www.bcaillustrated.com.au, viewed on 21 January 2009.

3 Mr Ross Connolly, *Transcript of Evidence*, 19 August 2008, p. 8.

than the housing designs mandated by the BCA, is discouraged by the current energy efficiency rating system:

> …[in a house that is elevated, long and thin with through-ventilation], I can say that there might be 20 days a year where the conditions are so humid and hot that you flick on a room air-conditioner which might sit in the wall. When you put the house on the ground, make it out of heavy weight construction, let the sun bear on the walls and heat up the walls through the day, put in small sliding windows instead of big louvres, you might find that it becomes 200 days a year that you feel that you need to have the air-conditioner on in the building.
>
> While the [BCA] computer models will assess the amount of insulation and the amount of sealing against energy infiltration there is no doubt that, if you are using an air-conditioner for 200 days of the year, you are using a great deal more energy than if you are using it for 20 days a year.[4]

5.12 Mr Gregory McNamara, another Darwin architect, supported this view:

> The current direction of regulation is counterproductive and is leading us to an energy-reliant scenario.[5]

5.13 The Committee heard further evidence that, in some areas of Australia, inefficient housing design is also being driven by ill-informed demand. People moving to warmer parts of Australia from the southern states have a pre-existing notion of good housing design. Namely, there is a wide expectation of a ground level brick veneer design with small sealed windows and air-conditioning, which may be appropriate in more temperate regions but is not suitable for a tropical climate. The housing market then responds to this demand leading to the proliferation of energy-inefficient housing designs.[6]

5.14 This issue is exacerbated by the low costs of this housing design and the short term interests of the developers who are contracted to build these houses. Mr McNamara stated that:

> The real concern is that these sealed houses are cheaper and faster to build and the mass building market will take on this narrow view of energy efficiency with great vigour…[7]

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4 Mr Ross Connolly, *Transcript of Evidence*, 19 August 2008, p. 9.

5 Mr Gregory McNamara, *Transcript of Evidence*, 19 August 2008, p. 4.

6 Mr Ross Connolly, *Transcript of Evidence,* 19 August 2008, p. 15.

7 Mr Gregory McNamara, *Transcript of Evidence*, 19 August 2008, p. 4.

5.15 Ensuring energy-efficiency in the design phase of new buildings throughout all regions of Australia would aid in reducing the amount of energy used by buildings and their occupants in Australia.

5.16 Mr McNamara concluded that it is imperative for building design regulations, namely the BCA, to be responsive to the local climate and conditions of different regions throughout Australia.[8]

5.17 To combat the negative force of market demand, Mr McNamara advocated educating the public about appropriate design and the long-term benefits of such design.[9]

5.18 Ms Karen White, from the Northern Territory Branch of the Real Estate Institute, cited a range of mechanisms that could be implemented to encourage the uptake of energy efficient design by developers, including rewarding efficient design with rebates on infrastructure charges and stamp duty or with the relaxing of other design regulations such as height and volume.[10]

Recommendation 10

The Committee recommends that the Australian Government direct the Australian Building Codes Board to review the Building Code of Australia to ensure that it better provides for energy efficiency standards suitable for varied climate zones.

Energy efficiency in existing buildings

5.19 Energy efficiency in buildings is mainly driven through regulating the design of new constructions. The Committee received evidence that encouraging energy efficiency in pre-existing buildings should also be a priority.

5.20 Ms White stated that each year there is an increase of only two percent in Australia's residential building stock, implying that 98 percent of Australia's building stock consists of pre-existing buildings. Encouraging

8 Mr Gregory McNamara, *Transcript of Evidence*, 19 August 2008, p. 10.

9 Mr Gregory McNamara, *Transcript of Evidence*, 19 August 2008, p. 14.

10 Ms Karen White, *Transcript of Evidence,* 19 August 2008, pp. 13-14.

energy efficiency in existing buildings could thus deliver a significant reduction in household emissions.[11]

5.21 A range of options are available to reduce energy usage in existing buildings depending on the regional climate:

- increasing insulation and double glazing windows;
- installation of energy efficient ventilation systems;
- installation of energy efficient light bulbs such as fluorescent lamps or LED lighting;
- installation of energy efficient heating systems such as geothermal and solar heating;
- installation of energy efficient cooling systems such as evaporative cooling;
- installation of energy efficient water heating systems such as gas or solar water heaters; and
- upgrading appliances to modern models with higher energy efficiency.[12]

5.22 There is a range of barriers preventing the uptake of energy efficient technologies and practices in existing buildings.

5.23 One of the central factors preventing an increase in energy efficiency in buildings is a lack of the necessary experts to advise on and implement energy efficiency measures. In turn, a lack of supply of experts increases the cost of their services, thus increasing the cost of upgrading the energy efficiency of existing buildings.

5.24 Business operators may lack incentives to invest in increasing the energy efficiency of existing properties. Operators may be focused on short term profits whereas the benefits of increased energy efficiency are generally only realised in the long-term. Thus operators are not likely to choose to invest significant capital in upgrading their current properties.

5.25 In the rental market, any potential benefits from increased energy efficiency will be felt by the tenants through lower energy bills, resulting in

11 Ms Karen White, *Transcript of Evidence*, 19 August 2008, p. 6.

12 Gurney, A., Ford, M., Low, K., Tulloh, C., Jakeman, G. and Gunasekera, D., *ABARE Research report 7.16: Technology toward a low emissions future,* September 2007, pp. 17-25.

little or no benefit to the landlord. Thus, landlords have few incentives to upgrade the energy efficiency of their existing investments.[13]

Star rating programmes

5.26 The New South Wales Government currently manages the National Australian Built Environment Rating System (NABERS). This is a voluntary national initiative through which property owners can reliably assess the energy efficiency of their properties and seek ways to improve their energy efficiency.[14]

5.27 Australian Government agencies, in conjunction with NABERS and subject to the 2006 *Energy Efficiency in Government Operations* policy, must meet mandatory energy efficiency targets, and thus reduce the amount of emissions resulting from Government operations. Part of these efficiencies must be gained through achieving a specific level of efficiency, denoted by a star rating, in existing buildings.[15]

5.28 Ms White discussed some of the disadvantages of the star rating system in warmer parts of the Australia:

> We need to be careful that any rules that are put in place regarding the building sector do not drive the obsolescence of existing buildings, because that would not be a good environmental outcome. …When you build a new building it takes at least 30 years to reclaim the annual operating energy that could be saved, so it really is not the best environmental outcome to have any policy that drives the knocking down of existing buildings and a preference for new buildings.[16]

5.29 Rather, Ms White advocated a system where improvements on current energy ratings should be sought. For example, an improvement of one star during the reporting period as opposed to having to achieve a mandatory 4.5 star rating. Ms White stated that this form of programme would lessen the dangers of building obsolescence whilst maintaining the incentive for land holders to increase efficiency.[17]

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13 Gurney, A., Ford, M., Low, K., Tulloh, C., Jakeman, G. and Gunasekera, D., *ABARE Research report 7.16: Technology toward a low emissions future,* September 2007, p. 41.

14 National Australian Built Environment Rating System, NABERS, 2008, viewed 15 January 2009, www.nabers.com.au, viewed on 15 January 2009.

15 Department of the Environment, Water, Heritage and the Arts, *Energy efficiency in government operations - Fact sheet 1 of 12*, 2006, p. 1.

16 Ms Karen White, *Transcript of Evidence*, 19 August 2008, p. 17.

17 Ms Karen White, *Transcript of Evidence*, 19 August 2008, p. 17.

5.30 Ms White outlined a range of mechanisms available to governments to reward increased energy efficiency in homes. Ms White advocated a reduction in council rates or accelerated depreciation for homes with high energy efficiency and grants to assist in retrofitting of energy efficient technologies.[18]

Land clearing and climate

5.31 The Committee has already discussed the impact changes in land use can have on carbon sequestration. However, land use change can also impact the climate more directly. Studies have shown that a reduction in vegetation across a region may affect temperature and rainfall levels in that region.

5.32 The impacts of land clearing on climate can be divided into two categories: biogeochemical and biogeophysical.[19]

5.33 Biogeochemical refers to the transfer between living things and the physical environment.[20] A good example is the 'water cycle', which describes the continuous rotation of water between the atmosphere, the land and living things.

5.34 The biogeochemical effect of land clearing is already recognised in climate science through the concept of carbon sequestration: as vegetation is cleared, less carbon dioxide is removed from the atmosphere.[21]

5.35 Biogeophysical refers to the effect of living things on the physical environment. A common example is the use of plants to prevent erosion.[22]

5.36 Biophysical effects on the environment are starting to be considered very seriously as part of the climate change debate. There are four principal biophysical effects of concern to climate scientists:

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18 Ms Karen White, *Transcript of Evidence*, 19 August 2008, p. 17.

19 Feddema, J.J., Oleson, K.W., Bonan, G.B., Mearns, L.O., Buja, L.E., Meehl, G.A. and Washington, W.M., *The importance of land-cover change in simulating future climate science*, December 2005, Vol. 310, p. 1674.

20 "biogeochemical adj." *The Australian Oxford Dictionary, 2nd edition*, 2004, www.oxfordreference.com, viewed on 14 January 2009.

21 Feddema, J.J., Oleson, K.W., Bonan, G.B., Mearns, L.O., Buja, L.E., Meehl, G.A. and Washington, W.M., *The importance of land-cover change in simulating future climate science*, December 2005, Vol. 310, p. 1674.

22 Feddema, J.J., Oleson, K.W., Bonan, G.B., Mearns, L.O., Buja, L.E., Meehl, G.A. and Washington, W.M., *The importance of land-cover change in simulating future climate science*, December 2005, Vol. 310, p. 1674.

- a reduction in leaf cover means that less moisture is transmitted to the atmosphere through the process of transpiration resulting in less convective build up;
- as land cover is altered, so are the reflective properties of that area, which means that land clearing changes the ratio of solar radiation absorbed and reflected by a particular region;
- the conversion of woody vegetation to low lying crops and pastures decreases aerodynamic drag in the atmosphere which in turn increases the strength of surface winds; and
- changing the structure of vegetation affects the water runoff patterns across the altered region thus affecting the balance between runoff, evaporation, and surface and sub-soil moisture.[23]

5.37 Studies by Feddema et al, and, in Australia, McAlpine et al, show that land clearing is affecting temperature and rainfall on a regional scale and may even be influencing global weather patterns. [24]

5.38 The evidence indicates that whether a reduction in vegetation will result in a cooling or warming effect depends on the latitude and geographical nature of the region. For example, snow generally reflects more solar radiation than alpine vegetation. A reduction in vegetation in a region with snow cover may result in a larger amount of solar radiation being reflected, which in turn may cause a cooling effect. However in other areas, with different geographical attributes, land clearing may force a warming effect.[25]

Effect of land clearing on temperature and rainfall

5.39 The Australian landscape has undergone a significant amount of land clearing since European settlement. Land clearing in Australia has primarily taken the form of converting native vegetation to pastures and cropland.

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23 Feddema, J.J., Oleson, K.W., Bonan, G.B., Mearns, L.O., Buja, L.E., Meehl, G.A. and Washington, W.M., *The importance of land-cover change in simulating future climate science*, December 2005, Vol. 310, p. 1674.

24 Feddema, J.J., Oleson, K.W., Bonan, G.B., Mearns, L.O., Buja, L.E., Meehl, G.A. and Washington, W.M., *The importance of land-cover change in simulating future climate science*, December 2005, Vol. 310, pp. 1674-1678; and McAlpine, A.C., Syktus, J.I., Deo, C.D., Lawrence, P.J., McGowan, H.A., Watterson I.G., and Phinn, S.R., *Modelling impacts of vegetation cover change on regional climate*, Geophysical Research Letters, November 2007, Vol. 34.

25 Betts, R.A. *Offset of the potential carbon sink from boreal forestation by decreases in surface albedo*, Nature, September 2000, vol. 408, p. 187.

5.40 In 2007, researchers from the University of Queensland, Queensland Government, the University of Colorado and the CSIRO completed a study concluding that the clearing of native vegetation has resulted in significant changes in regional climate in Western Australia and eastern Australia.

5.41 The study compared two simulations of the Australian climate for the period 1949-2003. One simulation recreated the climate for this period with pre-European land cover characteristics whilst the other simulation reproduced the climate over this period with modern day land cover characteristics.

5.42 To accurately carry out these simulations, the study used satellite imagery data on leaf area to build a map, with a resolution of eight kilometres, of vegetation in modern-day Australia, reflecting the significant land clearing that has taken place. The map was then used to extrapolate Australia's pre-European vegetation characteristics where no land clearing had taken place. These two different sets of information were then used to run two climate simulations.[26]

5.43 The simulation showed that modern day land clearing produced significantly higher temperatures than the simulation with no land clearing. These temperature differences showed a correspondence with areas where major clearing of native vegetation had taken place, such as eastern and southwest Western Australia.[27]

5.44 The study further indicated that, in the scenario accounting for modern-day land clearing, the mean summer rainfall in eastern Australia and southwest Western Australia was lower by four to 12 percent and four to eight percent respectively compared to the non-cleared scenario.[28]

5.45 In other words, the study inferred that land clearing increased the severity of drought. In particular, the study concluded that temperatures during

26 McAlpine, A.C., Syktus, J.I., Deo, C.D., Lawrence, P.J., McGowan, H.A., Watterson I.G., and Phinn, S.R., *Modelling impacts of vegetation cover change on regional climate*, Geophysical Research Letters, November 2007, Vol. 34, pp. 4-5.

27 McAlpine, A.C., Syktus, J.I., Deo, C.D., Lawrence, P.J., McGowan, H.A., Watterson I.G., and Phinn, S.R., *Modelling impacts of vegetation cover change on regional climate*, Geophysical Research Letters, November 2007, Vol. 34, p. 6.

28 McAlpine, A.C., Syktus, J.I., Deo, C.D., Lawrence, P.J., McGowan, H.A., Watterson I.G., and Phinn, S.R., *Modelling impacts of vegetation cover change on regional climate*, Geophysical Research Letters, November 2007, Vol. 34, p. 6.

the 2002–2003 El Nino event were 0.75-2.0 degrees Celsius higher than they would have been if the land had not been cleared. [29]

5.46 Similar climate modelling studies provide additional evidence for the effect of land clearing on temperatures and rainfall:

- Two separate studies from 1989 and 1992 both modelled climate in the Amazon with and without land clearing. The studies found that where forest had been converted to pasture, there was an increase in temperature and decrease in rainfall. Further, the 1992 study found that the length of the dry season increased in areas where deforestation had taken place.[30]
- A 2002 climate modelling exercise established that changes to the land surface in the Amazon directly affects the circulation patterns of clouds and thus changes the level of rainfall in the Amazon.[31]
- A 2003 study of the Tocantins River in the Amazon demonstrated that deforestation has increased runoff from precipitation in the region, thus altering river flows and soil moisture in the region.[32]
- Finally, a global climate modelling study from 2000 demonstrated that land clearing affects temperature differently depending on the latitude and geographical nature of the region. The study suggested that deforestation in high latitude alpine regions results in a cooling effect.[33]

5.47 Dr McAlpine, a researcher from the 2007 study on land clearing in Australia, advised the Committee that:

> …when we start getting the interaction of a drier climate from increased concentrations of carbon dioxide in the atmosphere and we move into a more drought-prone climate, the land surface is going to dry, the vegetation is going to become more stressed, and our ability to keep the remaining vegetation in the landscape is

29 McAlpine, A.C., Syktus, J.I., Deo, C.D., Lawrence, P.J., McGowan, H.A., Watterson I.G., and Phinn, S.R., *Modelling impacts of vegetation cover change on regional climate*, Geophysical Research Letters, November 2007, Vol. 34, p. 6.

30 Lean, J. and Warrilow, D.A., *Simulation of the regional climatic impact of Amazon deforestation*, Nature, November 1989, Vol 342, pp. 411-413; Shukla, J., Nobre, C. and Sellers, P., *Amazon deforestation and climate change*, Science, March 1990, Vol. 247, pp. 1322-1325.

31 Baidya Roy, S. and Avissar, R., *Impact of land use/land cover change on regional hydrometeorology in Amazonia*, Journal of Geophysical Research, August 2002, Vol. 107, pp. 4-10.

32 Costa, M.H., Botta, A. and Cardille, J.A., *Effects of large-scale changes in land cover on the discharge of the Tocantines River, Southeastern Amazonia*, Journal of Hydrology, July 2003, Vol 283(1), p. 206.

33 Betts, R.A. *Offset of the potential carbon sink from boreal forestation by decreases in surface albedo*, Nature, September 2000, vol. 408, p. 187.

> going to become more difficult. Potentially we are going to see a stronger feedback of the land surface on climate, which could actually make our climate change impacts even worse than what is predicted...[34]

5.48 Dr McAlpine further commented on the interconnectedness of the impacts of land clearing across separate regions:

> When we change the land use and clear the vegetation, we essentially change the radiative force that is coming off the land surface and also the surface hydrology and the transpiration rates, which then has an impact on the atmosphere—the ability of that atmosphere to produce convective rainfall, which also affects circulation patterns beyond the area where the clearing occurred.[35]

5.49 This proposal is again supported by studies from abroad. A 2004 modelling exercise indicated that land clearing in the Amazonia and Central Africa severely reduces rainfall in the U.S. Midwest during summer and reduces rain fall on the Californian coast in winter.[36] A similar study found that land clearing in Australia and Africa may affect the Asian monsoon season.[37]

5.50 In regard to land clearing's importance as a driver of climate change Dr McAlpine concluded:

> I am confident that I can say that [land clearing] is part of the problem and that climate change is a multidimensional process.[38]

5.51 A key question is the magnitude of land clearing's effect on climate change. Some studies conclude that whilst the effect of land clearing is perceptible on a regional scale, its overall impact on global average temperatures is minor.[39] However, others argue that the spatial scale of land clearing at a global level is comparable to the size of the oceanic drivers that influence the El Niño.[40] In Dr McAlpine's view:

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34 Dr Clive McAlpine, *Transcript of Evidence*, 9 December 2008, p. 14.

35 Dr Clive McAlpine, *Transcript of Evidence*, 9 December 2008, p. 12.

36 Avissar R. and Werth, D., *Global hydroclimtalogical teleconnections resulting from tropical deforestation*, Journal of Hydrometeorology, August 2004, Vol 6., p. 134

37 Feddema, J.J., Oleson, K.W., Bonan, G.B., Mearns, L.O., Buja, L.E., Meehl, G.A. and Washington, W.M., *The Importance of land-cover change in simulating future climates* science, December 2005, Vol. 310, p. 1674.

38 Dr Clive McAlpine, *Transcript of Evidence*, 9 December 2008, p. 16.

39 Bounoua, L., Defries, R. G., Collatz, J., Sellers, P. and Khan, H., *Effects of land cover conversion on surface climate*, Climatic Change, January 2002, Vol. 52, p. 1573.

40 Pielke, R.A., *Land use and climate change*, Science, December 2005, Vol. 310, p. 1626.

> … when we come to Australia … I would say that [land clearing] is getting up there to being equal with carbon dioxide in terms of some of its effects. I think it is the interaction between the two. As one changes, it is going to accelerate the feedback of the other ones.[41]

5.52 If Dr McAlpine is correct, then the restoration of cleared vegetation could significantly ameliorate the regional effects on temperature and rainfall of global heating. Dr McAlpine was of the view that the restoration of vegetation in certain regions may lead to higher rainfall and lower temperatures.[42]

5.53 The 2007 Australian climate modelling study, of which Dr McAlpine took part, also recommends that protecting and restoring Australia's vegetation should be a priority in mitigating the effects of climate change.[43]

5.54 It is the view of the Committee that Dr McAlpine may have identified a way of limiting the effects of global heating in certain regions. This is an area that requires further investigation and is too valuable a possibility to be passed up.

Recommendation 11

The Committee recommends that the Australian Government investigate using revegetation as an adaptation mechanism to reduce temperature and increase rainfall in applicable parts of Australia.

5.55 This chapter has examined two adaptation strategies for Australia to manage climate change. The Committee has not set out to undertake a thorough review of adaptation strategies, and has limited itself to reporting on those strategies that were presented to it during the course of the inquiry.

5.56 As climate change becomes more noticeable, adaptation strategies are likely to become more important for Australia. We need to begin the process of identifying and developing adaptation strategies now.

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41 Dr Clive McAlpine, *Transcript of Evidence*, 9 December 2008, p. 16.

42 Dr Clive McAlpine, *Transcript of Evidence*, 9 December 2008, p. 20.

43 McAlpine, A.C., Syktus, J.I., Deo, C.D., Lawrence, P.J., McGowan, H.A., Watterson I.G., and Phinn, S.R., *Modelling impacts of vegetation cover change on regional climate*, Geophysical Research Letters, November 2007, Vol. 34, p. 6.

Recommendation 12

The Committee recommends that the Australian Government conduct an inquiry into adaptation strategies for climate change. This inquiry should include consideration of projected sea-level rise due to climate change and its impact upon Australian coastal communities and neighbouring countries.

Kelvin Thomson MP
Chair