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Our Ref: Submission 11/432

Barriers to Effective Climate Change Adaptation  
Productivity Commission  
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By email: [climate-adaptation@pc.gov.au](mailto:climate-adaptation@pc.gov.au)

15 December 2011

Dear Commissioners,

**Re: Productivity Commission Issues Paper: Barriers to Effective Climate Change Adaptation**

We thank you for the opportunity to provide comments on the above Issues Paper. Our detailed responses can be found in the attached submission.

We envisage this submission as the basis for further discussion between the Flagship and the Productivity Commission. Please do not hesitate to contact my office on 07 3833 5637 or email me directly at [andrew.ash@csiro.au](mailto:andrew.ash@csiro.au) if you would like further information or clarification about our submission.

Yours sincerely,

Dr Andrew Ash  
Director  
Climate Adaptation Flagship



CSIRO Submission 11/432

Productivity Commission Issues Paper:  
Barriers to Effective Climate Change Adaptation

Productivity Commission, Australian Government

December 2011

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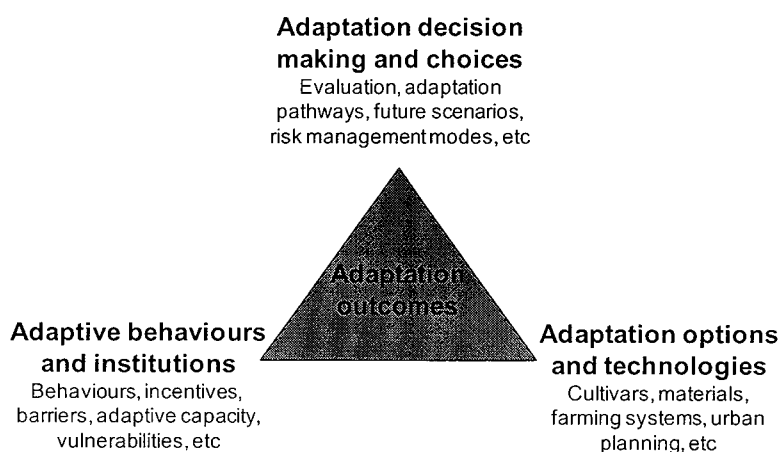
## Introduction and background

CSIRO welcomes the opportunity to comment on and provide input to the Productivity Commission's Issues Paper *Barriers to Effective Climate Change Adaptation*.

The *Issues Paper* covers a broad range of climate adaptation options, and ties policy objectives to on-ground issues and actions. This *Issues Paper* is useful for matching existing science projects to policy issues and in helping to identify gaps in knowledge.

CSIRO, through its Climate Adaptation Flagship, has significant research activities nationally and internationally and works closely with governments, industry and the community to develop practical and effective adaptation options.

This research encompasses the delivery of climate projections and the development of adaptation options for policy, and management of settlements and infrastructure, primary industries and ecosystems. We work to link three components needed for adaptation – adaptation options, adaptation information and decision-making, and adaptive behaviours – at all levels from households and businesses up to government policy.



Our comments have been prepared by a team of scientists from CSIRO's Climate Adaptation Flagship with experience and international recognition in many facets of climate adaptation research. This document provides some general comments about the framing of the Commission's task (section 1), then addresses each of the three main areas of questions raised by the Commission's Issues Paper (section 2). We note that we have previously provided the Commission with a copy of the documentation developed for a recent review of the Flagship, and we also attach a bibliography of publications that have emerged from CSIRO in this area over the past year. The submission is quite brief and we would welcome the opportunity to discuss any areas in more depth with the appropriate subset of CSIRO scientists.

### Case for considering adaptation and its urgency

The Issues Paper largely proceeds on the presumption that the case for needing to consider adapting to climate change can be taken for granted. This submission proceeds on the same basis, given the very strong rationale for this assumption in climate change science (e.g. for recent summaries see (Cleugh *et al.* 2011; Steffen 2011). However, a material concern for the Productivity Commission is that the past few years, since the 2007 IPCC report, have seen the emergence of substantial evidence that it will now be hard for the world to avoid at least 2°C of warming and must take higher levels very seriously given the slow progress in decarbonising the global economy (Anderson and Bows 2008; Allen *et al.* 2009; Meinshausen *et al.* 2009; Rogelj *et al.* 2010; Anderson and Bows 2011). This has significant implications for the "adaptation challenge", particularly in terms of the psychology and sociology of internalising long-term uncertainties, and consequently for managing those uncertainties in decisions with longer lifetimes (Stafford Smith *et al.* 2011). Whilst the case for considering adaptation and for the urgency of that consideration is not pursued further here, implications of that case will appear below.

## Section 1: Framing and general principles about adaptation

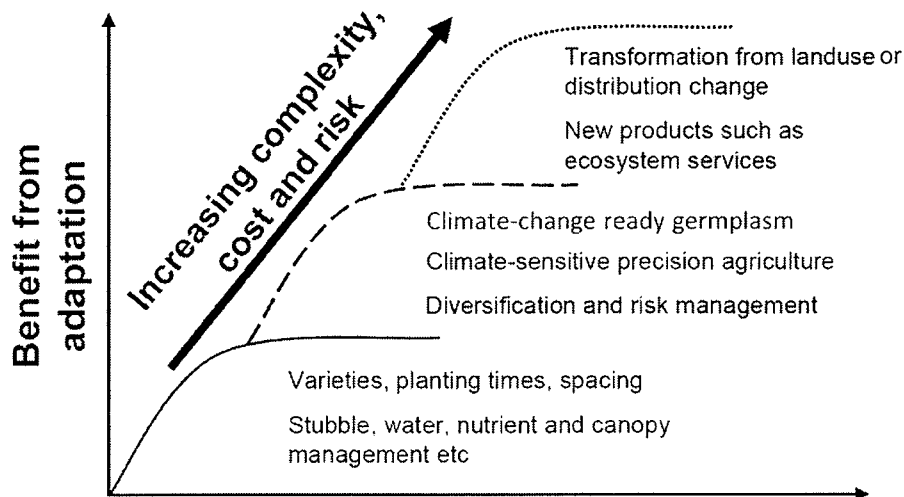
Adaptation to climate change is challengingly complex, more akin in nature to Ecologically Sustainable Development than other major policy concerns such as competition policy reform. It is thus perhaps not surprising that the Issues Paper does not as yet provide a clear framework for how the Commission is going to approach their task. This section therefore focuses on outlining some issues that need to be encompassed or satisfied by whatever framework the Commission eventually settles on, as well as canvassing a few potential approaches. Since this is a genuinely challenging area of new science and policy formulation, CSIRO would welcome further discussion on the following points.

As noted but not very explicitly characterised in the Issues Paper (pp.3-5), adaptation involves a huge potential variety of types of decisions: from short to long term; in and across all sectors and domains of society; at levels of organisational scale from the household to the nation; from small or incremental to large or transformational; and encompassing both policy or context-setting for others and immediate management actions. Whilst the Commission will ultimately focus on the actions that can be taken at a governmental level to trigger appropriate types and levels of adaptation, this analysis needs to conceptualise the whole system of adaptation that it is seeking to affect.

Some concepts that are particularly important in this regard are:

1. *Adaptation as a scale-nested process.* Adaptation is a nested process that operates at multiple levels of organisational scale (Adger *et al.* 2005; Preston and Stafford Smith 2009): there is a tendency to perceive that adaptation actions happen locally or regionally, whilst adaptation policy making (that sets the context for actions) occurs at a government level. In fact, decisions about both adaptation 'policy' and actions occur at all levels of organisational scale, from the household (where context setting household 'policy' decisions about energy or transport options set the context and constrain the options for adaptation actions by individual family members) to national (where policy decisions certainly set a context for options at other levels, but there are also actions to be taken specifically at this level to manage government assets, etc). This highlights the point that the adaptive capacity of national governance institutions and the way they are organised to make the right choices about adaptation is just as important as the adaptive capacity of local communities or businesses.
2. *A decision-centred approach to adaptation.* Whilst the climate change literature often focuses on impacts (and vulnerabilities) at future dates such as 2050 or 2100, what actually matters for adaptation are the decisions that need to be made *now* (i.e. next 5-10 years), who should make them, and whether the outcomes of these are likely to be affected by future climate change. The focus on future dates tends to cloud clarity compared to a decision-centred approach which then drives what sort of information is needed about the future to assist that decision-making (e.g. Willows and Connell 2003; Meinke *et al.* 2009; Stafford Smith *et al.* 2011). Another concern with placing too much emphasis on climate changes in 2050 or 2070 is that it tends to invoke discounting behavioural responses. This then can mask the need to be making more immediate decisions in preparation for the future.
3. *Adaptation responses vary from incremental to transformative.* The response to a particular adaptation challenge can vary immensely, from small, incremental adjustments to business-as-usual for a farmer gradually amending crop planting dates, through to major transformational changes as may be required for regional irrigation communities where there will be insufficient future water for maintain the current way of life (Park *et al.* 2011). There are various classifications of these levels of challenge and

response (e.g. routine – non-routine – complex unbounded (Dovers 2009); coping – more substantial – system transformation (Moser and Ekstrom 2010); incremental – transitional – transformational (Howden *et al.* 2010 – see Figure below)), and their interpretation is scale dependent (e.g. a transformational challenge for an individual farmer may be an incremental challenge at the level of maintaining food production systems nationally).



**Figure:** Hypothesised relationship between incremental and more transformational adaptations as climate change increases, indicating possible types of adaptations and the likely increasing complexity, cost and risk associated with the more transformative adaptations. (Source: Howden *et al.* 2010).

4. *Adaptation beyond normative approaches.* The IPCC (2007) definition of adaptation cited by the Issues Paper is constructed normatively. However, it is more helpful to ensure the term is not constrained to normative approaches (Moser and Ekstrom 2010, p.22062), since an action which may be successful in the short-term may create maladaptation in the long-term (as in building sea protections that provide a false sense of security and are eventually overwhelmed with more catastrophic consequences than would have occurred if they had never been implemented). Defining adaptation normatively implies a holistic multi-temporal analysis of benefits which is rarely performed and becomes extremely hard with long-term uncertainty. It is clearer to assess these issues where appropriate in the context of specific decisions.
5. *Interpreting uncertainty and risk:* A key characteristic of climate change is the uncertainty associated with future climate projections, although it is worth noting that some changes are actually much less uncertain in direction and magnitude than perceived – CO<sub>2</sub>, temperature rise, sea level rise, ocean acidification, probability of heatwaves are all examples of global environmental changes that have a clear direction in the foreseeable future and often a reasonably clear magnitude at least to mid-century, compared to other issues such as regional rainfall. In general, however, the uncertainties associated with climate projections are usually stated explicitly and this tends to drive an expectation that more accurate models and predictions will improve the certainty needed for adaptation decision-making. The result is that many decision-makers believe that adaptation responses should be delayed until more accurate climate models materialise. However, the accuracy of projections is limited by fundamental, irreducible uncertainties in the climate models, particularly when downscaled locally. In addition there are many other uncertainties associated with decisions on adaptation that cascade from climate models

to impacts to the range of adaptation options to decisions on how to respond (Jones 2000).

6. *Adaptation and uncertainty*: Rather than taking a reductionist approach to uncertainty, adaptation needs to understand the uncertainties and incorporate them into robust decision-making (Dessai and van de Sluijs 2007; Dessai *et al.* 2008; Hallegatte 2009; Stafford Smith *et al.* 2011). This leads to a continuum of responses that may be exemplified by three classes:
  - (i) In some cases, organisations that are already good at managing risk using diverse tools and approaches are adjusting relatively easily to this additional source of risk (e.g. Gardner *et al.* 2010), and see below; note that identifying these cases involves characteristics of both decision and decision maker).
  - (ii) Some decision areas, such as most planning instruments and engineering standards, are implicitly predicated on a constant background environment; profound changes to ways of thinking in planning are needed in these areas to accept, for example, standards that need to be regularly updated in response to a non-stationary climate (see below), with implications for issues such as legal protection for best practice planning with the standards at the time of that planning. In these cases, a once-off change in approach, whilst challenging, could provide effective adaptation indefinitely, such that it is thereafter 'mainstreamed' (or the market failure is resolved).
  - (iii) It is likely, however, that some areas will be subject to persistent uncertainty; for example, we are unsure what the climate of 50 years time will be now; but in 25 years time we are likely to still be uncertain about the climate 50 years after that, as we better understand the limitations to our ability to predict the complex earth system (this point is exemplified by the fact that, although understanding has hugely deepened and with it our scientific certainty that climate change is happening, the succession of IPCC reports has actually resulted in an increase in the range of possible future climates, not a decrease). For these cases, it is likely that new challenges will continue to emerge (the 'unknown unknowns'), mainstreaming may not be possible or market failures maybe persistent, and a continued focus on adaptation will be important.

These issues lead to some observations about different possible framing elements for the Commission's analysis:

1. A narrow approach to economic framing would suggest that adaptation action should be left to the market with government focusing on market failures. The Garnaut report (Garnaut 2008), for example, largely took this approach, but with a strong sense that market failure and the role of government was really a small residual on a free market response. Whilst it is undoubtedly appropriate that as much action as possible is left to market forces and sound economic approaches, many aspects of adaptation challenge this framing: the increasing likelihood of system threshold changes or tipping points requiring a transformational approach to some adaptation decisions, the potential for major conflicts between private and public interests and related values, the potential benefits in some areas of early and coordinated action, the complex multi-scalar aspects of some aspects of adaptation, as well as the potential for persistent uncertainty surrounding some decisions. All of these mean that market failure and the role of government is likely to be a much larger and persistent part of the problem than normally conceived in an economic rationalist framing.
2. In terms of the role of government, market failure is neither an entirely necessary nor a sufficient criterion for intervention. It is not *necessary* in that there are issues which are not even encapsulated by a market-based paradigm which require collective consideration in society, such as path dependent processes (e.g. development locations

and changes in technology) with potentially large but long term and uncertain implications. It is not *sufficient* in that, even if there is market failure, it is not necessarily true that government will resolve that failure any better than other social mechanisms. Determining these issues may be particularly hard in problems with the above characteristics, but the analysis anyway needs to transcend a market-based view.

3. A related but different element is the matter of 'mainstreaming' or 'normalising' adaptation as part of business-as-usual operations of all parts of society including government agencies. This is widely supposed to be a primary goal (e.g. Dovers 2009), but it is worth asking whether this may result in a failure to deal with deeper issues raised by climate change. In this regard, many of the characteristics of climate change adaptation listed above are shared with sustainable development (but not with other pervasive policy issues such as gender equity issues and occupational health and safety, a point which may deserve further analysis): the Productivity Commission report in 1999 on the *Implementation of Ecologically Sustainable Development by Commonwealth Departments and Agencies* highlighted how adoption of Ecologically Sustainable Development (ESD) in many agencies was hampered by inappropriate processes, often related to a failure to appreciate the more transformative and cross-sectoral implications of ESD (in this case, being beyond just an 'environmental' agenda). An additional dimension emerging in the development arena, where discussions to mainstream adaptation into development agendas have been active for some years, is that resourcing for adaptation is lost when it becomes mainstreamed in funded programs. The same failings could be expected with premature mainstreaming of climate change adaptation, although, as with ESD, the more nuanced question should be: "*which adaptation responses can be mainstreamed safely and quickly into business-as-usual, and which require an on-going focused attention, whether by government compared to non-government organisations, or by specialist agencies within government institutions?*" In terms of government responses, and particularly the best institutional arrangements within government, it may help the Commission to address this question squarely. CSIRO has some work-in-progress exploring this issue.



## Section 2: Responding to the Issues paper main topics

There is large amount of material among CSIRO's research projects that has more or less relevance to the questions raised in the Issues Paper. We have attached a recent bibliography of this material, acknowledging that this is a very blunt instrument; however, it provides a wide variety of sources for the Commission's work. It is hard to focus comments on the questions raised in the Issues Paper without clarity on what framing is intended. Therefore in this section we provide some comments on those questions and a few vignettes of issues from current research that may be useful, but do not attempt any comprehensive treatment. We would welcome further discussion of specific areas and questions around which we could convene the relevant expert staff.

### 2.1. What does adaptation to climate change mean?

In coming to a decision on how to define adaptation to climate change, the Commission may find it helpful to focus on those characteristics of adaptation that will be important in framing whether government intervention is appropriate. This will include recognising the scale-nested nature of adaptation, the continua (albeit messy) from reactive to proactive and from incremental to transformative responses, and the important (potentially long) time dimension of adaptation with respect to different types of decisions being taken today (see Section 1).

The Issues Paper notes the IPCC (2007) definition of adaptation; this is normative, in that adaptation is defined only as a successful response to actual or expected climate-related effects. Two issues arise. First, most entities adapt to the full range of (perceived or actual) changes in their environment, not only climate-related, so it helps to apply a definition which acknowledges this whilst focusing on the climate-related portion; many benefits from climate adaptation will be synergistic with other outcomes. And second, a less normative definition, such as that of (Moser and Ekstrom 2010), allows for a better examination of deliberate responses that turn out to be maladaptive. Theirs is:

“Adaptation involves changes in social-ecological systems in response to actual and expected impacts of climate change in the context of interacting nonclimatic changes. Adaptation strategies and actions can range from short-term coping to longer-term, deeper transformations, aim to meet more than climate change goals alone, and may or may not succeed in moderating harm or exploiting beneficial opportunities.”

For adaptation to be worth carrying out, (i) there must be a demonstrated current or future impact of climate change, (ii) at least one response option must be available which reduces that impact (or captures an opportunity) and (iii) the cost of implementing that option today must be exceeded by some net flow of benefits into the future. Further, for government (rather than some other entity) to act, (iv) the impact must include current or future impacts on government revenue (including those caused by an inevitable expectation on government as 'insurer of last resort' and those having indirect effects such as through impacts on the broader economy and resulting tax income) or other social or environmental assets, and (v) government intervention must be at least as effective as that of someone else.

#### **Adaptation to climate change and variability to date**

Within the research that has been undertaken on climate change adaptation there is evidence that it is not yet adequately addressing some key challenges of adaptation implementation. Most research has focussed on impacts and vulnerability with well over half of research papers dealing with these issues (Berrang-Ford *et al.* 2011; Hofmann *et al.* 2011). As yet, surprisingly few papers (c. 10%) deal with adaptation responses or assessments. Although the literature remains sparse (cf. Tompkins *et al.* 2010; Ford *et al.* 2011), CSIRO is involved in various studies exploring examples of both relatively incremental (e.g. Crimp *et al.* 2010; Howden *et al.*

2010) and more transformative (e.g. Park *et al.* 2011; Taylor *et al.* 2011) adaptation to both climate change and variability, as well as all levels in between (e.g. Stokes and Howden 2010 for agriculture; see also <http://www.csiro.au/products/adaptive-capacity-spatial-assessment-tool.html> for a national mapping tool that provides region by region information on the capacity of broadacre agriculture communities to adapt to climate change and climate variability). Importantly, we are also exploring how a systematic analysis of problems, drivers, decision types and decision-makers may provide typologies that enable lessons to be generalised. In most areas (e.g. agriculture, coastal councils, urban environments) this remains a work-in-progress that we would be happy to discuss. Some of the more recent work is to be found in our Working Paper series (<http://www.csiro.au/resources/CAF-working-papers>).

Given that existing climate variability and extreme weather have such a strong influence on Australia through droughts, floods, cyclones and bushfires, it may be instructive to examine how policies in that area have served communities and industries. Clearly some policies have worked well: for example, building codes in cyclone prone areas (Henderson *et al.* 2006) have had clear success in reducing damage for complying buildings compared to others though as indicated earlier standards need to be managed adaptively in the face of climate change. However, in many areas “one size fits all” policies have not been able to adequately deal with the complexity and diversity of local biophysical and social conditions and drought policy is a good example of this challenge (e.g. Nelson *et al.* 2008).

### **Assessing effective adaptation in the face of uncertainties**

The major challenge with assessing adaptation is that the benefits are accrued in the future, often a long time away. CSIRO is putting considerable effort into considering this issue in various areas at present, including assessing its own effectiveness in contributing to climate adaptation. In a few cases, existing responses can be observed (see previous section), and hence immediate feedback on efficacy is possible. However these are not generally the longer term, more transformative issues where intervention and research is needed. In general assessment must rely on proxy indicators, as in many other areas of endeavour (e.g. Natural Resource Management, Ecologically Sustainable Development), and there are matters that can be learned from the long history in those areas. In general, indicators are used without as much rigour as is desirable; a powerful recent critique of over-dependence on quantitative indicators for their specific values (as opposed to their use as part of wider processes) is provided by Hinkel (2011). There is much CSIRO work on vulnerability, impact and adaptive capacity indicators (e.g. Marshall *et al.* 2009; Brown *et al.* 2010; Marshall 2010; Nelson *et al.* 2010a; Nelson *et al.* 2010b; Park *et al.* 2012), where observed change in indicators may be expected to be a good lead indicator of subsequent adaptation success; however, there is limited work to confirm this.

Adger *et al.* (2005) argue that elements of effectiveness, efficiency, equity and legitimacy are important in judging success in terms of the sustainability of development pathways into an uncertain future. In this regard, it is notable that the Issues Paper makes little mention of equity. No matter the level (timeliness, intensity, pervasiveness) of adaptation there will be residual impacts and damage, which will be unevenly distributed over space and time. How will society decide what is an acceptable level of risk and what is an acceptable distribution of this risk over space and intergenerationally? And how do we manage this? These questions need addressing since the proposed goal of ‘efficiency’ (in the sense of non-wasteful use of limited resources) needs to be tempered by goals of justice between generations and justice towards nature. This is important because it requires a broader set of criteria for evaluating options that are socially acceptable and the processes for choosing, evaluating and implementing responses. CSIRO is beginning to explore some issues of equity.

A further missing consideration is the question of what is the appropriate baseline against which to evaluate options and progress. Many modelling analyses still assume that the baseline is no climate change impacts, which is clearly unrealistic; indeed, today it might be more reasonable to take a 2°C warmer world (with associated impacts, damage and costs) as a baseline, but whatever the decision, this needs consideration.

There is a growing set of case studies which demonstrate the potential costs of climate change impacts (e.g. Wang *et al.* 2010a; Wang *et al.* 2010c), in some cases extended to the costs and benefits of adaptation actions (e.g. Wang *et al.* 2010b), with some studies showing the strong benefits to be had from early, collective action (e.g. Stewart and Wang 2011 - see figure below). Notably, we now have work not only on impacts on depreciating assets (most common in the past) but also on *appreciating* assets such as land values: hedonic pricing studies show that as much as 73% of property values in areas of Brisbane are now based on the land rather than buildings (Rambaldi *et al.* submitted). This has significant implications for the costs and benefits of adaptation options in response to flooding and inundation (Fletcher *et al.* submitted).

### Adaptation Timing and Benefit

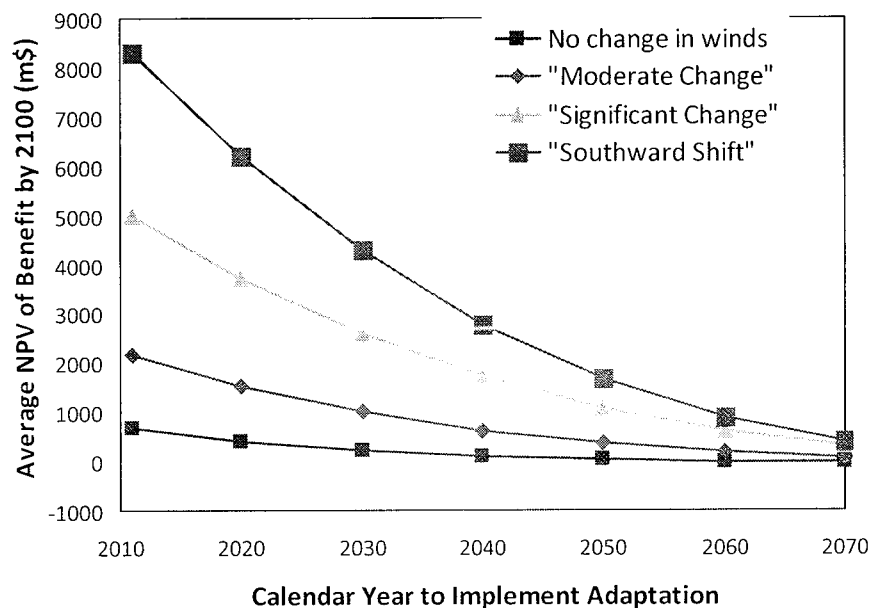


Figure: Stewart and Wang's (2011) analysis of the net present value of implementing improved building standards with respect to extreme winds in south eastern Queensland, showing that the decision would robustly produce positive outcomes across a range of possible future responses of winds to climate change, and illustrating how delay in implementing the change results in rapid reductions in the NPV.

Uncertainty is a feature of many assessment processes, even though the long-term nature of some adaptation decisions makes this especially prominent. There are consequently a number of practices in common usage to take account of this. First, framing the decision as managing risk rather than optimising a singular output means that the assessment may be of the general resilience of the decision outcome (e.g. improved adaptive capacity, or a flexible institutional arrangement) rather than of a specific project (e.g. the optimised height of a bridge). Second, it is possible to differentiate measures of success, for example, instead of using an absolute value of net benefit, exploring the likelihood of achieving net benefit given adaptation options and timing to indicate the degree of adaptation effectiveness. Stewart and Wang (2011) defined effectiveness as the probability of the benefits being greater than costs as a result of adaptation,

which is not only dependent on adaptation options and timing, but also on when the benefits and costs are measured, to reflect their time-dependency.

Uncertainty is a pervasive, and in some cases likely to be a persistent, characteristic of the challenges faced by adaptation decision making. In these cases (as for other decisions facing uncertainty in society), adaptation decisions need to be re-framed in terms of managing risk (Jones 2001). A significant part of future policy should be aimed at assisting this reframing so that decision-makers do not feel they cannot act until there is more certainty (which may never come). It is possible to classify the types of uncertainty that different decisions face (Stafford Smith *et al.* 2011) and identify risk mitigation strategies that may be more or less appropriate for different types (e.g. Hallegatte 2009); there is a tendency to promulgate one-size-fits-all methodologies, whereas it is vital that the skills are learned to correctly diagnose the correct approach (Jones and Preston 2011). Many decisions are amenable to reasonably straightforward application of the precautionary principle or robust decision-making approaches; however, there remain some particularly challenging decisions where risk-hedging is likely to be the only option (e.g. in conservation management for long-lived species: (Steffen *et al.* 2009). The area of conservation management is one that faces particular challenges, due to the complexity of interactions in ecosystems, and the impossibility projecting these with any precision. Again, a change in problem formulation is generally needed, to emphasise management goals more related to processes and function rather than structure and composition; CSIRO has contributed considerably to this thinking (e.g. Dunlop and Brown 2008; McDonald-Madden *et al.* 2011; CSIRO 2011; and current work for the Commonwealth and various state governments, soon to be released).

## **2.2. Are there barriers to adaptation?**

Whilst the 4 types of barriers identified by the Issues Paper exemplify one classification, there are others, with different analytical consequences. For example, the adoption of changed practices in many areas of society is known to require multiple preconditions, sometimes classified as awareness and motivation about the need to act, options for action, and the resources and capacity to act (Swim *et al.* 2009). Barriers to adaptation can arise from any of these areas. This classification highlights the fact that the *absence* of (as opposed to lack of access to) options and information can be barriers and is not included in the Issues Paper classification. As an example of another conceptualisation, highlighting different implications, (Gardner *et al.* 2009) describe a pathway for adaptation engagement with different associated drivers and barriers at each step (see Figure below). This focuses on the fact that different people and entities may be at very different stages along this pathway, such that one-size-fits-all communications and policy responses are likely to fail to meet the needs of many potential decision makers at any given moment (see also the points related to adaptive capacity below).

The main conclusion here is that the classification adopted by the Commission will have consequences for framing subsequent conclusions, so this should not be too narrow or prescriptive.

CSIRO has much work in progress of relevance to this issue, including a whole programme on behavioural barriers. Therefore in the next sub-section we highlight a few examples that illustrate the variety of issues, but many more may be found in the bibliography or in current work; the sub-sections following provide a little more detail in two specific areas.

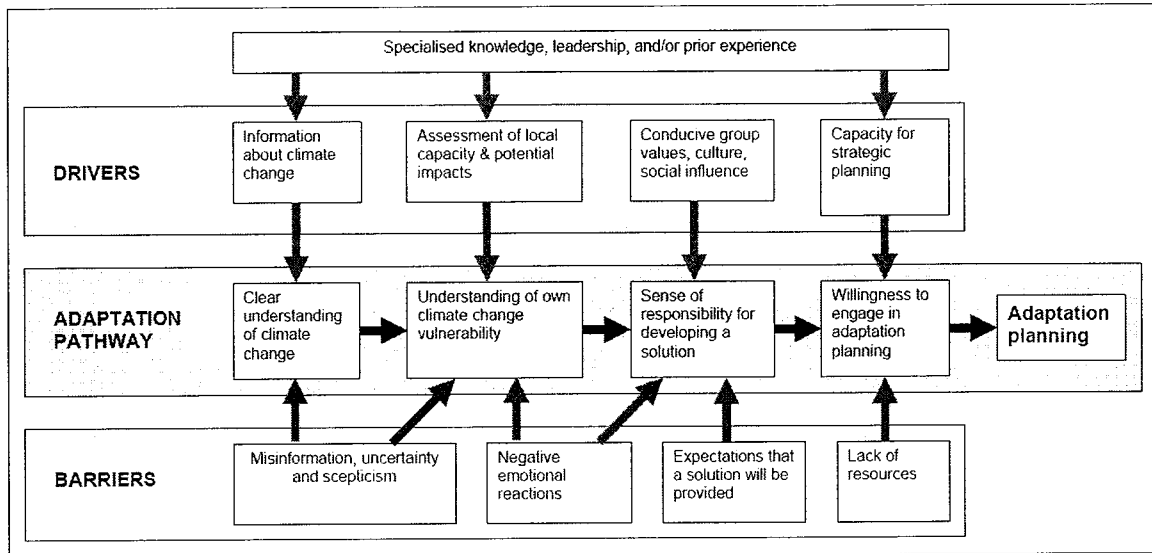


Figure 1 from Gardner et al. 2009: a pathway for adaptation engagement with associated drivers and barriers.

### Specific examples of barriers from CAF work

An important regulatory barrier to adaptation is the assumption within land use planning instruments that the climate is stable. Attempts to adapt land use to a changing climate are undermined when the basis of planning frameworks assume a stable climate (Measham *et al.* 2011), and a transformation towards adaptive planning frameworks is needed. This has flow on effects for legal liability, which needs to be clearly limited when planning is carried out according to the standards of the day, even if those standards subsequently change. This in turn may imply the need for some nationally agreed scenarios of the future against which planning is done and which are updated over time; if these are to inform robust decision-making in the face of uncertainty, then they will probably need to encompass a reasonable diversity of alternative futures along the lines of the Figure below, with the more detailed linked consequences for different climate (and other) elements. The provision of such a consistent set of future scenarios is clearly a potential role for government, based on nuancing internationally accepted results such as the new IPCC scenarios for Australia.

A key social barrier to adaptation is short-term decision-making, which makes projected climate impacts irrelevant to the day-to-day operation of many businesses. There is clear evidence from CSIRO's benchmarking survey work with organisations (Gardner *et al.* 2010) that businesses with longer typical planning horizons are more likely to incorporate adaptation into their planning. A second important barrier relates to perceived impacts. Projected climate change impacts are only meaningful if a decision-maker can see the link between impacts and their own immediate operating environment. Much work needs to be done to contextualise climate impacts so that people perceive the risk to themselves. At the moment these risks are invisible, therefore irrelevant.

A key organisational barrier to effective climate change adaptation (related to the 'mainstreaming' issue noted in Section 1) is to quarantine climate adaptation within the 'environment section' of an organisation. This silo approach constrains the effectiveness of adaptation by exacerbating resource constraints, limiting information exchange and increasing competition with other organisational priorities (Measham *et al.* 2011). Related to this, recent work on decision-making about coastal protection and environmental values in coastal regions has highlighted how hard it may be to negotiate adaptations in contexts such as these where the governance systems are multi-scalar, multi-sector and multi-stakeholder. In these complex systems not only are the values on which decisions might be based contested, but even the

institutions that might help resolve those differences are themselves contested (Gorddard *et al.* in prep). Such complexities are poorly served by a simple linear market perspective on decision-making.

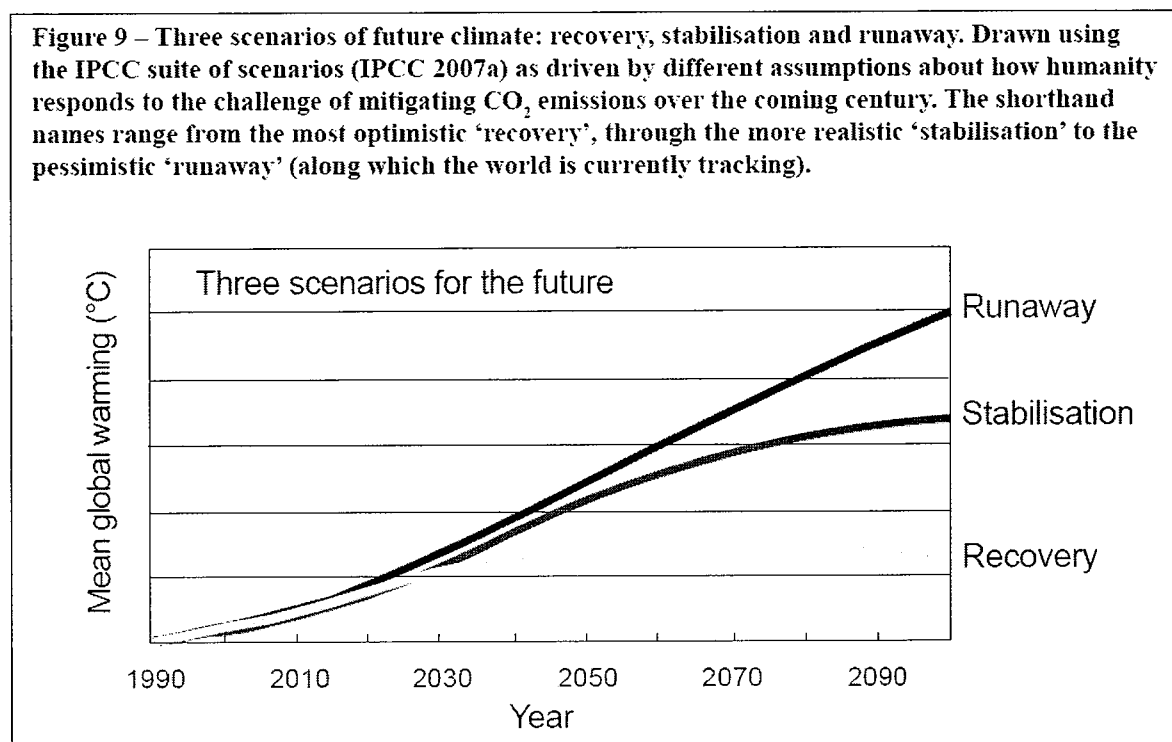


Figure 9 from Steffen *et al.* (2009) illustrating three broad scenarios of the future.

The issues paper raises the need to understand the costs and benefits of climate change. In terms of climate adaptation, a key barrier to action is not merely an issue of the overall costs, however, but rather who bears those costs of adaptation, and who is likely to resist change and lobby against it. While governments are key actors in the governance of climate change adaptation, the actions that are ultimately implemented are the result of complex negotiations between all stakeholders. This means that in seeking to understand the economics of climate adaptation, it is also critical to understand the distribution of costs and benefits to all key stakeholders (Hartzell-Nichols 2011).

Recent work on transformation change (Park *et al.* 2011 and work in progress) is identifying fundamental changes (i.e. transformational adaptation) being made in response to climate in both the structure and function of a number of enterprises in the wine industry. Various factors are emerging that can facilitate or hinder such adaptation, including high levels of place attachment, lack of financial resources, reliance on incremental change and lack of information (including in relation to acceptance of climate change).

### **Social and psychological barriers**

CSIRO is carrying out an increasing amount of research in to the social determinants of adaptation, which is generally an under-examined area of literature and poorly represented in policy responses. The following points are derived from analyses-in-progress of a series of surveys and interview instruments (Gardner *et al.* 2010, Leviston and Walker 2010, Leviston and Walker 2011) note that these potentially interact with all areas of policy and decision-making.

1. Many people shy away from 'climate change'; some aggressively so, others through apathy or issue-fatigue. This itself is a barrier, as it prevents people from engaging with any aspect of climate change.
2. Most people do not distinguish between adaptation and mitigation, do not understand the difference, and are probably not motivated to find out the difference. Thus, policies or interventions promoted as addressing 'climate change adaptation' are likely to produce bemused reactions.
3. To the extent that individuals, households, or organisations are engaging with 'adaptation' or 'climate change', they seem to do so by locating climate change within a portfolio of 'environmental stuff' or 'sustainability stuff' and not within a risk portfolio. This seems to suggest little appreciation of any sort of vulnerability to climate change.
4. To the extent that people engage with 'climate change', they often seem to associate it with catastrophe or armageddon. This is often exacerbated by a media who focus on the more dramatic aspects of climate change impacts and provide little coverage of responses. Consequently, there is little appreciation of opportunities, or that risks can be contained and managed.
5. Organisations that have engaged in climate change adaptation planning are more likely than those that haven't to (i) have more resources available for planning and risk management, (ii) have engaged in other forms of risk management planning and strategic planning, and (iii) have longer-term planning and strategic thinking horizons in their habitual business operations (Gardner *et al.* 2010).
6. Adaptive capacity and practice are not just features of individuals, households, organisations, and governments, but are also a product of the associations and relationships between those agents. Some patterns of networks among the agents (or 'social capital') within a region can promote adaptation at a regional level; others can inhibit adaptation. Often these networks are outside any simpler 'market' conceptualisation of influences on decision-making.
7. Most of the time, humans are not very good at being rational (fully, or bounded). Interventions based on rational-economic models of behaviour are therefore likely to have at best moderate success. Under some conditions, though, we can be very good at rationality and problem-solving.
8. Partly related to the previous point, most research and policy on climate change adaptation focuses on cognitive and 'rational' responses to climate change. We know, though, that the emotional responses to 'climate change' are mostly apathetic or negative (e.g. Leviston and Walker (2011) found that the strongest emotions people felt in relation to climate change were anger, confusion and irritation), and such emotions are likely to inhibit rather than impel relevant and effective behaviours. We also know that emotional responses to climate change partially mediate the link between climate change beliefs and relevant behaviours. Interventions and policies that rely solely on cognitions and rational decision-making may produce odd or paradoxical effects on behaviours – or no effects at all.
9. If they admit to climate change, people typically think it is something caused by other people (mostly in other nations), and that it will affect other people. It is typically not seen as an issue directly relevant to them and theirs.
10. Arguably, the people in our society most vulnerable to the effects of climate change are – unsurprisingly – those who are most vulnerable to just about everything else and who have the fewest resources to do anything about it. The poor, the elderly, and the homeless are most likely to suffer the worst effects of a heatwave or a lengthy cold

period or widespread flooding, and are generally unable to devote many or any resources to avoid the consequences of such extreme weather events. They are typically excluded from the market. Collective policy and action are needed to cater for such vulnerable groups of people.

11. When assessing the 'effectiveness' of any adaptation practice, people are likely to do so mostly in relative to their own situation. An adaptation behaviour (installing an air conditioner, to use the common example) may be 'maladaptive' and it may become a negative externality for others, but the person who installed the air conditioner will mostly or only be concerned with whether they are more comfortable. People are not good at acting out of concern for others. This can easily result in classic commons dilemmas.
12. Behaviours of all sorts are usually strongly influenced by social norms. In the case of climate change, individuals, householders, business leaders, and government decision makers are likely to be influenced by what they believe everyone else believes. Our national surveys show two things that are likely to act as barriers to effective adaptation actions. First, when we categorise people by their belief type (a. accept climate change and attribute it to human activity, b. accept climate change but think it's a natural phenomenon, c. reject climate change, d. don't know) everyone thinks that their belief type is the most common in the population. Second, everyone, regardless of belief type, grossly overestimates the prevalence of deniers (by nearly 400%). Some public education/information may help dispel some of these misperceptions.

### **Barriers and adaptive capacity at the individual scale**

Not all individuals have the same capacity to transform. Adaptive capacity is essentially the potential to mobilise existing resources necessary for adapting to change (Berry *et al.* 2011; Darnhofer *et al.* 2010). It is not the availability of resources. Two individuals may receive similar resources to prepare themselves for future challenges, but will not necessarily convert those resources as effectively. Research has shown that the differences between individuals occur as a result of differences in four main areas: (i) their perception of the risks of change and how they manage for uncertainty, (ii) the level of skills in planning, experimenting, learning and reorganising, (iii) the level of financial and emotional flexibility to undertake change; and (iv) the level of anticipation of the need and willingness to contemplate and undertake change (Marshall and Marshall 2007; Marshall 2010). These dimensions appear to be robust across incremental and transformative change processes.

We know that the capacity of individuals to undertake change processes can be influenced (e.g. Darnhofer *et al.* 2010; Park *et al.* 2011). Specifically, in resource dependent industries, research has shown that adaptive capacity can be influenced by the nature and strength of the relationship that people have with the environment that they depend upon for income and everyday living (Marshall *et al.* 2011). Resource-dependent communities such as fishing, farming, grazing and coastal communities are more likely to be vulnerable to climate change since climate change is likely to significantly affect the resources upon which they depend. However, resource dependency is a complex relationship since it has social, economic and environmental components. Individuals can be dependent on the resource in each of the following ways: their (i) identity, (ii) place attachment, (iii) employability, (iv) family situation, (v) informal and formal networks, (vi) business approach, (vii) diversity of farm income, (viii) diversity of household income, (ix) business size, (x) financial buffer, (xi) financial turnover, (xii) local environmental knowledge, (xiii), environmental awareness, (xiv) use of the resource, (xv) use of climate technology, (xvi) production levels. Studies have shown a clear and significant relationship between dimensions of adaptive capacity and various components of resource dependency (Marshall 2007; Marshall *et al.* 2007; Marshall *et al.* 2011).



Importantly, adaptive capacity can be enhanced through minimising aspects of resource dependency. In this way, resource dependency acts as an important conglomerate of factors representing “barriers to change” at the individual scale (Marshall *et al.* 2011). Individuals are embedded within a social network at local, regional, national and international levels, and will be influenced across all scales. Individuals have their own barriers to change that are partially represented by resource dependent factors; they will also be influenced by their local colleagues, family, friends and formal networks, as well as regional policies and programmes, and drivers at much higher scales such as the international economy and market. Note that in many situations there will need to be a critical mass of individuals that adopt a new practice for an industry-wide adaptation to occur.

### **2.3. What institutional arrangements and policy instruments could be used to address the barriers?**

CSIRO is involved in a considerable body of work relating to a variety of policy instruments and institutional arrangements, though relatively little of this is very mature. Here we provide a few notes of relevance but would welcome a more targeted discussion on what insights are required by the Commission.

#### **General reform and institutional arrangements**

The Commission may wish to focus on reform issues that relate to the characteristics of the adaptation challenge noted in Section 1, and also on those that are exacerbated in Australia (for example because we already have a variable climate and therefore find it hard to detect changes in the mean over existing large variability). A few relevant points are:

- **Limits to processes:** The Issues Paper does not deeply address the limits of markets and of political processes (i.e. government decision-making cycles and institutions) in being able to promote/support adapting to slow-change variables. In other words, markets-based approaches will often not be the appropriate solution (Ostrom 2007; Young *et al.* 2008) and secondly the role of government will need to also involve introspection and willingness to change itself (i.e. its processes, organisational structures, and institutional arrangements) (Australian Public Service Commission 2007). The “adaptive capacity” of these institutions is just as important as the adaptive capacity of individuals and communities. Markets (including real estate) are extremely poor at accommodating the impacts of slow-change variables (e.g. sea level rise; gradual declines in quality of ecosystems; creeping path-dependent development). Also, political pressures (in the form of vested and/or powerful interests) often mean that short-term responses to extreme events and increased variability being felt today may reinforce existing inappropriately located developments, setting us on the wrong trajectory to dealing with the delayed insidious consequences of slow-change variables, i.e. they promote maladaptation. The short-term time horizon of decisions that often occurs in political processes compounds the difficulties of managing or avoiding these problems. Further difficulties that cannot be easily addressed by existing institutions (market or political) are that the spatial scale at which these slow-change variables occur and the cross-scale nature of these changes are also incompatible with the jurisdictions of the institutions (Abel *et al.* 2011, Folke *et al.* 2007).
- **Path-dependency and maladaptation:** Path dependent processes can be important to adaptation and are not usually captured by a market failure perspective. Path dependence implies that current decisions may have large but long-term implications. These long term highly uncertain effects may be overlooked if analysis focuses on efficiency criteria and short time horizons. Two examples of important path dependent processes are:

(i) *Path dependent development locations*: Cities and towns are located by historical accident. These locations may not be best suited for populations under future climates. Factors that influence the location of future growth may need to be strategically directed. These include: public infrastructure provision, and the distortion of location decisions due to “NIMBY” planning (for example Glaeser (2011) suggests that Nevada and Arizona were settled due to restrictive zoning practices in California).

(ii) *Path dependent change in institutions and technology*: North (1990) argues that institutions have economies of scope and network effects that make change difficult. For example, undeveloped economies that are clearly inefficient are that way for institutional not market failure reasons. It is therefore arguable that our institutions will fail to adapt effectively to climate change, regardless of information availability. Identifying how to enable institutional change is an active research topic.

- **Funding mechanisms**: No mention is made of mechanisms for government to get the necessary funds to cover the huge costs and liabilities they will not be able to avoid (in terms of both the costs of adaptation and the costs of the residual damage after adaptation). Consideration needs to be given to the issue of how Governments will begin building the financial reserves required to cover or offset these future costs. For example, it may be a (socially contentious) option for these costs to be reduced by returning parts of the conservation estate to private use where that parcel of land can no longer meet conservation objectives (Fuller *et al.* 2010).
- **Water policy**: water policy illustrates how having a policy which deals well with current Australian variability risks creating maladaptation to climate change (drought exceptional circumstances in agriculture may be another example). Australia has very high year to year variability in rainfall and river flows. Irrigated agriculture is more successful if this variability can be evened out while maintaining an average level of water use (drought policy essentially seeks to do likewise in other aspects of agriculture). Australia does this very well by licensing water entitlements for a nominal average volume of use and then making allocations against those entitlements each year to reflect the water available each year. In dry years the allocations do not drop as much as the inflows, so water users are buffered against the dry years by being allowed to use more than expected from the fall in water availability, but then use less than expected in wet years. The problem comes when there is an overall reduction in river flow as a result of climate change. The good intentions for dealing with variability mean that less of the impact of the climate change is borne by water users than it should and more is borne by the environment. The Murray-Darling Basin Sustainable Yields Project demonstrated this (<http://www.clw.csiro.au/publications/waterforahealthycountry/mdbsy/>). The Guide to the Basin Plan noted that result and said that all water plans had to share reductions in river flow equally between water users and the environment. But when making allocations each year, planners cannot precisely know whether it is annual variability or climate change (i.e. they do not know if the average is moving or not until about 30 years of allocations have passed). To provide equal sharing of climate change impacts in a plan would remove buffering against annual variability if the change was not factored into the water planning in advance. So the policy dilemma is how to deal well with climate variability and climate change, not one or the other, which may require a significantly different approach altogether. The equal sharing requirements in the Guide have not been carried over to the draft Basin Plan but the policy dilemma remains. (In the drought case, the partially-implemented resolution in a Western Australian trial has been to remove buffering subsidies in extreme dry years but couple this with the requirement (and financial support) for planning for climate variability and change, so as to promote adaptive capacity to changing conditions in the industry rather than inhibiting adaptation).

These points generally relate to the issues of transformation and of mainstreaming noted earlier – that we have a growing body of research on what inhibits or facilitates transformation where needed, and that premature mainstreaming of some types of decisions is likely to fail, particularly those longer-term, more value-laden, more transformational decisions by entities with shorter habitual planning horizons, and facing persistent uncertainty. These remain the role for a centralised agency to pursue (over and above monitoring the success of other mainstreaming).

### **Other issues**

**Provision of climate information:** The Issues Paper notes the importance of good information. We would note that this is not enough (as discussed earlier), and that it extends well beyond only climate information. Nonetheless, timely and appropriately delivered information about future climate projections is one vital input to many adaptation decisions, generally required at a national level. CSIRO is working to understand how projections may be delivered in future so that they interface more readily with decision-making, with the goal of providing projections associated with the next IPCC report in a new form that targets decision support better than we have been able to in the past (notwithstanding the important role played by the 2007 Climate Change in Australia data and website – CSIRO and BoM 2007). Support for this improved delivery format remains important and a public good of very widespread use. This in turn depends on underpinning climate change science, including regional projections science, to deliver future climate scenarios that are the best possible representation for Australia and the region, as articulated in the National Framework for Climate Change Science. There are various areas of need, particularly related to extreme weather events and the potential for the coincident occurrence of multiple events of the same or different types at various scales in space and time. In particular, understanding the full potential exposure of Australian governments to ‘coincident events’ within their jurisdictions within a budgetary cycle is significantly lacking in terms of determining the national and state-level exposure to climate change, and thereby making the case for early adaptation.

**Private-public relationships:** Given the breath of actions and investments required to adapt to climate change, effective adaptation will not be feasible without forging partnerships with private industry and the community sector (e.g. see the recent Queensland Issues Paper on climate adaptation). Hence the ‘subsidiarity’ concept referred to on page 22 of the Issues Paper needs to be much broader – it needs to accommodate the view that all stakeholders need to be considered in the governance of climate change adaptation. In terms of privately owned infrastructure, recent CSIRO work has focused on the growing tensions within private-state developments. There is evidence that the private sector both acknowledges and prefers a model of governance whereby roles and responsibilities are distributed across key stakeholders, including non-government (e.g. see Taylor *et al.* in press). Overall this broader view of governance needs to be reflected in the Issues Paper. The work shows that private industry is willing to take on greater responsibility, but that research is needed to understand how responsibility can be transferred to the private sector while maintaining the public interest (Taylor *et al.* in press).

Government can play an important role in private-public relationships in providing incentives or supporting research and development that leads to innovation that is taken up by the private sector. For example, the Climate Adaptation Flagship is undertaking research into “climate ready crops” because there is a need to breed crops to a future climate of higher temperatures and higher carbon dioxide concentrations (Howden *et al.* 2010). From initial trait testing to the release of commercial varieties can take 10-20 years so it is important to commence work now on crops for a future climate. This research is being supported by the Department of Agriculture, Fisheries and Forestry through its Climate Change Research Program and by the Grains Research and Development Corporation. While ultimately the breeding of commercial varieties

will occur privately, public investment in R&D is an important mechanism to stimulate this innovation.

**Market-based instruments:** The Issues Paper does not address MBIs. In particular it is important to note (see previous section on individual adaptive capacities) that these need to be matched to the different types of people in terms of their adaptive capacity. Not all individuals will be similarly motivated by economic drivers, and a range of incentives will need to be offered if broad scale adoption of new practices is to be successful.

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