WENTWORTH GROUP

OF CONCERNED SCIENTISTS

Dr Wendy Craik AM
Commissioner
Barriers to Effective Climate Change Adaptation Inquiry
Productivity Commission
LB2 Collins Street East
Melbourne Vic 8003

14 December 2011

Dear Dr Craik,

Continued exponential rise in greenhouse gas emissions is making the challenge of keeping global temperatures below 2°C above pre-industrial levels more and more difficult.

The best estimates suggest that with immediate concerted global action, there is a possibility that temperatures won't increase beyond 2 °C above pre-industrial levels. Without concerted global action however, climate modelling suggests global temperatures will increase by 4°C or more - a level the world has not experienced for over 40 million years.

Any temperature increase of this magnitude will have implications for the health of Australia's natural environment, and the economies and communities that depend on it. As acknowledged in the Issues Paper, climate change impacts could be large, wide-ranging, complex, and varied.

Australia needs to deal with this uncertainty. We need to prepare for these impacts by ensuring policies, institutions and management approaches are flexible and able to deal with the uncertainty posed by a changing climate. We also need to invest in enhancing the resilience of Australian landscapes so that they are better able to adapt to climate change.

There are two key areas for reform in the way Australia manages natural resources and ecosystems that will facilitate an effective adaptation response:

1. Commonwealth, state and territory, and local governments agree to develop regional climate change adaptation plans that align government policies, natural resource management investments and land use plans to manage the opportunities and risks from a changing climate.
2. Governments establish a system of regionally-based National Environmental Accounts that measure and track changes in the condition of ecosystems and other natural assets to underpin climate change adaptation. If you don't measure it, you can't manage it.

The Wentworth Group's documents that detail the above are attached to this letter.

We would be pleased to discuss our thinking with you.

Yours sincerely,

Peter Cosier
Wentworth Group of Concerned Scientists

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Optimising Carbon in the Australian Landscape

How to guide the terrestrial carbon market to deliver multiple economic and environmental benefits

WENTWORTH GROUP OF CONCERNED SCIENTISTS

OCTOBER 2009

Wentworth Group of Concerned Scientists

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Summary

The focus in climate change policy has centred on reducing greenhouse gas emissions from energy generation, manufacturing and transport, because this is fundamental to any solution to climate change.

The science now tells us that it will be next to impossible for nations to achieve the scale of reductions required in sufficient time to avoid dangerous climate change unless we also remove carbon from the atmosphere and store it in vegetation and soils.

Terrestrial carbon includes carbon stored in forests, woodlands, swamps, grasslands, farmland, soils, and derivatives of these carbon stores, including biochar and biofuels.

The power of terrestrial carbon to contribute to the climate change solution is profound.

At a global scale, a 15% increase in the world's terrestrial carbon stock would remove the equivalent of all the carbon pollution emitted from fossil fuels since the beginning of the industrial revolution.

The multiple public policy benefits for Australia in adopting full terrestrial carbon offsets are enormous, but there are also significant risks of an unregulated terrestrial carbon market to other areas of public policy.

In a report recently commissioned by the Queensland government, *Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use*, CSIRO estimate that the Australian landscape has the biophysical potential to store an additional 1,000 million tonnes of CO_2-e in soils and vegetation for each year of the next 40 years.

If Australia were to capture just 15% of this biophysical capacity, it would offset the equivalent of 25% of Australia's current annual greenhouse emissions for the next 40 years.

This represents a gross investment potential of terrestrial carbon in Australia of between $3.0 billion and $6.5 billion per annum.

It is good news for Australia. It lowers the economic cost of achieving Australia's emissions reductions, and makes it possible for Australia and the world to adopt deeper emission cuts.

If Australia commits to reducing our greenhouse gas emissions by 25% by 2020, and carbon forestry offsets are included, ABARE estimate that the majority of these forests will be permanent environmental plantings rather than harvested plantations.

If we plan wisely, terrestrial carbon presents an economic opportunity of unparalleled scale to address a range of other great environmental challenges confronting Australia: repairing degraded landscapes, restoring river corridors, improving the condition of our agricultural soils, and conserving Australia's biodiversity.

It also poses significant risks. Without complementary land use controls and water use accounting arrangements in place, there is a risk that carbon forests will take over large areas of agricultural land, causing adverse impacts on food and fibre production, and impacting on regional jobs that are dependent on these industries.

ABARE has estimated that if Australia commits to reducing greenhouse gas emissions by 25% by 2020, over 40 million hectares (an area equivalent to 40% of the entire Murray Darling Basin) would be economically suitable for carbon forestry.

In some locations, newly established carbon forests could also cause a reduction in runoff into rivers and worsen existing over-allocation problems.

The challenge for Australia is to optimise this new terrestrial carbon economy to drive investments towards improving the health of our agricultural soils, protecting areas of high conservation significance and repairing degraded landscapes, and away from damaging native vegetation and prime agricultural land.

It is also counterproductive to create economic incentives to revegetate overcleared landscapes without introducing complementary measures to reduce broadscale land clearing. Clearing of native vegetation still contributes 13% of Australia's greenhouse gas emissions.

Australia needs to plan where we want trees, where we produce food and where we might do both.

It is the role of Australia's governments (Commonwealth, State, Territory and Local) to build the institutional structures to create these opportunities and manage these risks by:

1. Designing a Carbon Pollution Reduction Scheme that captures the full potential of terrestrial carbon in vegetation and soils, providing land managers across Australia the opportunity to optimise their contribution to the climate change solution;
2. Regulating the terrestrial carbon market so that multiple economic and environmental benefits can be realised, whilst avoiding unintended consequences for fresh water resources, biodiversity and agricultural land;
3. Assisting communities prepare regional *Climate Change Adaptation Plans* to manage the impacts of climate change on the Australian landscape and guide the development of policies to optimise future investments in terrestrial carbon;
4. Underwriting climate change adaptation policies and terrestrial carbon investments by building a system of regionally based, *National Environmental Accounts*, to monitor the health and change in the condition of our natural resource assets;
5. Establishing a *Climate Change Adaptation Fund*, by applying a 1% levy on the sale of emission permits to monitor, plan and invest in actions to minimise the impact of climate change on Australia's biodiversity, coasts, and land and water resources; and
6. Strengthening international efforts to protect and restore terrestrial carbon in tropical forest landscapes that will promote new international rules to provide the opportunity for developing countries to capture this potential.

These reforms will mean that a price on carbon stored in the landscape can make a substantial contribution to Australia's efforts to combat climate change.

They can also help Australia adapt as climate change imposes its footprint across the Australian landscape, and they can be a catalyst for driving a new generation of economic reforms to improve the health of our farmlands and the protection and restoration of Australia's biodiversity.

The Science of Climate Change

The world's climate scientists believe that even stabilizing greenhouse gas concentrations at around 450 ppm of CO_2-e is likely (best-estimate) to result in global average temperature increases of between 2.0° and 2.4°C (above pre-industrial levels) by 2050.[1]

Achieving a '450 ppm' stabilisation scenario requires global CO_2 emissions to peak no later than 6 years from now, and for net global emissions to be reduced by between 50 and 85% by 2050 (relative to 2000).[2] Even then, there is more than a 50% likelihood that global temperature increases will exceed 2°C, and there is a 5% likelihood that temperature increases will exceed 4°C.[3]

Australia's landscapes have not seen increases of global temperatures by 2°C for about 10,000 years.[4] The world has not experienced temperature increases exceeding 4°C for over 40 million years.[5]

Achieving stabilisation at '450 ppm' will require developed countries such as Australia, the United States and Europe to reduce emissions by between 25% to 40% in 2020 (relative to 1990 levels) and by 80% to 95% in 2050,[6] and for developing industrial economies to change the way they generate and use energy.

This is a staggeringly difficult political, institutional and technological challenge.

The Power of Terrestrial Carbon

The focus of climate change policy has centred on reducing greenhouse gas emissions from energy generation, manufacturing and transport, because this is fundamental to any solution to climate change.

The science now tells us that it will be next to impossible for nations to achieve the scale of reductions required in sufficient time to avoid dangerous climate change, unless we also remove carbon from the atmosphere and store it in vegetation and soils. The level of long-lived greenhouse gases in the atmosphere in 2005 was 455 ppm CO_2e, already exceeding the long-term stabilization target needed to minimise the risk of dangerous climate change.[2]

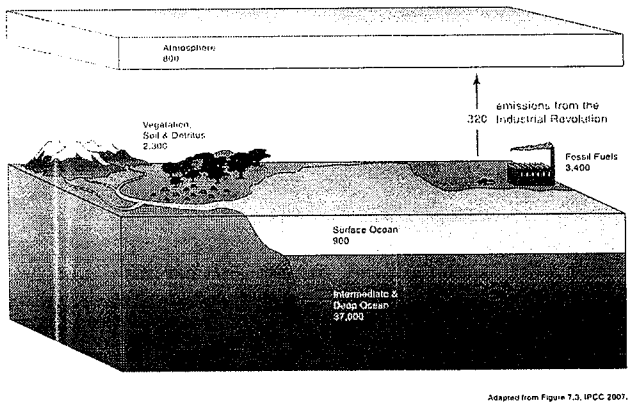
Terrestrial carbon emissions (primarily from clearing of tropical rainforests) are responsible for 20% of annual global emissions.[7]

Terrestrial carbon includes carbon stored in forests, woodlands, swamps, grasslands, farmland, soils and derivatives of these carbon stores, including biochar and biofuels.

The power of terrestrial carbon emissions to contribute to the climate change solution is profound. At a global scale, the total stock of carbon in the world's terrestrial landscapes (stored in vegetation and soil) is approximately 2,300 billion tonnes (Gt), about three times more than in the atmosphere.[8]

A 15% increase in the world's terrestrial carbon stock would remove the equivalent of all the carbon pollution emitted from fossil fuels since the beginning of the industrial revolution.

FIGURE 1: GLOBAL CARBON STOCKS



Adapted from Figure 7.3, IPCC 2007.

Figures are in billion tonnes of carbon (GtC).

Terrestrial Carbon in Australia

The total stock of carbon in the Australian landscape is approximately 28 billion tonnes, half of which is found in native forests and woodlands, and half in Australia's extensive grasslands and crop land (Table 1).[9]

Figure 2: Terrestrial Carbon in Australian Landscapes[10]

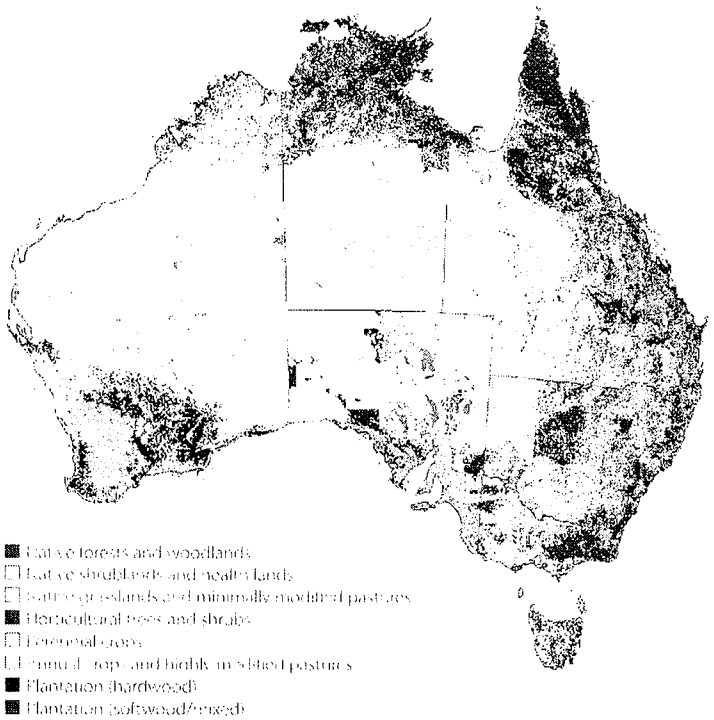


Table 1: Carbon in Australian Landscapes

	Total GtC	Total C %	Total CO_2e Gt CO_2e
Forest – living biomass	6.6		24.3
Forest - debris	2.7		10.1
Forest - soil	5.5		20.2
Sub-total Forest	*14.9*	*52.5*	*54.7*
Grassland - grass	0.1		0.4
Grassland – sparse woody vegetation	0.2		0.8
Cropland - crops	0.3		1.0
Grassland and cropland - soil	13.1		48.1
Sub-total Grassland and Cropland	*13.5*	*47.5*	*49.3*
Total	28.3	100.0	103.9

(1 tonne of carbon [C] = 3.67 tonnes of carbon dioxide equivalent [CO_2e]).

Terrestrial carbon emissions (primarily from land clearing) are responsible for 14% of Australia's annual greenhouse gas emissions.[11]

In a report recently commissioned by the Queensland government, *Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use*[12], CSIRO estimate that the Australian landscape has the biophysical potential to store an additional 1,000 million tonnes (Mt) of CO_2e in soils and vegetation each year for the next 40 to 50 years.

If we could capture just 15% of this biophysical capacity, it would offset the equivalent of 25% of Australia's current annual greenhouse emissions for the next 40 years (15% of 1,017 Mt = 153 Mt).

TABLE 2: BIOPHYSICAL POTENTIAL OF AUSTRALIAN LANDSCAPES TO SEQUESTER CARBON 2010 - 2050[13]

Action	Potential (Mt CO_2-e /yr)
Agriculture	
Grazing land management (incl. soil carbon)	100
Livestock emissions (mainly methane)	26
Crop land management (incl. CO_2 and N_2O emissions)	25
Savannah Fire Management	13
Sub-total Agriculture	*164*
Forestry	
Carbon forestry (biodiversity plantings - 350; plantations - 400)	750
Land clearing and regrowth	56
Eucalypt forest management	47
Sub-total Forestry	*853*
Bioenergy[14]	
Biofuels	not avail
Biochar	not avail
Total	**1,017**
Australia's total net annual greenhouse gas emissions (2007)	597

This is good news for Australia and the world:

- it lowers the economic cost of achieving Australia's emission reduction targets;
- it paves the way for Australia and the world to adopt deeper emission cuts;
- it provides a new source of income for Australian agriculture and other land managers to manage our landscapes more sustainably; and
- it helps Australia adapt to climate change by improving the health of our natural assets.

Managing Terrestrial Carbon

If Australia was to capture 15% of the biophysical capacity identified in the CSIRO report, the gross investment potential of terrestrial carbon in Australia would be between $3.0 billion and $6.5 billion per annum.[15]

TABLE 3: THE ECONOMIC POWER OF TERRESTRIAL CARBON IN AUSTRALIA

Sector	Biophysical Potential Mt CO_2e per/yr	Gross Economic Potential (15% of biophysical potential, $ per annum)		
		CPRS -5 @ $20 t CO_2e	CPRS -15 @ $43 t CO_2e	Garnaut -25 @ $43 t CO_2e
Agriculture	164	$402 m	$689 m	$1,058 m
Forestry	853	$2,559 m	$3,583 m	$5,502 m
Bioenergy	not avail	-	-	
Total	1,017	$3,051 m	$4,271 m	$6,560 m

Earlier ABARE modelling suggests investments of similar magnitude.[16]

Whilst there will be many issues affecting whether this potential is converted into reality, the implications are that a price on carbon presents an economic opportunity to use the new carbon economy to address the range of other great environmental challenges confronting Australia: repairing degraded landscapes, restoring river corridors, improving the condition of agricultural soils, and conserving Australia's biodiversity.

An Economic Opportunity to Revolutionise Landscape Conservation

Because forests and restored river basins store vast quantities of carbon, carbon economics of the 21st century presents our generation with the opportunity to improve the health of our landscapes and conserve the world's biodiversity, at scales that would have been unimaginable even a few years ago.

ABARE modelling suggests that such an outcome is feasible, because the higher the carbon price the greater proportion of terrestrial carbon investments that are likely to be directed into environmental plantings.[19] ABARE define environmental plantings as carbon forests that are not harvested for their timber.

With a 25% 2020 target, ABARE estimate that the majority of the land dedicated to carbon forestry will be in the form of permanent plantings, rather than harvested plantations.

TABLE 4: BIODIVERSITY CONSERVATION POTENTIAL 2010 TO 2050

(Kyoto Compliant Forests Only)

2020 Target	Timber Plantations 2010-2050 Million Ha	Environmental Plantings 2010-2050 Million Ha	Total Afforestation 2010-2050 Million Ha	% Environmental Plantings
CPRS -5	3.0	2.7	5.8	47%
CPRS -15	4.5	21.8	26.3	83%
Garnaut -25	5.0	34.0	39.0	87%

This does not guarantee that a terrestrial carbon market alone will produce plantings that also optimise biodiversity outcomes, because the economic driver is to maximise carbon.[14]

A major factor dictating the economics of harvested plantations is that harvesting and transport costs represent a large proportion (in the order of 40%) of total growing costs. In contrast, environmental plantings can be established anywhere in the landscape with suitable climatic conditions.

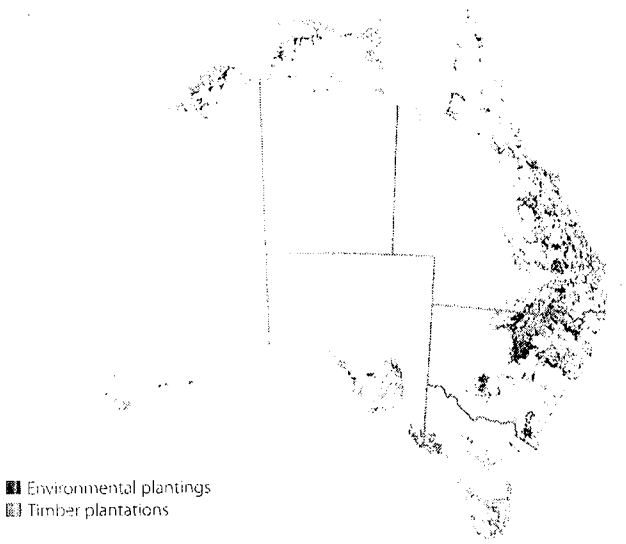
On the other hand, the Carbon Pollution Reduction Scheme will also increase the cost of producing emissions intensive products such as cement and steel, making wood products relatively more attractive.[15] This is likely to increase the profitability of harvested plantations relative to permanent carbon forests.

Biodiversity plantings do, however, have a natural competitive advantage over plantation forests. The carbon stock of native forests is higher on average than the carbon stock of plantations.[16] Biodiversity plantings are also self regenerating and are therefore more resistant to climate variability.

ABARE suggests that most of the environmental (permanent) plantings are likely to be established in eastern Australia, primarily in northern NSW and Queensland.

The policy challenge for many parts of Australia may simply be how to guide the terrestrial carbon market to those areas in the landscape in ways that deliver multiple economic and environmental benefits.

FIGURE 3: POTENTIAL LAND USE CONVERSION TO AFFORESTATION



Source: ABARE CPRS -15 scenario.

The Co-Benefits of Soil Carbon

Agricultural practices over the past century have mined Australian soils of their carbon stores. Nearly 40% of carbon stocks have been lost from Australia's cropping soils.

The loss of soil carbon is a primary cause of land and water degradation, acidification and the destruction of soil structure.[22]

This reveals the great co-benefit of improving soil carbon. Soil carbon sequesters carbon from the atmosphere which also improves soil health and as a consequence, agricultural production.

CSIRO have identified the significant biosequestration potential of the Australian landscape to absorb carbon. The paradox in their analysis is that whilst nearly 50% of terrestrial carbon in the Australian landscape occurs in grasslands and croplands, less than 20% of the estimated potential of the Australian landscape to store carbon occurs in these landscapes. This is because without changes to existing agricultural practices, any increase in carbon will come at the cost of agricultural production.

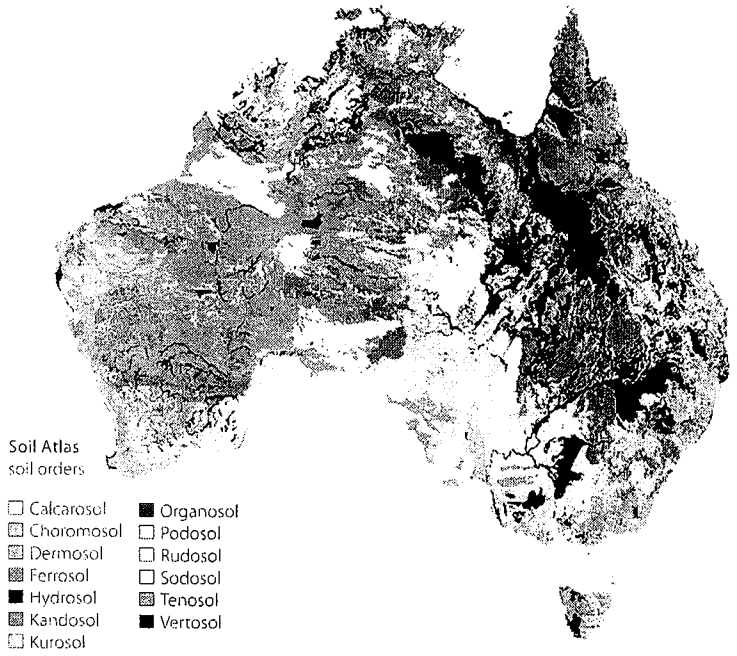
It is estimated that Australia's grasslands and croplands store an estimated 48,000 million tonnes of CO_2e in their soils (Table 1).

As a consequence of the loss of soil carbon in agricultural systems, many Australian soils now have a significant capacity to store additional carbon.

Australian soils are complex and their potential to store carbon varies significantly. Three soil types (Kandosol, Sodosol and Vertosol) which occupy 50% of the continent have the biophysical potential to sequester 80% of the soil carbon (Table 9).

In Australia, livestock grazing and cropping land occupies over 400 million hectares – nearly 60% of the Australian continent. Even small increases in soil carbon can produce significant offsets in greenhouse gas emissions.

Figure 4: Australian Soils Atlas[23]



Changing farming practices, such as *Carbon Grazing* [23], have the potential to reduce emissions of greenhouse gases while simultaneously increasing productivity, reducing input costs and producing wider natural resource management benefits.

Experts believe that it is technically feasible for Australian agricultural landscapes to increase soil carbon levels by 2% per year. This would result in the storage of an additional 900 Mt of CO_2e per annum.[24]

TABLE 5: SOIL CARBON STORAGE POTENTIAL IN AUSTRALIA

Estimated areas of each soil type within the >200mm average annual rainfall zone.[24]

Soil Type	Area (Million ha)	Carbon Increase (tonnes per annum per ha)	Biosequestration Potential (Mt CO_2e)
Calcarosol	42	0.12	18
Chromosol	16	0.74	43
Dermosol	7	0.74	19
Ferrosol	4	1.23	18
Kandosol	90	0.51	168
Kurosol	3	0.74	8
Rudosol	42	0.12	18
Sodosol	69	0.74	187
Tenosol	89	0.12	39
Vertosol	75	1.48	407
Total	**437**		**927**

If changed grazing and cropping practices resulted in the capture of just 15% of this potential, carbon stores in Australia's agricultural soils would offset 140 Mt CO_2e of Australia's emissions each year.

Without planting a single tree, it would improve the health of our farmlands and Australian agriculture would become carbon neutral.

Food Security

The terrestrial carbon economy provides an historic opportunity to repair our degraded river systems and estuaries, restore habitat for threatened species, and build economic drivers into agriculture that pays farmers to improve the health of our soils. But if 100% of the CSIRO estimate of the biophysical potential of the Australian landscape was committed to carbon, then we would most likely see vast tracts of agricultural land converted to carbon forests.

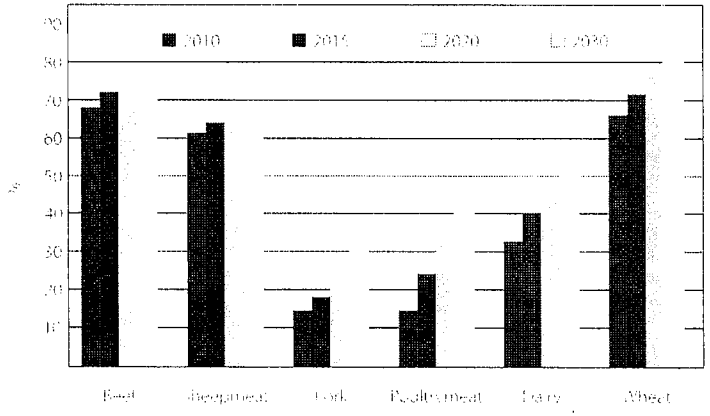
One of the challenges facing humanity is increasing food production (increasing current demand by 70% according to some estimates[26]) to satisfy the needs of an expected 9 billion people. This is against a background of a dwindling global natural resource base, whose biophysical productivity is being undermined by pollution and land and water degradation.[27]

The world's population has doubled in the past 40 years, from 3 billion people in 1969 to over 6 billion people today. It is projected that the world's population will exceed 9 billion in the next 40 years.[28] Australia is expected to add another 15 million people in the next 40 years, to reach a population of about 35 million by 2050.[29]

Historically the answer to world population growth has been found in the green revolution, where high input systems have been sustained by a suite of new seed varieties, pesticides and fertilisers, and by bringing more land under cultivation.[30]

Australia is an important producer and exporter of food. Australian agriculture exports over 60% of our beef, sheep and wheat products and this proportion is expected to grow to 80% within the next 20 years.[31]

FIGURE 5: EXPORT SHARE OF SELECTED AUSTRALIAN COMMODITIES[33]



Source: RIRDC, 2009 using GLOBAL, Dairy and Grain model projections.

Food and fibre production provides the backbone to many regional economies, as well as the resource base for the valued-added industries that support regional jobs.

If the new terrestrial carbon economy takes large areas of agricultural land out of production, as has happened recently in the United States, when corn was turned into biofuel, or when the European Union set biofuel targets but didn't ban the clearing of tropical rainforests to produce it, then we risk creating more problems for Australia and the world than we solve.

ABARE has estimated that if Australia commits to reducing greenhouse gas emissions by 25% by 2020, over 40 million hectares – an area equivalent to 40% of the entire Murray Darling Basin - could be economically suitable for Kyoto compliant carbon forestry.[32]

TABLE 6: ECONOMIC POTENTIAL OF AFFORESTATION 2010 TO 2050

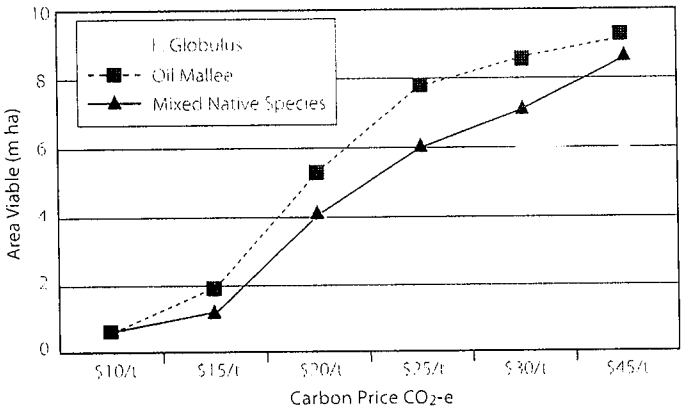
Target	Total Afforestation Area 2010-2050 Million ha	Total Carbon Sequestered 2010-2050 Mt CO2e
CPRS -5	5.8	1,082
CPRS -15	26.3	3,245
Garnaut -25	39.0	4,107

** Based on Australia Treasury 2008 carbon price assumptions.*

Whilst these estimates should be interpreted as conditional projections and not forecasts, the results suggest that the introduction of a carbon price can substantially influence land use change in Australia.

In an economic analysis of the impact of a carbon price on agricultural land in South Australia, CSIRO estimate that over 5 million hectares (half the study area) would be economically viable to reforest if the carbon price was above $20 tonne CO_2e. At $45 per tonne (the price Australian Treasury estimates for a -25%, 2020 target), the area estimated to be economically viable for conversion to forestry could increase to over 8 million hectares.[33]

FIGURE 6: AFFORESTATION POTENTIAL IN SOUTH AUSTRALIA



All things being equal, individual farmers are likely to keep productive areas in food and fibre production and look for less profitable parts of the farm to provide an additional income stream from carbon forestry.[34] This would be a good outcome for everyone.

However, in the highly distorted global agricultural markets, an unregulated carbon market of this scale has a significant potential, in the short term at least, to destabilise many agricultural regions across Australia, as investors move to take agricultural land out of production to grow carbon instead.

It is the role of our governments (Commonwealth, State, Territory and Local), to capture the opportunities presented by the new terrestrial carbon economy. It is also their responsibility to manage the risks.

Water Resources

Unregulated carbon forestry poses risks to Australia's fresh water resources, particularly in high rainfall zones above 700mm where large scale forestry is most viable, because it can reduce the amount of runoff into rivers, groundwater and dams.[35]

The risks from large-scale forestry on Australia's fresh water resources were recognised in the historic National Water Initiative, agreed by the Council of Australian Governments in 2004: *"... a number of land use change activities have potential to intercept significant volumes of surface and/or ground water ... if these activities are not subject to some form of planning and regulation, they present a risk to the future integrity of water access entitlements and the achievement of environmental objectives for water systems."*[36]

The solution is for the Commonwealth to require carbon forest offsets to hold a water access entitlement in areas where forestry is likely to affect runoff into rivers, groundwater or dams, and for these entitlements to be surrendered equivalent to their environmental impact.[37]

This requires State and Territory governments to honour their obligations under the National Water Initiative *"to implement ... no later than 2011, ... in water systems that are fully allocated, overallocated, or approaching full allocation, ...* (that) *any proposals for additional interception activities above an agreed threshold size, will require a water access entitlement."*

Land Clearing and Native Forest Management

It is counterproductive for Australia to create economic incentives to revegetate overcleared landscapes, without introducing complementary measures to further reduce broadscale land clearing.

Clearing of native vegetation is the prime cause of land degradation and biodiversity loss in Australia and contributes significantly to Australia's greenhouse gas emissions.

Despite significant reductions in land clearing in Australia in recent years, land clearing still releases an estimated 77 Mt CO_2e each year, contributing 13% of Australia's greenhouse emissions.[xi]

If Australia was to buy back the clearing of regrowth, CSIRO estimate that action alone would save 11 Mt CO_2e per year.[xii]

Emissions reductions from improved management of native forests also has potential to make an important economic contribution to Australia's greenhouse gas reduction targets. CSIRO estimates of the benefits that could be achieved from improved forest management are in the order of 47 Mt CO_2e per year.[xiii]

Optimising Carbon in the Landscape

The introduction of a Carbon Pollution Reduction Scheme in Australia which provides for terrestrial carbon offset credits, will require a suite of institutional responses by Commonwealth, State, Territory and Local governments, if we are to optimise this new terrestrial carbon economy across the Australian landscape.

Many have direct implications on the design of Australia's Carbon Pollution Reduction Scheme and some require international agreement at the UNFCCC Conference in Copenhagen in December this year.

State, Territory and Local government also have an important role to play in guiding investments and regulating land use. These need to be in place before the Carbon Pollution Reduction Scheme becomes operational in 2011.

Australia's immediate policy response for managing the terrestrial carbon economy should focus on six priority actions:

1. Designing a Carbon Pollution Reduction Scheme that captures the full potential of terrestrial carbon in vegetation and soils, providing land managers across Australia the opportunity to optimise their contribution to the climate change solution;
2. Regulating the terrestrial carbon market so that multiple economic and environmental benefits can be realised, whilst avoiding unintended consequences for fresh water resources, biodiversity and agricultural land;
3. Assisting communities prepare regional *Climate Change Adaptation Plans* to manage the impacts of climate change on the Australian landscape and guide the development of policies to optimise future investments in terrestrial carbon;
4. Underwriting climate change adaptation policies and terrestrial carbon investments by building a system of regionally based, *National Environmental Accounts*, to monitor the health and change in the condition of our natural resource assets;
5. Establishing a *Climate Change Adaptation Fund*, by applying a 1% levy on the sale of emission permits to monitor, plan and invest in actions to minimise the impact of climate change on Australia's biodiversity, coasts, and land and water resources; and
6. Strengthen international efforts to protect and restore terrestrial carbon in tropical forest landscapes that will promote new international rules to provide the opportunity for developing countries to capture this potential.

1. Capture the Full Potential of Terrestrial Carbon

It is in Australia's self interest to adopt full terrestrial carbon accounting:

1. It lowers the economic cost of Australia's greenhouse reduction targets for at least 40 years and paves the way for Australia and the world to adopt deeper emission cuts;
2. It provides a new source of income to help Australian agriculture and other landholders create more sustainable farming systems;
3. It has the potential for almost unlimited possibilities for repairing degraded river systems and financing the conservation of Australia's biodiversity; and
4. It provides a capital base to help us adapt to the impacts of climate change on our natural resource assets.

According to CSIRO, approximately 75% of the biophysical potential of the Australian landscape is already built into the rules adopted by Australia under the Kyoto protocol, primarily through forestry.[41]

TABLE 7: RESTRICTIONS ON AUSTRALIA'S BIOSEQUESTRATION POTENTIAL

Legal Status	Activity	Biophysical Potential
Benefits captured in CPRS Bill	Carbon forestry Biofuels (displacing fossil fuels)	73%
Not in CPRS but emissions counted under Kyoto rules	Emissions from Livestock Savannah burning Land clearing and re-growth	10%
Not counted under Kyoto rules because Australia has not elected to include in our national carbon accounts	Grazing land management Native Forest management Crop land management	17%
Ineligible under Kyoto rules	Biochar	unknown
Total		100%

The Carbon Pollution Reduction Scheme Bill creates credits for reforestation on land that is 'Kyoto compliant', and potentially through the displacement of fossil fuels with biofuel.

The current bill does not however reward carbon sequestration in grazing land, cropping land and forest management, primarily because the international rules require Australia to account for natural as well as human induced changes in carbon stocks.

Such rules constrain the potential for terrestrial carbon to contribute to lowering the cost of meeting mitigation targets. They also create an economic distortion in agricultural markets where tree planting is given a competitive advantage over soil carbon stored in agricultural soils.

The United States House of Representatives has passed legislation which allows full terrestrial carbon offsets, including soil carbon offsets.[43]

The new Copenhagen framework should mirror these reforms and rectify the flaws in the current international accounting rules to allow Australia and other nations to incorporate the benefits of full terrestrial carbon accounting.

Biochar is another carbon sequestration technology which has potential to both remove carbon from the atmosphere and increase plant production by reducing soil acidity, lowering fertiliser use, and increasing water holding capacity.[43] Biochar is a form of fine-grain charcoal which is created by converting organic matter (such as wood, leaves, food wastes and manure), though heating in a low or zero oxygen environment.[44] This opportunity should also be recognised in the new Copenhagen framework.

Australia should take the lead with these reforms, and extend the Carbon Pollution Reduction Scheme Bill to allow for the inclusion of carbon offset credits from all terrestrial carbon sources once the international rules are in place, and definitional and measurement standards are agreed.

This will provide a signal to the market that there will be a level playing field in terrestrial carbon, and this market signal will create an economic driver that rewards innovation to develop cost effective methods for addressing the measurement and monitoring issues.

Where there is confidence in current measurement and verification systems, these activities can be included immediately (eg. biodiverse revegetation, forestry and avoided deforestation). Other activities such as grazing land management and biochar would be included once reliable and cost-effective measurement systems are in place.

Australia should also introduce complementary measures to reduce broadscale land clearing. To do otherwise will result in more damage to Australia's biodiversity and water resources and impose higher costs on the rest of the Australian economy in meeting our national emissions targets.

Recommendation 1:

1. Australia promote at the UNFCCC Conference in Copenhagen, new international rules for including full terrestrial carbon accounting, by removing the requirement to count natural as well as human induced sources of emissions and sinks in cropland, grazing land and forest management, and include biochar as a new carbon capture technology that is eligible to receive emission credits.

2. The Commonwealth extend the Carbon Pollution Reduction Scheme Bill to enable carbon offset credits to be generated from all sources of terrestrial carbon, including soil carbon and forest management, so that when these new international rules and definitional and measurement standards are agreed, all sectors can compete on a level playing field with carbon forestry.

3. State and Territory governments extend existing (and where necessary introduce) laws to end the broadscale clearing of remnant native vegetation (both urban and rural) unless it maintains or improves environmental outcomes (including for carbon sequestration).

4. The Commonwealth amend the Carbon Pollution Reduction Scheme Bill to require the effects of broadscale clearing of native vegetation on greenhouse gas emissions to be offset, either by the planting of native vegetation elsewhere or the purchase and surrender of an emissions permit.

5. The Commonwealth establish a public fund from which regional natural resource management bodies offer incentives to landholders to reduce clearing, particularly in areas of high conservation significance.

2. Regulate the Terrestrial Carbon Market

The introduction of an emission trading scheme in Australia that allows offset credits for carbon forestry requires complementary regulatory arrangements to ensure the protection of high value agricultural land for food production, protection of fresh water resources, and the promotion of environmental co-benefits (such as restoring river corridors, biodiversity plantings and regrowth of native vegetation over monoculture plantings).

Whilst ABARE and other modelling suggests that a large proportion of terrestrial carbon investments are likely to be directed into permanent plantings, this does not guarantee that a terrestrial carbon market alone will produce plantings that optimise biodiversity, water quality and other environmental outcomes.[45]

Governments can use a combination of economic incentives and existing land use planning schemes to direct terrestrial carbon investments to optimise these outcomes across the Australian landscape.

One option is for the Commonwealth to establish a *National Carbon Bank*[46] - a large public fund, managed by Australia's existing regional natural resource management bodies. This fund would invest in biodiversity plantings which produce a double environmental dividend. It would use a price on carbon to help Australia meet its greenhouse gas emission targets in a way that also restores the native vegetation along the nation's river systems, restores habitat for threatened species, improves water quality, and secures landscape health in the face of climate change.

The Wet Tropics NRM Group in north Queensland[47] has a pilot scheme in place now which uses their existing accredited regional natural resource management plan as the framework for creating a carbon market enterprise to deliver complementary biodiversity, sustainable agriculture, water quality and community benefits.

There are other economic vehicles, such as targeting existing environmental programs to compensate for the difference between biodiversity and monocultures on sites of high conservation value but where carbon economics favours monocultures.

Another option is to provide taxation incentives to landholders who are engaged in 'accredited' biodiversity carbon projects.

An effective regulatory tool for optimising terrestrial carbon is for State, Territory and Local governments to improve the quality of existing regional natural resource management plans and link these plans with their existing land use planning schemes to zone land according to its acceptability for carbon forestry.

These land use planning schemes can then guide terrestrial carbon into areas of highest benefit and away from areas of risk, without significantly undermining the terrestrial carbon market.

The Commonwealth has recently gazetted guidelines for the establishment of trees for carbon sequestration under the *Income Tax Assessment Act 1997*.[xx] These guidelines require carbon sink forests to be based on best practice for land and water environmental benefits and to be guided by regional natural resource management plans and water sharing plans. These provisions should also apply to all carbon offset credits generated by the Carbon Pollution Reduction Scheme.

Recommendation 2:

1. The Commonwealth amend the Carbon Pollution Reduction Scheme Bill to require that terrestrial carbon credits are only available where they meet national environmental and natural resource management standards consistent with the existing Income Tax Guidelines.

   This creates the legal authority to link the carbon forestry offsets created by the Commonwealth legislation with State, Territory and Local government powers to designate land as suitable or otherwise under regional natural resource management plans, water sharing plans and regional land use plans.

2. The Commonwealth amend the Carbon Pollution Reduction Scheme Bill to require that carbon forestry offset entitlements are only issued if they hold a water access entitlement in areas where forestry is likely to affect runoff into rivers, groundwater or dams, and to ensure these operations surrender entitlements equivalent to their environmental impact.

3. In areas of Australia where carbon forestry is likely to cause other adverse economic, social or environmental impacts, State, Territory and Local governments amend their land use planning schemes to zone land according to its suitability for carbon forestry:

   - Green light for areas identified by regional natural resource management plans and/or regional land use strategies, as suitable for biodiversity plantings could be zoned "permitted use", subject to compliance with environmental guidelines with regard to location and species type;

- Red light for areas of high value arable land deemed unsuitable for carbon forestry because of its long-term impact on food production, jobs and regional economic development; and
- Amber light for areas not in the two categories above, when carbon forestry developments would be subjected to a formal development application or environmental impact assessment processes.

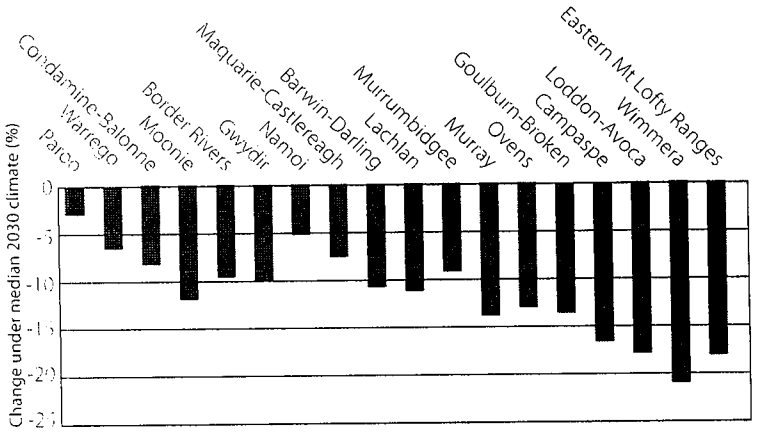
4. The Commonwealth establish, as a complimentary measure alongside the Carbon Pollution Reduction Scheme, a *National Carbon Bank* - a large public fund for Australia's regional natural resource management bodies to invest in biodiversity plantings which produce a double environmental dividend.

3. Regional Climate Change Adaptation Plans

Even with concerted action, projected temperature increases of 2.9°C (above pre-industrial levels) over the next 40 years, are likely to have profound impacts on Australian agriculture, water security, coastal systems, icons like Kakadu and the Great Barrier Reef, and biodiversity.

Irrigated and dryland agriculture in southern Australia is facing a bleak future. CSIRO (median) modelling suggest reductions in average annual rainfall of 5% in the south of the Murray Darling Basin within the next 20 years, which could translate to reductions in average annual runoff of 15% or more in many southern catchments.[19]

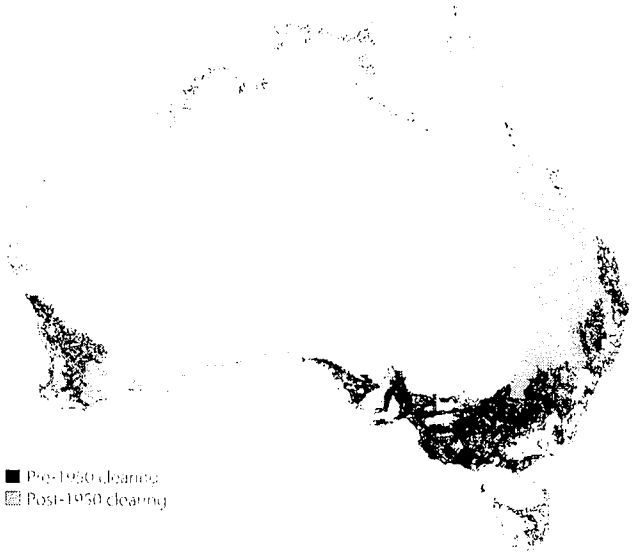
FIGURE 7: CLIMATE CHANGE IMPACT ON WATER AVAILABILITY IN THE MURRAY DARLING BASIN



Source: CSIRO 2008 Water availability in the Murray-Darling Basin. A report to the Australian Government from the CSIRO Murray Darling Basin Sustainable Yields Project CSIRO, Australia. 67pp.

In many parts of Australia where native vegetation has been fragmented into small patches by urban development and agriculture, climate shifts will almost certainly lead to a wave of regional extinctions of native plants and animals, because the remaining islands of native vegetation will no longer provide the habitat needs for many native species.[50]

FIGURE 8: LAND CLEARING IN AUSTRALIA[51]



Australia needs to equip our existing regional natural resource management institutions to prepare *Regional Climate Change Adaptation Plans to:*

- identify the risks posed to our natural resource base from climate change;
- build greater alignment between Commonwealth, State, Territory and Local government policies and natural resource management and landscape adaptation investments; and
- offer communities opportunities to assess their options for improving land use management under new climate conditions.

These plans would identify areas and set investment targets for:

- restoring native vegetation along the nation's rivers, wetlands and estuaries, which would improve water quality and re-connect native vegetation across our vast, fragmented landscapes;
- expanding habitat to create viable populations of threatened species, which is a foundation stone for their long-term survival;
- identify opportunities in agricultural landscapes for improving soil carbon, which helps address both climate change and improve the condition of our agricultural soils; and
- in coastal areas, allow for the expansion of ecosystems that help protect low-lying land from inundation and erosion.

Recommendation 3

1. Commonwealth, State and Territory governments agree, preferably through their existing Regional Natural Resource Management and land use planning bodies, to develop *Regional Climate Change Adaptation* plans to:

    - identify the risks posed to our natural resource base from climate change;
    - build greater alignment between Commonwealth, State, Territoty and Local government policies and natural resource management and landscape adaptation investments; and
    - offer communities opportunities to assess their options for improving land use management under new climate conditions.

4. Regional Scale, National Environmental Accounts

It is not possible to effectively manage our landscape to adapt to climate change, nor is it possible to optimise investments in terrestrial carbon, unless this new generation of regional land use planning is underwritten by a system of environmental accounts.

It would be like trying to manage the global economic crisis without access to economic accounts.

The scale and speed of the change and the uncertainty of the science demands that we equip our natural resource management institutions with the capacity and technology to monitor changes in real time. The next generation of climate models will have a finer resolution, but are never going to be enough.

If we are to have any hope of adapting to climate change and addressing the other great environmental challenges of the 21st century, we need to apply the same level of discipline to environmental decision making that we apply to managing other complex issues in our society.

One model put forward last year for building the *National Environmental Accounts of Australia,* proposes a regionally based system across Australia for monitoring the health of key environmental assets and the change in condition of these assets over time.[32]

The power of this model is that it creates a common set of accounts – an environmental currency - across the country for all environmental assets, at all scales. In doing so, this allows a single accounting system to be used to guide a range of investments, from a range of sources, both public and private, at a range of scales, into activities that produce the most cost-effective environmental benefits.

A regional reporting system is necessary because each region has unique environmental characteristics which need to be managed to cater for the specific pressures on these landscapes and environmental assets.

National Environmental Accounts have application beyond climate change policy and have the potential to be one of the great transforming investments of our generation. They present an opportunity for Australia to influence global environmental reform into the 21st century.

They will guide the new terrestrial carbon economy. They will also change the design of our town and cities, how and where we produce our food and fibre, and they will deliver far better environmental outcomes for the $8 billion of other public investments in environmental programs across Australia.

TABLE 8: INVESTMENTS IN ENVIRONMENTAL MANAGEMENT IN AUSTRALIA

Program	Annual Investment
Caring for Our Country program	$400 million
other Commonwealth Environment programs	$3,600 million
State and Local Government programs	$4,000 million
Sub-total	*$8,000 million*
Terrestrial Carbon (150 Mt/y @ $30 tonne)	$4,500 million and rising[53]
Total	**$12.5 billion (1.3% GDP)**

Recommendation 4:

1. The Council of Australian Governments establish a system of regionally based, *National Environmental Accounts*, to underpin climate change adaptation policies, guide public and private sector terrestrial carbon investments, urban and regional planning, and other public investments in environmental management across Australia.

5. Climate Change Adaptation Fund

One way of financing the regional system of *National Environmental Accounts* and resourcing the development and implementation of *Regional Climate Change Adaptation Plans*, is to apply a levy on the sale of emission permits under the Carbon Pollution Reduction Scheme and investing this revenue into an *Australian Climate Change Adaptation Fund*.

If Australia adopted a 25% emission reduction target for 2020, a 1% levy would raise approximately $250 million per annum.[54]

This would resource the planning of investments arising from the *Regional Climate Change Adaptation Plans*, guide other investments arising from the terrestrial carbon market created by the Carbon Pollution Reduction Scheme, and finance the management, data gathering and reporting costs associated with the regional scale, *National Environmental Accounts*.

Recommendation 5:

1. The Commonwealth amend the Carbon Pollution Reduction Scheme Bill to apply a 1% levy on the sale of emission permits and invest this revenue into an *Australian Climate Change Adaptation Fund* to:
   - monitor, plan and invest in actions to minimise the impact of climate change on Australia's biodiversity, coasts, and land and water resources;
   - guide other investments arising from the terrestrial carbon market created by the Carbon Pollution Reduction Scheme; and
   - fund the monitoring and reporting costs associated with the establishment of a system of regionally based *National Environmental Accounts*.

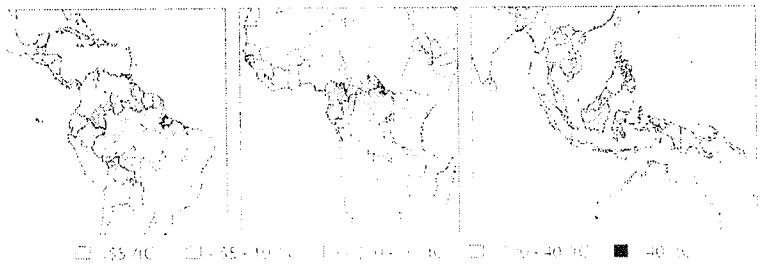
6. Support the Conservation of Tropical Forests

Australia, through its $200 million *International Forest Carbon Initiative*,[55] has been playing a leadership role in creating the opportunity for developing countries to contribute to the global climate change solution, by promoting economic and technical solutions to assist them reduce the clearing of the world's tropical rainforests.

The tropical forests in the developing countries of Asia, Oceania, Africa, and South and Central America, are estimated to contain 538 billion tonnes of carbon.

If the current rate of deforestation (an estimated 12.5 million hectares per annum) remained constant over the next 40 years, approximately 24% of this carbon stock would be lost.[56] This would release over 8,000 million tonnes of CO_2e, 25% of existing global emissions, each year.

FIGURE 9: CARBON PRICES TO AVOID DEFORESTATION[57]



The world is now negotiating to include reduction of greenhouse gas emissions from deforestation in developing nations in the post 2012 international climate framework.[58]

To harness the potential of tropical forests in developing countries to contribute to the climate change solution in a way that balances the competing demands for food and fibre, it is necessary to create an economic framework that values terrestrial carbon in these developing countries, so that it can compete with other land uses.

One model, put forward by the *Terrestrial Carbon Group*[59] uses international carbon markets to create economic incentives to maintain existing terrestrial carbon and create new terrestrial carbon in tropical forest landscapes, whilst avoiding perverse economic and environmental outcomes.

This model shows that it is possible to create an international framework that allows international trading (whether bilateral, multilateral, or global) of carbon credits based on the maintenance and creation of terrestrial carbon, in a way that guarantees that action under the system will contribute to long-term climate change mitigation.

Designing the rules in this way means that terrestrial carbon does not restrict the economic use of land in developing countries, but it does open up a new economic development option – generating and selling terrestrial carbon credits.

The benefits for Australia and other developed countries is that it provides access to a large source of abatement opportunities and as such, establishes a financially viable means for developing countries to contribute to global climate change mitigation.

Creating an international market for terrestrial carbon also presents an opportunity for Australian enterprises to market the potential of the Australian landscape to store carbon.

Recommendation 6:

1. Australia promote at the UNFCCC Conference in Copenhagen, new international rules for the creation of a legally binding, but voluntary terrestrial carbon market in developing countries.

   This international framework should be built on robust design principles that are in the self-interest for participating nations, guarantee the permanence of the carbon stores, and address global leakage and additionality issues as proposed for example by the Terrestrial Carbon Group.

2. Provide Australian industry access to buy and sell terrestrial carbon credits, through the Carbon Pollution Reduction Scheme.

Conclusion

The Wentworth Group is encouraged by Australia's commitment to reduce greenhouse gas emissions by 25% of 2000 levels by 2020 if the world agrees to stabilise levels of CO_2-e in the atmosphere at 450 parts per million.

This is an important first step on the path to a carbon pollution free economy.

Achieving a '450 ppm' stabilisation scenario requires global CO_2 emissions to peak no later than 6 years from now, and net global emissions to be reduced by between 50 and 85% by 2050 (relative to 2000).

This is a staggeringly difficult political, institutional and technological challenge.

The use of terrestrial carbon is an essential ingredient to help meet these emissions targets, because it is next to impossible for Australia and the world to achieve such targets without harnessing the full power of terrestrial carbon.

Terrestrial carbon presents our generation with an opportunity to not only help stabilise the world's climate system, but to also create an economic system that will improve the health of our farms and conserve the world's biodiversity, at a scale that would have been unimaginable even a few years ago.

CSIRO analysis shows that if we could capture just 15% of the biophysical capacity of the Australian landscape to store carbon, it would offset the equivalent of 25% of Australia's current annual greenhouse emissions for the next 40 years.

This will allow Australia to adopt deeper emission targets and it would make Australian agriculture carbon neutral.

With a 25% 2020 target, ABARE estimate that the majority of carbon forestry will be environmental plantings. This presents an economic opportunity to use the new carbon economy to address the range of other great environmental challenges confronting Australia: repairing degraded landscapes, restoring river corridors, and conserving Australia's biodiversity.

Left unregulated however terrestrial carbon also poses significant risks. If Australia commits to reducing greenhouse gas emissions by 25% by 2020, over 40 million hectares - an area equivalent to 40% of the entire Murray Darling Basin - would be economically suitable for Kyoto compliant carbon forestry.

These carbon forest offsets have the potential to take over large areas of prime agricultural lands, impacting on food and fibre production, regional jobs and the security of Australia's fresh water resources.

It is the role of government to create these opportunities and manage these risks.

The challenge for Australia is to optimise this new terrestrial carbon to drive investments towards improving the health of our agricultural soils, protecting areas of high conservation significance and repairing degraded landscapes and away from damaging native vegetation and prime agricultural land.

Notes and References

1 IPCC, 2007. *AR4 Synthesis Report*. Fig SPM.11 and Table SPM.6, and Ramanathan and Feng, 2008.

2 IPCC, 2007. *AR4 Synthesis Report* Table SPM.6.

3 V. Ramanathan and Y. Feng, 2008. *On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead*. PNAS, 105, 14245–14250.

4 Pedersen, E., J. Overpeck, K. Briffa, J. Duplessy, F. Joos, V. Masson-Delmotte, D. Olago, B. Otto-Bliesner, W. Peltier, S. Rahmstorf, R. Ramesh, D. Raynaud, D. Rind, O. Solomina, R. Villalba, and D. Zhang, 2007, Palaeoclimate, in Climate Change 2007: *The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.), pp. 433-497, Cambridge University Press, Cambridge, United Kingdom, 462pp.

5 Barrett, P. 2005. *What 3° of Global Warming Really Means*. Pacific Ecological Summer 2005/06.

6 IPCC, 2007. *AR4 Working Group III* Box 13.7.

7 Terrestrial Carbon Group, 2009. *Distribution of Terrestrial Carbon Across Developing Countries*. Draft Policy Brief #1, June 2009.

8 Based on 2007 IPCC 4th Assessment Report, Figure 7.3 (pg 515) for stocks of carbon, and updated with rates of flux from Table 7.1.15 (pg). 2005 terrestrial stocks of carbon estimated to be 2271 GtC and atmospheric stocks to be 802 GtC.

9 Prepared with assistance from the Department of Climate Change, Canberra, 2009.

10 Australian Bureau of Rural Sciences, 2003. *Integrated Vegetation Cover, version 1*.

11 DCC, 2009. *Australia's National Greenhouse Accounts: National Greenhouse Gas Inventory accounting for the KYOTO target May 2009. Department of Climate Change*. (Deforestation 12.9%, agricultural soils 2.5%, prescribed burning 1.9%, agricultural residues 0.1% and afforestation and reforestation -3.5%).

12 CSIRO, 2009. *Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use*. Edited by Sandra Eady, Mike Grundy, Michael Battaglia and Brian Keating for the Queensland Premiers Climate Council.

13 Adapted from CSIRO, 2009. *Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use.*

14 It was not possible to estimate national figures biofuels and biochar, where a national analysis was not undertaken due to time constraints and the enormous complexity of modelling at a national level, the range of feedstocks and different pathways for biofuels (bio-energy).

15 Based on Australian Treasury, 2008. *Australia's Low Pollution Future: Summary Report - The Economics of Climate Change Mitigation*. See 3.2 on 19pp.

16 Lawson, Burns, Low, Heyhoe and Ahammad, 2008. *Analysing the economic potential of forestry for carbon sequestration under alternative carbon paths*. ABARE.

17 Lawson, Burns, Low, Heyhoe and Ahammad, 2008. *Analysing the economic potential of forestry for carbon sequestration under alternative carbon paths*. Tables 5, 7, and 11 and 6, 8, and 12.

18 Crossman, Bryan and Summers, 2009. *Hotspots of threat and opportunity from widespread reforestation for carbon credits*. 18th World IMACS/MODSIM Congress, Cairns, July 2009. CSIRO.

19 Australian Treasury, 2008. *Australia's Low Pollution Future: The Economics of Climate Change Mitigation Summary*. 17pp.

20 Mackey et al, 2009. *Green Carbon: The role of natural forests in carbon storage*. ANU Press.

21 Gifford, Cheney, Noble, Russell, Wellington and Zammit,1990. *Australian land use, primary production of vegetation and carbon pools in relation to atmospheric carbon dioxide concentration*. In: RM Gifford and MM Barson (eds) Australia's renewable Resources: Sustainability and Global Change. BRS. Canberra.

Australian Natural Resource Atlas, Soils. www.anra.gov.au/topics/soils/maps/national/soil_atlas.gif.

22 Lauder, A. 2008. *Carbon Grazing: The Missing Link*. Saltbush Systems Pty Ltd, The Gap Queensland. www.carbongrazing.com.au.

23 Grace, P. 2008. Unpubl. Estimates calculated using the SOCRATES model. The average annual soil carbon sequestration rate of 0.59 T/ha for the top metre is consistent with the work of Stephen M. Ogle, Richard T. Conant and Keith Paustian. Deriving Grassland Management Factors for a Carbon Accounting Method Developed by the Intergovernmental Panel on Climate

Change Environmental Management, Volume 33, Number 4 / August, 2004, who suggest sequestration rates of 0.17-0.62 T/ha (0-30 cm) for similar environments and soil types when shifting from nominally managed grassland to improved grasslands. The average sequestration rate of 0.59 T/ha, equates to a 2.1% increase in soil organic carbon (0-100 cm) per annum.

[25] Soil types by area from: www.anra.gov.au/topics/soil/overview/index.html. Table: Australian Soil Classification Orders by land use type (hectares).

[26] FAO, 2009. Global Agriculture Towards 2050. Discussion paper from *How to Feed the World in 2050* - High Level Expert Forum.

[27] World Bank, 2007. *Agriculture for Development. World Development Report, 2008.* The International Bank for Reconstruction and Development-The World Bank, Washington, DC.

[28] UN, 2008. *World Population Prospects: The 2008 Revision.* Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat.

[29] Australian Bureau of Statistics, 2008. *3222.0 Population projections, Australia, 2006 to 2101.*

[30] Williams and McKenzie, 2008. *Food versus the environment – and the winner is?* In: Australian Science, August 2008.

[31] RIRDC, 2009. *On-farm Impacts of an Australian Emission Trading Scheme – An Economic Analysis.* Rural Industries Research and Development Corporation.

[32] Lawson, Burns, Low, Heyhoe and Ahammad, 2008. *Analysing the economic potential of forestry for carbon sequestration under alternative carbon price paths.* 1pp., and Table 11.

[33] Crossman, Bryan and Summers, 2009. *Hotspots of threat and opportunity from widespread reforestation for carbon credits.* 18th World IMACS/MODSIM Congress, Cairns, July 2009. CSIRO.

[34] Burns, Vonda, Heyhoe and Ahammad, 2009. *Opportunities for Forestry under the Carbon Pollution Reduction Scheme: an examination of some key factors.* ABARE Insights 09.1. 21pp.

[35] CSIRO, 2008. *Water availability in the Murray-Darling Basin: A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project.* CSIRO Australia.

[36] National Water Initiative, 2004. Clauses 55 and 57.

[37] Young, M. and McColl, J.C., 2008. *Double trouble: the importance of accounting for and defining water entitlements consistent with hydrological realities. Australian Journal of Agricultural and Resource Economics.* 19-35pp.

[38] DCC, 2009. *Australia's National Greenhouse Accounts: National Greenhouse Gas Inventory accounting for the KYOTO target May 2009.* Department of Climate Change.

[39] CSIRO, 2009. *Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use.* Edited by Sandra Eady, Mike Grundy, Michael Battaglia and Brian Keating for the Queensland Premiers Climate Council. 34pp.

[40] CSIRO, 2009. *Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use.* Edited by Sandra Eady, Mike Grundy, Michael Battaglia and Brian Keating for the Queensland Premiers Climate Council. 99pp.

[41] CSIRO, 2009. *Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use.* Edited by Sandra Eady, Mike Grundy, Michael Battaglia and Brian Keating for the Queensland Premiers Climate Council. Based on Table 1.5.

[42] American Clean Energy and Security Act, 2009.

[43] Krull, E. 2009. *Stabilisation of organic carbon in soil through biochar production.* In: An Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use. CSIRO.

[44] Lehmann and Joseph (eds), 2009. *Biochar for Environmental Management.* Earthscan Publishing, London.

[45] Lawson, Burns, Low, Heyhoe and Ahammad, 2008. *Analysing the economic potential of forestry for carbon sequestration under alternative carbon paths.* Tables 5, 7, and 11 and 6, 8, and 12.

[46] Wentworth Group, 2008. *Proposal for a National Carbon Bank.* Submission to the Garnaut Climate Change Review.

[47] Terrain Natural Resource Management, 2009. Degrees Celcius. Carbon Trading in the Wet Tropics. www.terrain.org.au/programs/climate/degrees-celsius.

[48] Income Tax Assessment Act Schedule, 2008. *Environment and Natural Resources Management Guidelines in relation to the establishment of trees for the purposes of carbon sequestration.* Income Tax Assessment Act 1997 – Sect 40.1010.

[49] CSIRO, 2008. *Water Availability in the Murray-Darling Basin.* A report to the Australian Government from the CSIRO Murray Darling Basin Sustainable Yields Project. CSIRO, Australia. 67pp.

[50] Possingham and Field, 2000. *Regional bird extinctions and their implications for vegetation clearance policy. Lifelines* 7:15-16.

[51] Thackway R and Cresswell ID (eds), 1995. *An Interim Biogeographic Regionalisation for Australia: a framework for establishing the national system of reserves.* Australian Nature Conservation Agency: Canberra.

[52] Wentworth Group, 2008. *Accounting for Nature.* A Model for Building the National Environmental Accounts of Australia. May 2008.

[53] Estimate based on 25% of 600Mt @ $30 per tonne.

[54] Australian Treasury, 2008. *Australia's Low Pollution Future: The Economics of Climate Change Mitigation*, Table 3.2

[55] DCC, 2008. *International Forest Carbon Initiative.* www.climatechange.gov.au/international/publications

[56] Terrestrial Carbon Group, 2009. *Distribution of Terrestrial Carbon Across Developing Countries*, draft Policy Brief #1

[57] Terrestrial Carbon Group, 2009. *Estimating Tropical Forest Carbon at Risk of Emission from deforestation Globally.* Policy Brief 3 Discussion Draft June 2009.

[58] UNFCCC, 2007. *Bali Action Plan*, paragraph 1(b)(iii).

[59] Terrestrial Carbon Group, 2008. *How to Include Terrestrial Carbon in Developing Nations in the Overall Climate Change Solution.* July 2008.

WENTWORTH GROUP OF CONCERNED SCIENTISTS

Submission on the Carbon Farming Initiative

January 2011

Action on climate change is urgent. The challenge of keeping global temperatures below 2°C above pre-industrial levels[1] is mounting given the continued rise in greenhouse gas emissions and the delays in agreements to reduce global emissions[2].

Australia needs to make its contribution. We need deep emissions cuts and we need a price on carbon.

In Australia, most of the focus in climate change mitigation has been on reducing greenhouse gas emissions from energy generation, manufacturing and transport. However, it is near impossible to achieve the scale of reductions required unless we also harness the full potential of our landscapes to remove carbon from the atmosphere and store it in vegetation and soils.

Storing carbon in vegetation and soils lowers the economic cost of achieving Australia's targets and makes it possible for Australia and the world to adopt deeper emissions cuts.

CSIRO estimate that the Australian landscape has the biophysical potential to store an additional 1,000 Mt of CO_2e in soils and vegetation each year for the next 40 to 50 years[3]. If Australia were to capture just 15% of this biophysical capacity, it would offset the equivalent of 25% of Australia's current annual greenhouse emissions for the next 40 years[4].

The multiple public policy benefits for Australia in adopting full terrestrial carbon offsets are enormous, but there are also significant risks to other areas of public policy from an unregulated terrestrial carbon market.

If we plan wisely terrestrial carbon presents an economic opportunity of unparalleled scale to address a range of other great environmental challenges confronting Australia: repairing degraded landscapes, restoring river corridors, improving the condition of our agricultural soils, and conserving Australia's biodiversity.

It also poses significant risks. Without complementary land use controls and water use accounting arrangements in place, there is a risk that carbon forests will take over large areas of agricultural land, causing adverse impacts of food and fibre production, and impacting on regional jobs that are dependent on these industries.

The challenge for Australia is to optimise this new terrestrial carbon economy to drive investments towards improving the health of our agricultural soils, protecting areas of high conservation significance and repairing degraded landscapes, and away from damaging native vegetation and high value agricultural land.

The Wentworth Group has reviewed the consultation paper, the draft bill and the draft methodology guidelines for the carbon offset crediting scheme under the Carbon Farming Initiative. We consider that the scheme is a sound market-based approach.

However, because the scale of abatement potential from offset projects has the potential to bring about substantial environmental, social and economic changes in Australian landscapes,

it is equally important that systems are put in place to ensure these impacts and benefits are carefully managed.

We recommend that:

1. The Carbon Farming Initiative is guided by an additional principle to ensure that carbon is *optimised* in the landscape. That is, to ensure the scheme maximises potential environmental, social and economic benefits (in addition to greenhouse gas abatement) and minimises any adverse impacts. This principle should also be included in the objects of the draft bill.
2. Commonwealth, state and territory and local governments establish an agreed framework for natural resource management and land use planning systems to drive terrestrial carbon investments towards improving the health of our agricultural soils, protecting areas of high conservation significance and repairing degraded landscapes, and away from damaging native vegetation and prime agricultural land.
3. A number of other specific changes to the draft bill and the draft methodology guidelines are made to improve clarity, robustness, and consistency with the *optimisation* principle.

1 Optimising carbon in the Australian landscape

We support the principles of the scheme to ensure that real abatement is achieved and to enable broad participation through clear and simple rules. These are important for the credibility of offset credits in markets and for providing incentives to land managers to help address climate change.

We consider that reforestation offset projects are likely to make up the bulk of abatement initially, simply because the science and practicality of carbon sequestration in vegetation is relatively well advanced. Reforestation projects have the potential for high environmental benefits, such as improvements in biodiversity, dryland salinity and soil erosion, but also for adverse impacts, such as loss of valuable agricultural land to forestry or alteration of hydrological systems[1].

These benefits and impacts will depend on local and regional factors, and the way the offset project is managed. For example, biodiversity benefits can be maximised by ensuring that reforestation projects use diverse species in plantings or by siting them in locations which enhance connectivity. Alternatively, biodiversity benefits may be negligible or negative if monocultures or exotic species are used.

For soil carbon sequestration projects and other agricultural emissions avoidance projects, the science and practicality of abatement activities is less certain, and the ability to satisfy integrity standards likely to be more difficult. However, the potential long-term benefits in areas such as soil health and agricultural productivity may be significant. These type of offset projects should therefore be encouraged, not only from a climate change mitigation perspective, but also because of their potential to improve landscape health and farm productivity.

Recommendation 1: The Carbon Farming Initiative is guided by an additional principle to ensure that carbon is *optimised* in the landscape. That is, to ensure the scheme maximises potential environmental, social and economic benefits (in addition to greenhouse gas abatement) and minimises any adverse impacts. This principle should also be included in the objects of the draft bill.

2 Realising the potential for co-benefits and minimising impacts

The scheme as currently designed does not adequately promote or encourage the realisation of the potential co-benefits, nor provide confidence that any negative impacts will be managed effectively.

There are three ways of doing this – through integrated natural resource management planning, linked to economic incentives and targeted land use planning regulations.

2.1 Natural resource management plans

Offset projects need to be targeted to areas with the greatest potential for achieving co-benefits.

Public investment in regional NRM bodies across Australia in recent years has created the institutional capacity across Australia to produce more spatially explicit regional plans. These plans can be used to guide the carbon offset markets toward high value, multiple benefit products and also underpin land use planning instruments to manage potential adverse impacts on water resources, biodiversity and the loss of high value agricultural land.

Regional NRM plans provide this information already (or could with additional support) by identifying priority areas for biodiversity, water, and soil health improvements.

Whilst the consultation paper flags an option to require project proponents to consider regional NRM plans, this option is not included in the draft bill or methodology guidelines. Consistency with regional NRM plans should be included within the draft bill as an eligibility requirement. This provision could require that relevant offset projects are consistent with regional NRM plans and water sharing plans, and that environmental impacts at a catchment scale are considered and managed. Ideally this should then be incorporated in state and local government land use planning instruments.

Regional NRM bodies could also be encouraged to propose methodologies that cover offset projects with large co-benefits.

2.2 Economic incentives

The market alone will not guarantee projects that maximise environmental, social and economic benefits. For example, in many areas, the carbon economy will drive reforestation offset projects towards monocultures with negligible biodiversity benefits.

One option would be to support regional NRM bodies, landcare groups and others to take on a facilitation role in creating high environmental value offset projects. This could involve directing public funds from existing programs to 'top up' offset projects with additional incentives in order to leverage multiple public benefit outcomes from carbon offset projects.

Another option would be to provide targeted taxation incentives to landholders that are engaged in biodiversity-carbon projects in areas identified in the regional NRM plans as being of high conservation significance.

2.3 Land use planning

We also consider that the scheme's current approach to rely on state regulations to manage impacts will not adequately manage the possible environmental, economic and social impacts from offset projects.

This is particularly a risk for offset projects that result in large-scale land use change such as major reforestation projects. There is scope for improving existing plantations approvals processes by:

- ensuring that environmental, social and economic impacts are all considered
- ensuring that impacts at different scales are considered as well the possibility for cumulative impacts
- ensuring adherence with the National Water Initiative commitment to requiring water access entitlements for reforestation projects
- ensuring that locations of high value agricultural land are avoided.

This requires NRM and planning systems working together to encourage carbon offset projects into areas where they can deliver other benefits, such as biodiversity and improved soil or water health, and away from high value agricultural land. For example, economic opportunities for carbon forestry can be identified, regional NRM groups can be resourced to identify areas in their regions in which carbon forestry could deliver multiple benefits, and planning schemes could then be amended to consider carbon forestry and steer it away from valuable agricultural land[6].

Although NRM and land use planning are the responsibilities of other levels of government, the Commonwealth has a responsibility to ensure the best outcomes from implementation of its own policies.

The above options will require collaboration and agreement between federal, state and territory, and local governments to align aspects of their NRM systems and planning legislation with the Carbon Farming Initiative.

Recommendation 2: Commonwealth, state and territory and local governments establish an agreed framework for natural resource management and land use planning systems to drive terrestrial carbon investments towards improving the health of our agricultural soils, protecting areas of high conservation significance and repairing degraded landscapes, and away from damaging native vegetation and high value agricultural land.

3 Specific changes to the draft bill and methodology guidelines

Recommendation 3: We also suggest several changes that should be made to the draft bill and methodology guidelines:

1. The objects of the Act should reflect the principles of the scheme, including the principle recommended above (Recommendation 1).
2. Criteria for review of the Act should be specified in the bill, and they should at least include a review of whether the objects of the Act have been achieved.
3. Comprehensive project eligibility requirements should be specified in the Act, not the regulations.

4. Additional project eligibility requirements in the Act should include that the project is consistent with the priorities set out in spatial regional NRM plans, where relevant.

   This provision could require that relevant offset projects are consistent with regional NRM plans and water sharing plans, and that environmental impacts at a catchment scale are considered and managed. In doing so it will provide an incentive for state and local governments to incorporate NRM priorities into land use planning instruments.

5. The Act should specify that the 'common practice' additionality criterion can be defined differently for different circumstance, conditions and locations.

   An activity that is common practice in one context may not be common practice in another context due to a range of institutional, cultural, biophysical, economic and technical barriers and constraints.

6. The Act and Guidelines should allow for methodologies to cover multiple abatement activities within one land management system (for example, a farming enterprise) to align with whole farm planning approaches employed by many land managers and encouraged through the NRM system.

   The current guidelines appear to require methodologies and projects to be developed for individual abatement activities. This would result in high transaction costs for any land manager who wished to undertake a variety of activities to reduce their overall carbon footprint.

   Regional NRM bodies should also be encouraged to propose methodologies that are unique to offset projects with large co-benefits.

7. The requirement for a project to account for all sinks and sources on a project site should be made clearer in the bill (it is clear within the methodology guidelines).

Notes and References

1 Australia, along with 113 other countries, is a signatory to the Copenhagen Accord which agreed to hold any increase in global temperature to below 2 degrees Celsius.

2 As outlined in the recent Royal Society journal edition "Four degrees and beyond: the potential for a global temperature increase of four degrees and its implications" *Philosophical Transactions of the Royal Society A* (2011) 369.

CSIRO, 2009. *Analysis of greenhouse gas mitigation and carbon biosequestration opportunities from rural land use.* Edited by Sandra Eady, Mike Grundy, Michael Battaglia and Brian Keating for the Queensland Premiers Climate Council.

4 Wentworth Group of Concerned Scientists, 2009. *Optimising carbon in the Australian landscape: How to guide the terrestrial carbon market to deliver multiple economic and environmental benefits.* October 2009.

See for example: CSIRO, 2009, and review in Australian Farm Institute, 2010, *The implications of greenhouse mitigation policies on the demand for agricultural land.* August 2010.

For example, the Queensland Government recently announced it will be undertaking these activities in DERM, 2010. *Queensland Government Response to Premier's Council on Climate Change. Working Paper 4 Capturing carbon in the rural landscape: Opportunities for Queensland.* May 2010. Available at http://www.climatechange.qld.gov.au/

WENTWORTH GROUP OF CONCERNED SCIENTISTS

Submission on the
Carbon Credits (Carbon Farming Initiative) Bill 2011

SUMMARY

Continued exponential rise in greenhouse gas emissions[1] is making the challenge of keeping global temperatures below 2°C above pre-industrial levels more and more difficult.[2]

The best estimates suggest that with immediate concerted global action, there is a possibility that temperatures won't increase beyond 2°C above pre-industrial levels.[3] Without global action however, climate modelling suggests global temperatures will increase by 4 degrees or more[4] - a level the world has not experienced for over 40 million years.[5]

This would have profound implications for Australian agriculture and for the health of the Australian environment.

It is in Australia's self interest that global greenhouse gas emissions are reduced. Australia needs to make its contribution.[6] We need deep emissions cuts and we need a price on carbon.

Most of the focus in climate change mitigation needs to be on reducing emissions from energy generation, manufacturing and transport. Whilst this is fundamental for reducing Australia's emissions, it is near impossible to achieve the scale of reductions required unless we also harness the full potential of our landscapes to remove carbon from the atmosphere and store it in vegetation and soils.

Storing carbon in trees, grasslands and soils lowers the economic cost of achieving Australia's targets and makes it possible for Australia and the world to adopt deeper emissions cuts.

CSIRO has estimated the biophysical potential of the Australian landscape to store carbon.[7] Whilst only a proportion of the total potential is practically achievable and will take time to build the capacity for it to take effect, if Australia were to capture 15% of the biophysical potential of our landscape to store carbon, it would offset the equivalent of 25% of Australia's current annual greenhouse gas emissions for the next 40 years.[8]

With a carbon price of $25 tonne CO_2e, this has the potential to generate over $2 billion per annum into carbon farming offset investments across the Australian landscape.

The multiple public policy benefits for Australia in adopting full terrestrial carbon offsets are enormous, because healthy landscapes store vast quantities of carbon. Our natural landscapes and agricultural systems are built from carbon. Biodiversity is carbon.

A well designed carbon offsets scheme presents an economic opportunity of unparalleled scale to address a range of other great environmental challenges confronting Australia: repairing degraded land, restoring river corridors, improving the condition of agricultural soils, and conserving Australia's biodiversity.

However there are also significant risks from an uncapped, unregulated market. Without complementary land use controls and water use accounting arrangements in place, there is a risk that carbon forests could take over large areas of agricultural land or affect water availability. This could create adverse impacts on food and fibre production, and impact on regional jobs that are dependent on these industries.

The challenge for Australia is to use this new terrestrial carbon economy to drive investments towards improving the health of our agricultural soils, protecting areas of high conservation significance and repairing degraded landscapes, and away from high value agricultural land, while avoiding perverse impacts on the environment and community.

We see three clear opportunities in carbon farming:

1. Landholder #1 will want to restore creeks and rivers with trees and will enter a long-term agreement to store carbon on their property;
2. Landholder #2 will want to use innovative farming practices to improve the health of their grazing lands and restore carbon in their depleted agricultural soils; and
3. Landholder #3 will want to lease some or all of their property for carbon forestry.

We should use the carbon offsets markets to help landholders #1 and #2 wherever we can. However, landholder #3's goals may put them on a collision course between their personal economic benefit and broader community interests and societal demands - a clash between food and fibre crops and the demands on water and soil.

If we simply leave it to the market, the market will maximise carbon abatement without any guarantee of achieving any other benefits, and with the risk of large scale land use change. We need to manage the carbon offsets market so that carbon farming is guided into areas of highest benefit, and away from areas of high risk.

This submission makes recommendations on:

- linking carbon offset credits with a domestic (and international) price on carbon;
- managing the carbon offsets market using natural resource and land use plans;
- using economic instruments to address other market failures; and
- managing the transition.

We need to plan for where we want trees, where we produce food and where we might do both. Before communities disconnect, we need to equip our existing regional natural resource management institutions to do this.

If we plan it well, a price on carbon linked to a carbon offsets market is a once in a lifetime opportunity to pay landholders to manage our landscapes more sustainably.

It is an opportunity that our generation cannot afford to get wrong.

1. The Carbon Credits (Carbon Farming Initiative) Bill 2011

The Wentworth Group commends the Carbon Credits (Carbon Farming Initiative) Bill 2011:

1. It is a sound market-based approach for achieving greenhouse gas abatement in the land sector;
2. It establishes a solid framework for taking advantage of the potential for biosequestration to help Australia meet its international emissions reductions obligations; and
3. It provides a base upon which complementary measures can deliver multiple environmental, social and economic benefits.

Other positive features of the legislation include:

1. It enables broad participation across the land sector through clear and simple rules for including both Kyoto and non-Kyoto abatement activities (Table 1);
2. It creates an economic opportunity for Australian farmers and other land managers to generate accredited carbon credits which can be sold in Australia, and allows Australian agriculture to take advantage of the growing international carbon market;
3. It provides a government accredited mechanism for individuals and businesses, both in Australia and overseas, to voluntarily offset their greenhouse gas emissions; and
4. It commits to developing a low-cost, credible standard for co-benefits which can be recognised within the carbon market.

Table 1: Kyoto and non-Kyoto abatement activities covered by the Carbon Farming Initiative

	KYOTO CREDITS	NON-KYOTO CREDITS
SEQUESTRATION PROJECTS	• Reforestation • Avoided deforestation	• Revegetation • Improved forest management • Native-forest protection • Forest restoration • Activities that enhance carbon in agricultural soils (grazing land management, cropland management, biochar)

EMISSIONS AVOIDANCE PROJECTS	• Reductions in emissions from agricultural production, including from:
	  • livestock digestion;
	  • fertiliser application or use;
	  • manure management in intensive livestock farming;
	  • reduced burning of stubble and agricultural crop residues; and
	  • rice cultivation.
	• Savannah fire management
	• Landfill emissions avoidance
		• Management of emissions from feral animals

2. Linking Carbon Offset Credits with a Domestic Price on Carbon

The Carbon Credits (Carbon Farming Initiative) Bill 2011 creates a legislative framework for the establishment of a voluntary carbon offsets market in Australia.

Whilst this is welcomed, the demand for offset credits in voluntary markets alone is unlikely to be of sufficient scale or at a high enough price to attract farmers, forest managers and other landholders to undertake substantial abatement activities.

In March 2011, the government announced a proposal for a carbon pricing mechanism comprising a fixed price on carbon, commencing on 1 July 2012, and transitioning to an emissions trading scheme after 3-5 years.[9] It has been suggested that an appropriate starting point would be fixed price starting between $20 and $30 per tonne CO_2-e, rising at 4 percent (real) per annum for three years.[10]

To realise the full potential of abatement in the land sector, carbon offset credits must be able to be purchased by parties who are liable under a carbon price. Any such carbon pricing mechanism should therefore be linked to the Carbon Farming Initiative.

The proportion of a liable party's emissions that could be offset through the purchase of carbon credits could be capped (at least in the early stages).[11] Without a cap there is a risk that there will be insufficient incentive to ensure that the carbon pricing mechanism drives the transition to a low carbon emissions economy, nor will there be sufficient revenue available for household and industry assistance to compensate them for the carbon price.[12] There is no proposal to cap the sale of Australian carbon offset credits into the international market.

We support the capping of carbon offset credits for the reasons stated above and argue that the level of the cap should be in proportion to the level of greenhouse gas emissions that originate from the land sector in Australia.

The land sector currently contributes around 23 percent of Australia's greenhouse gas emissions.[13] Even with a 23 percent cap, a carbon price of $25 tonne has the potential to generate over $2 billion per annum into carbon farming offset investments across the Australian landscape. This represents a substantial amount of carbon finance available to farmers and other landholders and still leaves revenue of over $9 billion for compensation to households and industry, and other purposes.

This scale of abatement potential from domestic offset projects, driven by potential future demand from an uncapped international offsets market, has the potential to bring about substantial environmental, social and economic changes across rural Australia.

It is essential that complementary institutional arrangements are put in place to ensure any perverse impacts are carefully managed.

This carbon offset market has the potential to yield over 100Mt CO_2e[14] of abatement per annum from sequestration and emissions avoidance activities such as carbon forestry, biodiversity plantings, and changed grazing, fire management, cropping and livestock management practices.

The Wentworth Group also considers that all carbon offsets, not only Kyoto compliant offsets, should be linked to Australia's emissions target. Incorporating carbon offsets from both Kyoto compliant and non-Kyoto abatement activities (Table 1) within Australia's emissions reduction target will lead to further innovation across the land sector.

The rigour and integrity of the Carbon Farming Initiative, through the establishment of the Domestic Offsets Integrity Committee, and the monitoring, leakage and additionality standards, means that this is a policy position that should be supported by the international community. In time, the carbon farming legislation may also be used as a template for other nations to follow.

Recommendation 1:

Ensure there is sufficient demand in the market for carbon credits by linking the Carbon Farming legislation to the domestic and international carbon pricing mechanism.

Recommendation 2:

Liable parties under a future carbon price mechanism be entitled to offset up to 23% of their emissions by purchasing credits created under the Carbon Farming legislation.

Recommendation 3:

All carbon offsets, not only Kyoto compliant offsets, should be counted towards Australia's emissions reduction target.

3. Optimising the Carbon Offsets Market by Linking Natural Resource Management and Land Use Plans

This new carbon offsets market has the potential to transform how we manage our landscapes and how we farm in Australia.

An annual $2 billion carbon offset market is four times greater than the entire annual budget of the Australian Government's *Caring for our Country* program, and this will grow over time as the price on carbon increases.

A price on carbon linked to a carbon offsets market is a once in a lifetime opportunity to pay landholders to manage our landscapes more sustainably. It is an opportunity that our generation cannot afford to get wrong.

A well designed carbon offsets scheme presents an economic opportunity of unparalleled scale to help pay Australian farmers and other land managers address a range of other great environmental challenges confronting Australia: repairing degraded land, restoring river corridors, improving the condition of agricultural soils, and conserving Australia's biodiversity.[15]

However there are also significant risks from an unregulated market. Without complementary land use controls and water use accounting arrangements in place, there is a risk that carbon forests could take over large areas of agricultural land or affect water availability. This could create adverse impacts on food and fibre production, and impact on regional jobs that are dependent on these industries.

We therefore support the objective of the Bill to *"increase carbon abatement in a manner that: (a) is consistent with the protection of Australia's natural environment; and (b) improves resilience to the effects of climate change".*

However, we argue that the objective should be extended to ensure opportunities for biodiversity conservation are promoted, and that carbon abatement activities maximise other social, environmental and economic benefits, and to ensure any adverse impacts are avoided.

Recommendation 4:

That Objective 3 of the Bill is amended to read:

The third object of this Act is to increase carbon abatement in a manner that:

(a) is consistent with the protection of Australia's natural environment;

(b) improves the resilience of Australian landscapes to adapt to the effects of climate change;

(c) maximises other social, environmental and economic benefits, and avoids any adverse impacts.

The Carbon Farming Bill acknowledges that if we simply leave it to the market, the market will maximise carbon abatement without any guarantee of achieving any other benefits. There are provisions in the scheme aimed at optimising community and environmental benefits, such as: the establishment of a 'negative list' (Pt 3, Div 12, clause 56); the establishment of a co-benefits index (p7, Explanatory Memorandum); requiring regional natural resource management plans to be taken account of (Pt 3, Div 2, clause 23); and monitoring for impacts.

These are important provisions, particularly for managing the transition to a full carbon farming offset market, but they alone are not sufficient to guarantee the objective of maximising benefits and avoiding adverse impacts.

Governments will also need to use our existing regional natural resource management institutions and state, territory and local government land use planning schemes to direct carbon offset investments to achieve these outcomes across the Australian landscape.

Regional NRM plans coupled with land use plans can help to identify and manage community and environmental benefits and impacts from carbon farming, and can work together to both incentivise and regulate carbon offset activities.

Existing regional NRM plans identify priorities for working with land managers to invest in improving biodiversity, soils, water and other natural resources. Existing land use plans (and development approval processes) in state, territory and local governments regulate where and how land use changes and how land is managed. The challenge for governments is to link the carbon offsets markets into these two existing complementary systems.

Both NRM and land use planning, when done well, involve communities and stakeholders in determining where and how land should be used and managed to achieve a variety of objectives - social, economic and environmental.

Public investment in regional NRM bodies across Australia over the past decade has created the institutional capacity across Australia to produce more spatially explicit regional plans, and some state governments have begun this process.[16]

Regional NRM plans can be used to identify where carbon offset projects might be located in a region to deliver multiple benefits. They can also identify where there might be impacts on the environment or communities if offset projects were to take place in certain locations. For example, a regional NRM plan might identify where the highest biodiversity benefit might be achieved through environmental reforestation, or where there might be risks to water availability from plantation establishment.

In many cases, it is local and regional communities that are best placed to determine whether or not a project is likely to cause adverse impacts. It is local and regional communities that are often best placed to make decisions on the most appropriate locations for offset projects, and NRM and land use plans are the appropriate places for communities to have input.

The most effective approach for optimising carbon farming offsets at the appropriate scale is for state, territory and local governments to link regional NRM plans across Australia to land use planning schemes and zone land according to its suitability for carbon farming offsets.[17] Land use planning schemes can then guide carbon farming offsets into areas of highest benefit and away from areas of risk, without significantly undermining the terrestrial carbon market.

For example, in areas of Australia where an offset activity such as carbon forestry is likely to cause adverse economic, social or environmental impacts, state, territory and local governments would amend their land use planning schemes to zone land according to its suitability for carbon forestry:

- Green light areas identified in regional NRM plans as suitable for biodiversity plantings could be zoned "permitted use", subject to compliance with environmental guidelines with regard to location and species type;
- Red light areas of high value arable land deemed unsuitable for carbon forestry because of its expected long-term impact on food production, jobs or regional economic development could be zoned "prohibited use"; and
- Amber light areas for areas not in the two categories above could be zoned "permitted with consent", subject to a formal development application or environmental impact assessment process.[18]

Governments (through planning schemes and approvals processes) might choose to place upper limits on the amount of carbon forestry that can occur in a region or catchment. This could be an appropriate tool for avoiding adverse impacts on water availability or community values arising from large scale land use change.

A model for linking natural resource management planning to land use planning for carbon forestry is being developed by the Queensland Government.[19] It has agreed to identify economic opportunities for carbon forestry, resource its regional NRM groups to work with the community to identify areas in which carbon forestry could deliver multiple benefits, and then amend planning schemes to consider carbon forestry and steer it away from valuable agricultural land.

The challenge for the Australian Government is that whilst it is responsible for the creation of the carbon offsets market, it does not have constitutional power over land use and land management. This power resides with the states. The Commonwealth does however, by creating the carbon offsets market, have a responsibility to ensure that appropriate institutional arrangements are put in place.

It is in the interests of state and Commonwealth governments to agree on a framework for natural resource management and land use planning systems to drive terrestrial carbon investments.

Regional and state level ownership of the Carbon Farming Initiative is important for its success. We therefore need to find a way to encourage regional NRM bodies and state and local governments to upgrade their NRM and land use plans for optimising carbon in the landscape.

Recommendation 5:

The Commonwealth establish a 3-year Carbon Farming Program, funded from a portion of the revenue from a carbon price, to provide financial assistance to regional NRM bodies and state, territory and local governments to upgrade regional NRM plans.

Regional plans should identify where in the landscape carbon offset investments can improve the health of agricultural soils, protect areas of high conservation significance and repair degraded landscapes, and where there might be perverse impacts on high value agricultural land or water availability.

Where appropriate, the outcomes of these regional planning processes should be incorporated into land use planning schemes.

Recommendation 6:

The Act should authorise the Domestic Offsets Integrity Committee or another independent body, to accredit the terrestrial carbon components of regional NRM plans against a set of minimum standards consistent with the objectives of the Act.

This will ensure that planning processes are of a sufficient standard to optimise community and environmental benefits from the Carbon Farming Initiative.

4. Using Economic Instruments to Address Other Market Failures

Whilst land use planning, informed by regional NRM plans, can make a substantial contribution to optimising community and environmental benefits arising from the Carbon Farming Initiative, it alone does not guarantee offset projects will maximise environmental, social and economic benefits.

The Carbon Credits (Carbon Farming Initiative) Bill proposes the development of a co-benefits index to quantify the benefits of a given carbon offset project. The co-benefits index is intended to enable offset credits generated by that project to receive a premium price.[20]

This is a great innovation and should be supported. However a voluntary market alone it is not likely to fully address the market failure in accounting for the value of all environmental co-benefits, such as biodiversity conservation, salinity mitigation, and soil health and water quality benefits.

Governments should therefore take advantage of this innovation and use it as an opportunity to explore other instruments to encourage markets to better conserve our natural capital.

There are several options for using complementary economic instruments to contribute to the multiple benefits arising from the carbon offsets market. Governments could for example:

1. Redirect investments from existing government environmental programs, such as *Caring for Our Country*, to support regional NRM bodies, Landcare groups and others, to 'top up' offset projects with additional incentives to leverage multiple public benefit outcomes;
2. Create additional voluntary environmental markets, such as biodiversity offset markets or environmental stewardship schemes;
3. Provide targeted taxation incentives to landholders that are engaged in accredited co-benefits projects on properties identified in regional NRM plans as being of high conservation significance; or
4. Assist in the establishment of farm or sector based stewardship accreditation schemes.

Recommendation 7:

The Government review existing government environmental programs, such as *Caring for Our Country*, to support regional NRM bodies, Landcare groups and others, to 'top up' carbon offset projects with additional incentives to leverage multiple public benefit outcomes.

Recommendation 8:

The Government explore options for using economic instruments to more fully value co-benefits such as voluntary environmental markets, taxation incentives or stewardship accreditation schemes.

5. Managing the Transition

The use of 'positive' and 'negative' lists outlined in the Carbon Credits (Carbon Farming Initiative) Bill is an innovative way of managing the complexity of carbon offset eligibility assessment. The positive list is a simple means of streamlining project assessment against the additionality standard, and the negative list is a way of preventing carbon farming activities that have a high potential for perverse outcomes.

It is also possible to use this mechanism to manage the transition to a properly planned and regulated carbon offsets market. Regional NRM plans and local land use planning instruments should eventually become the primary means by which a project is assessed for environmental and community benefits and impacts.

We have recommended that regional NRM plans are upgraded to identify where in the landscape carbon offset projects can achieve co-benefits, and where there might be adverse impacts. We have also suggested that the outcomes of these regional planning processes should be incorporated into land use planning schemes.

However, it will take time to improve these plans so they can do that job – up to 3 years to do it well across Australia. Good planning takes time. Therefore we must find mechanisms in the interim to optimise environmental and community benefits from carbon farming.

As an interim measure, the positive list could for example, encourage carbon offset projects which involve environmental plantings in riparian zones, or environmental plantings on a small proportion of a property (to avoid wholesale land use change).

The negative list could be used as an interim measure to restrict projects that when unregulated have the potential to cause adverse impacts, such as exotic species plantings, or reforestation projects greater than a specified size that don't hold a water access license, until the necessary regulatory instruments are in place.

The benefits and impacts arising from different types of carbon offsets projects will vary depending on local and regional factors. The lists could be tailored to different projects in different regions. Therefore, the Government should seek input from state, territory and local governments, and regional NRM bodies on draft lists before including them in the regulations.

As the regional NRM bodies, state and territory governments, local councils and communities develop their regional plans, the positive and negative lists would be amended.

Examples of how the positive and negative lists could be used to streamline project assessment against the additionality test and as an interim transition to a planned approach for optimising environmental and community benefits are described in Table 2.

Recommendation 9:

Use the positive and negative lists to streamline project assessment, prevent projects with a high potential for perverse impacts, and as an interim mechanism, for transitioning to an accredited regional planning system to ensure the carbon offsets market is used to optimise environmental, economic and community benefits.

Recommendation 10:

The Government should seek input from state, territory and local governments, and regional NRM bodies, on the use of the 'positive' and 'negative' list, as an interim measure, before finalising the regulation.

Table 2: Examples of projects that could be included on 'positive' and 'negative' lists

	EXAMPLES FOR THE 'POSITIVE' LIST	EXAMPLES FOR THE 'NEGATIVE' LIST
ONGOING	1. Biodiversity plantings on suitable land identified in an accredited regional NRM plan. 2. Carbon forests on land identified in an accredited regional NRM plan. 3. Land containing a registered conservation covenant.	1. Projects that involve the conversion of harvest plantations into permanent carbon sinks.[21] 2. Carbon forests except those complying with an accredited regional NRM plan, including an assessment of the impacts on fresh water resources.
TRANSITIONAL LIST	1. Biodiversity plantings within 50 metres of prescribed rivers and streams. 2. Biodiversity plantings occupying no more than 15% of a property. 3. Projects certified by a regional NRM body that improve critical habitat and/or are consistent with recovery plans/conservation advice.	1. Plantings: • in large contiguous blocks; • without a water license that occupy greater than 10% of a farm; • occupying a whole farm; or • dominated by exotic species.

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- Prof. Lesley Hughes, Dept Biological Sciences, Macquarie University.

Notes and References

1 Royal Society, 2011. "Four degrees and beyond: the potential for a global temperature increase of four degrees and its implications" *Philosophical Transactions of the Royal Society A* (2011) 369.

2 Copenhagen Accord, 2009. Australia, along with 113 other countries, is a signatory to the Copenhagen Accord which agreed to hold any increase in global temperature to below 2°C above pre-industrial levels.

3 Meinshausen, M., Meinshausen, N., Hare, W., Raper, S., Frieler, K., Knutti, R., Frame, D.J., & Allen, M.R., 2009. "Greenhouse-gas emission targets for limiting global warming to 20C" *Nature*. 458. 30 April 2009.

4 Royal Society, 2011. "Four degrees and beyond: the potential for a global temperature increase of four degrees and its implications" *Philosophical Transactions of the Royal Society A* (2011) 369.

5 Barrett, P. 2005. *What 3° of global warming really means.* Pacific Ecologist, Summer 2005/06.

6 Australian Government, 2010. Submission to the Copenhagen Accord, United Nations Framework Convention on Climate Change. Under the Copenhagen Accord, Australia has committed to an unconditional 5% reduction by 2020 on 2000 levels and up to 15% or 25% conditional on the extent of action by other countries.

7 CSIRO, 2009. *Analysis of greenhouse gas mitigation and carbon biosequestration from rural land use.* Edited by Sandra Eady, Mike Grundy, Michael Battaglia and Brian Keating for the Queensland Premiers Climate Change Council.

8 Wentworth Group of Concerned Scientists, 2009. *Optimising carbon in the Australian landscape: How to guide the terrestrial carbon market to deliver multiple economic and environmental benefits.* October 2009.

9 http://www.climatechange.gov.au/government/initiatives/multi-party-committee/ carbon-price-framework.aspx

10 Garnaut, R, 2011. *Carbon pricing and reducing Australia's emissions.* Update Paper 6. Garnaut Climate Change Review Update 2011. Commonwealth of Australia.

11 Garnaut, R, 2011. *Transforming rural land use.* Update Paper 4. Garnaut Climate Change Review Update 2011. Commonwealth of Australia.

12 Professor Garnaut proposes that the purchase of Kyoto offset credits be capped at 10 percent by 2020 and non-Kyoto offset credits be capped at 4 percent by 2020. See Garnaut Climate Change Review Update Paper 4.

13 Australian Government, 2010. *Australian National Greenhouse Accounts: National Greenhouse Gas Inventory May 2010.* Department of Climate Change and Energy Efficiency.

14 Calculated on the basis of 23 percent of the emissions of the sectors likely to be covered by the carbon pricing mechanism.

Wentworth Group of Concerned Scientists, 2002. *Blueprint for a Living Continent: A way forward from the Wentworth Group of Concerned Scientists.* November 2002.

15 Natural Resources Commission, 2010. *Progress towards healthy resilient landscapes: Implementing the Standard, Targets and Catchment Action Plans.* Progress Report December 2010. NSW Government.

See discussion on regulating the terrestrial carbon market in Wentworth Group of Concerned Scientists, 2009. *Optimising carbon in the Australian landscape: How to guide the terrestrial carbon market to deliver multiple economic and environmental benefits.* October 2009. p16.

16 As for note 15.

DERM, 2010. *Queensland Government Response to Premier's Council on Climate Change. Working Paper 4 Capturing carbon in the rural landscape: Opportunities for Queensland.* May 2010. Available at http://www.climatechange.qld.gov.au/

17 Page 6 of the Explanatory Memorandum to the Carbon Credits (Carbon Farming Initiative) Bill.

18 Page 14 of the Explanatory Memorandum to the Carbon Credits (Carbon Farming Initiative) Bill.

Accounting for Nature

A Model for Building the National Environmental Accounts of Australia

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Accounting for Nature

"Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history. This has resulted in a substantial and largely irreversible loss in the diversity of life on Earth"

Millennium Assessment, 2005[1]

Why is it that the latest speculation on a 0.25 per cent increase in interest rates receives front page coverage in our daily newspapers, yet the most comprehensive assessment of the health of the world's ecosystems ever undertaken by science was largely ignored?

It was ignored because the link between future prosperity and functioning natural systems remains an abstract concept, unreconciled with everyday living.

Our taxes are now making major investments in our environment. Australian governments currently spend over $8 billion a year on the environment[2]. In 2007, the Commonwealth Government alone spent $4.3 billion[3]. Yet, because we have no accounting system in place, we do not know if these investments are improving or maintaining our natural capital.

Economic accounts present a statistical picture of the structure of the economy and the detailed processes that make up production and its distribution. This information is used by Treasury, the Reserve Bank, governments, financial markets, businesses and individuals to guide policy and inform investment plans.

These accounting systems evolved at a time when the natural world seemed endless and our focus was on managing the industrial revolution, not our natural environment.

Australia now needs to confront the challenge of managing our natural capital with the same discipline with which we manage our economy.

Australia needs an environmental accounting system that will, in an economically effective way:

1. Provide annual national, state/territory-wide and regional (catchment) scale reports which measure the health and change in condition of our major environmental assets;
2. Underpin the long-term catchment management and land use planning decisions by Commonwealth, state/territory and local governments, and regional authorities; and
3. Improve the cost effectiveness of public and private investments in environmental management and repair.

The benefits to Australia are enormous: we will create the platform for managing our natural resources as effectively as our national economic accounting systems have underpinned the management of our economy. National Environmental Accounts will enable us to track changes in our natural capital over time, just as financial balance sheets measure financial positions.

Future prosperity requires building a 21st century economy that is profoundly different to that of the 19th and 20th centuries. A 21st century economy needs to account for nature. We need to value the services that nature provides us – clean water, healthy soils, native vegetation – and we need to monitor the health of our natural world.

National Environmental Accounts are fundamental to this future. They should be core business of government in the 21st century.

The National Environmental Accounts of Australia

Why is it that whilst our environmental assets account for more than 40 percent of the total value of Australia, changes in their value are not included in measurements of national income[1]?

Why is it that a $5 billion Commonwealth program attempting to redress the *"radically altered and degraded Australian landscape"*, highlighted in the 1996 State of the Environment Report, receives a damning condemnation from the Auditor General[2]? He said that they could not make an informed judgement as to the progress of the programs towards either long term or even intermediate outcomes.

The lack of an environmental accounting framework is a fundamental weakness of Australian environment policy. It can not be fixed by simply re-structuring the delivery of existing programs. It can only be fixed by building a national, but regionally based monitoring, data collection, evaluation and reporting system.

There are parallels in economic policy during the rapid industrialisation of our economy in the early part of the 20th century. It was not until 1945 that Australia produced its first set of economic accounts. They have been progressively improved over the last six decades.

The National Environmental Accounts of Australia would catalogue our natural capital in a way that can both inform policy and guide future public and private investments at a local, catchment, statewide and national scale, across the Australian landscape. It would build on and correct the data gaps that have plagued the State of the Environment reporting process.

The National Environmental Accounts of Australia should be built on ten design principles:

1. National Environmental Accounts need to be based on a regional data collection and reporting framework.
2. Regional data collection and reporting would measure the 'health' of five environmental assets, and publish an annual report on any change in their condition in each region:
   - Land (native vegetation, native fauna, soils);
   - Water (rivers, wetlands and estuaries);
   - Atmosphere (greenhouse emissions which cause climate change);
   - Marine and coastal resources (fish stocks, reefs, beaches and estuaries); and
   - Towns and cities (air quality, waste, water use, consumption).
3. National Environmental Accounts should be produced annually, as an aggregation of the regional (catchment) accounts, using an agreed common scaling standard.
4. National Environmental Accounts must be based on scientific measurements of specific indicators to measure the health and change in condition of each asset in each region and the threats to those assets.
5. Data collection will need to be coordinated at a regional scale and delivered 'fit for purpose' within a cooperative, but tightly specified national framework, acquired from a range of existing and new national, state/territory and local sources, as appropriate.

6. Indicators used for evaluating the health of each asset class, and the frequency of data collection, may vary from region to region and from indicator to indicator, but within nationally accredited accounting standards.

7. An independent, expert based National Environmental Accounts Advisory Council, chaired by Australia's Chief Scientist and reporting under an Act of Parliament to the Australian Environment Minister, should be created to establish these accounting standards, accredit and monitor the regional reporting process, and publish the annual national report.

8. National Environment Accounting Standards should set out the criteria for the selection of indicators most relevant to each region, and define the method for determining a common single rating standard for what is considered 'healthy' for each asset type in each region.

9. The Australian Bureau of Statistics should be responsible for the management of the underlying data bases that make up the environmental accounts and the public release of the raw data as it is collected.

10. Commonwealth funding of all environmental programs (to Commonwealth, state/territory, regional and local government agencies) should be tied to the supply of any required data to a standard consistent with the data accreditation standards.

Reform of this scale requires a radical rethink of environmental monitoring and reporting in Australia.

Its successful implementation will require leadership from the Commonwealth government in establishing the accounting framework, setting the standards for data collection, negotiating intergovernmental agreements and auditing the assembly and reporting of the information.

State governments have constitutional responsibility for the management of a significant portion of Australia's environment. They too will be major beneficiaries of a robust environmental accounting framework. They should contribute to these reforms by providing the institutional support for regional (catchment management) authorities to undertake data gathering and reporting programs.

The Australian Bureau of Statistics is a world class information management institution. It is the official statistical agency of Commonwealth, State and Territory governments. It is sensible therefore to charge them with managing the National Environmental Accounts, using the *Census and Statistics Act, 1905* – the same legislation which regulates the economic accounting standards.

By building on existing programs, such as the National Greenhouse Gas Inventory, avoiding duplication of existing data collections at national, state/territory and local levels, and by reprioritising existing government programs, it is possible to build the National Environmental Accounts of Australia with little or no additional cost to the Budget.

Australia's Environmental Assets

The National Environmental Accounts would describe both the health of and any change in the condition of Australia's environment assets.[6]

Eventually, Australia should aim to build a set of National Environmental Accounts covering the complete range of indicators of environmental assets. The first set of accounts however, should report on five major environmental asset classes.

Under this model biodiversity is monitored within the asset classes.

Land

Three major environmental assets in Australia's terrestrial landscapes which should form the first set of environmental accounts are:

- native vegetation: extent (through the existing *National Carbon Accounting System*[7]) and condition (through an expanded *Atlas of Australian Birds*[8]),
- native fauna: distribution (by mapping areas of viable habitat for nationally listed threatened species and listing the major threats to each of those areas); and
- soil condition: by monitoring whether land is managed within its capability.

Native vegetation underpins the health of landscapes. It provides a vast range of environmental services – keeping rivers healthy, reducing soil and wind erosion, providing habitat for animals to control pests, influencing local weather patterns, reducing salinity, and as a carbon sink to reduce the impact of climate change. We have existing high resolution maps of the extent of native vegetation across Australia.

Native birds provide an excellent surrogate for assessing the condition of native vegetation. They are well distributed across all habitat types, they play a wide variety of ecological roles (pollinators, insectivores, predators) and they exploit a wide variety of resources (insects, fruit, fish). They are also cheap to count, their taxonomy is stable, there is a huge volunteer base of reliable observers, and there are some existing long-term data sets. Within 3 to 5 years we can build a cost effective system to gain, for the first time in our history, an understanding of the health of ecosystems, at a regional and national scale.

Healthy soils are fundamental to healthy, functioning landscapes. They have nutrient cycling and moisture holding capabilities and they support diverse populations of flora and fauna both above and below the ground. Managed well, soils circulate chemical elements, water and energy for great human benefit. Managed poorly, it is impossible to imagine an optimistic future for the landscapes on which we depend.[9]

Water

Due to the high variability of rainfall and runoff, with its significant annual and seasonal variations, monitoring river health is one of the more expensive, least developed and time consuming processes of data gathering.

The health of freshwater systems is dependent on two factors:

- volume: where is it, how much, and who owns and manages it; and
- quality: measuring river, wetland and estuary health.

Volume: The Commonwealth Government has approved a $480 million, ten year program to establish new capacity in the Bureau of Meteorology for water data collection and reporting standards which will be mandatory across the nation. This will provide the foundations for a nationwide monitoring and reporting program and create a comprehensive set of water accounts for Australia.

Quality: A number of frameworks have been developed for evaluating river, wetland and estuary health. For example, the National Framework for the Assessment of River and Wetland Health[10] recommends six sets

of indicator classes: catchment disturbance; hydrological change; water quality and soils; physical form; fringing zone; and aquatic biota.

The actual indicators used will often vary from catchment to catchment. The data from the indicators can be converted into an index on a scale of 0 to 1 to allow the results to be aggregated and displayed graphically, both within catchments over time and between catchments.

Greenhouse Gas Emissions

Under the United Nations Framework Convention on Climate Change, Australia has committed to reporting annually on Australia's greenhouse gas emissions, based on internationally agreed accounting rules.

This reporting system is already in place. It is reliable, authoritative and provides a detailed source of information on the state and trends in Australia's greenhouse gas emissions. This information, when provided at a regional scale, will give an indication of our carbon footprint.

The National Greenhouse Gas Inventory would therefore form a core of the National Environmental Accounts of Australia.

Regional greenhouse gas emissions accounts may differ in structure from the national accounts, with a focus on household and business consumption, and measuring terrestrial carbon balances in agricultural and natural landscapes.

Marine and Coastal Resources

Australia's Economic Exclusion Zone extends 370 km (200 nautical miles) from the coastline of Australia and its external territories. We are directly responsible for over 8 million km^2 of the world's marine environment, an area that exceeds the Australian continental land mass. To do this we must understand marine ecosystems and the biological limits to their use.

Two environmental assets in Australia's marine and coastal waters should form the basis of the first set of environmental accounts, using indicators to measure the condition of fish stocks (both commercial and recreational), and habitats (reefs, beaches, seagrass, mangroves).

Coastal and marine resources would be assessed by regional and state authorities to three nautical miles, whereas other marine resources are measured by the Commonwealth based on bioregional assessments.

Towns and cities

Four major environmental assets in Australia's urban centres should form the first set of national environmental accounts:

- air quality;
- consumption of materials;
- waste management; and
- water use.

Pollution is already monitored in urban areas, through the National Environmental Protection Measures[11]. Data are provided to the Commonwealth under agreement with participating States and Territories, who disseminate the information annually.

National Accounting Standards

If you can't measure it, you can't manage it.

National Environment Accounts need to be built on scientific measurement, just as our national economic accounting system is based on measurable financial information.

Fundamental to the success of the National Environmental Accounts will be the level of confidence that the information being collected is scientifically accurate and reliable, and comparable across time and space. Statutory environmental accounting standards are required to guarantee the quality of data collection. Formal Commonwealth accreditation is required to ensure consistency in the selection of indicators, methods and standards of collection and reporting.

Each regional, State, Territory and Commonwealth institution would need to agree to co-ordinate data collection and provision of data to the Australian Bureau of Statistics, and to adhere to a National Environmental Accounting Standard.

The national standard should also be used to drive cost efficiency in the data collection, so that the information collected can be used at multiple scales for multiple purposes by multiple users.

One of the primary roles of the national standard is to establish a process for determining 'healthy' – the benchmark for each environmental asset. This standard will be used by regional authorities to determine the benchmark for each of the indicators in their region.

A starting point for the national standard is to recognise a universally accepted definition that a healthy ecosystem has three attributes[7]:

- vigour, which refers to the level of productivity or 'pulse' of an ecosystem;
- organisation, which refers to the structure or number of interactions within an ecosystem (healthy ecosystems have many interactions – complex food webs – whereas disturbed systems are highly simplified and have fewer interactions); and
- resilience, which refers to an ecosystem's ability to recover following disturbance (healthy ecosystems 'bounce back' after a disturbance, unhealthy ones do not).

Indicators for each of the five environmental asset classes (land, water, etc) would be selected on the basis of their cost effectiveness in measuring the health (vigour, organisation, resilience) of that environmental asset in each region.

Once the indicators have been selected for each environmental asset in each region, benchmarks are then defined for each indicator, based on the best available science. These benchmarks become a standard for the environmental asset in a 'healthy' condition.

A National Environmental Accounts Advisory Council would oversee the development, maintenance and improvement to the national standard over time. It should comprise independent experts in each of the environmental assets and the Australian Statistician, be chaired by the Australian Chief Scientist and report to the Australian Environment Minister. It would:

- accredit monitoring and reporting standards (including rules for selection of indicators and consistency of ranking systems);
- oversee regional capacity building in environmental monitoring;
- oversee audits of data collection;
- provide expert assessment that regional accounts and report cards satisfy monitoring and reporting standards; and
- approve the annual National Environmental Accounts for public release.

Regional Data Collection and Reporting

This proposed model for the National Environmental Accounts adopts a new approach, built from a regional framework and aggregated upwards into a standardised, national environmental accounting framework.

The regional framework for the National Environmental Accounts creates the opportunity to convert the current regional action plans from a wish list of projects to a strategic plan for the future management and repair of Australia's natural capital.

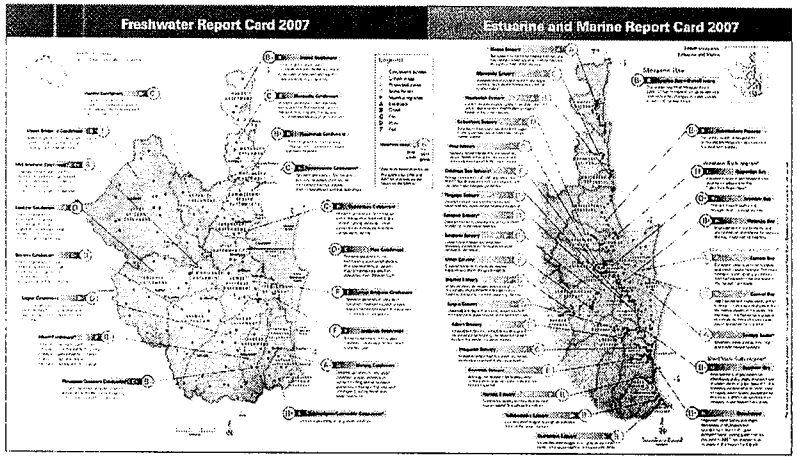
Each of the 56 Natural Resource Management regions in Australia would produce annual Regional Reports, which would summarise the health of each region[1]. The initial level of detail will vary from region to region in the early years until regional capacity and adequate data collection systems are built. Whilst the reporting of data is based on a regional scale, many of the data sets will be collected nationally. Satellite monitoring of vegetation is one example.

Regional data collection and reporting would be aggregated, using the National Environmental Accounting Standard, to produce the annual regional and national accounts. The same data collected for regional scale assessment would be used to produce the national accounts and visa versa, yielding significant cost savings by removing duplication.

Annual Regional Report Cards would report on the health of each environmental asset, as well as the change in condition of those assets over the previous year and years.

Data supply and alignment of data are key issues. In some cases these accounts may require new collections, but mostly it is about extracting or standardising data collection from existing systems. Because these data sets are owned by a range of Commonwealth, state/territory and local government agencies, a formal agreement, backed by national legislation is required to establish the framework for producing these accounts.

Once developed and operational, regional bodies should expect the annual report cards and the underlying accounts to be used to guide local, regional, state and national policy development. The data would be publicly available in a form to guide private investments and property management plans.



Annual regional report cards could be modelled on the South East Queensland Aquatic Ecosystem Health Report Card

A Common Currency to Measure our Landscape

Before money was invented people exchanged goods and services on a barter system. The creation of money, a common currency of exchange, revolutionised the world's economic system. It has taken infinite complexity and created a single unit of exchange in each country and exchange rates between currencies. From this foundation, the world has built the global financial system.

Environmental accounts are still in the dark ages. Creating a common currency to compare environmental assets is crucial in accounting for nature.

No single indicator can provide a complete picture of environmental health. Different indicators are often needed to monitor the same asset in different regions.

By adopting the same principles from the world's economic accounting systems, the process should become relatively straightforward.

Indicators for each environmental asset class are selected on the basis of their cost effectiveness in measuring the health of that environmental asset. Benchmarks are based on the best available science. They represent the standard for describing each environmental asset in a 'healthy' condition.

Once benchmarks have been established for all indicators, standard accounting practices can then be used to convert each indicator into a common metric (a scale of 0 to 1).

This creates a common currency to allow an unweighted comparison:

- between environmental assets in each region;
- between the same environmental asset in different regions; and
- changes within and between each asset over time.

An environmental asset in each region would receive an:

- A, where the data measures an indicator at or above the benchmark;
- B rating, for data at or above 84% of the benchmark;
- C rating, for data between 67% and 83% of the benchmark;
- D rating, for data between 50% and 66% of the benchmark; and an
- F rating, for an indicator less than 50% of benchmark.

In the same way economic ratings agencies use + and – to create finer categories, so too can the environmental monitoring scheme create sub-classes of A+, B-, C+, etc.

A positive change in condition, for example from a [C+] to a [B-] would score a [B-] with a △ or a ☺ it's getting better! If the condition changes in the negative, for example, from a C+ to a C, it would score a [C] with a ▽ or a ☹. No change, no smile: 😐

A scientific panel would interpret whether change is natural or human induced. Behind each symbol would be a collection of data that provides the basis for the interpretation of positive, negative or no change.

This method of creating a common currency allows the National Environmental Accounts to deliver national, state/territory-wide and regional (catchment) scale reports on the health and change in condition of our natural resource assets.

This information would then underpin long-term catchment management and land use planning decisions by all levels of government and regional (catchment) authorities. It would be used to guide investment decisions. It would also contribute to broader reviews of our progress as a nation, such as in the five yearly Intergenerational Reports[14].

Informing Policy and Guiding Public Investments

Our taxes are making major investments in our environment.

However, we have no environmental accounting system in place, and are therefore unable to evaluate if this funding is being directed towards the most cost effective environmental outcomes. People work too hard to see their taxes being wasted.

Many environmental monitoring programs lack economic or environmental rigour. There is too much focus on process and too little focus on measuring outcomes for the resources invested. In many cases, the money is being spent in such an ad hoc manner that it removes any realistic chance of detecting change [15].

The National Environmental Accounts would revolutionise the cost effectiveness of public and private investments in environmental management. They would allow for future project funding by the Commonwealth, state/territory and local governments, to be based on a transparent evaluation of the cost effectiveness of projects in improving the condition of environmental assets.

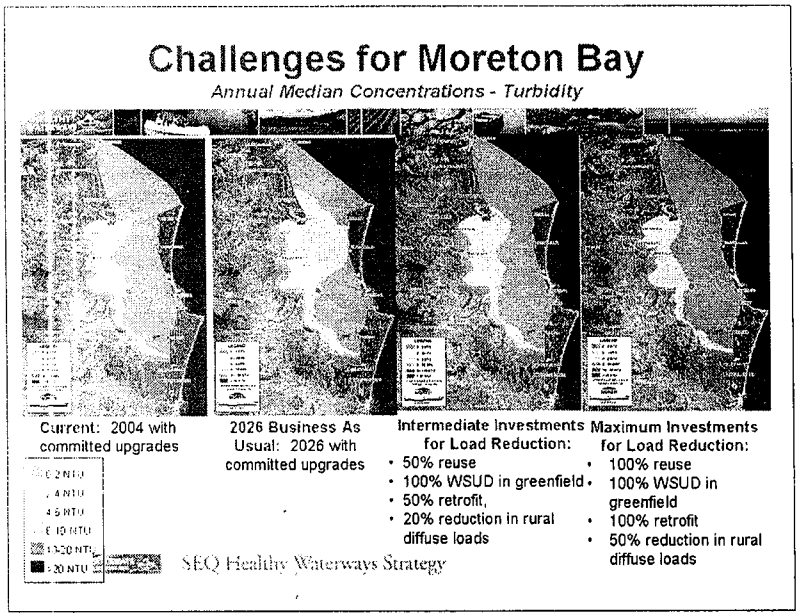
The formula is simple: *Cost Effectiveness = Change in environmental health/ Project cost ($).*

With this, the National Environmental Accounts would eventually become the cost benefit analysis tool for environmental management and public conservation investments.

These accounts would not only dramatically improve the design and delivery of regional investment programs, they would also improve the cost effectiveness of project funding.

For example, the South East Queensland Healthy Waterways Partnership uses the 10 years of data in models developed by the CRC for Catchment Hydrology to evaluate the cost effectiveness of future investment options for managing the health of Moreton Bay[16].

This modelling shows the risks of a business as usual approach versus a targeted investment of $480 million over 15 years to revegetation of river corridors in the affected catchments, at an average cost of $10 per rate notice. It reveals the most cost effective way to reduce the impact of population growth and improve the health of the Moreton Bay estuary.



Investment options for addressing turbidity in Moreton Bay

Institutional Design and Funding

Whilst the principles for building a regionally-based National Environmental Accounts framework are relatively straightforward, the institutional challenges are enormous.

Success will require a level of co-operation between environment agencies within and across governments to a degree never achieved before in Australia.

It will require:

- a framework agreement by the Council of Australian Governments;
- national legislation to ensure consistency of data collection;
- an overhaul of existing (often wasteful) Commonwealth and state/territory agency research and monitoring programs;
- building regional environmental accounting units across Australia; and
- tied funding to create the incentive to drive these reforms.

These challenges do not diminish the massive self interest for Australia in managing the health of our nation's natural capital, in understanding the impact of policies, and whether the billions of dollars of public investments and tax incentives are having the desired impact.

COAG Agreement

A COAG National Environmental Accounts Framework will need to:

1. Establish the National Environmental Accounts Advisory Council to develop an agreed National Environmental Accounting Standard;
2. Agree to national legislation to institutionalise monitoring and contributing data according to the national standard across the different levels of government;
3. Agree that Commonwealth and state/territory data sets will be aligned to the new national standard and supplied to the regions; and
4. Accept that all future Commonwealth environment and natural resource management program funding (to Commonwealth agencies, State, Territory and local governments, and regional authorities) will be tied to the supply of data for the National Environmental Accounts on time, and according to the national environmental accounting standard.

Staging

The National Environmental Accounts have the advantage of being built on information systems created from past investments in science and monitoring, such as the National Greenhouse Gas Inventory, continental mapping of native vegetation, and the national system for collecting air pollution data in major cities.

Whilst there will be gaps, it is possible to produce the first full set of regionally based, National Environmental Accounts within 4 years.

Phase 1 (2008) would comprise a COAG agreement to develop the National Environmental Accounts of Australia which:

- are based on a regional data collection and reporting framework;
- measure the health and change in condition of each environmental asset in each region;
- establishes an independent expert based, National Environmental Accounts Advisory Council; and
- links funding of environment programs of Commonwealth and State agencies to the delivery of these annual accounts.

Phase 2 (2009) would:

- have the National Environmental Accounts Advisory Council develop the environmental accounting standards;
- align existing data held by Commonwealth, state/territory and local government agencies, so that they are fit for purpose for the regional accounting framework; and
- select up to 6 regions across Australia to trial the regional report cards.

Phase 3 (2010) would see:

- the completion of the regional trials and release of the 6 report cards; and
- the establishment of 56 environmental accounting units across Australia to build capacity in all regions.

Phase 4 (2011) would see:

- the production of 56 regional report cards, which by necessity will be of variable quality, but of sufficient standard for public release and incorporation into the National Environmental Accounts; and
- the release of Australia's first National Environmental Accounts report.

Capacity Building

A regionally based national environmental accounting framework will require the establishment of environmental accounting units (ideally within the 56 Regional Natural Resource Management bodies) across Australia.

As the capacity for regional organisations to undertake this program will vary from region to region, targeted funding and technical support will be needed to resource and skill regional bodies. It will also require an overhaul of the excessively bureaucratic reporting requirements that are currently imposed on regional NRM bodies, allowing them to focus on monitoring for outcomes rather than reporting on inputs.

Funding

The SEQ Healthy Waterways Partnership provides a template for delivering regional monitoring in a cost effective way. Through contractual partnerships, they sample 30 freshwater indicators at 100 sites twice a year and 250 estuarine sites every month, with an annual budget of less than $3 million.

These data sets are used to produce the annual report card. The same data are used by 20 different agencies, including the Environment Protection Agency, 4 universities, 18 local councils, CSIRO, and the SEQ Catchments regional body.

Extrapolated across Australia, an investment of less than $200 million would represent less than 3 percent of public environment funding. However, we do not recommend the creation of a $200 million program. By removing duplication of existing data gathering currently spread across government agencies and by re-prioritising existing research and monitoring programs, the building of the National Environmental Accounts should be revenue neutral.

The Commonwealth should lead this reform, by redirecting investments in existing Commonwealth programs, such as the State of Environment Reporting, Land & Water Australia, the National Land and Water Resources Audit, CSIRO, Geosciences Australia, Bureau of Rural Science, ABARE and others. Reprioritising less than five percent of these and other Commonwealth programs alone would secure over $50 million per annum[17,18].

State/territory governments should also undertake a similar rationalisation of existing programs, and agree to provide regional bodies with resources for the assembly of the regional accounts and for the collection of regional data.

References

1 Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC.

2 Beeton RJS (Bob), Buckley Kristal I, Jones Gary J, Morgan Denise, Reichelt Russell E, Trewin Dennis, 2006. *Australia State of the Environment 2006*, Independent report to the Australian Government Minister for the Environment and Heritage, Department of the Environment and Heritage.

3 Department of the Environment and Water Resources, 2007. *Environment Budget Overview 2007-08: Protecting Australia's Future*.

4 Australian Bureau Statistics, 2008. *Year Book Australia, 2008* Australian Bureau of Statistics – Publication Number 1301.0

5 Auditor General, 2008. *Regional Delivery Model for the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality*. Audit Report 21 2007-08 Performance Audit Australian National Audit Office

6 These accounts measure the physical health and change in condition of our environmental assets. They will complement our economic environmental accounting system, such as the *Monetary Water Account* (ABS 4610.0.55.005), which focuses on who is using our natural resources, for what purpose and how patterns of use are changing over time.

7 National Vegetation Information System, 2001. www.environment.gov.au/erin/nvis/index.html

8 Birds Australia, 2007. *Atlas of Australian Birds*. www.birdsaustralia.com.au/atlas

9 Richter and Markewitz, 2001. *Understanding soil change*. Cambridge University Press

10 National Water Commission, 2007. 'Assessment of River and Wetland Health: A Framework for Comparative Assessment of the Ecological Condition of Australian Rivers and Wetlands' in *Australian Water Resources 2005: A baseline assessment of water resources for the National Water Initiative Level 2 Assessment. River and Wetland Health Theme*. Commonwealth of Australia 2007.

11 Environment Protection and Heritage Council, 2008. *National Environmental Protection Measures* www.ephc.gov.au

12 Rapport, D. J., Costanza, R. and McMichael, A. J., 1998. 'Assessing ecosystem health' in *Trends in Ecology & Evolution*, Volume 13: 10, 1 October 1998, pp. 397-402.

13 Natural Heritage Trust, 2005. *Annual Report 2004 – 2005*. December 2005. Commonwealth of Australia. www.nht.gov.au/publications/annual-reports/2004-05/pubs/annual-report-0405.pdf

14 Australian Treasury, 2007. *Intergenerational Report 2007*. As required under the *Charter of Budget Honesty Act 1998*, 'an intergenerational report is to assess the long term sustainability of current Government policies over the 40 years following the release of the report, including by taking account of the financial implications of demographic change'.

15 Possingham et al, in Field, S A et al, 2007. *Making Monitoring Meaningful*. Austral Ecology 32 485-491

16 SEQ Healthy Waterways Partnership, 2007. *South East Queensland Healthy Waterways Strategy 2007-2012* – Strategy Overview, September 2007, p53-55

17 Department of the Environment and Water Resources, 2007. *Environment Budget Overview 2007-08: Protecting Australia's Future*. Australian Government Department of the Environment and Water Resources, May 2007. www.environment.gov.au/about/publications/budget/2007/ebo/index.html

18 Commonwealth of Australia 2005. 'Whole-of-Government environment expenditure' in *Environment Budget Overview 2005-06*. Environment and Heritage Portfolio. www.environment.gov.au/about/publications/budget/2005/ebo/chapter1.html

Accounting for the Condition of Environmental Assets

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Expert meeting on Ecosystem Accounts
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SUMMARY

Exponential economic growth over the past two centuries has led to dramatic improvements in living standards across many parts of the world, but it has also resulted in the depletion of natural capital at a scale that is approaching (and in many cases has already exceeded) the ability of biophysical systems to meet future demands on them.

This rapid expansion of the global economy is likely to continue into the foreseeable future. Over the next 40 years, a projected fourfold increase in global economic growth, coupled with the need to feed 9 billion people, and climate change, will place even greater pressures on the health of the world's natural resources.

If humanity is to live within the biophysical limits of nature, we need to develop policy responses which decouple economic growth from ongoing damage to the natural environment. This requires policies and economic tools that both enable society to increase economic efficiency in the use of natural resources, and that maintain environmental assets, including ecosystems, in a healthy condition indefinitely.

We need to measure the quantity of physical natural resources and their economic value so that we know how efficiently they are being used and how economic activity affects the stocks of those assets. We must also be able to measure the impact economic activity is having on the condition of the natural environment from which these resources are being extracted.

Accounting for the condition of environmental assets must confront two problems: first we do not have, nor will we ever have, enough money to systematically measure everything in nature; and secondly without a common unit of measure that places diverse scientific information into an accounting framework, it is not possible to link the health of the natural environment to economic decision making.

Economic accounts are built using a common currency which reflects the monetary value for the exchange of goods and services. It is the common currency that provides the platform for individuals, businesses and governments to build economic accounts, across a range of scales.

The starting point for building a system of environmental (ecosystem) condition accounts must be the creation of a common, non-monetary currency that describes the condition of any environmental asset, including indicators of ecosystem health, at any location, at any scale.

This paper describes such a methodology being trialled at a sub-national scale across Australia.

Environmental accounts constructed from a common environmental currency will put environmental information on a level playing field with economic information. Only then will it be possible for societies to make informed decisions.

1. Policy applications of environmental (ecosystem) condition accounts

1. Natural capital comprises both natural resources (eg land and mineral deposits which have an economic value)[1] and ecosystems.[2,3] Together these are described as environmental assets.

2. Articulating why we need accounts which measure the condition of these environmental assets (including ecosystems) and how they can be used to improve decision making, is the first issue that should be addressed in designing standards for environmental accounts.

3. We can only manage what we measure.

4. Throughout modern history, economic growth has been achieved in large part from the conversion of nature into products for direct human consumption. As the economy grows so does the impact on our natural capital.

5. As a consequence *"... humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history (and) this has resulted in a substantial and largely irreversible loss in the diversity of life on Earth".*[4]

6. Exponential economic growth over the past two centuries has led to dramatic improvements in living standards across many parts of the world, but it also has also resulted in the depletion of natural capital at a scale that is approaching (and in many cases has already exceeded) the ability of biophysical systems to meet future demands on them.[5]

7. Rapid expansion of the global economy is likely to continue into the foreseeable future. Over the next 40 years, a projected fourfold increase in global economic growth[6], coupled with the need to feed 9 billion people[7], and climate change[8], will place even greater pressures on the world's natural resources.

8. Governments, businesses and individuals are now spending billions of dollars in an effort to manage these pressures. Because there is no system of condition accounts in place, we do not know whether these investments are repairing, or even maintaining the ecological fabric of the natural capital that underpins our economic wellbeing.

9. We are degrading natural capital at an unsustainable rate because accounting for economic output (GDP) does not include the costs of degradation to the natural capital on which much of our economic activity is based. It is unlikely that many of these costs will ever be 'priced' in markets, so it is very unlikely that environmental accounts will be fully embedded into GDP.

10. We use economic accounts to present a statistical picture of the structure of the economy and the processes that underpin it. This information is used by governments, businesses and individuals to guide economic and social policy and inform investment decisions.

11. If we are to achieve society's goal of sustainably managing the world's natural capital, we will need to apply the same principles to managing our environment. If you don't measure it, you can't manage it.

12. If humanity is to live within the biophysical limits of nature, we need to develop policy responses which decouple economic growth from those activities which lead to ongoing damage to the natural environment.

13. There is some evidence of a natural decoupling in recent decades as some economies transition from primary and secondary industries into the services sector, but even this research suggests that exponential economic growth is still accompanied by a significant increase in the absolute level of resource use.[9]

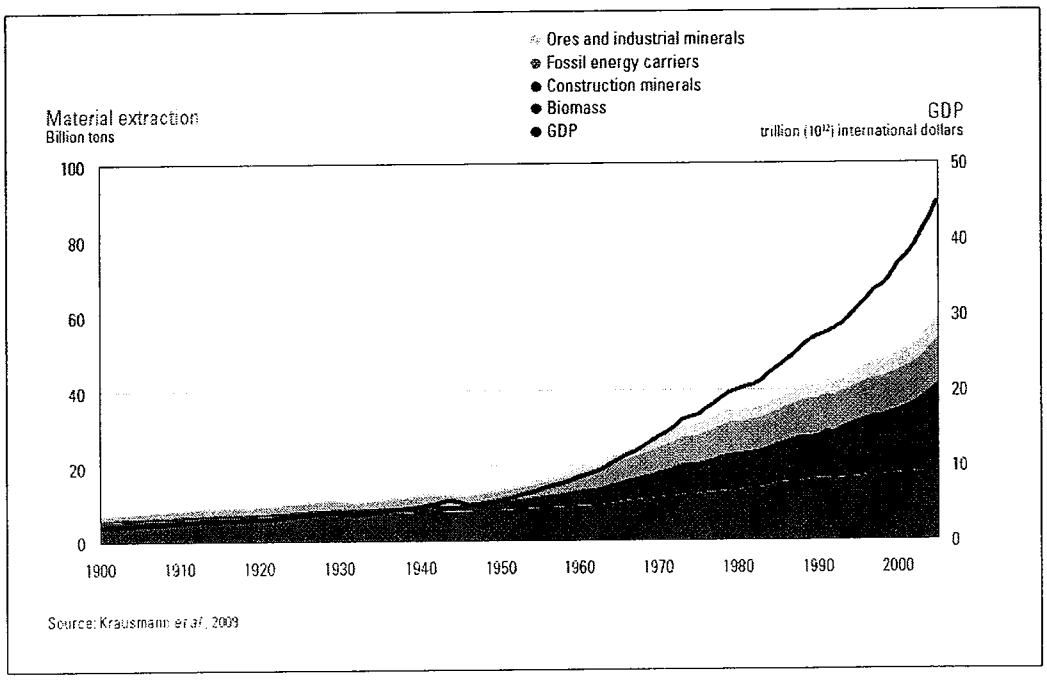

Figure 1 - Global GDP and Global Material Extraction, 1900-2005 [9]

14. There are many parallels between economic accounts and environmental accounts but there is one important difference. Economic policy is focused on improving living standards by continually expanding the value of the flows of good and services, whereas environmental policy is about maintaining the stock (condition) of natural capital, including ecosystems, so that they continue to provide services to humanity into the future.

15. Decoupling economic growth from on-going damage to ecosystems therefore requires policies and economic tools that both increase the economic efficiency in the use of natural resources, and that maintain environmental assets in a healthy condition indefinitely.

16. To achieve these policy objectives, environmental accounts need to measure:

- the quantity of physical natural resources;
- the economic value of those physical resources; and
- the condition (quality) of environmental assets, including ecosystems.

17. We need to measure the quantity of physical natural resources and their economic value (SEEA Volume 1[10]) so that we know how efficiently they are being used and how economic activity affects the stocks of those physical assets. We must also be able to measure the impact economic activity is having on the condition of the natural environment from which these resources are being extracted.

18. Environmental (ecosystem) condition accounts will improve the quality of decisions in a number of ways:

1. ***Information***: they provide a statistical picture of the health and change in the condition of environmental assets and ecosystems over time;
2. ***Informing Policy***: they provide a numerical measure which can be used to inform policy trade-offs (both positive and negative) between economic development and environmental health; and
3. ***Guiding Investment Decisions:*** with the construction of a common environmental currency, traditional decision tools, such as cost-benefit analysis and multi-criteria analysis, can be used to evaluate the cost-effectiveness of investments in environmental management and repair.

19. Accounts which measure the condition of environmental assets (including ecosystems) provide society with the tools we need to manage natural capital: how and where we produce our food and fibre, how we direct public and private investments to improve and maintain the health of our environmental assets, and guide us as we begin the challenge of adapting to the impacts of climate change.

2. The concept of a common currency for environmental health

20. Accounting for the condition of environmental assets must confront two problems:

- First, we do not have, nor will we ever have, enough money to systematically measure everything; and
- Second, without a common unit of measure that allows us to place diverse scientific information into an accounting framework it is not possible to link environmental health to economic decision making.

21. Economic accounts are built using a national currency to record and aggregate the value of goods and services. Before money was invented people exchanged goods and services on a barter system. Without a common currency of exchange (money) it would not have been possible to construct economic accounts.

22. The starting point for building a system of environmental (ecosystem) condition accounts must therefore be the creation of a common, non-monetary environmental currency, one that can be applied to any environmental asset and indicator of ecosystem health, at any location, at any scale.

23. An environmental asset is "any physical feature in nature that can be measured in time and space."[11] It can be a river or forest ecosystem, a fishery, or any other physical feature, such as groundwater or populations of individual species (eg whales or birds).

24. An ecosystem is "a dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit."[12]

25. The *Accounting for Nature*[13] model developed in Australia in 2008, seeks to create a common unit of measure of the condition of all environmental assets, including indicators of ecosystem health that can be applied at any location, at any scale, irrespective of the unit of measurement.

26. Creating a common measure for the condition of environmental assets must address a number of challenges:

- no two environmental assets are the same;
- often different indicators are used to measure the same asset in different locations;
- the cost of data collection creates significant variation in the quality and frequency of information collected; and
- no single indicator can provide a complete picture of ecosystem health.

27. The *Accounting for Nature* model does this by using the science of reference condition benchmarking. This allows environmental accounts to adopt an economic accounting framework.

28. Environmental (ecosystem) condition indicators based on reference condition benchmarks are conducive to statistical accounting, because they create a standardised numerical unit capable of addition and comparison. They can assess and compare the condition of environmental assets across regions and between assets, and upscale and aggregate over multiple spatial scales.

Reference condition based indicators

29. Reference condition is a scientific method for standardising the measurement of environmental assets so that we can assign a numerical (non-monetary) value to describe the relative condition of one asset to another, such that information at different scales and for different assets may be aggregated into a set of accounts.

30. No two rivers, or two bushland patches, nor two coastlines are the same. Defining a common point of reference for each system resolves these differences, because it puts all assets on a common scale.

31. Applying a reference condition benchmark performs the essential function of allowing different landscapes to be measured with indicators that are specifically suited to a particular location. This avoids having to use one set of indicators for distinctly different landscapes.

32. The reference condition is a scientific estimate of the natural or potential condition of an ecosystem in the absence of significant human alteration.[14]

33. Reference condition based indicators are used extensively in the scientific literature to describe a standard or benchmark against which to compare the current condition of an environmental asset or an indicator of ecosystem health.[15] It can be a fixed point in time (for example, an estimate of its condition prior to industrial development),[16]observed at reference condition sites,[17] or a scientifically accredited model that estimates the naturalness of the biota in the absence of significant human alteration.[18]

34. Reference condition benchmarks stay the same over time and in doing so provide a reference point by which future changes in the condition of an environmental asset or ecosystem can be measured.

35. A reference condition score is created by comparing the current condition of an environmental asset or ecosystem relative to the reference condition benchmark. It is recorded as a number between 0 and 100, where 100 is the (reference) condition of an ecosystem as it would be had significant human intervention not occurred in the landscape, and 0 is where that ecosystem function is absent.

36. For example, one indicator of the condition of a terrestrial ecosystem is the extent of native vegetation cover. The change in percentage of native vegetation can be directly related to a change in biodiversity.[19] If there has been a decline in native vegetation in a region by 72% against a reference condition, that indicator would produce a 'condition score' of 28.

37. Reference condition metrics are used as a scientific benchmark for ecosystem management for several reasons:[20]

- ecosystems approaching conditions that prevailed prior to major periods of modification will generally better reflect the conditions to which persistent communities of native biota are adapted;[21]
- ecosystems are more resilient within their historical range of variation than ecosystems managed outside this range;[22,23]
- it is a pragmatic approach for assessing and managing ecosystems where data for communities and species or processes are lacking, or such data cannot be collected within the constraints of rapid assessment;[24]and
- ecosystems are assessed in relative rather than absolute terms, thereby avoiding the perverse situation where ecosystems that are naturally more structurally diverse or species rich are always assessed as in higher condition than ecosystems that are naturally less structurally diverse or species rich.

38. Reference condition accounting does not imply or suggest that environmental assets should be returned to a pre-disturbance condition: it simply uses this information, in the same way national accounts are used, as a scientific standard to inform policy development through other processes and products that are derived from these accounts.

39. The advantages of such a benchmark metric are that:

- it creates a common environmental currency that allows us to evaluate the relative environmental improvement of one action over another from investments we are making; and
- they drive cost efficiencies in data collection, because they allow areas under intense environmental pressures to be measured with greater precision than areas under less pressure, without diminishing the ability to compare one asset or region with another.

Scale

40. The creation of a common currency of exchange (money) has revolutionised the world's economic system, because it enables the construction of economic accounts that inform financial decisions at all scales – individual, household, business, national and international.

41. Environmental accounts too, must provide meaningful information at these scales.

42. The *Accounting for Nature* model of constructing a common environmental currency is designed to, over time, work at all spatial scales (property, catchment, regional, national, and international), because it enables data that is collected from a diverse range of indicators at property or catchment (watershed) scales to be aggregated.

A common measure of environmental (ecosystem) condition

43. In order to describe the complexity of an environmental asset in numerical (non-monetary) values, several indicators may need to be integrated to generate a single measure that best describes the health of that environmental asset.[25]

44. No two rivers, or two bushland patches, nor two farms are the same, and often different indicators are needed to measure these assets. The establishment of an environmental currency will allow us to compare the relative health of one environmental asset with another: a sand dune with a river; an estuary with a rainforest, or one river system with another.

45. An environmental health index can be generated by selecting a range of indicators that, when combined, best describe the condition of that environmental asset at a particular location.

46. These environmental health indices can be used to create the common measure of condition for each environmental asset. This allows any asset to be compared relative to a similar asset at any location; it allows us to compare the rate of change between different assets, and it enables this information to be aggregated to produce environmental accounts at a range of spatial scales.

47. To avoid confusion with the condition score of an individual indicator, each environmental health index could be referred to as an ***ECOND***.

48. An ***ECOND*** is a scientifically accredited measure, metric or model which reflects the health of an environmental asset, and is created by combining (where appropriate) condition scores of environmental indicators based on a reference condition benchmark.[26]

49. The ***Econd*** describes the common environmental currency, in the same way a dollar ($) describes a financial currency.

Scientific accreditation

50. For environmental accounts to be accepted, statisticians, markets and decision-makers must have confidence that the common currency properly reflects the condition of the environmental assets that are being measured.

51. They need to be confident that the choice of indicators and the quality of the information being collected is scientifically robust, accurate and reliable, and that the accounts satisfy statistical standards.

52. A formal scientific accreditation process is therefore required to assure users that the environmental accounts contain appropriate measures of ecosystem health, are based on consistent quality data, and that this information can be aggregated to contribute to regional, national and international scale environmental accounting.

3. Constructing environmental (ecosystem) condition accounts

53. Environmental (ecosystem) accounts will contain a great depth of information, and can be summarised to display varying levels of detail according to need.

54. Environmental assets can be described under broad asset classes:

- Land
- Water
- Atmosphere
- Marine

55. Within each asset class there are a range of environmental assets. Biodiversity should not be a separate asset class, because biodiversity is an intrinsic part of all environmental assets.[27]

56. An environmental asset can be large or small, degraded or pristine, localised or dispersed. An asset can be a discrete thing (such as a particular wetland), or it can be a collection of smaller assets (such as a particular soil type occurring in different locations across a region).

57. Each asset class can be represented in a stock account, which has embedded the assets and associated ecosystem condition (*ECOND*) indicators that measure the health of that asset.

58. The most basic structure of an environmental account may be a summary table, describing the environmental asset classes, displaying each individual environmental asset (or ecosystem), and the environmental health indices (*ECOND*), generated for that time period and over time.

59. Tables described in Appendix 1 demonstrate a way to house, compute and present this information for the environmental accounts.

60. There are 3 levels of tables:

- The first table summarises the *ECOND* (condition) for each asset.
- The second set contains the Asset tables, which describe the Condition Scores for each indicator, and calculate the *ECOND's* for each asset.
- The third set contains the raw Data, which underpin the Asset tables.

61. These tables are all linked so that users can drill downwards through the cells and can also aggregate upwards. All show change over time.

Environmental Asset Class				
LAND	Vegetation	40		
	Soils	60		
	Fauna	80		
WATER	Rivers	60		
	Wetlands	54		
	Floodplain	75		
	Groundwater	68		
ATMOSPHERE				
MARINE				

Table 1 – Example summary table of an environmental (ecosystem) condition account

4. Australian regional (sub-national) trials

62. Public policy decisions in Australia on population, water reform, climate change and food security are taking place in a vacuum because we have no accounting system in place that measures the impact these pressures are having on the long-term health of our environment.

63. Australia has come a long way in recent decades in our understanding of how our landscapes and ocean ecosystems function: world class scientific research, the evolution of the Landcare movement, the establishment of regional natural resource management institutions, and the allocation of significant levels of public and private funding to repair results of past decisions and practices.

64. Australian governments are now spending over $8 billion a year on the environment[28], and individual landholders and businesses invest considerable time and resources in an effort to manage these pressures. Yet because there is no accounting system in place we do not know whether these investments are repairing, or even maintaining the natural capital that underpins our economic wellbeing.

65. While there have been many attempts to systematically measure the condition of environmental (ecosystem) assets,[29,30] few have succeeded in providing comprehensive mechanisms that regularly measure and report on the health and change in condition of environmental assets or ecosystems.

66. As a consequence, those charged with managing the environment do not have the information they need to inform effective land use and environmental policy, nor make informed investment decisions.

67. In an effort to address this policy flaw, a trial of Regional Environmental Accounts is being conducted across Australia, using the accounting principles described in the *Accounting for Nature* model.

68. Australia has a regionalised natural resource (watershed) management system in place, with 56 regions established across a continent of 7.5 million square kilometres. In 2011, 10 of these regions, covering a variety of landscape types and varying levels of professional and technical capacity are undertaking a 'proof-of-concept' trial of the *Accounting for Nature* model.

69. These Regional Natural Resource Management bodies are being supported by the Australian Bureau of Statistics, Australian Bureau of Meteorology, CSIRO, the Wentworth Group of Concerned Scientists and other independent experts. Two technical committees have been established, one to accredit the science and one to ensure the information complies with an appropriate accounting framework.

70. We expect that these trials will inform the System of Environmental and Economic Accounts (SEEA, 2011)[31] process on the practical application of ecosystem condition accounting.

71. A regionally based reporting system is necessary because every region or catchment has unique environmental characteristics which need to be managed to cater for the specific pressures on these landscapes and environmental assets. As a consequence, it might be necessary for indicators of ecosystem condition to vary from region to region, so that they can best describe the health of an environmental asset in that locality.

72. Managing healthy and productive landscapes requires regional, landscape scale responses because the pressures on our landscapes and marine ecosystems vary considerably from region to region. It is at the regional scale where the management of our land, freshwater and marine resources needs to be conducted, so it is logical that it is at this regional scale that we build environmental accounts.

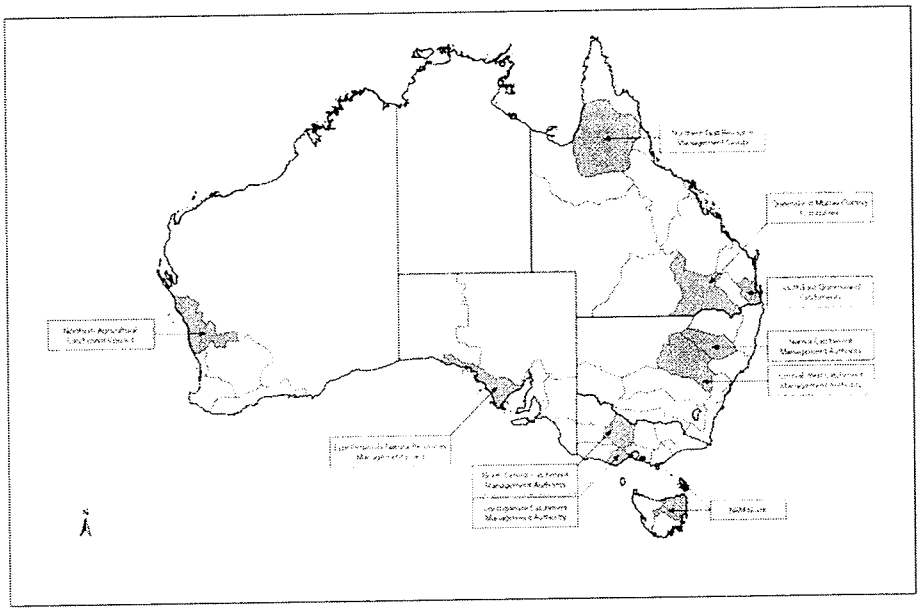

Figure 3 - Participating Regional Natural Resource Management Groups in Trial, 2011-2012

73. These trials will take existing information, both current and past (to establish trends), and use the reference condition benchmarking to create the common environmental currency.

74. They will test, at a regional (landscape) scale, whether the environmental (ecosystem) condition accounts framework described in this paper can be incorporated into the SEEA accounts, and whether regional (landscape scale) accounts can be aggregated to construct State and National Environmental Accounts.

75. Not only will there be 'headline' scores of the environmental condition of assets for each of the 56 NRM regions in Australia, which can be compared from year to year, but these could be aggregated to state and national scale or disaggregated within each region to reveal where and why the ***ECOND*** for the region has declined or risen as a result of remediation or removal of degradation pressures.

6. Conclusion

76. Modern technology has allowed us to acquire masses of information on just about every natural resource that we wish to exploit for direct human use, where it is, and in what volumes it is available, but we have very little useable information to measure the impact of these economic decisions on the long-term health of the natural environment.

77. Natural systems are complex, which is why measuring environmental quality is so difficult. If we don't have an accounting system that systematically describes the condition of environmental assets, it is not possible to measure the impact of an economic activity on the health of our environment, or trends in changes in those conditions, or to evaluate where to best invest resources to protect or improve the health of these assets and therefore assess the effectiveness and efficiency of investments in remediation.

78. There is no doubt that modern science is capable of providing the required information. There are decades of science dedicated to developing methods of measuring the health of environmental assets so that different assets and different indicators, at different scales, can be compared.

79. The science of reference condition based indicators provides what economics already has: a common currency to measure the condition of all environmental assets, including ecosystems.

80. In the same way national accounts developed from simple beginnings to the complex, sophisticated accounts we have today, so too will environmental accounts need to evolve from simple measures, from data that is available today. In time, they too will grow in complexity and sophistication, as more detailed information is required to resolve emerging issues.

81. At the moment societies are faced with impossible choices. If we are to live within the biophysical limits of our natural environment, we need to develop policy responses which decouple economic growth from ongoing damage to natural capital.

82. This requires policies and economic tools that both enable society to increase economic efficiency in the use of natural resources, and that maintain environmental assets in a condition that will sustain them indefinitely into the future.

83. Environmental condition accounts will put environmental information on a level playing field with economic information.

84. Only then will it be possible for societies to make informed decisions.

ACKNOWLEDGEMENT

This paper is a synthesis of the work of the many authors who have contributed to the development of three primary sources from which this paper is derived: *Accounting for Nature: A model for construction the National Environmental Accounts of Australia*, 2008; *A Common Currency for Building Environmental (Ecosystem) Accounts*, 2010[32]; and *Australian Regional Environmental Accounts Trials, 2011: Draft Guidelines.*

Appendix 1: Australian Regional Environmental Accounts Trials

Draft Environmental Asset Accounts Tables

(Version 6, November 2011)[33]

TABLE A - Environmental Account

ENVIRONMENTAL ASSET CLASS	ENVIRONMENTAL ASSET	*CONDITION (ECOND)*		
		2008	2009	2010
LAND	Vegetation	40		
	Soils	60		
	Fauna	80		
WATER	Rivers	60		
	Wetlands	54		
	Floodplain	75		
	Groundwater	68		
ATMOSPHERE				
MARINE				

Note: Colours and example *ECONDs* derived from INPUT tables

TABLE B – Native Vegetation Asset

Native vegetation				Year 1		Year 2	
	Indicator	Unit	Reference Condition Benchmark	Year 1 measure	Condition Score	Year 2 measure	Condition Score
Econd TOTAL				40			
VA1 Econd							
VA1	Vegetation extent						
	Structure						
	Connectivity						
VA2 Econd							
VA2	Vegetation extent						
	Structure						
	Connectivity						
VA3 Econd							
VA3	Vegetation extent						
	Structure						
	Connectivity						
VA4 Econd							
VA4	Vegetation extent						
	Structure						
	Connectivity						

Notes: VA = vegetation association; summarised in Table A. Indicators are examples only.

TABLE C – Soil Asset

Soil				Year 1		Year 2	
	Indicator	Unit	Reference Condition Benchmark	Year 1 Measure	Condition Score	Year 2 measure	Condition Score
Econd TOTAL				60			
Soil type 1 Econd							
Soil type 1	pH						
	Carbon						
Soil type 2 Econd							
Soil type 2	pH						
	Carbon						
Soil type 3 Econd							
Soil type 3	pH						
	Carbon						
Soil type 4 Econd							
Soil type 4	pH						
	Carbon						

Notes: summarised in Table A; indicators are examples only.

TABLE D - Native Fauna Asset

Native fauna				Year 1		Year 2	
	Indicator	Unit	Reference Condition Benchmark	Year 1 Measure	Condition Score	Year 2 measure	Condition Score
Econd TOTAL				80			
Birds Econd							
	Diversity						
	Abundance						
	# threatened species						
Mammals Econd							
	Diversity						
	Abundance						
	# threatened species						
Amphibians Econd							
	Diversity						
	Abundance						
	# threatened species						
Reptiles Econd							
	Diversity						
	Abundance						
	# threatened species						

Notes: summarised in Table A; indicators are examples only

TABLE E – River Asset

Rivers			Year 1		Year 2	
	Indicator	Reference Condition Benchmark	Year 1 Measure	Condition Score	Year 2 Measure	Condition Score
Econd TOTAL			60			
Creek 1 Econd						
Creek 1	Macroinverts					
	Water flow					
	Riparian					
Creek 2 Econd						
Creek 2	Macroinverts					
	Water flow					
	Riparian					
Creek 3 Econd						
Creek 3	Macroinverts					
	Water flow					
	Riparian					
Creek 4 Econd						
Creek 4	Macroinverts					
	Water flow					
	Riparian					

Notes: summarised in Table A; indicators are examples only

TABLE F - Wetland Asset

Wetlands				Year 1		Year 2	
	Indicator	Unit	Reference Condition Benchmark	Year 1 measure	Condition score	Year 2 measure	Condition score
Econd TOTAL				54			
Wetland 1 Econd							
Wetland 1	Macroinverts						
	Water flow						
	Riparian						
Wetland 2 Econd							
Wetland 2	Macroinverts						
	Water flow						
	Riparian						
Wetland 3 Econd							
Wetland 3	Macroinverts						
	Water flow						
	Riparian						
Wetland 4 Econd							
Wetland 4	Macroinverts						
	Water flow						
	Riparian						

Notes: summarised in Table A; indicators are examples only

TABLE G - Floodplain Asset

Floodplains				Year 1		Year 2	
	Indicator	Unit	Reference Condition Benchmark	Year 1 Measure	Condition score	Year 2 Measure	Condition score
Econd TOTAL				75			
Floodplain 1 Econd							
Floodplain 1	Vegetation						
	Water flow						
	Water quality						
Floodplain 2 Econd							
Floodplain 2	Vegetation						
	Water flow						
	Water quality						
Floodplain 3 Econd							
Floodplain 3	Vegetation						
	Water flow						
	Water quality						
Floodplain 4 Econd							
Floodplain 4	Vegetation						
	Water flow						
	Water quality						

Notes: summarised in Table A; indicators are examples only

TABLE I – River Asset Data Table

Macro-invertebrate Indicators for Creek 1

Creek 1	Year 1
Indicator	Year 1 measure
Macroinverts	**20**
Sample 1	10
Sample 2	20
Sample 3	20
Sample 4	40
Sample 5	16
Sample 6	20
Sample 7	18
Sample 8	18
Sample 9	18

Notes: Linked to Table E

Notes and References

[1] "Natural resources consist of naturally occurring resources such as land, water resources, uncultivated forests and deposits of minerals that have an economic value" – definition in the *System of National Accounts 2008*.

[2] "Natural capital is the extension of the economic notion of capital (manufactured means of production) to environmental goods and services. A functional definition of capital in general is: "a stock that yields a flow of valuable goods or services into the future". Natural capital is thus the stock of natural ecosystems that yields a flow of valuable ecosystem goods or services into the future. For example, a stock of trees or fish provides a flow of new trees or fish, a flow which can be sustainable indefinitely. Natural capital may also provide services like recycling wastes or water catchment and erosion control. Since the flow of services from ecosystems requires that they function as whole systems, the structure and diversity of the system are important components of natural capital".

[3] Robert Costanza; Cutler J. Cleveland (Topic Editor);. 2008. "Natural capital." In: *Encyclopedia of Earth*. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment). First published in the *Encyclopedia of Earth* February 26, 2007; last revised July 31, 2008; retrieved August 26, 2010.

[4] Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC.

[5] *Ibid.*

[6] *Ibid.*

[7] United Nations, Department of Economic and Social Affairs, Population Division, 2010. *World Population Prospects: The 2010 Revision*. www.unpopulation.org

[8] IPCC, 2007. *Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[9] United Nations Environment Programme (UNEP), 2011. *Decoupling natural resource use and environmental impacts from economic growth, A Report of the Working Group on Decoupling to the International Resource Panel*. [Fischer-Kowalski, M., Swilling, M., von Weizsäcker, E.U., Ren, Y., Moriguchi, Y., Crane, W., Krausmann, F., Eisenmenger, N., Giljum, S., Hennicke, P., Romero Lankao, P., Siriban Manalang, A.]

[10] United Nations Committee of Experts on Environmental Economic Accounting (UNCEEA) and the Statistics Division / Department of Economic and Social Affairs, United Nations, 2011. *SEEA Revisions*, Draft Version. http://unstats.un.org/unsd/envaccounting/seearev/, retrieved November 21, 2011.

[11] Australian Natural Resource Management Groups, 2011. *Australian Regional Environmental Accounts Trials 2011: Draft Guidelines*.

[12] Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

[13] Wentworth Group of Concerned Scientists, 2008. *Accounting for Nature: A model for building the national environmental accounts of Australia*. www.wentworthgroup.org

[14] Stoddard, J.L, Larsen, D.P, Hawkins, C.P., Johnson, R.K. and Norris, R.H., 2006. Setting expectation for the ecological condition of streams: A concept of reference condition. *Ecological Applications*. 16(4): 1267-1276.

[15] Stoddard, J.L, Larsen, D.P, Hawkins, C.P., Johnson, R.K. and Norris, R.H., 2006. Setting expectation for the ecological condition of streams: A concept of reference condition. *Ecological Applications*. 16(4): 1267-1276.

[16] For example, Australia often uses a 'pre-European settlement' date of 1750 (Norris, R.H. and M. Thomas, 1999. What is river health? *Freshwater Biology*. 41:197-210), North America uses a 'pre-Columbian' benchmark (Hughes, R. M., P. R. Kaufmann, A. T. Herlihy, T. M. Kincaid, L. Reynolds, and D. P. Larsen. 1998. A process for developing and evaluating indices of fish assemblage integrity. *Canadian Journal of Fisheries and Aquatic Sciences,* 55: 1618–1631) and Europe uses a 'pre-intensive agriculture' date. For Great Britain this has been defined as approx. 1850 (Wallin, M., T.Wiederholm, and R.K.Johnson, 2003. Final guidance on establishing reference conditions and ecological status class boundaries for inland surface waters. EU Common Implementation Strategy (CIS) for the Water Framework Directive.

[17] Reynoldson, T.B., Norris, R.H., Resh, V.H., Day,K.E., & Rosenberg, D., 1997. The reference condition: a comparison of multimetric and multivariate approaches to assess water-quality impairment using benthic macro-invertebrates. *Journal of North American Benthological Society*, 16: 833-852.

[18] Stoddard, J.L, Larsen, D.P, Hawkins, C.P., Johnson, R.K. and Norris, R.H., 2006. Setting expectation for the ecological condition of streams: A concept of reference condition. *Ecological Applications*. 16(4): 1267-1276.

[19] Rosenzweig, M. L., 1995. *Species diversity in space and time*. Cambridge University Press, Melbourne.

[20] Gibbons, P., Briggs, S.V., Ayers, D.A., Doyle, S, Seddon, J., McElhinny, C., Jones, N., Sims, R., and Doody, J.S., 2008. Rapidly quantifying reference conditions in modified landscapes. *Biological Conservation* 141: 2483 –2493.

[21] Landres, P.B., Morgan, P., Swanson, F.J., 1999. Overview of the use of natural variability concepts in managing ecological systems. *Ecological Applications,* 9: 1179–1188.

[22] Fule, P.Z., Covington, W.W., Moore, M.M., 1997. Determining reference conditions for ecosystem management of southwestern ponderosa pine forests. *Ecological Applications,* 7: 895–908.

[23] Holling, C.S., Meffe, G.K., 1996. Command and control and the pathology of natural resource management. *Conservation Biology,* 10: 327–328.

[24] Gibbons, P., Briggs, S.V., Ayers, D.A., Seddon, J.A., Doyle, S.J., Cosier, P., McElhinny, C., Pelly, V., Roberts, K., 2009. An operational method to assess impacts of land clearing on terrestrial biodiversity. *Ecological Indicators*, 9: 26–40.

[25] Costanza, R., 1992. Toward an operational definition of ecosystem health. In Constanza, R., Norton, B., and Haskell, B. (eds.). *Ecosystem Health: New Goals for Environmental Management*. Island Press, Washington.

[26] Australian Natural Resource Management Groups, 2011. *Australian Regional Environmental Accounts Trials, 2011*. Draft Guidelines, Version 6.1, November 2011.

[27] Saunders D, 2011. Pers comm. The term "biodiversity" was coined by E.O. Wilson, as shorthand for biological diversity, meaning the variety of all life forms and their patterns in space – the different plants, animals and micro-organisms, the genes they contain and the ecosystems of which they form part. Importantly, it consists not only of the genes and the life forms themselves, but also includes the interactions between them and the environment. The term therefore covers a large array of ecological complexity and it is in general poorly understood. It is not short hand for native fauna and flora or endangered species, which is the most common misinterpretation. Nor

does biodiversity mean species diversity, as it is too often taken to mean. A narrow species-focused view of biodiversity gives rise to the notion that landscapes can be compartmentalised. For example, in agricultural landscapes, many people assume that biodiversity is found only on conservation reserves, however agriculture is totally dependent on ecosystem processes and functions which are all driven by interactions between elements of biodiversity.

[28] Beeton RJS (Bob), Buckley Kristal I, Jones Gary J, Morgan Denise, Reichelt Russell E, Trewin Dennis, 2006. *Australia State of the Environment 2006,* Independent report to the Australian Government Minister for the Environment and Heritage, Department of the Environment and Heritage.

[29] Internationally, examples include the 2005 *UN Millennium Assessment*; the 2007 *UNEP Global Environmental Outlook*; and the 2010 *World Bank World Development Report: Development and Climate Change.*

[30] In Australia, examples include national *State of the Environment Reports* in 1996, 2001, 2006, and 2011; the 2001 National Land and Water Resources Audit; and the Australian Bureau of Statistics, 2008, *Australia's Environment: Issues and Trends 2007.*

[31] System of Environmental-Economic Accounts (SEEA), 2011. *SEEA Experimental Ecosystem Accounts: A Proposed Outline, Road Map and List of Issues.* Paper prepared by UNSD, EEA and the World Bank, 17th Meeting of the London Group on Environmental Accounting, 12-15 Sept., 2011, Stockholm, Sweden.

[32] Cosier P and J McDonald, 2010. *A Common Currency for Building Environmental (Ecosystem) Accounts, 2010.* Paper prepared for the 16th Meeting of the London Group on Environmental Accounting, Santiago, Chile, 25-28 October, 2010.

[33] Australian Natural Resource Management Groups, 2011. *Australian Regional Environmental Accounts Trials, 2011 Draft Guidelines*, Version 6.1, November 2011, p37-41.