Submssion 023.1
Received 05/03/12

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CSIRO Submission 11/417

Supplementary Submission

Inquiry into Australia's biodiversity in a changing climate

House of Representatives Standing Committee on Climate Change, Environment and the Arts

March 2012

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Climate Change, Biodiversity and Blue Carbon

Supplementary submission by CSIRO to the inquiry 'Australia's biodiversity in a changing climate'
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CSIRO's submission to this inquiry provided in July 2011, and other submissions to this inquiry, have detailed the negative impacts of ocean acidification (reduced pH as a result of carbon dioxide (CO_2) dissolving in the ocean – see Box 1) on marine life, such as corals. Avoiding high CO_2 levels in the atmosphere via emission control mechanisms is considered to be the best way to protect this biodiversity from the impacts of climate change[1]. In the interim, two approaches have been advocated and debated in the scientific literature, ocean fertilization[2] (not recommended) and blue carbon (recommended).

Ocean fertilization has been proposed in a number of published scientific studies as one way to reduce atmospheric CO_2 levels[3]. Iron fertilization is the intentional introduction of iron to the upper ocean to stimulate a phytoplankton bloom. This is intended to enhance biological productivity, which can benefit the marine food chain and remove carbon dioxide from the atmosphere. Iron is a trace element necessary for photosynthesis in all plants. It is highly insoluble in sea water and is often the limiting nutrient for phytoplankton growth. Large phytoplankton blooms can be created by supplying iron to iron-deficient ocean waters. A number of ocean labs, scientists and businesses are exploring fertilization as a means to sequester atmospheric carbon dioxide in the deep ocean, and to increase marine biological productivity which is likely in decline as a result of climate change. Since 1993, thirteen international research teams have completed ocean trials demonstrating that phytoplankton blooms can be stimulated by iron addition[4]. However, controversy remains over the volume of iron that would be required on an ongoing basis, the effectiveness of atmospheric CO_2 sequestration and unforeseen ecological effects[5]. In common with many other scientific organisations, **CSIRO does not recommend this approach to reduce impacts on Australia's marine biodiversity.**

A more recent alternative has been dubbed 'Blue Carbon'[6]. This describes the natural processes by which atmospheric carbon is captured and stored (sequestered) by marine environments. Here we use 'carbon sequestration' to define carbon storage that is unlikely to be reintroduced to the atmosphere for more than 100 years (in keeping with the accepted terrestrial definition). Australia's coastal wetlands have the potential to sequester carbon in the tissues of plants and sediments, just as trees on land sequester carbon. Carbon sequestration and storage in seagrass, mangrove and wetland ecosystems is considered to be extremely high (rates of up to 5 times those of tropical forests[7]), and turnover is low in undisturbed systems. For Australia, our coastal ecosystems also support many of our inshore fisheries, creating jobs and providing high quality seafood to Australians and more broadly. Since European settlement we have lost large quantities of our coastal ecosystems, which in turn have impacted on coastal biodiversity, ecosystem services, and fisheries productivity and sustainability.

[1] IPCC. 2007. Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22 and
Zeebe, RE & Archer, D. 2005. Feasibility of ocean fertilization and its impact on future atmospheric CO_2 levels. *Geophysical Research Letters* 32: L09703, doi:10.1029/2005GL022449.
Hoegh-Guldberg, O & Bruno, JF. 2010. The Impact of Climate Change on the World's Marine Ecosystems. *Science* 328: 1523-1528.
[2] e.g. Zeebe, R. E. & Archer, D. 2005 as for note 1
[3] e.g. Buesseler, K. O., et al. 2004. The effects of iron fertilization on carbon sequestration in the Southern Ocean, *Science* 304: 414– 417 and Martin, J. H., et al. 1994. Testing the iron hypothesis in ecosystems of the equatorial Pacific Ocean, *Nature* 371: 123–129.
[4] As for note 3
[5] As for note 2
[6] Executive summary: IOC/UNESCO, IMO, FAO , UNDP. 2011. Summary for Decision-Makers : A Blueprint for Ocean and Coastal Sustainability. Paris: IOC/UNESCO, refer Attachment 1.
[7] IUCN/UNESCO International Blue Carbon Working Group: http://bluecarbonblog.blogspot.com.au/2011/03/scientists-offer-warning-and-plan-for.html

Restoration or protection of these coastal habitats presents a win-win-win situation: (1) positive biodiversity outcomes, (2) enhanced fishery production (many species use these habitats as nursery areas), and (3) an important opportunity for ecosystem-based climate mitigation -'blue carbon'- which also preserves the essential ecosystem services of these habitats. In the case of blue carbon, there is also a potential market that could be created for carbon trading (as on land), although significant efforts are required to develop this into reality, including science background and policy reform. There is potential for blue carbon to be traded and handled in a similar way to green carbon (such as forest carbon under the UN collaborative initiative on Reducing Emissions from Deforestation and Forest Degradation, UN-REDD) and entered into emission and climate mitigation protocols along with other carbon-binding ecosystems (**Attachment 1**).

Valuing the carbon sequestered by Australia's coastal ecosystems would require research into the opportunity costs and market price for preserving intact coastal ecosystems and the application of offsets and compensation when coastal ecosystems are to be modified.

One of the two major areas of focus for Rio+20 (United Nations Conference on Sustainable Development, to be held in Rio de Janeiro, Brazil, on 20-22 June 2012 - *www.uncsd2012.org/*) will be the Green Economy. Australia has made a submission to this meeting (**Attachment 2**). According to CSIRO's analysis of the scientific literature on this topic, in recent years there has been a widely accepted shift from traditional thinking about environmental protection and management being separate from economic development, to the perspective that future economic development is inextricably linked with both environmental and social considerations. A Blue Economy has been advocated along similar lines, by the International Union for the Conservation of Nature and other organisations. Developing a Blue Economy for Australia, will have at least the following benefits:

- Protection and restoration of ocean ecosystems and biodiversity, including beyond national jurisdictions;
- Recognition and adoption of ocean/coastal carbon sinks and the creation of a market for trading ('blue carbon');
- Dramatically enhanced recycling of major ocean pollutants such as nutrients through market mechanisms;
- Change in fisheries and aquaculture management regimes at regional and national levels toward sustainable practices;
- Integrated coastal management and adaptation to sea level rise and climate change.

<u>Research underway</u>
The CSIRO Wealth from Oceans Flagship (http://www.csiro.au/en/Organisation-Structure/Flagships/Wealth-from-Oceans-Flagship.aspx) is currently finalising development of a "Carbon Cluster Project", that will assist CSIRO accelerate the development and delivery of marine, climate and ecological information streams based on its biogeochemical and ecological models and ocean colour (chlorophyll) remote sensing capability that can:

(i) better evaluate and predict *primary productivity*[8] and its importance to environmental and economic services;
(ii) assess the implication of climate-induced changes on biogeochemical cycles, including *ocean acidification* and
(iii) sequestration options including the application of *Blue Carbon* and other strategies for carbon burial;

[8] Primary Production is the production of organic compounds from atmospheric or aquatic carbon dioxide, principally through the process of photosynthesis. Primary production is a key indicator of ecosystem health and carbon cycling and this can have a strong influence on the economic, social and physical health of the human population living in the coastal zone.

(iv) develop and improve methods that can be used to (i) make carbon measurements (ii) assimilate carbon data into models and (iii) quantify model uncertainties.

Increased efforts are required to realize this potential for both carbon sequestration, and biodiversity benefits for Australia. Other countries and organizations are already progressing this approach (**Attachment 1**).

Box 1. Ocean acidification

Ocean acidification is the name given to the ongoing decrease in the pH and increase in acidity of the Earth's oceans, caused by the uptake of anthropogenic carbon dioxide (CO_2) from the atmosphere. Increased carbon dioxide levels in the atmosphere then dissolve in the ocean, lowering the pH.

Over the last 200 years, oceans have absorbed 40–50% of the anthropogenic CO_2 released into the atmosphere. Rising atmospheric CO_2 concentrations via fossil fuel emissions will lead to enhanced oceanic CO_2 as the ocean equilibrates with the atmosphere. Elevated CO_2in the upper ocean will alter the chemical speciation of the oceanic carbon system. As CO_2 enters the ocean it undergoes the following equilibrium reactions:

$$CO_2 + H_2O \Leftrightarrow H_2CO_3 \Leftrightarrow HCO_3^- + H^+ \Leftrightarrow CO_3^{2-} + 2H^+$$

Two important parameters of the oceanic carbon system are the pH and the calcium carbonate ($CaCO_3$) saturation state of sea water (Ω). Ω expresses the stability of the two different forms of $CaCO_3$ (calcite and aragonite) in sea water.

Increasing CO_2 concentration in the surface ocean via uptake of anthropogenic CO_2 will have two effects.

- First, it decreases the surface ocean carbonate ion concentration (CO_3^{2-}) and decreases Ω. Laboratory experiments have shown that some species of corals and calcifying plankton are highly sensitive to changes in Ω, which has led to the hypothesis of large decreases in future calcification rates under elevated atmospheric CO_2 (Gattuso *et al.* 1998, Langdon *et al.* 2000, Orr *et al.* 2005) Kleypas *et al.* 1999).
- Second, when CO_2 dissolves in water it forms a weak acid (H_2CO_3) that dissociates to bicarbonate, generating hydrogen ions (H^+), which makes the ocean more acidic (pH decreases).

A pH drop of 0.3 - 0.4 units by the year 2100 and a further decline of 0.7 by the year 2300 has been predicted. Oceanic absorption of anthropogenic CO_2 over the next several centuries may result in a pH decrease greater than inferred from the geological record over the past 300 million years, with the possible exception of rare, extreme events such as meteor impacts or dramatic ocean seafloor gas releases.

Reference: Poloczanska, E. S., Babcock, R. C., Butler, A., Hobday, A. J., Hoegh-Guldberg, O., Kunz, T. J., Matear, R., Milton, D., Okey, T. A. & Richardson, A. J. 2007 Climate Change And Australian Marine Life. *Oceanography and Marine Biology Annual Review* **45**, 409-480.

Attachments

1. **Executive summary:** IOC/UNESCO, IMO, FAO , UNDP (2011). *Summary for Decision-Makers : A Blueprint for Ocean and Coastal Sustainability*. Paris: IOC/UNESCO
2. **Australia's Submission to the Rio+20 Compilation Document.**