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Caps, Sinks, Drains and Hot Air: The Implications and Opportunities to Restore Rivers Arising from Controls on Greenhouse Emissions

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SUMMARY: Controlling greenhouse gas emissions through the development of a carbon credit trading scheme presents both opportunities and threats for river health. The developing market in carbon credits provides recognition of the scarcity of the resource and allows a dollar value to be placed on the reduction of pollution. There are many opportunities to improve river health concurrently with a reduction in carbon dioxide emissions. For example, the adoption of measures for energy demand management could provide reductions in the amount of carbon emitted and the volume of water used in town water supplies, thereby reducing the costs associated with the provision of environmental flows. Other options include the development of carbon sinks by planting or protecting vegetation in priority areas (eg restoring riparian zones and wetlands, protecting fragile soils and lowering elevated water tables). A critical benefit of the trade in carbon credits is that it creates a significant financial incentive for landholders to invest in revegetation activities. Conversely, an inadequate framework for the management of the carbon market may result in adverse outcomes for river health, including increased demand to extract water from rivers for new hydroelectricity generation activities and/or the introduction of weeds, changed hydrology and soil erosion in areas that have been revegetated and poorly managed. The maximum environmental (and river health) benefit could be received from the carbon credit trading market, by ensuring that all potential links between carbon credit mechanisms and river health are discussed in the development of the carbon credits scheme.

- The development of a carbon credit market creates opportunities and threats for river health.
- The implementation of measures for energy demand management and/or the development of new generation technologies to reduce carbon emissions can also lead to improvements in water use efficiency, thereby increasing the feasibility of providing environmental flows.
- The development of the framework for a market in carbon credits could be influenced to promote plantings and/or the retention of vegetation in areas that provide the greatest protection and enhancement of river health (eg wetlands or riparian zones).
- The trade in carbon credits could provide a financial incentive for farmers to invest in revegetation activities. Preliminary estimates indicate that this could be worth several hundred dollars per hectare per year. This compares to recent returns of $17 per hectare per year for beef.

1 INTRODUCTION

The introduction of a cap on greenhouse gas emissions and the proposed trade in carbon credits, including the potential use of vegetation ‘sinks’ presents new challenges and opportunities for securing river health. The concepts of sustainable development, underpinned by the recognition of the fundamental scarcity and values of natural resources, have led to the development of carbon credit trading schemes aimed at protection of atmospheric ‘health’. The parallel recognition of the scarcity of river resources, and the need to implement measures to contain river uses to sustainable levels, leads to a consideration of the potential linkages between atmospheric and river health.

Key challenges in the development of the carbon credit market include the development of appropriate rules in the terms of trade. These rules should recognise the carbon sequestering potential of vegetation and the need for effective management of weeds, fire, soil erosion and changes in catchment hydrology. Trading rules could be also designed to create incentives for landholders to restore vegetation in areas that are of strategic importance to the restoration of rivers, such as in areas of rising groundwater, riparian zones, fragile soils and/or wetlands. They could also be designed to drive the adoption of more efficient water use strategies in town water supply systems, thereby reducing the costs associated with the provision of environmental flows.

The aim of this paper is to advance discussion on the opportunities to integrate the development of policies for greenhouse gas emissions as well as the protection and restoration of rivers.

2 EMERGING CONTROLS ON GREENHOUSE GAS EMISSIONS

The emergence of controls on the emission of greenhouse gases into the atmosphere gained renewed impetus following the Framework Conference on Climate Change held in Kyoto, Japan, in December 1997 (United Nations, 1998). A key outcome of the conference was an international agreement for the introduction of a cap on the amount of carbon emitted into the atmosphere at a level 5 percent below the 1990 level of emissions in the commitment period between

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2008 and 2012 (United Nations, 1998). Emissions include those from industrial sources and the removal of sinks resulting from direct human induced landuse change and forestry activities (United Nations, 1998).

Signatory nations are to achieve demonstrable progress towards achieving the cap, in terms of designing mechanisms to meet it, by 2005 (United Nations, 1998). It is intended that this will include the establishment of a market(s) for developed (Annex 1) nations to enable the trade in carbon credits and debits. The benefit of a market approach, set within an appropriate regulatory context, is that it provides the opportunity for those organisations that produce carbon to meet the cap by seeking the most cost effective means to directly or indirectly reduce their emissions (Moran et al, 1991; Ferguson, 1998; Anderson & Leal, 1991).

The market approach outlined in the Framework Convention on Climate Change will allow transfers or acquisitions of emission reduction units from one country (or an authorised legal entity representing that country) to another. These units can be produced by projects that reduce anthropogenic emissions or enhance anthropogenic removals in any economic sector where this is supplemental to domestic action to meet a country's commitment (United Nations, 1998). Verifiable changes in human induced land use and forestry are to be included in meeting the commitments provided it involves afforestation, reforestation or deforestation relative to a 1990 baseline (United Nations, 1998).

A profile of the net uptake of carbon from the atmosphere (taking into account risks and uncertainties) can be constructed for a project or a nation, leading to the package of 'carbon futures' that will be delivered over the life of the project or market period (Greenhouse Issues, 1998). Presently, there are two emission trading groups to be created, a European Union 'bubble' and a trading umbrella for the US, Japan, Russia, New Zealand, Canada and Australia (Cohen, 1998). This will allow the countries involved to meet differentiated targets for reducing greenhouse gas emissions (Cohen, 1998). Developing nations will be allowed to 'opt in' to the treaty through the Clean Development Mechanism and Joint Implementation of projects (Cohen, 1998). This allows a proportion of emission reductions to be included in calculations for both the Annex 1 and developing nations (Michaelowa, 1998). The details of the market structure are to be considered at a fourth international conference in November 1998 in Buenos Aires.

As the Kyoto Protocol will not enforce nation targets until 2008, there is only limited incentive to develop an international market until this time. Whilst all players recognise that there are some decisions on carbon credit policy that will not be made in the near future, there are important preliminary meetings being held that will set the context for future carbon credit schemes. Recognition of the expected future value of carbon credits is presently being reflected both internationally and within Australia by companies becoming involved in buying or developing carbon credit programs on a speculative basis.

There is however, the potential for carbon credit markets to develop at a national scale before an international market and/or after the international market has been set up. Individual countries, depending upon how they divide their greenhouse emission target, will need to develop their own internal trading framework. This will provide the incentive for market creation. Whilst Australia is yet to announce how the national target will be divided, states have already commenced work on various elements of a market framework.

In New South Wales, the Sustainable Energy Development Authority (SEDA), in conjunction with other agencies, is presently developing a framework for controlling emissions within the state's electricity sector (Dunstan, unpubl.). The framework involves the specification of limits on emissions in contracts with electricity distributors, including monetary penalties for those who exceed the limits (Dunstan, unpubl.). The creation of a cap on emissions gives appropriate recognition to the scarcity of the atmospheric resource, it terms of its ability to receive greenhouse gases. This creates the context for the establishment of a market in which recognition is given to the value of emission reductions. The deregulation of the electricity industry and the introduction of a Green Power Accreditation scheme have also facilitated the entry of new operators into the market, using alternative generation technologies (SEDA, 1997).

In Western Australia, the State Government is undertaking studies to determine the amount of carbon that different types of vegetation species sequester from the atmosphere at various growth stages and under differing climatic conditions to capitalise in their current forestry programs (Shea, 1998a).

At the international level, at least one organisation, SGS Forestry, has set up a service to verify carbon offsets, including certification of project design, projected carbon achievement and verification of the amount of carbon offsets accrued (Greenhouse Issues, 1997). Due to the absence of an international standard, SGS Forestry has developed criteria based on guidelines published by existing regulatory bodies (including Australia) (Greenhouse Issues, 1997).

3 RESPONSES TO THE CAP AND RIVER HEALTH

Responses to a cap on carbon emissions can have direct and indirect implications for river health. The three major types of responses are energy demand management strategies, new generation technologies and carbon sinks. The implications of these responses for river health are examined below.

3.1 Energy Demand Management Strategies

Energy efficient devices are frequently also water efficient. The reduction of carbon emissions through the achievement of greater efficiencies in a range of industrial, urban and agricultural production processes, may also provide the opportunity to reduce demands on the volume of water extracted from rivers.

For example, it would be possible to reduce domestic water and energy consumption by installing 'high efficiency' shower roses and washing machines (White, 1997; Von Weizsacker et al, 1997). Such measures conserve both energy and water at the user interface. Further, when combined with other measures such as dual flush toilets, this can lead to reductions in the total volume of water that water supply operators need to extract, store, treat and transfer, thereby further reducing energy consumption and carbon emissions (White, 1997; HRC, 1998). Therefore ensuring that resources are used efficiently will benefit river health by minimising the impact of existing and potential water extractions whilst still providing the same end service.

3.2 New Electricity Generation Technologies

The deregulation of the electricity sector and community concern about greenhouse emissions has created the incentive and opportunity for existing and new operators to develop alternative generation technologies, which have benefits for river health. For example, the introduction of the Green Power Accreditation scheme in New South Wales, enables accredited operators to obtain a higher price for the electricity that they generate through alternative 'greener' means (SEDA, 1997).

Some alternative technologies have spin off benefits for rivers. For example, water supply operators can offset the cost of implementing environmental flows, in some circumstances, by installing hydro-electricity turbines to take advantage of releases from storages (NSW Govt., 1998). In New South Wales, the Hunter Water Corporation is presently designing such a system for Chichester Dam near Newcastle (HRC, 1998.). Similarly, technologies are being developed to utilise sewage effluent to generate electricity, therefore potentially reducing the volume of effluent discharged to waterways (Isentropic Systems, unpubl.).

These opportunities however, also raise potential adverse implications for river health. For example, the potential to obtain 'green endorsement' for hydroelectricity generation may increase the demand for access to river flows, with its associated impacts on the flow regime and riverine ecosystems. This implication however, could be turned into an opportunity for river health. For example, new operators could be permitted to only access river flows through a market in water entitlements, particularly in streams with a high degree of existing hydrologic stress. This could therefore facilitate the replacement of less beneficial and less sustainable enterprises, provided that appropriate conditions are implemented to limit water access conditions for new entrants (COAG, 1994).

Green endorsement also could further increase the financial value of existing hydroelectricity schemes. However, notwithstanding this financial benefit, this could increase the cost of implementing environmental flows, in terms of the foregone production of electricity. Nevertheless, this also could be turned into an advantage for river health. For example, the provision of a sufficient level of environmental flows could be included as a prerequisite in the criteria for granting green endorsement for hydroelectricity production. Such an approach would therefore give greater recognition to operations that are green in terms of atmospheric and river health.

3.3 Carbon Sinks

The Kyoto Protocol outlines two ways of utilising vegetation to create carbon credits and a related method of creating carbon debits. Deforestation (sink removal) will lead to a creation of a carbon debit for the carbon released to the atmosphere (United Nations, 1998). Whilst reafforestation can develop a sink that will receive credits totaling the amount of carbon absorbed (United Nations, 1998). Alternatively, protection of land that was to be cleared provides a credit equal to the debit that would have been otherwise incurred for clearing, plus the additional carbon sequestered by the vegetation sink (United Nations, 1998).

A number of major enterprises that produce carbon emissions are presently seeking opportunities to 'invest' in carbon sinks (Ferguson, 1998; Shea, 1998). For example, in NSW, Delta Electricity recently announced an agreement with NSW Forestry to retain the rights to the carbon sequestered in a new plantation forest to be established on the generator's property. It has also been reported that BP and Toyota are seeking to enter similar arrangements. Such agreements are speculative at this stage, given the uncertainties regarding the final arrangements for the cap and trade in carbon credits. However, those participating are doubtless factoring into their commercial arrangements their estimates of future trading rules and terms.

The prospect of operators seeking to offset their carbon emissions by buying carbon credits in the form of vegetation, raises adverse implications and opportunities for river health. These aspects are examined below.

3.3.1 Reafforestation

The adverse implications of widespread revegetation, particularly within plantations, could include the proliferation of weeds; the loss of vegetation diversity, through the establishment of monoculture forests; changes in catchment hydrology, due to modified rates of infiltration, runoff and plant transpiration; the creation of a new demand for water extractions from rivers for the establishment of new plantings; the disturbance of soils, if plantation forests are subsequently harvested; and wildfire. Further, the opportunity to obtain an additional return for carbon sequestration may promote the expansion of some types of agricultural systems, with associated ecological implications.

Each of these factors could have a significant impact on river health. For example, it has been reported that reafforestation can significantly reduce all levels of river flows (Burt & Swank, 1992; Schofield, 1996). This has the potential to significantly increase the competition between consumptive users and instream ecosystems for access to river flows, particularly in streams with a high level of hydrological stress and/or during periods of low flows (HRC, 1998). However, each of these challenges could be addressed through the application of appropriate management actions (see section 5).

The replanting of vegetation on a wide scale also could provide positive ecological outcomes, particularly if it is guided towards high priority areas for restoration, such as along riverbanks and wetlands. The broad definition for 'reafforestation' that has been included in the Kyoto Protocol, which is subject to review, may provide for the inclusion of vegetation in these areas (United Nations, 1998).

A critical opportunity that the trade in carbon credits raises is the opportunity for farmers to derive an alternative source of income by 'farming' (planting and maintaining) vegetation as part of their overall farm management. Early estimates suggest that carbon credits could be worth between $US15-$US100 per tonne (Acil, 1998; Ferguson, 1998). This would equate to around $10 to $1200 per hectare per year, depending on the species and planting scheme (Landline, 1998; Scolel Te, 1998). This compares to returns as low as $17 per hectare per year for beef production at present. Further, there is evidence emerging that farmers would respond positively to such an income stream (HRC, 1998).

Efficiencies in agricultural production also could be improved by utilising a mix of carbon credit forestry and traditional agriculture. For example, a project is being developed in Mexico to demonstrate the potential to achieve efficiencies on farms by using trees as live fences, to provide shade for live stock and to enrich fallows (de Jong, Tipper & Taylor, 1998). The efficiency improvements (when linked with the ecological improvements and the carbon credits) can generate the necessary capital for long term farm forestry investments.

There is also potential for increasing the carbon credits received for plantings along riverbanks or in wetlands that will not be harvested. By using financial inputs that recognise the other (non-carbon sequestration) ecological benefits, the cost of sequestration to the financing agency is reduced. This could lead to a farm forestry plan that consisted of plantation timber (with appropriate carbon credit value) as a crop with extra plantings in significant environmental zones such as riparian zones for carbon credits and other environmental benefits. The carbon credit for such environmental planting could provide a sufficient incentive for farmers to plant and manage these sensitive areas (possibly with assistance or in partnership with Forestry departments).

3.3.2 Prevention of Land Clearing

The loss and degradation of forests contribute to approximately 20 percent and 25 percent of worldwide and Australian carbon dioxide emissions, respectively (Australian Greenhouse Office, undated). In order to control these emissions, parties can either buy or create carbon credits elsewhere through the development of new low emission technologies, achieve increased emission efficiencies or by planting carbon sinks. A further alternative is through the prevention of land clearing. If land that was going to be cleared, and hence release carbon, is protected and allowed to regenerate it will continue to sequester carbon, thus generating a notional carbon credit. This has the potential for many and varied environmental and river health benefits provided that it can be guaranteed that credits are associated only with net additions to the forested areas. Otherwise the carbon sequestered is not included in the Kyoto Protocol definition of afforestation, reforestation and deforestation changes relative to a 1990 baseline (United Nations, 1998).

It has been estimated, in a trial project, that 300tC/ha can be stored by protecting closed forests and 120tC/ha by managing and restoring other forests (Scolel Te, 1998). This compares with 70 to 120tC/ha by planting of trees on former pasture land (Scolel Te, 1998). Therefore the greatest value for a carbon credit investor may be to prevent land clearing, rather than to develop new vegetation plantations. For example, Costa Rica first led this approach, achieving an income of $20 million in 1998 (Greenhouse Issues, 1998). This involved the development of carbon offsets by buying private land that would have been otherwise cleared, with the proceeds from the sale of the carbon offsets (Greenhouse Issues, 1998).

Recognition of the value of existing vegetation as a carbon sink could also alter the economics of land clearing for new enterprises, by driving the internalisation of costs. That is, landholders may be required to pay for the carbon released into the atmosphere by clearing vegetation.

4 SEIZING OPPORTUNITIES AND ADDRESSING THREATS

Now is the time to recognise that the framework for the trade in carbon credits could include a set of incentives and sanctions both to effectively address the potential adverse implications and to maximise the opportunities for river health benefits.

Key elements in this framework should be the inclusion of appropriate conditions in the terms of trade, the strategic use of public funding for ecosystem restoration and the modification of other policies in order to create a consistent set of signals. For example, it may be possible to specify the terms of trade and market rules so that they include provisions that provide a higher level of credits for revegetation in priority areas. As such, replanting vegetation along rivers could attract a higher level of credits, in recognition of the additional benefits to the environment or recognition that the vegetation will not be harvested. Similarly, a higher level of credit and/or sanctions could be applied to ensure that adequate measures are implemented to manage fire, weeds and soil erosion. The magnitude of any such credit weightings could be influenced by the capacity of different types of vegetation to sequester carbon.

The array of other policies and associated public funding schemes associated with the management of natural resources also should be reviewed and amended in order to create a mutually supportive set of signals, which promote measures to constraint threats and maximise opportunities to restore priority ecosystems. For example, funds from schemes such as *Rivercare* and the *Natural Heritage Trust* could be used to supplement the returns to farmers for replanting/vegetation protection in priority areas. Similarly, the criteria for funding new or augmented town water supply schemes could include a requirement for more rigorous demand management measures, such as high efficiency shower roses.

These measures would therefore create a comparative advantage for riverine ecosystems, which acts to attract investment to these areas. This is important because there are likely to be organisations that will compete to sell carbon credits in other areas, such as forestry plantations. Further, it could be particularly important in addressing any imbalance in the relative rates of carbon sequestration between different species of vegetation and localities.

The move towards the introduction of trade in carbon credits is also presenting other opportunities to direct action towards restoring priority ecosystems in the interim. For example, an emission contract scheme is presently being prepared for the New South Wales electricity industry, which includes fines for those operators who exceed their allocated level of emissions (Dunstan, unpubl.). These funds could be directed towards establishing carbon sinks, particularly in areas that favour the restoration of priority ecosystems.

There is of course a substantial role for scientists to play in the development of a framework for trade in carbon credits. This includes undertaking investigations to determine the amount of carbon emitted from various production processes, developing more efficient production processes and determining the rate and amount of carbon sequestered and released from different types of species and communities. Ecologists and other scientists will have a role to play in determining how revegetation on a wide scale will affect river health. Some initial investigations are presently being undertaken in this regard, including carbon exchange and storage in floodplains.

6 CONCLUSION

If the framework for the carbon credit market is not defined appropriately, there could be serious consequences for river heath in terms of changed catchment hydrology, the introduction and proliferation of weeds, reduced biodiversity, altered fire regimes and soil erosion. Vegetation sinks can provide improvements in atmospheric health through sequestering carbon and additionally improve river health through the most effective placement of sinks. These benefits will only occur if the opportunities to improve river health utilising the carbon credit trading scheme are recognised early.

The notion of living within the carbon 'cap', without unduly constraining human economic activity, has resulted in the concept of carbon 'sinks' to offset (in effect) the 'hot air' that our activity generates. Just as the atmosphere is otherwise at risk of intolerable damage, rivers are increasingly under threat because of the tendency to regard them as convenient 'drains' for the undesirable consequences of land based activities. While rivers of course perform a natural drainage function, their capacity in that regard is limited in ways comparable to the limits on atmospheric storage of carbon dioxide. As discussed in this paper, the carbon 'sinks' (designed to enhance atmospheric health) create a real possibility of cleaning up the 'drains' and thus restoring river health.

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