Issues in Designing Measures to Address Declining Water Quality in the Great Barrier Reef Lagoon

An Environment Australia submission to *Industries in the Great Barrier Reef Catchment and Measures to Address Declining Water Quality***,** a commissioned study by the Productivity Commission**.**

Environment Australia

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Introduction

This submission provides input to the last of the Productivity Commissions terms of reference for its commissioned study, *Industries in the Great Barrier Reef Catchment and Measures to Address Declining Water Quality,* namely*:*

> "analyse the likely costs and benefits at the local, regional, State and national level of policy options for addressing the issue of declining water quality entering the Great Barrier Reef lagoon."

Environment Australia does not advocate any one environmental policy mechanism over another in this paper. Rather, the paper notes the advantages and disadvantages of a range of instruments in the context of addressing land-based pollution of the Great Barrier Reef lagoon.

It is the agency's belief that a range of mechanisms, including legislative change and incentives to landholders, will need to be adopted in order to achieve the necessary change in land management in a cost-effective manner. Whatever mechanisms are proposed will need to have effect at the individual landholder level, as it is primarily at this level that decisions on land management are made.

The paper begins by summarising the policy context for achieving water quality improvements in the Great Barrier Reef lagoon.

The middle section of the paper outlines a range of instruments that could be useful in achieving reductions in pollution and inducing behavioural change. The instruments are discussed in more detail in Attachment A.

The paper concludes by asking questions that the Department thinks will be relevant to the choice of instrument to address the pollution issue.

The paper focuses on policy instruments to control the impact of land-based nutrient and sediment pollution on water quality, including from urban sources, in the Great Barrier Reef lagoon. It does not look at other impacts on the reef from tourism use, fishing, coral harvesting, or shipping.

An issue is the relative responsibilities of landholders and the broader Australian public to addressing the decline in water quality entering the reef. The Department considers that this is a shared responsibility with landholders having a responsibility to meet their duty of care. Environmental responsibilities above this level may in many cases be the responsibility of the Australian public and assistance to landholders to address these responsibilities may be required. Clearly efficiency in delivering this assistance is important.

The policy context

The environmental problem

Land-based pollution in the Great Barrier Reef catchment may damage estuaries, seagrass beds and inshore corals in the Great Barrier Reef lagoon. Sediment, nutrient pollution (nitrogen and phosphorous) and chemicals from pesticides are finding their way into the lagoon through groundwater and surface water flows.

Eutrophication and sedimentation are consistent with reductions in the abundance and diversity of corals and other marine species.

- Particulate nutrients and sediment can smother corals and inhibit their growth and reproduction by shutting out sunlight. Sediment on coral surfaces prevent settlement of coral larvae thereby reducing the recruitment of young corals. Excessive phosphorous concentrations have also been found to weaken the coral skeleton of the reef builders thereby making the reef more susceptible to damage in cyclones and storms. The combination of sediment and nutrient may be particularly damaging, including through the production of 'marine snow' (sticky suspended particles in a mucus matrix produced by marine bacteria) which is especially difficult for sessile marine organisms to deal with.
- Too many nutrients can lead to massive growth in non-reef building filter feeders (tubeworms, sponges and biovalves). In particular, nutrient-rich conditions are consistent with increases in the Crown of Thorns Starfish, which feeds on corals.
- The degradation and loss of coastal habitats reduces the diversity of species within the lagoon as many pelagic species rely on coastal habitats for part of their lifecycle. For example, of the order of 80% of fish species rely on coastal wetlands and estuarine habitats for part of their life cycle.

Increased suspended solids and phytoplankton in the water also damages sea grass meadows, an essential food source of the Dugong, marine turtles and other marine species.

Pesticides and herbicides have been detected in sub tidal muds with the herbicide, diuron, at levels that can cause harm to seagrasses.

Localised problems in terms of algal blooms and loss of biodiversity also occur from eutrophication of rivers and estuaries.

Declining water quality can reduce the capacity of the reef and other ecosystems to recover after being stressed through other impacts, for example coral bleaching or damage from cyclones. The reef is therefore not likely to rapidly degrade due to the decline in water quality, but rather over time gradually become less diverse, abundant, attractive and capable of playing a role in ecosystem functioning. Importantly international experience shows that once a reef begins to show decline it is extremely difficult to reverse the decline. The Great Barrier Reef is beginning to show a decline in some areas.

Sources of pollution

The Great Barrier Reef catchment covers 433,000 square kilometres, stretching from the tip of Cape York down to the Mary River near Hervey Bay. The catchment contains many individual river catchments ranging in size from 490 square kilometres (Mossman River) to 142,000 square kilometres (Fitzroy River) and encompasses many land uses contributing sediments and nutrients into the catchment and, subsequently, estuaries and the Great Barrier Reef lagoon. Pollution sources include broadacre and intensive agriculture and treated sewage and storm water from urban and tourism development.

Research has pointed to a 4 to 9-fold increase in quantities of sediment entering the inshore lagoon of the Reef from the Great Barrier Reef catchment over the last 150 years. This trend is continuing with increasing levels of sediment likely in the future if remedial action is not taken. There has also been a 3 to 15-fold increase in phosphorus and 2 to 4 fold increase in total nitrogen inputs.

The vast majority of sediment loss occurs in the upper parts of the catchments, especially the large dry tropic catchments towards the south including the Burnett, Fitzroy and Burdekin catchments.

While the majority of nitrogen lost from the catchments is associated with sediment loss, nitrogen derived from fertilisers is most dangerous to marine ecosystems as it is highly bioavailable and bioreactive. Approximately 30-50% of applied fertiliser nitrogen may be lost to the environment through runoff or leaching in to groundwater. With the exception of cotton, the majority of intensive agriculture occurs on the coastal plains and the wet tropic catchments.

Agriculture

Catchments adjacent to the Great Barrier Reef host in the order of 10,000 agricultural land holders. Major land uses include cattle grazing and intensive cropping, particularly sugar cane. The impact of agriculture on water quality is far from uniform, with an estimated 80 per cent of the decline in water quality entering the lagoon coming from 20 per cent of agricultural land.

Cattle grazing is by far the largest land use by area in the GBR catchment, at just under 77% of the entire catchment. An estimated 4,500,000 cattle graze in the GBR catchment, with highest stock numbers in the Burdekin and Fitzroy catchments.

Cropping is close to 4% of the catchment area with the majority of cropping being for cane, which covered approximately 400,000ha in 2000. The Great Barrier Reef catchment is also home to a number of expanding industries, such as such as cotton, bananas, mangoes and vegetable cropping, which are intensive users of fertiliser. Bananas require nitrogen application up to twice the rate of sugar cane (400kg's per hectare per year), whilst cotton application rates are similar to cane (150kg/ha/year).

Urban and tourism development

Urban areas occupy 1.6% of the catchment and support a thriving tourist industry. Urban stormwater and sewage only contributes a few percent of terrestrial discharge of nutrients to the reef, however local impacts can be significant. Urban sewage is a small contributor to total nutrient flows, but these flows are constant throughout the year and, in the dry season, outflow from sewage farms can constitute the entire stream flow in some areas.

Wetland removal

In the Great Barrier Reef catchment south of Cooktown, most of the freshwater wetlands have been reclaimed for agriculture and urban uses. Wetlands filter out soil and nutrients from river systems and the loss of these filters has exacerbated the amount of pollution reaching the lagoon.

Mapping action to influence

Nutrients, sediment and other pollutants are transported through surface water and groundwater flows.

The transport of sediment and nutrients is generally associated with periods of heavy rainfall due to the enhanced soil erosion and the stronger river flows associated with floods. High river flows in the wet tropics region occur at relatively regular intervals (approximately annually) compared to the variable flows of the Fitzroy and the Burdekin Rivers where high river flows may only occur once every 5-10 years. The

high flood flows from the Fitzroy and Burdekin Rivers discharge a much higher load of sediment and nutrient in plumes which can remain in inshore ecosystems for periods of days to months.

Sediment may reach coastal waters when either the river is confined within natural high channels and there are limited natural opportunities for settlement of the sediment within the river, or where the natural floodplain has been lost to development such that areas that would have previously allowed the settlement of sediment have been lost. Both these circumstances exist in the GBR catchments where flows from a significant number of catchments exit directly onto the coast, while there has also been an estimated 70-80% loss of wetlands that would historically have acted as sediment traps for a number of major catchments.

The vast bulk of sediment and nutrient pollution in the Great Barrier Reef lagoon comes from non-point sources, such as run-off from agricultural properties. Compared to point source polluters, such as heavy industry, sewage farms or feedlots, pollution from diffuse sources is much more difficult to quantify precisely, both in terms of the quantity and period of time over which it is released.

The influence of one landholder's actions on reef ecosystems could be more or less influenced by his or her location in the catchment, river flow-rates at the point in the catchment the landholder occupies, the potential entrapment of material in the catchment's river system and the location of the river mouth in relation to the sensitive areas and coastal estuaries.

The Commonwealth and Queensland governments are responding to the threat posed by declining water quality entering the reef through the development of a Reef Water Quality Protection Plan (the Plan). The development of the Plan, and guidance for its content, was agreed through a Memorandum of Understanding launched by the two governments on 13 August 2002. A draft Plan is currently under development.

What the Plan will be seeking to achieve is a minimisation of soil nutrient and pesticide loss in rainfall runoff, and a minimisation of sediment and nutrient transport to coastal waters. The strategies for achieving this are relatively simple, for example minimising soil loss in rangeland areas will generally mean maintaining deep rooted vegetation on highly erodible soils, revegetating currently cleared highly erodible soils, maintaining pasture cover on moderately erodible soils, and maintaining or revegetating riparian areas where stream bank degradation is likely. Equally in coastal areas the strategies will include better fertiliser management, capturing (and possibly reusing) polluted tail water, maintaining and restoring riparian vegetation, protecting and restoring coastal wetland areas and protecting and restoring areas where high nutrient loss is likely.

However the approximately 10,000 landholders occupying agricultural land in the catchment will differ in how they respond to mechanisms to influence their behaviour depending on their circumstances and outlook, and hence a variety of mechanisms will be needed to achieve the necessary overall change in land management. An appropriate mix of voluntary, incentive and regulatory mechanisms are likely to be required.

As also outlined earlier all areas with catchments are not equal in their likelihood to contribute to the decline in water quality entering the reef. For example sediment can be added to the system through hillslope erosion (rill erosion), gully erosion or bank erosion. There are a considerable number of variables that determine the erosion hazard of an area, including vegetation cover and soil erodibility. A considerable

amount of work, including modelling, has however been done in this area, starting with the work undertaken as part of the National Land and Water Resources Audit. This work enables relatively precise targeting of initiatives for different areas. The work proposed to be undertaken over the next few years within the Burnett, Mary, Burdekin and Fitzroy rivers under the National Action Plan for Salinity and Water Quality will further refine this work, but will probably not fundamentally change our current understanding. This information will be able guide where emphasis needs to be placed within the catchment.

The economic and social context

A wide variety of industries operate throughout the Great Barrier Reef catchment. Each will tend to be more or less linked into the regional economy, and projections of growth vary.

As noted above, beef cattle and sugar cane are the most established of the agricultural sectors. The cane industry is likely to undergo significant restructuring in the medium term, and the prospects of both cattle and cane are heavily influenced by the global price outlook. Intensive cropping, such as bananas and cotton, are growth sectors.

Tourism is also a major revenue earner for the state and a large regional employer, and its fortunes are more strongly aligned with the Reef's. Likewise with coastal development for urban and retirement purposes.

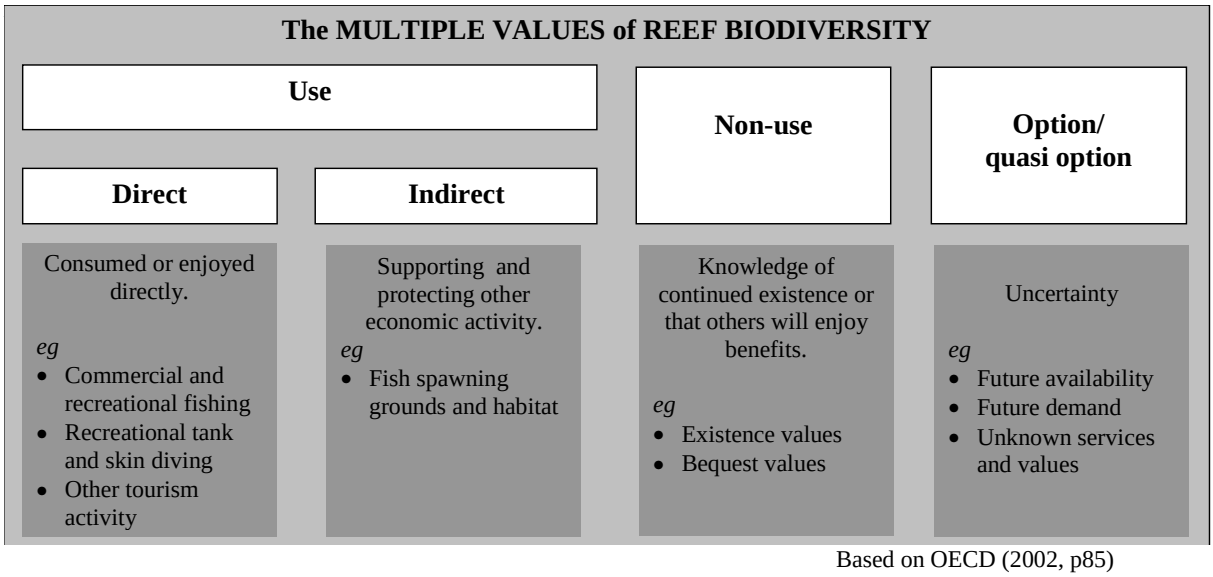
The mining sector also has a significant economic and employment presence in the region but is not a major polluter.

Market failure

Economists characterise pollution as a market failure. That is, the impact of nutrient, sediment and other forms of pollution in the lagoon are a cost of production which is not borne by the producers of the pollution, but by those that use the reef more directly and more generally benefit from a healthy reef and lagoon.

Like the sources of pollution, the beneficiaries of the reef are many and varied. The range of these benefits are summarised in Figure 1.

FIGURE 1



Based on OECD (2002, p85)

Some of these benefits are commercial in nature, whereas many are not. The latter are inherently difficult to quantify because, like pollution, they are not traded or priced in markets in the manner of conventional commodities.

The choice of policy intervention may be characterised as a process of choosing between different states, of which 'no intervention' is one option. All costs and benefits need to be canvassed, although some will be larger and more relevant than others.

To be justified, the benefits of policy intervention should outweigh the costs.

The costs of policy intervention can be characterised as:-

Economic costs

These arise from the curtailment of opportunities to use or enjoy resources. Examples are the lost value to cane producers from restricting their ability to use riparian land for sugar cane production, or capital works on grazing properties to reduce sediment run-off. Second order impacts include the lost value to businesses that supply landholders affected by pollution abatement regulation.

Administrative costs

Administrative resources incurred by the community in implementing the regulation. Examples may be any costs incurred by landholders of estimating nutrient run-off, or resources expended in enforcing regulations.

Social costs

These arise in the broader community as a result of the transition from a sub-optimal level of pollution to an optimal one and are differentiated from the direct economic costs to owners or other businesses in the community. Rather, these costs look at the social costs to individuals, regions or industries of making the transition, for example, from one form of employment to another, or the problems resulting from the period of unemployment in-between.

A range of policy instruments

There are a range of policy instruments that could be part of a cost-effective and robust package to reduce pollution in the Great Barrier Reef lagoon. Some are listed below and discussed further in Attachment A.

The choice of instrument will depend upon the context of the problem and many of the instruments could be used in a complementary fashion to address different aspects of implementing the solution.

As an example, a duty of care measure could specify a minimum set of high value or low cost abatement activities on an industry or regional basis, with an emissions-based incentive system phased in over time to induce further pollution reduction to secure additional abatement necessary to meet target levels of pollution entering the Great Barrier Reef lagoon. An incentive to increase uptake of environment management systems could sit alongside both.

Direct regulation

There may be a number of instruments to deliver command and control style regulation of landholders and other pollution in the Great Barrier Reef catchment. These include:-

- Revision of the industry-based duty of care requirements under Queensland's *Environment Protection Act 1994* to more clearly articulate the 'bottom line' requirements of the general environmental duty or alternatively to provide some statutory minimum requirements.
- The Queensland government is currently reviewing rural leasehold arrangements prior to the expiry of many rural leases. There is the potential for requirements to be agreed with, or placed on, rural leaseholders as part of the renewal of leases. This could include requirements relating to pasture cover or clearing of areas subject to erosion hazard.
- Under the *Water Act 2000* a Water Use Plan may be required where the State Minister is satisfied that there are risks of negative effects (including deteriorating water quality) in a particular area that may be caused by water use.

These instruments have the capacity to focus on individual actions and at the regional (catchment/sub-catchment) level so as to require ameliorative actions to be taken by landholders. When informed by information on the relative risk of different areas of the catchment they have the capacity to ensure that there are no 'free riders' on actions to address the decline in water quality.

Flexible and outcome-focused mechanisms

The following incentive-based measures attempt to target low cost abatement, with a varying degree of emphasis on accounting for the variations between the activity and the ultimate environmental outcome.

- Fertiliser levy – a levy on fertiliser applied at the point of sale.
- Emissions charges – a charge on emissions based on estimating nutrient or sediment loss from a property.
- Emissions trading – capping total emissions from a region or industry sector and allowing trading under the cap.
- Bubble-licensing – a variation on emissions trading which allows regional, industry or organisational entities flexibility in achieving targets.
- Environmental tender – using a tender mechanism to buy actions from landholders that reduce pollution of the lagoon.

Some of the above measures have not been routinely applied to the resolution of environmental issues in the past, particularly those issues arising from diffuse source pollution. The more sophisticated versions may require significant new monitoring and enforcement infrastructure that may take some time to develop.

As incentive based instruments these measures work alongside other influences on the landholder, including external economic factors and incentives and regulation targeting other environmental outcomes.

These measures provide a fair degree of flexibility to manage the regulatory impact over time and address equity issues through modifications to the instrument design or through the use of complementary mechanisms.

Inducing technological and cultural change

The following measures focus on facilitating reduction in actual or perceived costs of pollution abatement by driving the uptake of new information and technology, or facilitating cultural change.

- Information and suasive measures
- Rate rebates and income tax incentives
- Cross compliance with other incentive delivery mechanisms
- Duty of care – minimum levels of information provision
- Grants – eg support for developing EMS

Controlling pressure on the environment

Offset schemes seek to control aggregate pressure on the environment by regulating and capping pollution from a particular sector, but at the same time giving the regulated sector the flexibility to earn pollution 'credits' through specified activities.

- Offset schemes
- Environmental Banking

Managing the distribution of costs and benefits

The following list outlines some options for managing the distribution of costs from implementing pollution control measures.

- Revenue recycling
- Environmental levies from beneficiaries

Analysis of costs and benefits and instrument choice

Environment Australia believes that a cost-benefit framework is useful in analysing the construction of an instrument package to address land-based pollution in the Great Barrier Reef lagoon.

That said, we believe that many of the analytical issues are not straightforward. In this section, we attempt to draw out a number of issues we think are important in analysing the costs and benefits of this complex policy issue, and put questions that, to the extent they can be answered, could shed light on the design of an optimal package.

Uncertainty about costs and benefits

In reality, there is often great uncertainty about the exact nature of environmental benefits, and the extent of action required to achieve a given environmental outcome. This complicates the assessment of the trade-off between costs and benefits.

In an environment of uncertainty, environmental outcomes may be determined with reference to key thresholds and the concept of sustainability. The policy problem then reduces to one of attempting to choose between policy instruments that minimise the cost of achieving the desired environmental outcome.

- Can key environmental thresholds for water entering the reef be established on the basis of information held now?

- How important is the ability of the instrument to be able to adapt and accommodate new information about the costs and benefits of reducing pollution?
- For particular instruments, how difficult is it to change overall policy settings once a particular instrument is in place?

The nature of pollution, processes which transport it, and location of the catchment within the context of the Great Barrier Reef and lagoon will impact on the benefits of abatement in different river catchments. The larger these differentials, the greater the value in accounting for them in policy design.

- What information is available to differentiate between the benefits of abatement from different river catchments?
- Are these differences large?
- Is this information likely to change over time?

Minimising the costs of pollution abatement

Regardless of the benefits, choosing policy instruments which reduce the cost of achieving environmental outcomes effectively increases society's wealth and well-being. From an environmental perspective, as environment outcomes and benefits become cheaper, the community will tend to demand more of them.

The scale of the change

The scale of pollution reduction and consequent costs to the community will influence the relative importance of different types of costs, and hence the relative value in choosing an instrument emphasising savings in one set of costs, *eg* economic, over another.

- Overall, is the ultimate scale of pollution reduction likely to be large?
  - Will small modifications in behaviour by individuals in existing industries be enough to significantly address the problem, now and in the long run?
  - For which industries are cheap or 'win-win' pollution abatement options available? For which would pollution abatement costs significantly impact upon productivity?
  - How important are the industry to the regional and state economy?
  - To what extent is pollution from current and emerging industries likely to increase over time?

The only attempt to date in determining the scale of change required has been through the end of river targets proposed in the *Great Barrier Reef Marine Park Authority's Water Quality Action Plan*. The Authority suggested that quite significant reductions were required. The recent Reef Science Panel review regarding water quality in and adjacent to the Great Barrier Reef suggested that the Action plan has value on a broad basis but requires significant refinement at the sub-catchment level.

There are likely to be win-win pollution abatement problems, such as precision fertiliser use which would restrict the level of fertiliser used on a property to the

amount required by the crop, minimising the amount of nutrients likely to enter waterways but also reducing the cost of production.

Uncertainty and flux are unique to government policy. All industries face more or less uncertainty from broader economic and social circumstances, such as changes in the commodity price outlook. The impacts of policy intervention and, more importantly, the means by which they are addressed should be informed by the broader social and economic context.

- What risks do operators in current industries face in respect to their viability?
- How are the size and structure of the industries expected to change over time? What are the expected social impacts of these shifts? What social policies are in place to deal with the impact of these shifts?
- What new industries are emerging? How are they likely to impact upon the economic and social structure of the region?

Dynamic context and synergies between existing and new regulatory infrastructure

The costs of delivering incentives and enforcing regulation may be significantly reduced by using or adapting existing institutional mechanisms. Examples include industry codes of practice and duty of care regulation, tree clearing monitoring and permitting systems, State-wide salinity and water quality policy mechanisms, local, State and Commonwealth revenue raising instruments, and industry levies.

A recent example is the Commonwealth's Environmental Management System cash rebate, which is delivered through Employment National offices.

However, the cost implications for the existing system also need to be considered. Adapting a system designed for other purposes, such as revenue raising, can increase administrative costs through adding complexity, and it may be difficult to target environmental outcomes.

- What mechanisms are currently in place that influence, monitor and enforce the behaviour of landholders in the catchment?
- What are the additional costs of adjusting the system to deliver water quality outcomes? Are they likely to be large or small?

Synergies between regulatory infrastructure may also be developed over time and in the development of policy to address other social and environment issues.

In the longer run, the Environmental Management System ISO14001 accreditation and enforcement processes could be used to provide information on and better target regulation to address a range of environmental problems stemming from land use activity in the catchment. These problems include localised pollution impacts, salinity and water quality issues, greenhouse emissions and biodiversity loss.

There are potentially large crossovers between abatement actions to address different environmental issues. For example, between 80 to 90 per cent of phosphorous lost to waterways is attached to sediment from soil erosion, protection of riparian land can have significant biodiversity benefits and disturbance of acid sulphate soils can have significant impacts on the ecosystems of streams and rivers.

- What are the policy mechanisms being developed to address these other environmental issues?

- How could they be used to deliver incentives or enforce regulation to address water quality in the Great Barrier Reef catchment?
- How can they be made compatible with policy instruments to address pollution entering the Great Barrier Reef lagoon, so that net benefits from changes in land use activity can be maximised?

Technology is constantly evolving. Emissions modelling and monitoring systems are constantly improving and becoming cheaper, and internet technology is rapidly reducing the costs of trading and delivering up to date information. These trends are likely to reduce administrative cost of all instruments and open up opportunities for efficiency savings through outcomes focused and flexible instruments.

Likewise, the costs of improving water quality in the lagoon is likely to reduce over time through technological advances and the improved understanding of the link between activities on the land and the impact on the reef.

- How are the relative economic and administrative costs of policy instruments likely to change over time, given trends in emissions modelling, satellite imaging, internet usage and other forms of technological advance?
- How adaptable are the policy instruments in responding to changes in economic and administrative costs over time?

Investment in incentives and other mechanisms which facilitate or drive uptake of new technology, such as environmental management systems, or otherwise facilitate cultural or behavioural change can be seen as an investment in reducing costs of achieving environmental outcomes in the medium to long run. An example of cultural is that the horticultural industry, for example, are happy to use the process-oriented ISO14001 standard for Environment Management Systems, whereas participants in some other sectors have indicated they just want to know what they have to do on the ground.

On the other hand, these mechanisms need to structured so that they remain relevant to the context over time.

- What existing mechanisms can be used to drive technology uptake and development of new pollution abatement technologies?
- How quickly and easily can they be used to drive improvements in knowledge and land management in the short run?
- What are the costs or issues in structuring the mechanism so that its relevance is maintained over time?

<u>Comparing the costs of new policy instruments</u>

In many cases, policy instruments will share certain costs. Differences in costs and benefits between policy options need to be clearly defined to avoid double-counting or inappropriate comparisons between instruments.

For example, regulation prohibiting the further clearing of riparian vegetation would share much of the monitoring and enforcement cost of a incentives scheme to secure vegetation. The additional cost of allowing the monitoring and enforcement systems to accommodate differential responses by landholders is the relevant cost in comparing the two schemes, not total monitoring and enforcement costs. Another example is that social costs from unemployment will

need to be addressed as a result of any industry re-structuring to meet environmental objectives, regardless of the instrument that drives it.

- What administration costs are common to a number of instruments?
- What is the marginal cost of using one instrument over another to secure pollution abatement from a subset of landholders?

Cost savings in instrument design

Opportunities to reduce the economic and administrative cost of regulation to achieve reductions in pollution can be characterised as flowing from two sources:

(1) a shift away from regulating causal activities to regulating the ultimate environmental outcome;

(2) achieving the environmental outcome using low cost behavioural change, not high.

Focusing on the environmental outcome means allowing flexibility in how it is achieved, which in turn reduces the economic costs of achieving it. An instrument based on nutrient emissions from a property, for example, allows landholders more options in reducing nutrient emissions than a levy imposed on fertiliser use alone, and more again in comparison to regulation barring fertiliser use on the property altogether.

Economic and market based instruments focus on minimising the efficiency cost of regulation by targeting low cost options. They do this by using incentive or trading-based mechanisms to align individual's decisions with the environmental benefit of pollution abatement, while leaving each individual free to choose their response according to their personal circumstances. As a result, behavioural change comes from individuals from whom the cost of doing so is least.

Command-and-control instruments tend to focus on reducing administrative and enforcement costs by targeting behavioural changes that are simple to understand and monitor, making violations easy to spot and punish. By preventing an activity or prescribing how it should be done, the ultimate impact on the environment can be controlled.

Efficiency savings and administrative costs

A trade-off exists between administrative costs and achieving efficiency savings through shifting regulation to outcomes and limiting the economic cost to the community of achieving environmental outcomes and the costs of administering the instrument.

Trying to get a handle on emissions from individual farms, for example, is likely to involve costs for landholders and/or government in estimating emissions or undertaking monitoring activity compared to the current situation.

An example of efficiency loss could be using duty of care of regulation to specify the use of a particular irrigation technology for a certain type of crop, whereas the technology may not be the most effective way to reduce the impact of pollution in all circumstances. Attempting to incorporate flexibility into the regulation by having processes which certify variations will tend to complicate regulations and add administrative costs, particularly as technology changes over time.

Likewise, designing enforcement infrastructure which accommodates individual flexibility or trading is likely to incur additional costs, which can be significant. On the

other hand, however, efficiency savings will also tend to reduce the economic costs of regulation and, hence, the benefits of violating regulation.

The upshot of the above is that the cost-effectiveness of a particular policy instrument will depend on the circumstances in which it is to be applied, ie:

- the nature of the environmental problem being addressed;
- characteristics of the landholders and their businesses; and
- the capacity to target different instruments to different activities and different parts of the community.

A complex relationship between the causal activity and the environmental problem and the manifestation of the problem will tend to indicate potential efficiency gains from shifting the regulation focus from specific activities to the ultimate environmental impact, which may vary according to the location and the timing of the activity.

- How are pollution impacts on the lagoon likely to vary by activity from which it arises, its location and the time over which it occurs?
- Within regions and industries, to what extent are individual landholders likely to choose different abatement options? Is the variation in potentially effective abatement options large?
- What information is available that would enable differentiation of pollution impacts by activity and property? How much is the cost of acquiring additional information, and who bears it?

Efficiency savings from targeting low-cost abatement will tend to be larger the greater the variation in pollution abatement costs across the landscape. Greater abatement demand and, hence, larger economic costs will tend to make the benefits of targeting low cost abatement more important.

- Is there is a diverse range of opportunity costs within industries, or between industries?
- Is there a range of options for mitigating or ameliorating the impacts of economic activity, and is the choice of option likely to vary considerably between individuals and locations?
- Are large changes in the external circumstances of industries or individuals likely over time?

Regulation directly prescribing certain activities for a group of landholders may be more cost-effective if the efficiency gains are small and additional cost of making enforcement mechanisms flexible and output focused is large. The savings come from attaching regulation to an activity for which it is easy to determine compliance or otherwise. Efficiency gains are likely to be small if the activity is closely correlated with high environmental benefits across the landscape and is relatively low cost for all landholders. Efficiency savings from landholder flexibility might also be low if abatement options are limited and economic costs are spread relatively uniformly across landholders.

- Are there pollution abatement activities which are likely to have considerable environmental benefit if undertaken by most of a target group of landholders?

- Is the cost of the activity to landholders small?
- Are there groups of landholders for whom pollution abatement options are limited? Where are they located, and what industries are they a part of?
- Is compliance with regulation based on the activity easy to determine? What are the costs of enforcing the regulation, and with what degree of certainty?

Distribution of costs and benefits

Although environmental policy is intended to, overall, improve society's welfare the distribution of costs and benefits is seldom uniform. Costs of achieving environmental outcomes are often incurred by a small, self-identifying group, whereas the benefits accrue to a broad, diffuse population (see Figure 1). Regulation which impinges on a landholder's perceived property rights or imposes new taxes will meet opposition.

- Who benefits from improved water quality in the Great Barrier Reef lagoon?
- How is this achieved and who bears the economic, administrative and social costs?
- Are there beneficiaries from mitigating the economic impact on certain sectors of landholders?

Command and control regulation can appeal to common notions of fairness among both environmentalists and industry, because on the surface the same rules apply equally to everyone. This is despite the fact that the costs of adhering to the regulation might vary greatly between individuals and across the landscape.

Some policy instruments, such as offsets schemes, focus on specifying a particular distribution of costs and benefits, as do concepts like user and beneficiary pays.

Other instruments, like tradeable emissions permits, provide flexibility to the community in adjusting the impacts of costs and benefits through the process of allocating rights. Other ways of achieving a fair distribution of costs within the industry or region are to provide positive incentives or structure them so that they are revenue neutral.

Alternatively, funds generated from incentive instruments may be channelled back to landholders through structural adjustment assistance, assistance with the costs of new compliance regimes, or in local, community-based pollution abatement initiatives such as wetland enhancement without jeopardising the impact of the incentive on landholder behaviour. Funds raised from levying beneficiary communities, such as tourists, could also be used to fund these initiatives as well as providing positive incentives to landholders. However, funds channelled back into the landholder community need to be designed so that overall pollution outcomes are not compromised.

- What options are available to channel funds back into the community?
- Could these funds undermine the overall environmental outcome? How can the environmental outcome be secured?

Measures like environmental levies on reef users, seek to transfer some of the value from specific beneficiaries of improved water quality in the Great Barrier Reef lagoon to those bearing the costs. Environmental levies can also be applied at a local, industry, state and Commonwealth level. These forms of levies are distinguished from environmental taxes, such as emission charges, in that they generally focus on raising revenue, not changing behaviour. However, the willingness of the levied community to

bear the costs of pollution abatement will, in aggregate and over time, limit the amount of pollution abatement achieved.

The efficiency cost in raising the levy taken into account into the assessment of the costs of using a levy to raise funds. The cost of the levy is the extent to which the targeted individuals change their behaviour to avoid the levy, and the resource cost of administering the levy. For example, a large drop-off in tourist numbers as a result of a tourist levy would impose a significant cost on the community the extent that their enjoyment of the reef (and their value to the local economy) is not in itself contributing to the water quality problem.

- What will the impact of a levy be on the behaviour of target individuals, and the consequent economic and social impacts?
- What mechanisms can be used to levy various groups of beneficiaries, and what is the cost administering it?

Social costs of regulation to reduce pollution will tend to be higher, the greater the speed of the transition. As noted above, instruments that facilitate the development and application of new technology and knowledge will reduce the costs of pollution abatement in the long run.

- How flexible are instruments in phasing in pollution abatement effort over time?

Potential instruments

Direct regulation of land use and pollution abatement activities

A number of mechanisms are in place which could be used to implement regulation of landholder activities.

- minimum conditions as part of the legislated duty of care
- leasehold conditions
- inclusion of draining or filling of land for agriculture under the IPA 1997
- inclusion of the Reef Plan as a State Planning Policy
- inclusion of reef catchments under the Water Act

Direct regulation can be cost-effective where is based on actions which are highly likely to have a high net benefit to the community, such as actions which have a large impact on water quality, or for which the costs of which are low or offset to a significant extent by private benefits. Some forms of erosion control and upgrading farm information systems could form a reasonable regulatory baseline as part of a duty of care, and potentially have a large impact on reducing total nutrient and sediment pollution into the reef lagoon.

Administrative costs may be reduced by targeting actions that are comparatively easy to verify and hence enforce. Advances in satellite imaging are making property by property monitoring of certain land management practices, such as clearing and pasture cover, much more cost-effective. However, this technological capacity also reduces the costs of enforcing of incentive based apply instruments.

Relative costs of regulation are not readily apparent from direct regulation instruments and processes are required that keeps the regulation relevant over time.

The economic costs of direct regulation fall on those whose activities are curtailed, with flow-on effects to the surrounding community, although no revenue is generated from the measure. Where private benefits are significant, as is often the case with best management practice, direct and flow-on costs are likely to be minimal. In fact, structural adjustment packages which assist inefficient producers to upgrade their operation or leave the industry can make the industry more profitable as a whole, increasing pollution over time as the industry grows. A more flexible and targeted incentive-based instrument can be overlayed to ensure overarching pollution reduction outcomes are maintained over time.

Flexible and outcome-focused mechanisms

Fertiliser levy

Levies on the inputs to production can be used to reduce environmental impacts associated with the input. Examples could be levies on fertiliser, or water-use in the case of irrigated agriculture.

A fertiliser levy would encourage efficiency in the application of fertiliser to maximise uptake by the crop or pasture, and by implication reducing the likelihood of nutrient

pollution in run-off. If levied at the point of sale, the levy could be imposed and relatively cost-effectively since there are only two major suppliers of fertiliser in the state.

The levy could be broadly applied to all bulk users of fertiliser. Fertiliser use will reduce most in the agricultural sectors and landholders for whom it is cheapest to do so.

However, fertiliser is not free to farmers and demand for it may be fairly inelastic, ie unresponsive to price changes. If this is the case, a large levy may be required to deliver the necessary incentive to achieve significant reductions in use and pollution abatement, at least in the short term. Most abatement of pollution may come from the closure of marginal intensive agriculture.

Fertiliser taxes have been successfully implemented in Europe, most recently in Holland.

The levy could form a base against which discounts may be granted for measures which reduce the risk of nutrient loss, such as vegetated riparian zones or on-farm wetlands. This is moving towards the emission charges concept, discussed below, and would begin to encounter the same problems of ensuring that fertiliser is in fact used where it is claimed it was used. Similar problems arise in charging different levy rates to reflect the relative impact of where the fertiliser is used.

A fertiliser levy could be seen as the first step towards an emission charges system based on more sophisticated forms of emission accounting. However, if this is to be the case, a point of sale levy may be difficult to generalise to other environmental problems, such as accounting for sediment loss from broadacre grazing.

A straight levy follows the polluter pays principle. However, it could be structured to be revenue neutral or to just penalise fertiliser use over ‘best management practice’, which would vary according to the crop and the physical properties of the land. The latter would limit the possibility of adjusting the levy until the desired pollution outcome is achieved. The revenue could also be used to fund extension programs.

In theory, the levy may be adjusted until the desired level of pollution is achieved. However, frequent changes are costly to industry and would be resented.

Emissions charges

Emission charges are a volumetric charge on pollution into the environment and are becoming increasingly common in the regulation of industrial, point source pollution. While not commonly applied to diffuse source pollution, nutrient accounting has been developed as a basis for taxation in Holland. Charges could be applied on different forms of pollution and all manner of polluting industries, both point and non-point source.

Emission charges are more outcome focused than the fertiliser levy to the extent that they are levied on emissions into the environment, not the activities or processes that give rise to the emission. This gives emitters the flexibility to reduce emissions by a number of means, and this can be important when there is range of pollution reduction options available to landholders, and the most cost-effective is likely to vary. Compared to the simple fertiliser levy, there is also an incentive for agricultural

production to concentrate production on land which is less prone to run-off risk and retire land which is vulnerable.

The extent to which it is possible for each farmer to pursue abatement options will depend upon their individual circumstances, and is capped at the value of the charge. The charge would make abatement cost differentials between catchments apparent and inform broader policymaking, subject to the achievement of desired environmental outcomes in the catchment.

Like a fertiliser levy, emissions charges are an incentive-based instrument, and much of the above discussion of that measure applies here.

Emissions accounting

While it may not be possible to determine to two decimal places the exact level of nutrient or sediment pollution leaving a particular property in a given period of time, there could still be considerable value in differentiating regulation and incentives on a 'best available estimate' basis. For example, an estimate of nutrient loss into the catchment could be derived from:

- the amount of nutrient applied in the form of fertiliser and manure;
- less the amount estimated to be removed from the property in produce; plus
- adjustments could also be made for physical characteristics likely to influence the risk of nutrient loss in extreme rain events, such as eroded fields and watercourses, slope, or wetlands and vegetation buffers. Similarly, differences between the likelihood of extreme rain events between regions could also be taken into account.

To initially implement this measure a simple system of default estimation models and parameters could be developed, much in the same way as the Carbon Accounting Handbooks developed by the AGO for estimating emissions, or those developed to assist firms in contributing to the National Pollutant Inventory.

While simple in concept, the institutional infrastructure to monitor and enforce the charge is likely to need considerable development, based on some form of accreditation and/or auditing. However, the same system would be equally useful in dealing with other environmental issues, such as biodiversity, salinity control and soil acidification. The Environmental Management System ISO14001 standard and accreditation processes are a possible tool, particularly in the future, however the commercial nature of the transactions being based upon it could justify greater auditing effort than currently takes place.

Emission charges could be varied to attempt to take into account the timing and location of the discharge, based on an evaluation by catchment or government body's on the differential impact on the reef. Interaction between wetland creation or protection further down in the catchment and the level of the charge is an issue.

<u>Emissions trading</u>

Under a system that allows emission trading, the total load of nutrient emissions into the GBR lagoon is determined and capped (through regulation) and the rights to emit a certain type of pollution is allocated among polluters. Polluters may trade the rights.

Like the emissions charge, it would be broadly based, although multiple permits for different pollutants could complicate the trading system somewhat.

Much of the monitoring and enforcement infrastructure overlaps with the emissions charge instrument outlined above. The extra cost would be facilitating trades, although this could perhaps be achieved reasonably cheaply by using internet technology and a broker. Designing the permits to allocate risk between the permit holders and the environment and to allow the incorporation of new information over time is an issue.

The development of a secondary market in permits facilitates risk management and the quick adjustment of distribution of permits as circumstances change over time. The permit system offers a quick way for government and/or community groups to adjust the total amount of pollution through purchasing permits.

Emissions trading provides security over environmental outcomes, while the price could vary considerably. The reverse is true for environmental taxes such as the emissions charge above. A combination instrument may be achieved by the government capping the market price of permits to pollute by selling permits into the market at a set price.

Trading instruments rely on transactions to realise efficiency gains and the overall economic cost of the mechanism. If markets are small (eg if nutrient emission markets were segregated by trading rules to account for differential water quality impacts on the basis of where emissions occur in the catchment), the number of potentially viable trades might be too small to justify investment in market infrastructure to facilitate trading. Similarly, the risk of efficiency gains being lost through use of market power by one or two large players becomes more likely, the smaller the market.

Trading is like a hydraulic system in that it extends market pressure equally to all points around it. Broad application of trading can reveal or exacerbate problems in the same way that the salinity impacts of trading between irrigation regions on the Murray have become an issue.

The allocation of permits gives a wide scope for the amelioration of equity and property rights issues. Regular auctions can help establish a market price and limit barriers to new entrants. Property rights and structural adjustment issues will tend to be related to the level of adjustment required to get to the cap, however trades after that point are voluntary and hence effectively compensated.

Bubble-licensing

In this instance a regulator specifies the aggregate nutrient load within the bubble (the bubble in this instance may contain a number of farmers undertaking similar type enterprises) and the bubble sets a limit on the total pollutant load generated by the sources within the bubble scheme rather than specifying limits on each individual source.

Bubble licences are a form of regulation that facilitates flexibility to achieve targets. Achievement of targets within the bubble may be through formal trading or permits, say within an industry sector, or through negotiation.

A bubble licence scheme has been used in the Hawkesbury-Nepean River system to control nitrogen and phosphorous emissions.

Environmental tender

An environmental tender system allows polluters to enter into an agreement with a central authority to provide environmental management services, for example riparian revegetation to reduce sediment run off or adherence to a reduced stocking rate regime.

The tender is voluntary and allows polluters to specify their price for environmental management that they are prepared to offer. However, it is conducted on a sealed bid basis and the government pays the tendered price, not a market price or fixed subsidy. Bids are ranked and purchased on a best value for money basis.

Multiple environmental values may be purchased, and the tender operator can incorporate sophisticated geographic and physical information into its tender assessment process, and quickly change the tender evaluation process as new information comes to hand.

Tenders can have comparably high transaction costs, particularly for individual landholders. This will tend to increase the tender prices paid to achieve a desired environmental outcome.

Inducing technological and cultural change and capacity building.

Extension and information provision

There could be considerable scope for public benefits in terms of reduced pollution from the provision of information to landholders about the best way to operate their properties on a sustainable basis.

An example of the provision of information and win-win options is the "cleaner production" program in business. The "cleaner production" program through incentives to businesses makes public the economic and environmental benefits that can be reached through better management of production with the aim to encourage other businesses to adopt best practise cleaner production.

Adopting better environmental practise on an agricultural property (revegetation riparian strips for example) could see less fertiliser and sediment runoff and therefore the retainment of better soils on farm and the reduction in fertiliser application rates – a benefit for the agriculturalist (reduction in input cost) and a benefit for the environment (reductions in chemicals and sediment flowing to the reef). Provision of information on win-win options should be provided to landholders as a first step in the effort to reduce pollution to the GBR.

For example the use of cell grazing has demonstrated benefits in many grazing systems where both higher productivity and better environmental outcomes have been demonstrated. Similarly the use of dedicated tractor laneways can reduce soil loss while simultaneously increasing productivity and reducing farming costs.

While the initial impact on levels of pollution may be substantial, improving the profitability of the sector over time is likely to lead to increases in pollution over time as the size of the sector increases. If this is significant, a mechanism to ensure overall environmental outcomes over time is required.

Cross Compliance

Cross compliance may be used to drive the uptake of new monitoring and enforcement infrastructure or best management practice. Examples could include the linking of incentives schemes to property management plans, voluntary codes of practise or an approved environmental management system.

The Hildebrande report suggested that in some circumstances making the sale of sugar to a mill contingent on abiding by the Code of Practice, as occurs in NSW.

Duty of care and information infrastructure

There are two elements to environmental management systems. First, they are an information system that details the links between activity on the property and the environment. Second, predicated on obtaining this information, the landholder works towards reducing the impact of their activities on the environment over time.

The most cost-effective actions to undertake in reducing environmental impact may vary by landholder and across the landscape. The flexible mechanisms outlined above aim to differentiate between landholders and activities on the basis of cost.

However, the value in having the information systems in place with which to target activities and verify their outcomes is common to all landholders, and it is a tool for getting landholders up to speed about their impacts on the environment and how they may be reduced. It may be cost-effective to specify a reasonable or minimum level of investment in environmental management system as part of a landholders duty of care towards the environment, even if the level of specific measures to reduce pollution are achieved through other policy instruments.

Rewarding using current or new tax mechanisms

Tax systems at all levels of government are readily accessible by the community and have a powerful influence on the behaviour of individuals.

However, their primary purpose is to raise revenue and it can be difficult to use them to target environmental outcomes. This problem can be overcome to some extent by targeting environmental outcomes through other mechanisms.

Rate rebates for land being used for conservation purposes have been introduced in a number of councils around Australia. They can have a powerful effect in changing community perceptions of land which is not being directly used for commercial purposes as unproductive, even if the actual value of the rebate to the landholder is small. Some degree of rate rebate could be extended to include land covered by an environment management system, or which meets certain best practice environmental management guidelines.

Rate rebates also undermine the revenue base for local councils. An alternative may be impose an environmental levy on landholders and make discounts available based upon a simple system rating the overall environmental performance of the landholder. The rating system may be kept relevant over time through periodic review or having sunset clauses.

Controlling pressure on the environment

Offset schemes

There are a number of variations around the offset concept, although they are all predicated on capping the level of pollution from a regulated sector. The cap may be set higher or lower than the current level of pollution. The offset concept allows the regulated sector the option of expanding and increasing its emissions as long as it can find ways to by funding pollution abatement in other ways.

The growing differential between pollution abatement costs from point and non-point sources is driving the use of offset schemes in which regulated point source polluters receive credits for funding pollution abatement from diffuse source polluters. An example is the Watercorp of Western Australia's funding of an extension and grants scheme to improve local diary farmers' management practices in Busselton. Waste from the diary farmers' was ending up in the same tributary as outflows from the sewerage plant, and the Watercorp estimates it is reducing significant abatement at considerably lower cost than it would if it spent the money upgrading plant to meet stringent emissions requirements.

Offset schemes are efficient in that they allow development where the benefits from increasing pollution exceed the costs of achieving the same net pollution outcome in other ways, but block development which is more marginal.

Responsibility for organising offsets is left with the regulated sector, and difficulties can lie in specifying eligible offsets and securing the outcome of abatement activity over time. Pollution in one catchment that is offset by remediation in another will not allow catchment specific issues such as pollution concentration build up to be addressed.

Offsets have recently been seen in the aquaculture sector where increases in nitrogen from aquaculture development have been offset through the purchase and retirement of cane land.

Offset schemes may also applied to environmental commodities such as wetlands.

Environmental banking or brokering

Environmental banking is a variation on an offset schemes which gives scope for third parties to generate credits for pollution abatement and make a profit selling them on to the regulated sector. The regulated sector can benefit from the consolidation of expertise in pollution mitigation or the development and rehabilitation of environmental assets, such as wetlands.

The risk of adverse outcomes can be reduced if the schemes are, at least initially, operated in conjunction with NGO groups.

Managing the distribution of costs and benefits

Revenue recycling

Revenue raised through incentive-based instruments may be returned to the sector or local community or region without undermining the incentive value of the instrument.

Examples are funding environmental research and extension services, community projects such as rehabilitation of wetlands which offset the need for on-farm pollution

abatement, structural adjustment assistance for the industry and local regions, or funding economic measures which assist farmers in meeting increased regulatory requirements, such as emissions estimation and monitoring.

Levying beneficiaries

Funds from levying beneficiaries can be used to ameliorate the costs to landholders and their communities of reducing pollution in the Great Barrier Reef lagoon.

There is a large range of beneficiaries of improved water quality in the Great Barrier Reef lagoon (see Figure 1). Some of these values are of a public good nature, justifying a portion of funding from public sources. Specific beneficiary communities may be identified based on their proximity, *i.e.* coastal urban areas, or use of the reef for commercial or recreational purposes, such as dive charters and fishing.

As revenue raising instruments, environmental levies are not intended to change behaviour, in contrast with the incentive-based instruments outlined above. The economic value lost from behavioural change as people try and avoid the levy is a cost of the instrument, to the extent their behaviour is not directly related to land-based pollution of the lagoon. This is manifested in local councils being concerned that, as a result of a levy, development will occur elsewhere, or that an additional levy on tourist operators (who are already taxed) will, if passed on to tourists, dissuade a certain portion from visiting the region.

References

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