Conflicts and value trade-offs in the management of common property: insights from land use studies in the Australian Sugar Industry

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ABSTRACT

Traditionally, benefits of common property arrangements arose from complementarity in resource use, which permitted multiple uses for several users. Today, common property resources (CPRs) represent quasi-public goods, featuring increasing rivalry in consumption. As the domain of uses widens and number of users rises, potentially competitive activity increases, leading to greater conflicts. Non-excludability of benefits and rivalry in consumption of the common good promotes exploitation and escalates the risk of overcrowding in the absence of mutually binding agreements amongst users. This paper argues that the primary source of difficulty in achieving such binding agreements is the dilemma presented by the dichotomy in individual interest and common values. Differences in individual circumstances typified by endowments, beliefs and cultural make-up define individuals' capacity to respond to changing social norms and livelihood opportunities; rapid social change, instigated by globalisation and information technology, influences individual aspirations and value perceptions. Drawing on land-use studies in the Australian Sugar Industry, the paper illustrates how such conflicting and diverse values can be incorporated in quantitative analyses for determining socially acceptable trade-offs between alternative resource allocation strategies for production and conservation. In addressing the needs for preserving environmental quality as a common property and agricultural pursuits for private interest, the paper concludes that in a larger system, multiple use benefits may be gained through dominant use management. Coupled with discriminatory access restrictions and incentive structures, it provides an efficient approach to manage CPRs in the best interest of the community. The role of institutional innovations to foster community cooperation for governing common property and enhancing individual responsibility in private property management is highlighted.

Introduction

Developments over the past two decades have seen a resurgence of interest in common property resources. This has come about in response to a rising awareness of problems that transcend geographical, political and generational boundaries, and their potential impact on economic growth. As a result, the attention is moving from local commons such as fisheries and grazing areas to a new generation of 'global commons' such as the environment, the Internet and global financial systems. This move has been prompted by a growing awareness about the impacts of land degradation on production capacity, a concern about intergenerational equity, and uncertainties about global phenomena such as climate change. Consequently, the focus of governance has begun to shift from central control to local management, embracing cooperation (Kaul, Grunberg and Stern 1999).

In the meantime, there is a growing interest amongst international agencies to seek solutions to global problems based on successful local level common property institutions. Traditional resource use systems that take advantage of natural conditions are attracting interest and being encouraged as viable alternatives to achieve sustainable production (Huxley 1999). This attraction lies, at least in part, on tradition based common values that feature such systems, as against market-based private values that characterise the burgeoning global economy. In searching for lasting solutions to complex issues, such as environmental management in a society dominated by market forces, useful insights may be gained from methods to integrate market and community values in economic analysis.

Moreover, a softening of tariff barriers for trade, enhanced movement of financial and social capital across borders, and an unprecedented level of technological development brought about by the silicon chip, have contributed to a profound change in social perspective to view the world as a global village. Increasingly, we are seeing the world around us as an interconnected system, and in particular beginning to appreciate the critical dependence of our social system on natural resources (World Conservation Strategy 1980; Quiggin 1997). The vulnerability of our economic system to changes in natural conditions demands superior policies to manage natural resources to meet global food demand (Rosegrant and Ringler 1997). Moreover, we are looking back in time to find solutions to complex social problems of the day, often with a broader view spanning beyond narrow disciplinary bounds.

This emerging trend, in many ways, has been brought about by the perceived flaws in the economic system that enabled modern society, known commonly as market failures. The market system, with its central device of individual choice, exchange mechanisms, and opportunities for creating private wealth has transformed social perceptions. On the one hand, social advancement in the second half of the past century has led to a situation where the natural order of traditional systems has been replaced by a new set of social values driven primarily by the motives of freedom, democracy and private enterprise. On the other hand, in the context of the change in social perspective that began towards the turn of the last century, there is a growing disparity in the expressions of private and social values (Arrow 1967), which presents a set of new challenges in the form of resource use conflicts. For example, since the rise to prominence of environmental concerns, the pre-existing set of property rights that enabled private enterprise, has been overlaid by a new set of common property rights held by the public as a whole and allowing the imposition of constraints on activities seen as environmentally damaging (Mallawaarachchi and Quiggin 2001).

In this paper, the resource management problem in the Australian sugar industry, operating in a coastal environment, is identified as one of common property management. The objective is to draw on a set of land-use studies in the Australian eastern seaboard, to illustrate how conflicting and diverse community values can be incorporated in quantitative analyses for determining socially acceptable trade-offs between alternative resource allocation strategies for production and conservation. In addressing both the needs for preserving environmental quality as a common property and agricultural pursuits for private interest, the conflict between collective choice and private interest in the management of public goods is discussed. The role of values and choice in the determination of efficient allocations is examined in the light of two land-use studies in the Australian Sugar Industry. Insights are drawn on the relevance of these approaches for analysing management options in the coastal zone and across global commons in general. The following overview of CPRs and associated resource systems provides a preamble to this analysis, and identify some key features that will be explored further in the case studies presented.

Management of the commons

Discussions on common property revolve around two separate issues: the concepts relating to resource systems and those concerning property rights. This paper focuses on resource systems under joint ownership, known also as common pool resources (CPRs) and their management in association with private property.

Resources provide streams of benefits that may be enjoyed as private individuals or in common. The nature of these consumption possibilities are often used to treat goods and services derived from resources as either private or public goods. Nonexcludability of access and nonrivalry of benefits are key features of a pure public good (Table 1) (see also, Cornes and Sandler 1996). For this reason, they represent open access resources, and their use benefits may be obtained by any one so long as the property exists and the effort required to capture benefits is less than or equal to the level of benefits gained. When produced, such goods are freely accessible to anyone who seeks access and there is no market mechanism to gauge the level of preferences for pure public goods. Therefore, in a competitive economy, optimal conditions for their provision may not be met and a continuous supply of public goods may not be guaranteed (Randall 1972; Cornes and Sandler 1986; Cornes and Sandler 1986). Most public goods, however, do not fall in to this extreme category.

Impure public goods, for instance, include two important subcategories: common pool resources, a form of quasi public goods, that represent natural and human constructed resources in which exclusion of beneficiaries is costly and exploitation by one user reduces the availability of the resource for others (Ostrom, Gardner and Walker 1994). This definition, based primarily on appropriability, accommodates local level CPRs such as waterways, wetlands, beachfronts, grazing grounds, etc., regional CPRs such as rivers, fisheries and marine reserves, groundwater aquifers, rainforests and the like to global commons such as international waters.

Table 1: Classes of goods

	Domain of benefits	
Nature of benefits	*Excludable*	*Non-excludable*
Rival	Private goods	Quasi-public goods
Non-rival	Club goods	Pure public goods

A club good is a more restricted form of impure public good that is characterised by excludable benefits. Under a voluntary arrangement, a club shares either the costs of provision of members' characteristics or a good characterised by excludable benefits. A club is an important social invention: participation is voluntary in that the utility jointly derived from membership must be greater than the utility of independence or non-membership; sharing minimises costs, but increasing membership leads to overcrowding, forcing membership to be finite. An exclusion mechanism, such as a fee or a toll, prevents free-riding and restricts access to subscribers. To be effective, the fees must be set in a way that the cost of the exclusion mechanism is less than the benefits gained from forming the club. Club arrangements are also important mechanisms for resource allocation, because they form partitioned populations (Cornes and Sandler 1986). Of interest to natural resource allocation are various environmental interest groups, user organisations and lobby groups who are involved in collective action to pursue public goods.

Free access to the use of public goods and CPRs leads to dilemmas in which short-term interests are maximised at the cost of long-term benefits. In the absence of effective rules limiting access and defining rights and obligations, substantial free-riding will result. Congestion or inefficiencies related to overcrowding often prevail under common property arrangements such as common grazing grounds, fishing areas, fauna parks, etcetera. As a result, and over time, institutional arrangements have resulted in the definition of property rights that specify rights and obligations of the users of the resource (Bromley and Cernea 1989; Bromley 1989). However, problems of easy-riding where users obtain improper advantages of the collective benefits are associated with common property arrangements. Variable success rates of such arrangements around the globe indicate that designing and operating these institutions involve significant challenges including difficult collective choices to accommodate the wishes of different stakeholders (Ostrom et al. 1999). Improving our understanding of the operational context of CPRs may prove helpful in meeting such challenges.

The context of common property

By their very nature, CPRs mean different things to different people. At least economists' misuse of the term to describe the situations of open access has waned and open access resources are virtually ruled out of existence in most parts of the world because of various access and governance regimes (e.g., Convention of the Law of the Sea). The important systems of property of interest to a discussion of CPR, therefore are: the group or communal

property representing rights exercised by a defined group; individual or private property with resource rights held by individuals or firms; and government of state property where the resource access and use is defined by government statutes. As highlighted by Quiggin (1993), Edwards and Steins (1998) and Petrzelka and Bell (2000), CPRs must be understood in their specific contexts of resource use, including their intimate association with private property. This is of particular importance to multiple-use CPRs, such as the Great Barrier Reef, which are characterised by a multitude of extractive and non-extractive uses under different management regimes, over extended periods (Edwards and Steins 1999), and subjected to a multitude of influences from land-based activities (Wachenfeld, Oliver and Morrissey 1998). Understanding this context is crucial to learn from past performance of CPRs, and to define management strategies to replicate success stories in different contexts. With this view, the following discussion draws on examples from other regions familiar to the author to derive some useful insights pertinent to the theme of the paper.

Evidence from other settings

Edwards and Steins (1999) define contextual factors as "*dynamic forces constituted in the user groups' social, cultural, economic, political, technological and institutional environment".* These in turn, have a major influence in the choice of strategies for CPR management and affect "both the demand for, and supply of, benefits derived from the resource system". These forces include factors external to the system and those, which are internal in nature. For instance, Bromley and Cernea (1989) argue that the breakdown of many traditional CPRs were largely due to external influences that triggered social change. Numerous examples from the intra-tropical region indicate that the colonial era, and national development policies centred around plantation agriculture and cash crops that followed, initiated a wave of social change leading to diminished importance of the commons in favour of private enterprise (Bromley and Cernea 1989; Ostrom et al. 1999).

While communities responded to the incentives offered to enhance income opportunities, in adopting more exploitative forms of agriculture under private ownership, the evolving farming systems, such as in Sri Lanka, Malaysia and India, incorporated important features of traditional common resource systems that 'optimised' the use of resource through different forms and intensities of use over time and across space. A key point often overlooked in literature is the careful balancing of activities in those systems to accommodate multiple uses including competitive, complementary and supplementary activities (Etherington 1981; Thilakasiri 1985). The practice of multiple cropping, agroforestry, organisation of activities in different components of the farming system to allocate available labour and to meet basic subsistence and cash crop demands, and crop-livestock integration to maximise the desired bundle of output, are some examples of such resource management strategies derived primarily from past experiences with the common (Ibrahim, Thilakasiri and Mathes 1984).

As espoused by Quiggin (1993) following Baumol, Panzar and Willig (1982), such joint production activities offer *economies of scope*, where it is cheaper to produce one or more product jointly than to have them produced by separate farms. This is particularly important for those products, meant primarily for family consumption, noting that intra-family consumption patterns may differ reflecting demands placed on their labour. Often, dietary habits of women who perform lighter duties differ substantially from men who worked long hours in the field. Organising the utilisation of available resources to support a given farming system and family welfare in the provision of multiple outputs desired was therefore a key management strategy (Huxley 1999).

Most notably, configuration of activities across the landscape derived the benefits of *spatial complementarity* of resource use in terms of fertility gradient. Sequencing of activities to match rainfall distribution captured *temporal complementarities*, and allocation of activities amongst and within households offered *social complementarities*. The result is a highly resilient system that permitted high level of resource use efficiency. Organisation of activities, largely following the rules of nature, also embodied risk management, which was essential in the absence of institutionalised external support in times of misfortune. The *economies of scope* described earlier may be attributed to the collective influence of such complementary relations. In the contemporary context, these features of traditional and evolving systems offer valuable insights for addressing multiple use management in a multi-user environment, as applicable to forestry, fisheries, wetlands and many crop and livestock industries.

Cultural influences

Some other features integral to most CPR systems are the ethno-cultural, religious, and other belief systems founded on tradition. While physical determinants may influence the location of farm plots, or the access points to a fishery, how and when they are used will be determined by social factors (Lal 1998; Crean 2000). These factors influenced the close nexus between individuals and natural resources, which were often held in high esteem because of the power associated with their possession. Moreover, seasonality and time-critical nature of activities created a strong interdependence between members of the community who shared their resources within the group. Often, activities were organised to enhance group benefit drawing on reciprocity and trustworthiness of group members and guidance received from the local leadership. These activities reflected strong complementarity rather than competition, and offered flexibility in responding to external pressures on the livelihood system. Such organised collective action is highly compatible with observations in other CPRs across the globe (Ostrom 2000).

For instance, in lowland agriculture in Sri Lanka, individuals in a village shared their family labour and cattle, that provided the primary farm power to meet peak demand during highly time-critical land preparation and harvesting periods. In land preparation, cattle were often used for the first till following the fallow, while family labour was used for lighter, second and subsequent tills. Sequencing of activities along the slope of the valley, with the plots on the upper end commencing first, enabled efficient water use and resource sharing to match critical needs. This time delay also provided flexibility in meeting peak demand during harvesting. In appreciation of the common benefits of cattle to the community, rice paddies owned both by private and shared arrangements were used as common grazing and breeding grounds, following the harvest. Outside this fallow period, when rice occupied the field, cattle were raised on wet savannas within the forested portion of the landscape. Lactating cows and bullocks were managed on-farm, with wayside grass and supplementary feeding with stored straw. Milk supplemented nutritional needs of the family, and provided a source of exchange for other goods, while bullock driven carts provided the only means of heavy transport for the majority of the community (Ibrahim, Thilakasiri and Mathes 1984).

External influences

As noted in the vast literature on CPRs, the collapse of these systems, essentially during mid to late 20th century in the case of Sri Lanka, were largely influenced by external factors. Technological advancement and competition for land induced by tree crop agriculture; green

revolution, that produced short-term varieties of rice, and enabled double cropping; mechanisation that offered incentives for moving away from cattle, that already lost their feeding and breeding grounds, facilitated a chain of events that resulted in the current context. The commercial food-crop agriculture that replaced the subsistence sector has released much of the rural labour, and provided alternative off-farm income opportunities.

However, declining terms of trade, crop yields, and land quality are threatening the sustainability of the farm sector (Gunawardana and Somaratne 2000). The opportunity costs of environmental degradation resulting from deforestation, pollution, unproductive lowland agriculture and their widespread social implications are well documented in other regions (Phantumvanit and Sathirathai 1988). Nevertheless, the level of economic opportunity gained during the structural transformation of economies cannot be understated. Improvements in transportation, health and education have increased incentives for capital formation resulting in greater economic opportunities. In particular, new opportunities in growing commerce, service and value adding ventures assisted by external capital transfers and modern technology has raised aspirations of communities to enhance living standards (Japan Environmental Council 2000).

The context elaborated above, and such unintended consequences are equally applicable to many communities across the globe who are facing an enduring dilemma presented by a free-world, ripe with opportunities for individual excellence, and dwindling traditions and beliefs that once held communities together in a low-input-low-output environment. In the following section, the resource use context of the Australian Sugar Industry, which enjoyed a significant growth phase over the past decade in a fragile coastal environment, is examined to analyse implications for maintaining its viability and the well-being of a community closely associated with it.

Resource use planning in the Australian Sugar Industry

Sugarcane growing is an important economic land-use along the northeastern Australian seaboard. Most of Australia's sugarcane is grown on coastal plains and river valleys along 2100 km of the coastal fringe between Mossman in far north Queensland and Grafton in northern New South Wales. Sugar cane is one of the highest value agricultural commodities in Australia, worth over $2 billion annually, and is of particular importance to Queensland and the coastal towns of Northern NSW. The sugarcane area in Queensland has increased by 44% since 1990 to around 509 500 ha in 1999, and now represent 95% of Australia's total sugarcane area (Canegrowers 2000). New South Wales produces most of the balance 5% from a growing area of about 33 000 ha. A rapid expansion of this magnitude coupled with a rise to prominence of environmental concerns of development, turned a segment of the population against the industry despite significant national and regional economic benefits of the expanded industry. With the importance of environmental values becoming increasingly known in the community, there is rising pressure for reform in natural resource management in the Australian sugar industry to reduce environmental risks. Changes in public policies, community values and the market conditions have redefined the industry's operating environment from a dominant regional industry to one co-located in a multi-user setting. The major planning problem in industry management is how to balance individual benefits of cane growing and sugar production against the collective impacts on environmental public goods (Mallawaarachchi 1998). Achieving this goal without undue influence on the viability

of the industry and the well-being of a community dependent on it represents a further dilemma in planning and management.

Changing face of the sugar industry

The current location of the sugar industry along the coastline of northeastern Australia has been the result of progressive growth of the industry over the past 135 years. The availability of good soils, access to transport and a climate that supports successful growth of cane has determined the industry's present location. Protected markets in Europe, a ready flow of capital to the colonial mill owners, cheaper supplies of immigrant labour and a system of regulations protecting the industry laid the foundations for establishing the new export industry.

This initial growth phase was followed by a period of consolidation following controls introduced to safeguard the interest of established growers and mill owners from declining returns caused by growing supplies. The cane assignment system introduced in 1926, and discriminatory pricing that followed discouraged production on unassigned land and favoured higher returns to established growers. Assignment conditions stipulated that cane was grown only on specified land and that growers were required to deliver cane raised on assigned land to a dedicated mill, who were obliged to accept all cane so produced. This monopsony arrangement provided certainty to growers and millers but led to a series of conflicts relating to the share of benefits between the two parties. A pricing formula for cane was introduced in 1970, and amended later in 1979 to reflect a combination of economic and financial variables that relating to costs of production and processing.

A relative resource abundance, mechanisation and improvements in production technology, and growing land ownership amongst migrant labour encouraged further productivity improvements leading to significant capital accumulation and investment (Males 1994). Canegrowers organised under a central lobby group, CANEGROWERS, resisted government calls for deregulation until 1985. Changes occurred since 1985 led to the abolition of import embargoes in favour of tariff restrictions, changes to marketing arrangements and gradual restructuring of the industry. Moreover, further deregulation since 1991 has permitted a rapid expansion of the industry, with both the number of growers and the size of farm holdings and industry output increasing significantly.

Implications of industry expansion

The rapid expansion of the industry has created many economic opportunities. Yet, this benefit was achieved at significant indirect costs. While the industry was originally confined to areas of better soils, expansion has taken cane growing into less fertile areas. Modern production methods rely on added fertilisers and agrochemicals. Climatic limitations are often managed with supplementary irrigation, while agronomic practices and advances in plant breeding have raised industry productivity. Markets have become more competitive and substitutes for cane sugar are available.

During the expansionary phase of the industry's development, the focus was on the appropriate rate of expansion because the social costs of expansion were perceived to be low. In contrast, the mature phase of industry development is characterised by rising costs (monetary as well as social). For the sugar industry, these costs relate mostly to land because

land prices are driven by direct and intense competition among different resource users. Increased interdependencies among natural resource users also direct community attention to the social costs of externalities associated with land use.

With much of the industry in its mature stage, several issues become relevant. With the abolition of import tariffs, government assistance has diminished and industry profitability will become an important issue in determining continued growth. Factor pricing will become more competitive with greater attention paid to social costs, in particular, the non-cash components of the cost of inputs such as land, water, and nutrients and services such as harvesting and transport. Absolute and relative scarcity of cane land, externality problems associated with intensive farming, and differences of opinion among different kinds of land users will become increasingly relevant in the Australian sugar industry in coming years. For instance, more competitive capital markets have led to a shortage of investment capital in the milling sector. The traditional sugar town is becoming more diverse, with a growing population employed by other industries and an expanding service sector (Mallawaarachchi 1998).

In addition, advances in communication, improvements in general literacy, access to information and a changing lifestyle has made the 'bush' an attractive recreation facility. The economic value of the sugar industry is now viewed in tandem with other options for land use, including the conservation value of environmental resources that are being either replaced or altered due to sugar industry activities. The result is declining profitability and an increasing level of community scrutiny of industry activities for an industry which faces growing competition for land, and a population that takes a keen interest in managing the natural environment (Johnson et al. 1997; Marohasy 1999). Economics of resource use has become an increasingly important issue in industry planning and management to minimise social externalities.

Externalities

Externalities represent a wide variety of costs and benefits, which are not normally included in prices and charges. Some environmental externalities associated with sugar industry land use, also shared with other intensive agricultural industries, include the diffuse source pollution problems arising from run-off of pesticides, fertilisers and mill effluent (Mary Maher and Associates 1996; Johnson et al. 1997; Rayment and Neil 1997). Mallawaarachchi (2001) identifies two sources of externality associated with cane production in Australia: expansion of production area; and increase in production intensities on existing areas.

Expansion of the sugar industry following 1991 partial deregulation led to a growing number of environmental disputes, and attracted publicity amongst a fast-growing urban population in the region. Mary Maher and Associates (1996) and Johnson et al. (1997) identify a number of environmental issues connected to the sugar industry. The most pressing issues arise from an expansion of the area of land assigned for cane farming. In the absence of careful planning, expansion can create problems such as: altering the existing drainage regime, including wetlands, poorly drained coastal plains and coastal waterways; clearing of critical habitat and significant vegetation communities; disruption to aquatic life, water flows and fish breeding grounds; and fragmentation of previous integral native habitat.

Sustainability

In recent years, considerable emphasis has been placed on the sustainability of the sugar industry. For practical purposes, sustainability may be interpreted broadly to encompass two main concerns (Quiggin 1997). The interests of future generations should be given equal weight with the present in making decisions affecting the long term future (Howarth and Norgaard 1990); and the limits to substitution between man made capital and natural assets should be taken into account in resource management decisions (Hartwick 1977). In particular, it should not be assumed that capital, that is technology embodied in produced goods, can be substituted indefinitely to compensate for land, taken broadly to include all the contributions of the natural environment to human welfare (Quiggin 1997).

As with other intensive agricultural industries, soil erosion and land degradation are important issues, raising concerns about the long-term sustainability of the industry. In addition to the loss of productive capacity, soil erosion on land used in the sugar industry has the capacity to generate downstream environmental damage arising from siltation and deposition of soil along and off the coast (Moss et al. 1996; Rayment and Neil 1997). Considerable progress in controlling soil erosion has been made in recent years, combining traditional stabilisation measures such as contour banks with innovations in farming systems such as green cane harvesting and trash blanketing. Yet, runoff from cane farms remains a contentious issue in North Queensland.

Over 50 per cent of cane farms in Queensland use supplementary irrigation (Danzi, Rudwick and Topp 1997). Given much of the recent expansion has been on to marginal land, and in areas of low and uncertain rainfall, the demand for irrigation has increased significantly. There are problems associated with this growing demand for irrigation water (Mary Maher and Associates 1996; Johnson et al. 1997; Rayment and Neil 1997). Intensive agricultural industries based on irrigation have encountered numerous sustainability problems relating to salinity, siltation, and drainage (World Commission on Dams 2000; Quiggin 2001). The sugar industry is facing similar risks in major producing areas.

Resource use conflicts

These environmental concerns related to the effects on the natural environment of sugar industry expansion, externality implications of intensive growing practices and concerns over sustainability of resource use have led to a high level of conflict between economic and environmental objectives of land use within the sugar cane growing regions of Australia. The protracted dispute over the protection of an endangered species, the mahogany glider (Queensland Department of Environment and Heritage 1995), and the concerns of environmental interest groups over land allocation decisions by local Cane Assignment Boards are both examples of conflicts between conservation and development. In addition, the growing demand for residential and urban infrastructure developments along the coastal belt is placing economic pressure on cane farms. Hence, the level of interest and the range of stakeholders concerned with expanding natural resource use in cane growing regions has broadened substantially in recent years (Johnson et al. 1997).

Managing difficult environments

Having located in the coastal region, sugar cane farms run the risk of exposure to acid sulphate soils which typically occur in low lying land below 5 m AHD[1]. Acid sulphate soils (ASS) are the result of long-term bacterial activity in organic rich sediments now underlain by later alluvium. These soils are generally found in low-lying areas along the coastline, estuaries and estuarine flood plains throughout sugarcane areas of NSW and Queensland. In NSW, extensive deposits have been identified in the Tweed, Richmond and Clarence regions of north coast, which are important cane growing areas.

Moreover, continuous monoculture over a long period has exposed cane farms to natural fertility decline and some areas are indicating severe subsoil acidity (Mallawaarachchi, Hurney and Noble 1998). In other areas sodic soils, poor drainage and structural decline are causing productivity impacts.

Presence of these conditions means that growers need to take precautionary action and follow agreed management protocols to ensure that their activities are environmentally responsible. Additional costs incurred in doing so cannot be passed on to consumers, as they are price takers in an international market.

Impact on public goods

Both farm and non-farm development activities within cane growing regions diminish the area of open space that provides for the preservation of species, the provision of clean water, and other goods and services, which have the characteristics of public goods. Further, the activities carried out in developed areas have the potential to contribute to the degradation of existing public good aspects of the open space. Both the diminishing areas of open space, and the declining quality of the available open areas, thus increase the values placed by society on the preservation of land resources with amenity value.

Behind these issues is the question of the nature of institutional structures that might be used to achieve an improved allocation of land with an increasing population and a desire to improve living standards. Moreover, mutually acceptable solutions to resolve conflicts that surround land assignment within the industry have important implications for the economic viability of the industry, the ecological integrity of natural resources and the well being of regional communities (Mallawaarachchi 1998).

Resolving conflicts in resource allocation

Conflicts are a result of lack of consensus. Consensus can be reached through either coordination or isolation. Coordination permits guiding the conflicting situation towards harmony, while, isolation excludes the opportunity for conflict to arise. Isolation may be metaphorically seen as independent sets formed by the inclusion of elements denoting parties with a common purpose, whereas consensus reflects large intersecting areas representing common elements of multiple sets. In the context of the sugar industry, isolation is no longer a viable option, and solutions must be found in cooperation amongst various stakeholders.

[1] Australian Height Datum

Managing private and public benefits in resource management

The economic problem that surrounds the issues discussed above is that of addressing the trade-offs between economic and environmental objectives of resource use. Numerous difficulties are involved in finding a solution to the conflicts because it involves stakeholders with differing viewpoints, differing levels of understanding and ideologies. As indicated by Fisher and Thorpe (1990) following Davis (1988), finding solutions to the problem requires a process of 'legitimisation' to accommodate the conflicting claims. In the case of conflicts over land clearing for cane land expansion, the claims are on the non-use value of conservation to safeguard future use options and existence value, versus economic benefits of development for cane growing.

The fundamental difference between the two claims lies in the ownership of benefits: non use values of natural forests represent a public good, which is available for mass consumption, whereas, the benefits of sugar industry development accrues, in most part, to private individuals. The policy problem is to find the optimal level of public good, given the economic benefits of sugar industry development. Reconciling these conflicting claims requires a framework that is understandable, and at least partly acceptable to all parties (Fisher and Thorpe 1990). Such a framework can facilitate the policy development within the sugar industry in a manner more consistent with stakeholder interests. Mallawaarachchi and Quiggin (2001) presents an allocation mechanism that accommodates multiple use in a spatially differentiated setting within a region.

Mallawaarachchi and Quiggin (2001) used a regional optimisation framework to determine optimal allocations for competing land uses representing production and conservation alternatives. The method, that adopts the Krutilla-Fisher algorithm for total economic valuation (Krutilla and Fisher 1985), utilises scientifically based resource attributes, preference-based community values for environmental goods and market based value estimates for agricultural outputs to determine optimal intertemporal allocations.

The basic rationale of the framework can be summarised in relation to the driving force, state and response model adopted by the OECD (1997) (Figure 1). The model captures the interplay between values that define the operating environment within a cane farming catchment that guides resource management decisions. Implications of decisions are mapped in terms of different outcomes and the feed-back on the very values that impinge on the decisions. In this way, the model allows a robust understanding of the trade-offs involved in alternative decisions, and its implementation within a constraints optimisation framework offer quantitative estimation of opportunity costs under alternative assumptions for the magnitude of variables that drive various model scenarios.

An ability to specify the resource use context, in terms of resource constraints, production opportunities, input and output prices, and values of forgone benefits for environmental assets enhances model's potential to address complex resource management issues.

A detailed mathematical formulation of the model and an illustrative application is given in Mallawaarachchi and Quiggin (2001). The following sub-section describes the way in which the diversity of values was treated in model development.

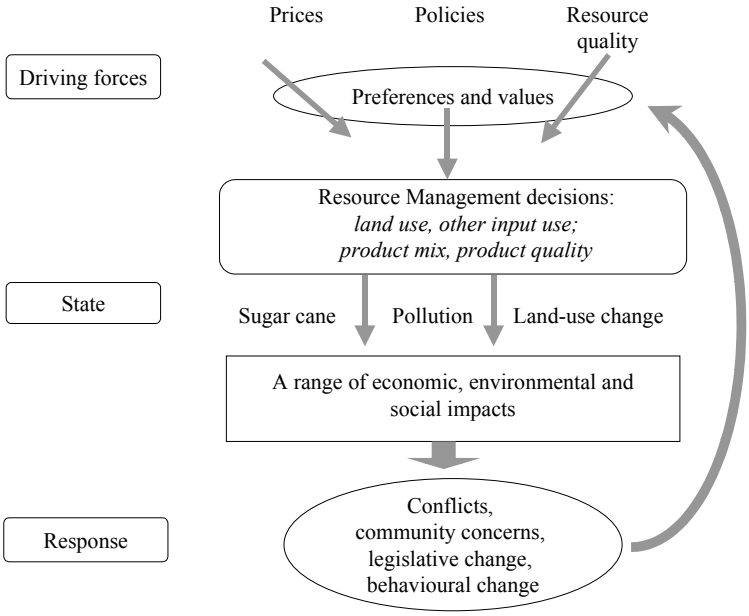

Figure 1: Forces that drive resource use in a cane growing catchment

Determinants of resource use patterns–the drivers

As highlighted earlier, understanding the operational context is crucial in devising management responses. In economic systems, the interaction of demand and supply determines the equilibrium values of prices and quantity exchanged (Hirshleifer 1980). For any resource, the factors that affect the level of aggregate demand and the aggregate supply determine the level of employment of that resource in the economy. Technological change, demand for final products and the availability of cooperating and competing factors causes shifts in demand. On the other hand, wealth, social trends and legal context (institutional setting), investment and accumulation, and demography are important parameters of factor supply (Hirshleifer 1980).

In a given locality, and at a given time, three factors become important in the choice amongst alternative ways of using natural resource endowment: the quantity or the level of stock, quality or productive capacity, and the rate of harvest or rate of depletion of the resources. Within the limits imposed by nature, the absolute effect of these three factors varies widely reflecting the stage of economic development. The stage of economic development determines the level of resource use by determining the level of income and technology. The latter, in turn, determines the knowledge that defines the relative limits of resources, and influences the cultural diversity of society, including tastes, preferences and civic values. These values in turn determine the personal objectives of consumers, entrepreneurs and resource managers, including the choice between reservation and production uses. The resource management contexts discussed earlier relating to both traditional CPRs and contemporary Sugar Industry setting complies with this description.

Civic values of society are primarily dealt with through the political system, and its influence on the economic system is manifest mainly through institutional arrangements, which set the broader parameters for the functioning of the market exchange system. Resultant values influence individual behaviour in market exchange as well as participation in economic activities that affect resource allocation decisions. Broadly, the institutional arrangements, whether they are formally specified or implicitly assumed, define property rights, legal structures and reward systems and shape the personal objectives of resource managers. In essence, the existing institutional setting defines the nature of production and consumption sets.

Property rights

Property can be viewed as a stock of resources that has the capacity to generate goods and services. Property rights specify rights and obligations associated with using property. While property changes its nature over time through use and natural aging, policies that define rights and obligations in resource use alter the effective capacity of resources to generate goods and services. Such policies affect the choice domain of decision-makers, and determine the difference between logical and feasible sets (Bromley 1989).

The definition of property rights makes man-made capital and natural capital somewhat comparable. In general, man-made capital represents bundles of attributes that are well specified and therefore uniquely comparable for the purposes of use and exchange. Although all man-made capital is derived from nature, the process of production enables the specification of unique characteristics and uses whereby the natural capital is transformed to tradeable commodities. Irrigation water and transferable water rights can be used to make this distinction clear. Water is a natural endowment and a freely available public good, essentially only subject to the costs of extraction from a range of sources across the earth. However, uncertainties exist as to its spatial and temporal availability, quality and access in many parts of the globe and even within proximate localities. Construction of a dam, a distribution network, and an allocation mechanism that specifies rights of access and quantities – all of which represent man-made capital – minimise the uncertainties and enable the conversion of the public good resource to a tradeable commodity.

This argument applies to all 'non-destructible qualities of earth' identified by classical economists such as David Ricardo. For this reason, neo-classical economics, which is largely based on the assumption of full information, including clearly defined property rights, does not distinguish between man-made and natural capital. However, the existence of joint costs, disparities in initial endowment, difficulties in negotiating contracts, excessive transaction costs, and physical difficulties in defining the nature of attributes make this assumption open to criticism (Randall 1972; Sagoff 1988; Sagoff 1994).

In reality, land ownership involves a mixture of private and common property rights (Quiggin 1997). In sugar production, the crop itself represents private property while the scenic value, open space and regional resources such as biodiversity dependent on on-farm land use decisions represents common property. A vegetation corridor for endangered Mahogany glider or a drainage scheme connecting several properties is an example of a collectively provided public good, through coordination amongst farmers and other stakeholders.

Endowments

A region marked by geographic boundaries such as a water catchment, or administrative boundaries such as a shire or a district, is a collection of endowments that can be considered as an appropriate unit for the purposes of economic planning. Such endowments include both physical and social entities, with the latter giving recognition to the significance of the community in the make up of regional endowment. Given the variety of agents interacting within such a *meso* scale unit, it is best viewed as a multi-user environment where communities respond to signals originating from the lower level of organisation such as households (micro) and a higher level incorporating national and global scales. This view permits the planner to appreciate the complex interactions between users that influence the functioning of the unit through appropriation and use involving a mixture of private and common property. Economic efficiency, equity, and environmental concerns arising from such influences are of particular interest in natural resource management (Grimble and Wellard 1997).

Technology

Technology embodies knowledge about resources and their use, and defines the feasible set of alternatives in a choice set within existing constraints on the deployment of a resource. Technological advances, such as a high-yielding variety, can bring about an increase in effective supply, leading to an increase in the quantity available and a fall in price. Technological change can also affect demand by identifying deleterious effects, such as carcinogenic properties of products, used as an input to production or produced as a by-product in the process of production. In the past, technological innovations have resulted in greater use of land and capital with a declining use of labour (Antle and McGuckin 1993). Often technological change has permitted productivity increases in the short-run, enabling a limited level of fungibility (Solow 1991), anywhere one kind of resource can be replaced by another in the production process. Technological change has also led to over-use of resources with harmful environmental effects. However, other developments in technology such as drip irrigation, plant breeding, and improved agronomic practices permit economies of scale and help preserve resources for future use. For these reasons, the effect of technology on resource use can vary widely, reflecting other factors such as preferences and values that drive the final demand for goods and services produced in the economy. Therefore, in determining optimal allocations of natural resources, knowledge regarding physical processes and systems or technology becomes an important consideration.

Preferences and values

Individuals' preferences that are revealed in markets by their choice of goods and services, and values that determine the expression of preferences and guide their behaviour in considering social responses, are important determinants of resource use. Individuals also have preferences over institutional arrangements that define the nature of choice sets and over how they can make choices within those choice sets (Bromley 1989). These preferences are in turn driven by social norms and values (Sen 1970; Elster 1989) predicated upon systems of knowledge and beliefs, and thus they influence resource allocation and use. In the contemporary context, differences in individual circumstances typified by endowments, beliefs and cultural make-up define individuals' capacity to respond to changing social norms and livelihood opportunities; rapid social change, instigated by globalisation and information technology, influences individual aspirations and value perceptions.

Therefore, in sum, the resource endowment, technology, market incentives, property rights, and personal objectives of resource managers guide resource use decisions at any given time. Given the differences in personal objectives, endowments and technology available to different economic agents, conflicts of interest often arise in the use and allocation of resources in the economy. Bromley (1989) observes that patterns of interaction in the economy and society produce outcomes that are either benign or offensive, and the social objectives are to constrain antisocial outcomes while providing opportunities to maximise socially desirable outcomes. In this respect "[t]he linkage between institutions, patterns of interactions and outcomes provides a model of cause and effect" (Bromley 1989). For an exchange economy, these properties collectively define the overall opportunity set subject to preferences. On the other hand, for a community representing a region for example, these arrangements define the 'capability set', which incorporates opportunities to optimise both preferences and values. Hence, they are important considerations in modelling regional resource allocation.

Economic-environmental model integration

Mallawaarachchi and Quiggin (2001) incorporates the interdependencies discussed above explicitly by considering the capability set of the region in terms of disaggregated natural resource data, social preferences for conservation and economic opportunities and implicitly by considering the existing policy framework, such as the cane production area assignment system and cane price formula as guidance for allocation within the modelling framework.

The integrated economic–environmental model incorporates on-site environmental benefits of existing natural resource stocks into an optimising model of land use. The spatial characteristics of natural resource stocks are first modelled using Geographic Information System (GIS) tools to prepare a data set that captures the spatial resource variability that affects the flow of benefits from environmental preservation and economic production by providing an implicit ranking of land units in terms of their suitability for sugar production.

Definition of an objective function to measure regional benefits from land use enables the comparison of economic and environmental values. On the one hand, the environmental attributes of land units influence production possibilities and welfare. On the other hand, agricultural production diminishes the quantity of environmental resources in their natural state and may diminish the quality of the environment through pollution.

In the model presented in Mallawaarachchi and Quiggin (2001), we do not capture reduction in environmental quality due to pollution. However, interrelationships between the economic and environmental systems are modelled using choice modelling (Mallawaarachchi et al. 2001), geo-spatial analysis, and a programming model of economic optimisation. Following a contextual overview of preference and value relations that concern choice modelling, the salient features of the choice modelling study are presented in the following discussion.

Capturing individual interests and common values

Capturing diverse values in quantitative modelling is particularly difficult because of incompatible bases for such values. Being cultural constructs, values differ widely between groups and between members of a single group (Lockwood and Spennemann 2000). Sagoff

(1994), (1988) questions the conventional treatment of preferences and values embodied in human expressions. In particular, he argues that the relationship between economic and non-economic concerns is best understood in terms of a distinction between consumer and citizen attitudes. Consumer attitudes are expressed as preferences in the marketplace, and the choices based on preferences relate well to private goods or traded commodities. Citizen attitudes, on the other hand, reflect 'values' or considered judgements a person makes about what is best for the society as a whole, and concern the domain of public values.

According to McAllister (1982) people's behaviour reflects their view of the world, as determined by their values, knowledge and beliefs. Preferences, interests, desires, likes and dislikes condition people's values. Values determine the significance of objects and events to individuals, and in this way, values direct choices. Values guide both actions and the thought process: conflicts in values arise because of scarcity (McAllister 1982). Blamey and Common (1993) and Blamey, Common and Quiggin (1995; 1996) argue that judgements about environmental policy are primarily based on citizen attitudes rather than consumer attitudes. These arise because of the absence of market exchange in environmental dealings.

Preferences based on sight, sound and smell – which are usually associated with environmental experiences – are always subjective and are not tangible in the sense of accounting in market transactions. Such things as visiting the Great Barrier Reef, watching a scenic movie, or walking in wilderness fall into this category of impure consumption, and reflect elements of existence value such as psychic or vicarious consumption, option value, intrinsic value, etc. (Quiggin 1998). On the other hand, values that attach to inputs to production or those linked with a pure consumption element – instrumental or market values – are more amenable to standard scientific inquiry. Nevertheless, systematic inquiry can explore the cause–effect interactions between preferences and values to provide a basis for comparing market and non-market values.

Knowledge gained through scientific inquiry plays a dominant role in understanding physical and biological relationships; but social understanding is gained primarily through personal experience. When both scientific and personal knowledge is weak, we are forced to rely on beliefs (Sen 1970) which have their roots in religious, political, moral, ideological and cultural values (Sagoff 1994). When the knowledge is uncertain (Wynne 1996), political or social deliberations allow people to argue their beliefs on their own merit (Sagoff 1988; Bromley 1989), permitting them to respond to changing circumstances. Essentially natural systems cannot themselves react to observations made about them; yet, in social systems predictions on the outcome of observations may change the predicted outcome (Checkland 1999).

Deliberations involve analysing observations and trading off differing views to achieve consensus. At times, a particular group or groups can capture a political process, to promote their view to serve their own interests than the public good (Lockwood and Spennemann 2000). Such groups could comprise experts, whose entrenched professional values may weigh more in the decision process than the views of the majority community holding unsubstantiated facts or firm beliefs. On the one hand, unimpeded expert advice is often necessary to guide decisions in the absence of firm evidence; however, decisions founded on ill advice could often result in loss of public benefits. As Lockwood and Spennemann (2000) highlights, one of the emerging strengths of economic analysis is the ability to incorporate diverse preferences of all stakeholders, albeit difficulties in capturing preferences in suitable forms. These abilities are primarily derived from the recent advances in non-market valuation

techniques. Based on replicable scientific methods, incorporating measures of chance and variance, with which to compare the likelihood of alternative decisions given a set of information, these techniques provide a means to estimate the value of benefits forgone in choice situations in the absence of market information.

Determining the economic value of environmental goods

Benefits of environmental services are not usually available for comparison with production benefits. However, planners need to make such comparisons to set priorities for resource allocation. The concept of total economic value, which includes the use and non-use components of value, offers a useful guide to measure the benefits an individual derives from a natural resource (Randall and Stoll 1983; Pearce and Turner 1990). Use values are those that individuals derive from directly using the natural resource. Non-use values represent those values that relate to the existence of the resource as a reserve, although it is not currently used.

Many approaches are available to determine the use values of environmental resources. They rely on market behaviour such as averting expenditures and changes in production costs. For instance, individuals reveal their preferences when they choose between recreational sites for visitation. Choice Modelling is an approach that uses responses from surveys to elicit monetary values by asking, respondents to choose scenarios involving varying price and levels of environmental attributes. This method has become popular in recent times for eliciting values for environmental assets with multiple attributes (Adamowicz et al. 1998) (Blamey, Gordon and Chapman 1999).

Choice modelling (CM) is a stated preference technique. It conforms to the economic notion that the value placed on a good is a reflection of its attributes (Lancaster 1966), thereby permitting the estimation of its part worth. The focus on attributes in the CM method makes it suitable for estimating both the values of attributes as well as situational changes. An important feature that favours the use of CM in environmental valuation is the ability to determine the relative importance of commercial, social and environmental factors in the make-up of non-use values. A detailed description of the CM approach is given in Blamey et al (2000) and Morrison, Bennett and Blamey (2000).

The choice modelling study conducted in the Herbert River District of North Queensland was designed to estimate the value placed on the protection of natural vegetation in areas suitable for cane production by the local community. Resource use options that vary in the level of environmental protection and the level of agricultural production were presented as a series of choice sets and respondents were asked to choose among a set of three discrete alternatives in a given choice set. The alternatives in each choice set were described by four attributes, pertaining to the area of teatree woodlands, the area of vegetation along rivers and in wetlands, regional income from cane production, and an environmental levy. The responses were analysed together with socio-economic data using a nested-logit discrete-choice model to estimate the community willingness-to-pay for the protection of natural vegetation. Given a representation of the feasible environmental and economic attributes, the choice model was used to estimate individual willingness to pay for a given level of environmental protection. Given the public good nature of the environmental values, the marginal value of the social benefit of protection was estimated by summing the individual values across the target population. The detailed study is presented in (Mallawaarachchi et al. 2001).

Accommodating multiple-use

As discussed in Mallawaarachchi and Quiggin (2001), multiple-use and dominant-use management are two broad options available for resource management at a regional level. These alternatives are conceptually similar to diversification and specialisation. Under dominant-use management, each unit of land is allocated to the single use that provides the greatest economic return. This was first mooted as an alternative approach to resource allocation in managed forests. Dominant-use management follows the theory of comparative advantage and is preferable when joint production is less efficient than specialisation (Helfand and Whitney 1994). Conversely, multiple-use systems involve using each unit of land to generate multiple outputs and are therefore preferable in the presence of complementarities in production.

The choice between dominant-use and multiple-use management depends on the scale at which management units are defined. Dominant-use management applied to small units within larger systems may be regarded as a form of multiple-use management applied to the entire system, and may yield higher levels of all outputs than a system where all units are devoted to multiple uses (Pearson 1943; Glascock 1972).

In large systems, where non-consumptive uses are dominant, multiple-use management can meet economic efficiency objectives (Ward and Lynch 1997). In general, the more intensive the consumptive use, the less the capacity for multiple-use management. However, given the changes in the social environment surrounding the sugar industry, the need to account for plurality of values cannot be overemphasised. In particular, decision making for terrestrial land use in the coastal zone encounters multiple interests and complex issues relating to marine, estuarine, wetland and coastal ecosystems (Clark 1992). Sensitivities arise due to natural interconnections between these systems and the multitude of benefits that are at risk in case of management failure. Therefore, decision-makers need to bear a broader responsibility and plan activities enabling multiple benefits where possible, by understanding the impacts of their decisions on other stakeholders and socio-economic sectors.

Given the intensive and regionally concentrated nature of activities such as land-use for cane growing, benefits of multiple-use may be gained by adopting a dominant-use framework that follows the theory of comparative advantage. Coupled with discriminatory access restrictions and incentive structures, such a system will enable complementarities in resource use, similar in context to traditional systems. It requires careful planning and agreement between competing users, in particular to identify important, but non-dominant, uses (Johnson et al. 1998). In this respect, the role of communication, including the provision of information to understand the context of resource use, and promoting institutional structures to facilitate community responses in a dynamic environment would assist in gaining optimal decisions that cut across private and public benefits.

Insights from land use studies

Land use studies undertaken within the CRC Sugar aims to facilitate the process of independent inquiry to promote stakeholder participation in determining efficient solutions to complex issues of managing the common interests, while maintaining the rights of the individuals to derive benefits from their private property. In this section, the results of the

studies are discussed and insights are drawn to illustrate the utility of such studies for broader application in other circumstances involving similar trade-offs.

Environmental values

Mallawaarachchi et al. (2001) examined preservation of two types of land in the Herbert river district: wetlands, which currently occupy an area of 2300 hectares, and tea-tree woodlands which currently occupy an area of 21000 hectares. The area of both land types is declining at present, primarily because of expansion in the area allocated to sugar-cane production. The marginal value elicited for wetlands was $2800 per hectare, considerably more than the maximum value that can be generated using the land for agricultural production ($1500 per hectare for sugar cane). Hence, optimal land use management should, as far as possible, prevent any further diversion of wetlands to agricultural production. Emerging land management strategies in the industry favour such constraints and allocation of land for agricultural uses incorporates requirements for preservation of wetlands. The marginal value elicited for tea-tree woodlands was $18 per hectare, with a 95% confidence interval of $3.20 to $36.90 per hectare. At the margin, this is less than the value of land in sugar production, but comparable to the value of beef production under extensive grazing ($34 per hectare).

Optimal land allocation

Using these choice modelling estimates in a regional allocation model, the trade-offs between direct financial and environmental impacts of alternative land use allocation strategies can be examined. Such studies in Herbert indicate that profitability of cane area expansion is highly responsive to changes in the price of sugar. In particular, prices similar to those that prevailed in the 1999 season would not only make conversion of marginal land to cane unprofitable, but would imply that some existing cane land should be converted back to their original use, grazing. Analysis also demonstrates the impact of land heterogeneity on profitability, confirming the established view that better information can yield efficient allocation decisions. The model also indicates that a finer disaggregation of land types enables greater efficiencies in land allocation in terms of optimal allocation of private and public goods.

These results have several implications. First, sugar industry stakeholders in Herbert can make use of these estimates in guiding their planning and management decisions to conserve environmental assets and to minimise the impact of future developments on the coastal environment. Moreover, these results are applicable in a more global sense where it is demonstrated that consideration of all aspects of economic costs, both production and environmental, in land allocation decisions improves the net social benefits of resource use. Non-market estimates of environmental values integrated into production models in this manner make them readily applicable to land-use planning, and become valuable as a management tool to mitigate harmful environmental consequences of production activities.

Values and the importance of context

Detailed insights on the nexus between the level of these values and the context in which they were drawn can be gained by comparing the Herbert study with another study conducted in the Sunshine Coast (Table 2). See also (Mallawaarachchi, Morrison and Ebert 2000; Mallawaarachchi, Morrison and Blamey 2001).

Herbert represents a rural coastal community dependent primarily on the sugar industry for its livelihood. The closely-knit community has benefited significantly from the expansion of the industry and the proportion involved in non-sugar industry activities is still very low. The Sunshine coast, on the other hand, is one of the fastest growing regions in Australia, with a diverse community dependent on an increasing level of economic activity relating to peri-urban living and tourism. The service sector contributes nearly 80% of the income. The share of agriculture is falling and the sugar industry, once a prominent industry in the region, has come under increasing pressure to remain viable. The Sunshine Coast also attracts a high level of investment, leading to rapid land use change away from agricultural and rural to urban infrastructure uses. In the changing landscape, farmland, including cane provides 'character' to the region, while very little areas of unique coastal vegetation communities are intact, following this land use change.

Table 2: Value estimates for different land uses in the two regions ($/ha)

Land use	Herbert[1]	Sunshine Coast[2]
Teatree woodlands	18	
Wetlands & riparian areas	2812	
Unique & rare vegetation		1980
Urban expansion		-1102
Sugarcane expansion		-75

[1] Population 7,000 households; rural
[2] Population 140,000 households; urban fringe

The value estimates presented in Table 2 conforms well to the description in the previous paragraph. The model estimates indicate that the Sunshine Coast community places a high value for preserving rare and unique vegetation, closely matching the level of interest for wetlands and riparian areas in Herbert. While the community attaches a high negative utility for the expansion of urban area, expansion of area under sugar cane is also not seen as utility improving. Part values estimated in the choice model suggest that cane fields have a positive aesthetic value, but the overall negative value for willingness to pay arises because of the negative externalities from sugar cane burning such as smoke and soot. Similarly, unique or rare vegetation is also associated with significant existence value (Mallawaarachchi, Morrison and Blamey 2001).

Mallawaarachchi, Morrison and Ebert (2000) used these value estimates in a regional land allocation model to determine socially optimal land allocation strategies that meet biophysical, social and economic constraints for the region, following a similar approach to Mallawaarachchi and Quiggin (2001). They investigated the effect on farm profits of distance to mill location by classifying potential land available under different distance classes and including transport costs in the model. The model optimisation suggested that under the prevailing cost structure, expansion of cane area is unlikely to be achieved, because rents from growing cane will dissipate as cane areas move away from the mill due to transport costs, and because most of the land available in close proximity to the mill is less suitable for cane.

A role for communication

The general thrust of resource management today is to develop systems that are consistent with the changing community attitudes. The community is increasingly more informed of environmental consequences of developments, and there is a growing scepticism about public institutions. The general call is for greater involvement of stakeholders in decision-making. As a result, the command-and-control policies of the past are increasingly being supplemented with policies that allow greater participation of decision agents in voluntary management regimes that are linked to achieving agreed objectives (Department of Environmental Protection 1996; Environmental Protection Agency 1998). Resource management therefore reflects strategic management as against focus on reactive management that characterised penalty-dominated management regimes of the past. This emerging multi-faceted approach aims to promote greater compliance through incentive structures and reward mechanisms; the role of regulatory exclusions and penalties are delegated to second place to be used as instruments of last resort.

In view of promoting compliance and greater participation, externalities can be seen as reflections of existing regulatory and incentive structures that deliver a set of goods and services in a particular combination, involving desired and undesired attributes (Cornes and Sandler 1996). Mitigation of the externality therefore entails examining alternative arrangements for delivering goods and services in a manner most acceptable to all stakeholders. Within this view, the aim of the sugar industry therefore would be to seek ways of producing sugar in the most efficient manner. The efficiency of production must match the quality of natural resources at its disposal, technological constraints that define the flexibility of altering the condition of natural resources to enhance productive capacity and to minimise external costs, and be consistent with the way in which institutions have evolved, reflecting individual preferences and the distribution of those preferences (Cornes and Sandler 1996).

Conclusions

The analysis presented in this paper highlights the importance of understanding the context of resource use systems in attempting to examine opportunities for efficient management. Designing solutions to match heterogeneity in resources and social values were considered particularly important given the need to accommodate multiple uses in a complementary fashion within a given socio-geographical space. While product differentiation is an important element in enhancing competition and capturing private rents, the analysis supports the view that public good values may be enhanced by organising

activities to represent natural advantage and complementary relationships. It must also be noted that, in an open system, what may be optimal at the local scale may be far from optimal at higher scales, because of different constraints relevant to each scale and the cumulative nature of externalities, which makes some incompatibilities insidious at lower scales. This implies that activities organised at one scale without reference to other scales may prove counterproductive in the long-run and organising activities at a meso scale, similar to a hydrological catchment, may provide a useful compromise. In that respect, strengthening local capacity will be important to correctly ascertain and incorporate local needs in planning and project delivery within broader perspectives. National level guidelines, often derived in the light of global consensus, must be flexible to accommodate differences in resource endowments as well as varying needs of local people.

Private resource use decisions, that do not capture externality implications, are both economically non-viable and socially disruptive because of their impacts on the public good. Promoting individual responsibility for ownership and control of assets held in private custody, in itself, will maximise total welfare because of the potential to minimise externality risk. This is particularly important in environmental management, because knowledge base is changing faster than individual behaviour (Fisher and Thorpe 1990).

"While issues of values, conflict and trust have long been considered in the study of public participation, most evaluations have not explicitly operationalised them into evaluation criteria (Beierle and Konisky 2000)." Given the nature of data requirements and complexities involved in developing value estimates of the type discussed in this paper, this will remain a significant challenge under most circumstances. Yet, the insights gained in these studies provide useful leads to further work.

With communities seeking greater environmental responsibility from industries, and governments endeavouring to address common concerns within budgetary constraints and information deficiencies, it is opportune for governments to encourage and facilitate communities and industries wishing to take greater environmental responsibility. Such strategies will benefit from a move towards two-way communication in order to make the bottom view comprehensible to the top and vice versa. Such deliberations will enhance the opportunity for stakeholders to developing solutions co-operatively as opposed to acting as advocates purely of their own views. Yet, the tendency for lead interests to acting strategically to promote their private interest can jeopardise the common good. Continued improvement in information access and delivery mechanisms may offer flexibility to counter such strategic dominance.

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