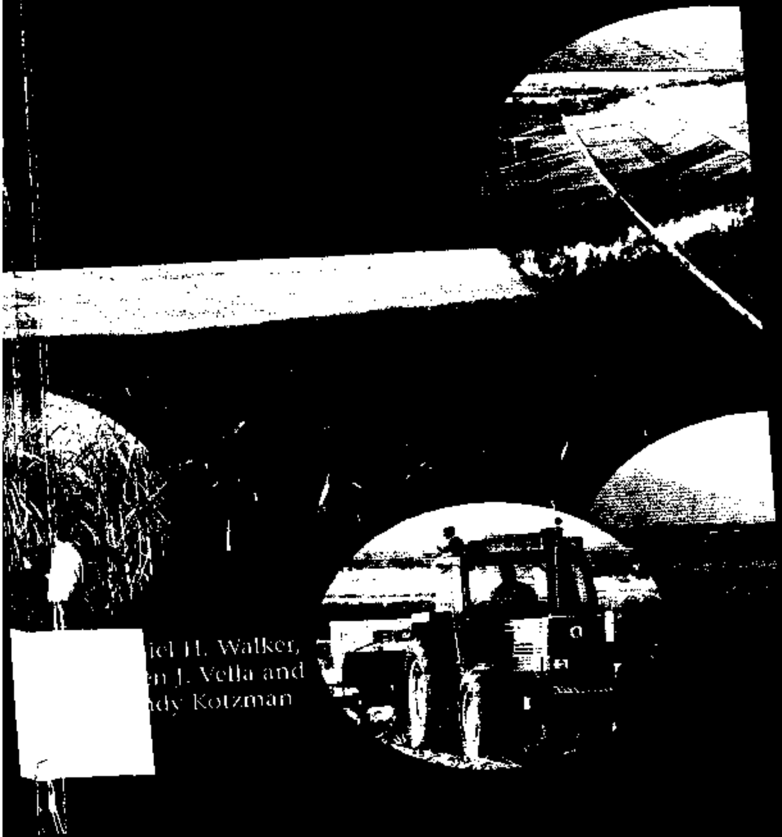

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Regional Planning and the Sugar Industry

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Foreword

The history of Australian sugar industry is in economies of scale and government run, industry driven regulation. It produces bulk raw sugar for the international market, mechanization is advanced, it is efficient and marketing is highly structured through a legislatively endorsed marketing body. However, price and access are distorted through industry protection and subsidy and commodity prices are falling so despite its efficiency, the industry is no longer profitable.

As well the industry has been criticized for its environmental impact but unlike other sectors made the fundamental mistake of denial rather than engaging with the problem.
The solutions to many of these problems lie at the regional scale where they can engage local ideas and be tailored to suit specific economic, environmental and social circumstance. For the larger mill areas the solution might be economies of scale - larger farms, improved harvest and transport efficiency, rationalization and better utilization of farm equipment. For the smaller mill areas it will be moving into specialized, value added products or closure. For both large and small it will be about putting the entire plant, that is its process by-products, to good use, not just the sugar crystal. The new world is about resource efficiency, value adding, blending, quality assurance, branding, marketing and ecologically sustainable farming.

The regional model, requires partnerships with local communities, science, local government and special interest groups. It requires local action with a global perspective, innovation, embracing change and accommodating diverse values.

The regional scale solution fits with the contemporary approach to environmental management. Regional natural resource management strategies are the new foundation for conservation and sustainable use of the environment. The reason - community ownership is essential, different regions need different approaches, agencies and agencies activities need integrating. The regional approach is quite different from the established, regulated structure that characterizes the industry.

The Sugar Industry Rescue Package is a classic example of the failure of a centralized approach to reform. Industry financial assistance was originally subject to the industry undertaking fundamental reform, deregulation and demonstrating a sustainable future so government would not have to "prop it up" once again. "Regional Guidance Croups" (RGGs) were to be established and given the job of developing regional business plans that were to include environmental reform and an overarching "Industry Guidance Group" (the IGG) was to tie the regional plans into an "Industry Reform Plan". It was a logical process undone by politics, industry resistance to change and leadership failure.

Lobbied by industry opposing change, governments could not agree on the deregulation agenda, the RGGs were never formed and the IGG was instructed to go it alone. To cut a long story short the plan was a failure, a third of the IGG refused to sign off on it and it never escaped the minister's office. It had a one-size-fits-all focus on economies of scale, it paid only lip service to diversification, it operated without the benefit of farmer, community, special interest group and wider scientific input.

Cast adrift by a failed planning process, no clear solutions and a looming election the Commonwealth abandoned its commitment to fundamental industry restructure, environmental reform and economic sustainability and instead returned to financial support with a $440 m package of which only $75 m is for restructure.

This was a potentially good process gone wrong but more fundamentally a failure to recognize the essentials of a regional specific, community endorsed approach.

Cr. Mike Berwick,
Mayor
Douglas Shire Council.

Preface

Industrialised agriculture is under challenge worldwide. Market globalisation requires ever-greater technological and economic efficiency to maintain profitability in the face of intensifying competition. At the same time, there are increasing demands for the natural resources, that is, the land, the water and the biological systems that are used by agriculture, to be managed in harmony with wider community interests and objectives.

The challenge is particularly acute in the Australian sugar industry which must raise its profitability in light of the immense competitive pressures from low cost countries like Brazil and imperfect markets in major industrialized countries. At the same time, located near environmentally sensitive rainforests, coastal wetlands and reef, the industry is under pressure to lift its environmental management in line with government and community expectations.

During the period 1995-2003, the Cooperative Research Centre for Sustainable Sugar Production (CRC Sugar) and its parties undertook extensive research on production and environment related issues confronting the Australian sugar industry. Much of the research addressed the technical aspects of natural resource management.

The largest single initiative within CRC Sugar's Protecting the Environment program, however, addressed the less tractable issue of how the often-complex technical knowledge that is the natural currency of scientists might be effectively integrated into a socio-economic framework that most stakeholders can understand, in order to identify and target desired economic, social and environmental objectives.

The challenge is a particularly daunting one, not least because the issues are complex, and the underlying scientific understanding of them is usually imperfect or even contested. Equally important, there is rarely a consensus between the various industry, community and government stakeholders on the relative values to be placed on competing economic, social and environmental objectives.

The CRC environment provided a unique opportunity for this challenging initiative, because of the capacity for a critical mass of scientists from several disciplines to work participatively with industry and community stakeholders over an extended period of time. The outcome is a unique body of research that was unprecedented in its extent and, given current industry circumstances, is unlikely to be replicated in the near future.

The purpose of this book is to capture and make available to a wider audience an integrated synthesis of the learnings from the work, in three quite different sugar catchments. The emergent information was acted on contemporaneously by the end-users in the course of the eight years of research, while specific findings have been reported in relevant disciplinary papers and reports referenced in the book.

CRC Sugar is proud to have sponsored the development of the book and to have funded much of the research that is captured in the book. We trust that it will prove a valuable resource for those whose task it is to promote sustainable natural resource management both within the sugar industry and in agriculture more generally.

Bob Lawn,
Former Director,
Cooperative Research Centre for Sustainable Sugar Production

Acknowledgements

Development of this book was an 8th year funded activity of the **CRC for Sustainable Sugar Production** (also known as the Sugar CRC). The Sugar CRC within its Protecting the Environment program, also undertook the core research at the heart of this project from 1995/1996 to 2001/2002. This work focused on developing analytical approaches to integrated evaluation of economic and environmental implications of changes in the sugar industry. Further development and application of this approach in the Herbert River district extended this project. Sincere thanks to Professor **Bob Lawn,** former Director of the CRC, and **George Rayment,** former leader of the Protecting the Environment program for their strong and continued support of this work. In conjunction, the **Sugar Research and Development Corporation** funded research into the role and application of negotiated planning approaches for natural resource planning in sugar catchments. This work emphasised the role of data, information and knowledge in informing, focusing and underpinning these approaches to rural land-use planning. Further support came from **Land and Water Australia,** through research focused on brokering the development of local capacity and structures for stakeholder participation, negotiation and implementation in the Moreton Mill district.

This document reports on the development of community-based resource-use planning in the sugar industry. As such, the success of the underlying projects has rested heavily on the support and inspiration of the regional stakeholders. We particularly want to thank the many individuals in the Sunshine Coast, Herbert and Mossman districts with whom we have worked.

The assorted efforts of many people have contributed to the completion of this document. **Andrew Johnson** pioneered this area of research by initiating the core projects that anchor this work. Through work in other projects, **Jenny Bellamy** and **Allan Dale** have had a strong influence on the conceptual basis for regional resource-use planning. As a core team member, **Vickie Webb,** led the work in the Sunshine Coast region, while **Duncan Chalmers** was engaged in work in the Herbert River region. **Colin Mayocchi** took the lead in implementing the Regional Dynamics Model and NRM tools. The regional profiles of the case study areas were developed by **Stuart Cowell,** who was also responsible for generating the social impact analysis. **Angela Murray** developed and provided a detailed account of spatial data, and **Stuart Kininmonth** completed and presented the transport modelling for the Sunshine Coast region. Together they assembled and analysed spatial databases for the Sunshine Coast and Herbert River regions. **Peter Byron** contributed cost-benefit analysis of riparian revegetation. **Thilak Mallawaarchchi's** widely published work on resource economics provided a review of the historic and economic landscapes of the sugar industry. **Anne Leitch** and **Raymond de Lai** provided material for the description of the Herbert River Information Centre. **Amanda Walmseley's** development of a land-use allocation model provided the foundations for the formulation of the multi-criteria analysis tool for cane land allocation by **Xuan Zhu.** Building on the experience gained in the Sunshine Coast and Herbert River regions, **Brian Roberts** is fulfilling the role of CSIRO co-ordinator of the Douglas Shire Agri-Industry Joint Venture Initiative. We have also drawn from CSIRO's submission to the Hildebrand Independent Assessment of the sugar industry, especially the regional profiling approach from **Romy Greiner.**

We also wish to thank the many people who reviewed drafts of this document, particularly **Diana Dawson, Lisa McDonald, George Rayment, Raymond De Lai, Anne Leitch** and **Stuart Cowell.**

Acronyms and abbreviations

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ACRES	Australian Centre for Remote Sensing
AGSO	Australian Geological Survey Organisation
AML	Arc Macro Language ~ a programming language used in ArcInfo
ANZLIC	Australia & New Zealand Land Information Council
API	Aerial Photograph Interpretation
ArcInfo	A GIS software package
ArcView	A windows based version of ArcInfo, a GIS software package
ASL	Above Sea Level
ASS	Acid Sulfate Soils
ATSIC	Aboriginal & Torres Strait Islander Commission
AURISA	Australian Urban & Regional Information Systems Association
AUSLIG	Australian Survey & Land Information Group (Title changed to GeoScience Australia in 2002)
BoM	Bureau of Meteorology
BSES	Bureau of Sugar Experiment Stations
CC	City Council
CCC	Catchment Coordinating Committee
CCS	Cane Content Sugar
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific & Industrial Research Organisation
CSIRO TAg	CSIRO Tropical Agriculture
CSR	Colonial Sugar Refineries
CZP	Coastal Zone Project (CSIRO)
DCDB	Digital Cadastral Database
DCW	Digital Chart of the World
DD	Decimal Degrees
DEC	Digital Equipment Corporation
DEM	Digital Elevation Model
DL	Department of Lands, Queensland
DLPE	Department of Lands, Planning & Environment (NT)
DME	Department of Minerals and Energy, Queensland
DMR	Department of Main Roads, Queensland
DNRM	Department of Natural Resources and Mines, Queensland
DoE	Department of Environment. Queensland (Formerly Queensland Department of Environment & Heritage)
DoT	Department of Transport, Queensland
DPI	Department of Primary Industries, Queensland
DSS	Decision Support System
EA	Environment Australia
EPA	Environment Protection Authority, Queensland
ESD	Ecologically Sustainable Development
ESRI	Environmental Systems Research Institute Australia
FRDC	Fisheries Research & Development Corporation
GIS	Geographic Information System
GBRMPA	Great Barrier Reef Marine Park Authority
GQAL	Good Quality Agricultural Land
HAC	Department of Health & Aged Care, Queensland
HMP	Herbert Mapping Project

HRCCC	Herbert River Catchment Coordinating Committee
HRIC	Herbert Resource Information Centre
IBRA	Interim Biogeographic Regionalisation of Australia
ICM	Integrated Catchment Management
IMCRA	Interim Marine & Coastal Regionalisation of Australia
IRUM	Integrated Resource Use & Management (CSIRO)
IT	Information Technology
JVP	joint Venture Partnership
Landsat MSS	Landsat (satellite) Multi-Spectral Scanner
LGA	Local Government Area
LUT	Look Up Table - Table of item value meanings stored in ArcInfo.
LUWQ	Land-use & Water Quality
LWA	Land and Water Australia (formerly LWRRDC)
LWRRDC	Land & Water Resources Research & Development Corporation
MAS	Mossman Agricultural Services
MSM	Moreton Sugar Mill
NRIC	National Resource Information Centre
NRM	Natural Resource Management
NR&M	Natural Resources and Mines (Queensland Government Department)
QSC	Queensland Sugar Corporation
Qld Herb	Queensland Herbarium, Department of Environment
QLIS	Queensland Land Information System
RDM	Regional Dynamics Model
RMS	Root Mean Square ~ error indicating digitising registration accuracy
SC	Shire Council
SCAR	Sugar-cane Assignment Register (QSC's database)
SRDC	Sugar Research and Development Corporation
Sugar CRC	Cooperative Research Centre for Sustainable Sugar Production
TIN	Triangulated Irregular Network - a surface modeling package
UMA	Unique Mapping Area ~ relating to the mapping of soils, geology, geomorphology and vegetation cover and associated classifications for agricultural land suitability and land limitations (e.g., erodability)
UPS	Uninterruptable Power Supply
UQ	University of Queensland
USDMA U.S.	U.S. Defence Mapping Agency
USGS	U.S. Geological Survey
WALIS	Western Australian Land Information System
WTMA	Wet Tropics Management Authority

1 Introduction

This document is designed for people interested or involved in regional planning in the sugar industry. Our motivation in generating this book has been to help those interested in contributing to the development of plans for the sugar industry's future, to explore the whole process of planning, and the elements of good planning processes and outcomes. The majority of people involved in regional planning aren't, and won't be, professional 'planners', but instead are stakeholders in the sugar industry - growers, grower representatives, millers, harvesters, local governments, special interest groups, and so on. However, there are also policy professionals and regional stakeholders becoming more interested in regional planning in the sugar industry. This audience is growing as a result of the widening range of people who have a 'stake' in sugar industry affairs. This reflects:

- a growing recognition of the importance of sugar production to economic, social, and environmental welfare in much of coastal Queensland and northern New South Wales, and
- a rising number of regional planning approaches, implemented through government programs and policies, that are relevant to sugar districts (e.g., the National Action Plan for Salinity and Water Quality, the Natural Heritage Trust, and the Reef Water Quality Protection Plan).

With this in mind, we have structured this document to provide information about approaches to regional planning, insights into successful processes and outcomes, and pitfalls to avoid. This is not a 'how to ...' manual for regional planning and doesn't provide prescriptive guidelines, but it does identify some of the options available to the industry in addressing regional needs. We don't claim to provide comprehensive coverage of the many issues of relevance to regional industry planning. Instead, we explore a range of ideas about successful regional planning from various perspectives. We try to provide the reader with an appreciation of the key questions and challenges they may face in undertaking regional planning processes and ideas on how to address these challenges. In order to do this, this book draws on CSIRO's experience in regional planning activities in the Queensland sugar industry. Although we focus on the Queensland sugar industry, many of the principles and many, if not all, of the contextual factors discussed in the Queensland cases, apply equally to the industry in New South Wales and Western Australia.

1.1 How to get the most out of this resource book

Who is going to read this book and how will it help them? Reviewers of earlier drafts of this document have commented that it may prove too technical for a non-technical audience and not technical enough for a professional audience and that, in trying to find a middle ground, this book may not meet the needs of either group.

From our perspective, this problem reflects a dilemma arising from the changing focus of regional planning in rural Australia. The way that regional planning is emerging in practice in Australia means that people involved in developing and implementing regional plans are not technical planners, but rather industry members, industry professionals, and other regional stakeholders who need to have an understanding of planning and the technical aspects of planning in order to be fruitfully involved.

We are trying to respond to this emerging issue by providing a resource for people in this middle ground to help them become effectively involved. Given the diverse backgrounds of people who may be interested or involved in regional planning in the sugar industry, information and ideas that one person finds valuable may be self-evident or irrelevant from another reader's perspective. Consequently, we have designed this book so that readers with different backgrounds and experience can dip into the sections that are most relevant and useful from their individual perspective.

The following synopsis intends to help you find the parts of the resource book that are likely to be of most interest to you. If you are a newcomer to industry affairs (e.g., policy professionals involved in sugar industry affairs for the first time), or want some background information on industry context, Chapter 2 is a good place to start. **Chapter 2 - the Australian sugar industry,** outlines the current challenges facing the sugar industry and provides a brief overview of the industry's location, operation, economic value, environmental impact and community significance. The current drivers of change are underscored by a rich history of change and adjustments. Much of this material will be familiar to those who are professionally involved with the industry, but will provide a useful context for other stakeholders interacting with the industry.

If you are already part of the sugar industry (e.g., growers, grower representatives, millers, harvesters), and have not previously been involved in regional planning, but would like to learn more about the potential of this approach for the industry, **Chapter 3 - Regional planning in principle,** is a great place to start. Chapter 3 introduces and discusses the regional nature and variation of the sugar industry and adopts the premise that regional challenges require regional solutions. In addition, this chapter outlines what regional planning is and presents a framework for regional planning in the sugar industry. This discussion forms an important foundation for much of the rest of this document.

If you are already part of the sugar industry and have not previously been involved in regional planning you may similarly be interested in **Chapter 4 - Regional planning in action,** which puts the principles from Chapter 3 into context and discusses several industry-based regional planning initiatives. The activities reported in the case studies are quite different in each region. While they don't represent the full range of regional planning approaches possible in the sugar industry, they do illustrate a range of planning activities, and some of the core principles and issues discussed in Chapter 3.

If you are an industry member or policy professional already involved in planning, and looking specifically for technical approaches and tools to undertake planning, **Chapter 5 - Information and analyses to underpin planning,** will be a useful resource. This chapter provides practical examples of analyses which have been undertaken in the sugar industry that illustrate some of the range of information and analytical tools available for planning. These examples include: regional profiling using diagnostic indicators, spatial and non-spatial data collection, multi-criteria analysis of cane land allocation, land suitability analysis, revegetation cost-benefit analysis, modelling transport options, and a modelling approach to exploring regional dynamics.

If you are part of the sugar industry or a policy professional currently involved in, or soon to be involved in, managing a regional planning process, you may wish to consult **Chapter 6 - Linking analysis with planning,** which focuses on practical issues associated with information gathering, and the impact it can have on planning and decision-making processes.

Finally, if you belong to the industry and are becoming more involved in regional planning for the industry for the first time, **Chapter 7 - Industry planning in the broader institutional context,** identifies some of the institutional factors in the external operating environment in Queensland that you may need to be aware of. It is important to be aware that although regional planning initiatives can be very good at tackling issues, there are some things that sit outside the scope of regional plans. Knowing the nature of arrangements governing the arena in which planning is undertaken helps us to understand where regional planning can have its greatest impact and how other institutional arrangements can be used to help deliver outcomes.

2 The Australian sugar industry

The Australian sugar industry is one of the country's larger rural industries. Historically, the industry has undergone major changes and adjustments in response to changing markets, technologies, community values, environmental conditions, and so on. Currently, industry viability is under threat from a combination of economic, social and environmental factors driving another period of major change. In the future, the industry may well need to respond to new kinds of pressures that threaten the viability of the industry in different ways. The manner in which the industry responds to the challenges it faces will determine its ability to thrive in the long-term.

This *resource book* outlines some of the options for the industry in responding to these challenges. In doing so, we begin with a brief introduction to the economic, environmental, and social context of the sugar industry and the pressures it is facing. The aim of this discussion is to provide a context in which to identify the main drivers of change, and introduce some of the opportunities for managing that change with particular reference to the development of regional resource-use planning processes.

2.1 The sugar industry in Australia

The Australian sugar industry occupies about 549,000 ha and produces around five million tonnes of raw sugar annually, which translated to $1.7 billion annual sales in 1994-1998. About 95% of the sugar is produced in Queensland (which exports 80% of its crop), 5% in New South Wales and 0.1% in Western Australia. In 1997, while cane farms ranged from 30-2,000 ha, the average Queensland farm of 72 ha generated around $47,000 net cash income from 5,800 tonnes of sugar-cane. This is equivalent to 98 tonnes sugar-cane/ha or 13.75 tonnes sugar/ha.

Most of the sugar-cane is grown on the high rainfall zones of coastal plains and river valleys along Australia's eastern seaboard between Mossman, in far north Queensland, and Grafton, in northern New South Wales (refer Figure 3-1). The biophysical characteristics of these regions that make them attractive to the sugar industry are also highly valued for a variety of other land-uses, including other agricultural production (such as, other crops, forestry and grazing), urban and industrial activities, and ventures related to recreation and tourism. The intrinsic value of the natural environment in much of this region is also formally recognised through the designated Wet Tropics and Great Barrier Reef World Heritage Areas.

While we talk about 'the industry' as a single entity, it is, of course, composed of several components in a value chain: growers, harvesters, transporters, mills and markets (Box 2.1). The nature of and relationships between these elements varies between regions, as do the communities and service industries associated with the industry. Therefore, pressures for change on the industry as a whole will have different implications in individual regions and their associated communities, and will likely require different solutions.

Box 2. 1 Sugar industry structure.

The sugar-cane industry, while frequently thought of as a single entity, is made up of several components in a value chain: growers, harvesters, transporters, mills and markets. The industry relies on cooperative arrangements, compulsory arrangements, and voluntary arrangements to integrate the separate supply chain elements to grow, process, price, and sell sugar. The nature and balance of these elements varies between regions, and so do the communities and service industries associated with the sugar industry.

Box 2 .1 (continued)

With its current structure, each separate sector must be independently profitable for the industry to be sustainable. However the mounting financial pressure has put considerable pressure on supply chain relationships, especially between growers and millers, as a result of:

Cost-shifting between sectors - Shifting the burden of costs to other components of the supply chain rather than implementing measures to share costs or reduce or remove the inefficiencies responsible for increased costs;

Expectations of sectoral reform - Rising expectations that individual sectors will implement major reform, at their own expense, to improve income to the other partners in the supply chain;

Uncertainty about the future of the industry - Rising uncertainty about the future of supply chain partners and the arrangements that preserve the relationships between sectors. Rising uncertainty about the probability that sectors will endure present hardships and operate endlessly;

Differences in the configuration of supply chain sectors - Different kinds of organisations and people with very different motivations are involved in primary production within the supply chain. For example hundreds of family farmers choose to be engaged in farming primarily for lifestyle reasons compared with milling corporations and public companies that tend to be involved in agricultural production for economic reasons; and

Sugar production alternatives - Diversification into new sugar products and into land-uses other than growing sugar-cane. Diversification threatens existing supply chain arrangements, particularly those relating to constancy of cane supply to sugar mills for raw sugar production. Diversification also requires new pricing arrangements for growers to capture financial benefits of sugar by-products (e.g., bagasse, molasses) and alternatives not paid for under the existing CCS (Cane Content Sugar) formula and pool pricing system. Diversification raises issues over the integration of new partners into the supply chain, and the impact this might have on the viability of existing partners in both diversified and non-diversified scenarios.

2.2 An historic perspective of an evolving industry

Throughout its history, the sugar industry in Australia has responded to changing conditions and has demonstrated an enormous capacity for change.

To respond to the challenges identified in several recent reviews of the sugar industry (see the additional resources at the end of this chapter), major changes may be needed in the sugar industry's structure and management. The industry's history shows that it has successfully responded to major challenges in the past, and it has demonstrated a will and capacity to evolve. Historic periods of change, like the challenges of today, were driven by changing international market forces, environmental constraints, technologies, and social views and values. Reviewing some of these changes provides the background against which to set the current situation facing the industry.

Sugar-cane came to Australia with the First Fleet in 1 788. It languished on Norfolk Island until the early 1820s, when a plantation, established at Port Macquarie, produced Australia's first sugar, and later, molasses and rum. Within a decade, this venture was abandoned, but another was initiated in the Hastings valley (NSW). Over the years, sugar-cane growing and milling was established in northern NSW, then near Brisbane, and between 1869 -1872 sugar-cane expanded into the Herbert River region. By 1877, Mackay had become the major sugar centre for Queensland. The industry expanded rapidly, and by 1885, there were 102 mills in NSW (where there are now 3), and 166 in Queensland (where there are now 25). This expansion was not without casualties; such as the collapse of the Bowen Sugar Company in 1868, a mere three years after its inception, and abandonment of lands that proved unsuited to cane production at that time.

Sugar companies too have come and gone. For example, the Australian Sugar Company of 1839 was taken over by the Australasian Sugar Company in 1842, whose assets were transformed into the Colonial Sugar Refining Company in 1855. In 1870, the crop was taken up by independent farmers, with the establishment of a system of central sugar mills by the Colonial Sugar Refining Company, known today as CSR. Today, three companies own 1 7 of Queensland's 26 mills: CSR Ltd. (7), Bundaberg Sugar Ltd. (6), and the Mackay Sugar Co-operative Association (4), while most of the remainder are owned by grower cooperatives. Sugar mill owners today produce 2.5% of the annual sugar-cane crop, and the majority of cane is grown on family farms.

Many of the early sugar ventures were based on individual farms with their own small-scale mills, or central mills supplied by surrounding farms. CSR established their first mills in 1869, and brokered a system of forward contracts with local growers that became the industry standard in NSW. In contrast, the Queensland sugar industry was founded on large plantations using Pacific Island labourers. The Queensland government passed the *Coolie Act 1862* to facilitate the use of Asiatic workers on Queensland cane plantations. During the 1880s-1890s, changing attitudes coupled with market pressures on plantation systems with low productivity and rising costs propelled a steady move away from 'coloured labour'. Following a Royal Commission in 1885 into the trafficking of Pacific Islanders, the importation of these labourers was outlawed in 1901. Although there were about 22,000 non-European labourers working in the cane industry in Queensland at this time, most of the nearly 10,000 Pacific Islanders were repatriated. This corresponded with a shift to smallholder farms and central milling, so that by 1 894, 92% of Queensland cane growers were smallholder farmers, and the remaining plantations were struggling. Today, a reversal of this trend, from small, unprofitable farms to larger, more-profitable enterprises, is one option proposed to promote industry viability.

For almost 200 years, the sugar industry relied on manual labourers to plant and harvest the crop. Although experiments with mechanical cane harvesters were carried out in the late 1800s, their impact was relatively insignificant until about 1960. In 1961, only 5% of the harvest was cut using mechanical means, in 1966 it was 48.5%, and by 1974, 98.5% - a revolution in less than 15 years! The huge increases in the total harvests associated with the introduction of mechanical harvesting (9.4 to 20.4 million tons from 1961 to 1974) also precipitated changes in the transportation of the cut cane. The loss of labouring positions undoubtedly had social consequences.

Another major development that was embraced during the decade preceding 1996 dramatically improved the industry's environmental performance. Harvesting the cane when it is green, and allowing the leafy tops of the stalks to fall to the ground provides a 'trash blanket' that reduces soil erosion and weed growth, and preserves soil nutrient levels. In 1987, as little as 20% of the area growing cane was harvested in this manner, but by 1996, it was close to 70-80% of sugar-cane. Bearing in mind that some areas (such as those inclined to waterlogging) will never be suited to this practice, it represents a significant shift in the industry over about 10 years.

Figure 2-1 Green cane harvesting is now a common sight in Queensland.

2.3 Current drivers of change

The sugar industry today finds itself driven to change by forces coming from many directions. Global changes and trends (population growth, changing diets, alternative sweetners, alternative uses for sugar, trading regimes, international relationships and competition, capital markets, etc.) determine prices and costs. National-scale changes, such as changing community attitudes to the environment, the explosion of information and institutional/regulatory changes can have a profound impact on the industry's operating environment. Similarly, biophysical variations (such as weather patterns and climate variability) can have a significant impact on farm profitability and viability. Social dynamics within the industry, for example farm inheritance, shifting populations and changing expectations are also important considerations. Technology and technological change, such as mechanised harvesting and, possibly in the future, ethanol production, can have profound impacts on industry viability. These and many other drivers interact to force structural adjustments to farm size, representative bodies, markets, the supply chain and so on (Box 2-2).

Box 2-2 Examples of drivers of change in the sugar industry.

Price - price is one of the primary drivers of change in the sugar industry.

Land-use pressures - the expansion and contraction of sugar-cane land, increasing competition for land resources in sugar-cane areas, diversification of land-uses in sugar-cane growing catchments, resource issues such as acid sulfate soils, changing cane transport systems, and changing land values.

Community pressures - change in community attitudes towards farming practices and environmental protection, changing community structure, declining viability of rural regions, and loss of rural services.

Information pressures - new information on environmental management and farm practices, traditional practices now considered poor practice, uncertainty about new information and new practices, uncertainty about the real impact of the industry on environment, increasing access to Internet, increasing pressure to measure and monitor activities.

Institutional pressures - change in the number and nature of rules and regulations governing sugar production, decreasing government regulation of transport, milling, and marketing activities, increasing government regulation of environmentally relevant activities, and restriction of property rights for environmental management. Many of these changes can be understood in terms of governments' increasing involvement in managing for sustainability.

Supply chain and internal organisational pressures - change in mill ownership (e.g., loss of cooperatives, foreign ownership of mills), mill closure, moves towards non-compulsory membership of farming organisations, and viability issues for small family farms.

Globalisation pressures - changing global market needs and expectations (efficiency standards, sugar products, environmental management), fluctuating world prices, increasing international competition, and increasing international agreements (for trade and environment).

Climate pressures - ever-changing weather patterns, el Nino/la Nina weather cycles, floods, cyclones and droughts.

Domestic economic pressures - cost of capital, financial management systems, interest rates, rural industry restructuring, and changing priorities for government funding to care for the environment.

Family pressures - passing on of farms to next generation, increasing off-farm employment, ageing farm owners/operators, migration of younger generation to urban areas, and changing family size and values.

Pressures on the sugar industry range from those over which it has significant control (either on its own or in partnerships) to those that are essentially beyond the industry's control. In either case, the industry may well be compelled to respond to these pressures. Understanding the level of control in each situation is important, as this will determine what types of actions are feasible and likely to be effective. Determining which pressures the industry can tackle head on depends on individual beliefs about political and market influences on the industry.

Many of these pressures are, of course, interconnected, and they operate at different scales - from the paddock and farm, to harvest group, mill area, district, state, national and international scales, which adds to the complexity of the situation. These pressures are brought together under the banner of 'sustainability', a challenge planted squarely on the shoulders of the industry (Box 2-3).

Figure 2-2 Encroaching urbanisation is threatening some cane-growing areas.

Box 2-3 The sustainability agenda and the sugar industry.

One way of thinking about the pressures and responses discussed here is in terms of 'sustainability'. Sustainability has emerged as a major national and international public policy goal and there is now a broad mandate for planning to seek sustainable resource-use outcomes. Sustainability includes various distinct, but interconnected, dimensions.

From an *economic* and technical perspective, sugar industry sustainability relates to the feasibility and viability of sugar-cane production. This includes scientific and technological developments, the global sugar market, domestic sugar pricing, the cost of capital, profit margins, the falling value of assets (such as farms and mills), and government policies, which affect the structure of the industry and influence profitability, economic feasibility and the financial viability of farming practices.

The biophysical dimension of sugar industry sustainability includes the natural system within which the sugar industry operates. It includes environmental resources, such as wetlands and mangroves, environments of national significance including the World Heritage listed tropical rainforests and the Great Barrier Reef. It includes rare and endangered species and animals, and ecologically significant landscape features. Sugar industry sustainability also concerns the impact of farming on natural resources and land management issues such as acid sulfate soils.

The *socio-political* dimension of sugar industry sustainability relates to sugar communities, the general public and relevant stakeholders, political relationships, and political organisations. It includes the resource governance system that influences individuals, groups and communities. It also includes the impact of policies and government actions on the sugar industry, including trade policies, price supports, taxes, research and development, compensation, marketing boards, land-use controls and incentives, production quotas, land tenure, and controls on inputs.

Although developing precise definitions and measures of sustainability has been problematic, practices that are more or less sustainable are often distinguishable. Furthermore, there is general consensus that sustainable practices must address the social, economic and environmental components of the system. The planning challenge facing the sugar industry includes all of these components. It includes the economic trade-offs between the cost-price squeeze threatening both the economic viability and the social structure of traditional family farms, and increasing community concerns about the perceived environmental impacts of sugar production.

2.4 Planning to influence change

In a free-market economy, profitability and sustainable practices are the key to the long-term viability of primary industries. Effective planning gives the sugar industry more opportunity to control the direction of inevitable change. Planning can enable the industry to respond to emerging pressures and opportunities in a proactive manner by providing a structured way to identify issues and responses, minimise risks and maximise desirable outcomes for the industry, the environment and the public.

To some extent, we are all, of course, involved in planning all the time. Having said that, developing plans to respond to the types of pressures outlined above in ways that 'work' for all the sectors of the industry and community is not straightforward. While it is something the industry has done before, the range of issues and the range of stakeholders relevant to planning and negotiation are now wider than ever before. In the next chapter, we explore the idea that the sugar industry needs to undertake planning at the regional scale as well as at state, mill area and farm scales.

Where to go for more information:

Bruce, R., M. Johnson and C. Rayment, eds. (2000) Environmental short course for sustainable sugar production: CRC Sugar Occasional Publication. Sugar CRC, Townsville.

Centre for International Economics (CIE) (2002) Cleaning up the act: The impacts of changes to the *Sugar Industry Act 1999.* Centre for International Economics, Canberra.

Hildebrand, C. (2002) Independent assessment of the sugar industry: 2002. Agriculture, Fisheries and Forestry Australia, Canberra.

Keating, B.A. and j.R. Wilson (1997) Intensive sugar-cane production: Meeting the challenge beyond 2000: Proceedings of the Sugar 2000 Symposium Brisbane, Australia, 20-23 August 1996. CAB International, Wallingford.

Productivity Commission (2003) Industries, land-use and water quality in the Great Barrier Reef Catchment: Research Report. Productivity Commission, Canberra.

Gutteridge Haskins and Davey (1996) Environmental audit of the Queensland canegrowing industry: Summary. Gutteridge Haskins and Davey, Brisbane.

3 Regional planning in principle

The future of sugar-growing regions depends on industry response to a combination of factors namely: sugar markets (including market access, market price, competitors etc.), environmental factors, and social systems. To take some control of this uncertainty, the industry can engage in planning activities to identify goals, devise and evaluate actions, and predict probable outcomes. If the planning process includes suitable feedback mechanisms, it will remain relevant and keep pace with changing goals and conditions over time.

In this chapter, we explore the concept of regions and regional variation within the sugar industry. The idea that different regions make up the sugar industry is fundamental to the principles, tools and processes identified throughout this resource book.

We also use this opportunity to consider the value and nature of regional planning, the opportunities for regional planning in the context of the sugar industry, and the likely requirements for truly functional regional planning in sugar industry regions. Ideally, regional planning is informed by the prevailing environmental, economic and social contexts, based on the best available information, and operates in a participatory and adaptive framework. Therefore, the type of planning we explore focuses on responding to changing circumstances and expectations through negotiation, analysis and change.

3.1 The sugar industry as a set of regions

Management happens at a variety of scales in the sugar industry. For example, growers manage their production activities at block and paddock scales, as well as managing the farm as a whole, and millers manage transport and sugar processing. They don't do this in isolation - for example sugar growers interact with local government, state agencies, banks, the mills, the BSES, productivity boards and so on. Harvesting and transport involves harvesting groups, contractors and the mills. Marketing occurs (in Queensland) at a state scale through a single desk. Bodies like CANEGROWERS have evolved to represent the growers' interests in negotiations with state and federal agencies, with the sugar mills and with other organisations. The federal government is responsible for representing industry interests in international trade negotiations and so on.

This resource book focuses on one particular scale of management - the regional scale. In contrast with many of the management processes discussed above, the industry has had limited experience in integrated, regional-scale planning. The regional scale is the scale at which many of the challenges facing the industry can best be understood (particularly the balancing of economic, social and environmental aspirations and challenges), because it sits at the interface between farm level management and social policy. Thinking about the future of the industry at the regional scale provides a useful means of understanding the impacts of policy and other drivers of change, and of clarifying what needs to happen at the next scale down (farms, mills, and harvest groups and so on) to seek sustainable development.

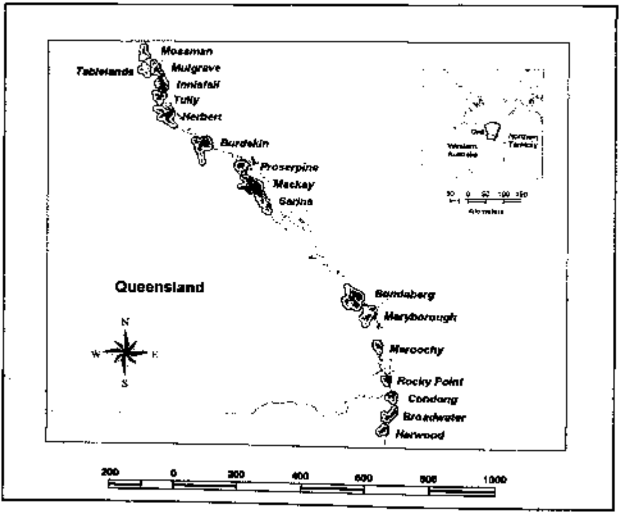
The value of a regional-scale focus for the sugar industry is now widely recognised, and recent assessments and government programs support this approach. Of nine actions recommended by Hildebrand (2002), more than half focused on regional-scale or regionally-based activities. Furthermore, the Sugar Industry Rescue Package describes the allocation of federal funds for regionally focused projects to facilitate industry restructuring, based on the differing needs and priorities of individual sugar-producing regions. The funding for Regional Projects will be provided through Regional Guidance Groups over three years, in conjunction with mandatory industry reform, in a manner similar to existing federal Government programs such as Regional Solutions, Dairy RAP and Sustainable Regions.

3.1.1 Regions of the Australian sugar industry

What do we mean when we think of the Australian sugar industry as a set of regions? 'Regions' are primarily defined by geography (Figure 3-1), by the relationship or value chain relationship between mills and growers, and even by harvesters. For example, Tully is a cooperative mill, the Herbert region has a separate mill ownership and the Tablelands Mill does its own harvesting. The nature of these different relationships within a region has a significant impact on a region's ability to change.

The summary statistics in Table 3-1 illustrate the variability of sugar-growing regions. The size of the industry in terms of number of growers, area of production, tonnes produced and numbers of mills has enormous implications for the industry's viability in different regions. So does the nature of the other industries and land-uses in a region. For example, land values in sugar regions close to growing populations like Brisbane may often be

Figure 3-1 Locations of sugar-cane growing regions in Australia.



determined more by alternative uses than by inherent agricultural value (such as, for growing sugar). Districts more remote from large population centres are more likely to have land values that reflect actual agricultural value.

The tabulated regional statistics provides a sketchy view of the range of regional variation.

Table 3-1 Regional sugar industry variables.

1 Sugar region	Main residential areas	Mills	Cane suppliers	Assignment area ha (Qld -1999, Other 1998)	Tonnes of cane (1999)
Mossman	Craiglie, Mossman, Port Douglas	Mossman	275	15,162	1,062,084
Mulgrave	Cairns, Gordonvale, Kuranda, Yarrabah, Babinda, Mirriwinni	Mulgrave, Babinda	519	32091	1,997,694
Tablelands	Atherton, Mareeba, Yungaburra	Tableland	78	6,712	480,442
Innisfail	Innisfail, Johnstone South, Mission Beach, Wongaling Beach	Mourilyan, South Johnstone	581	35,336	1,900,006
Tully	Cardwell, Tully	Tully	333	29,302	1,609,466
Herbert	Allingham, Ingham, Lucinda	Macnade, Victoria	814	65,582	4,151,742
Burdekin	Ayr, Home Hill, Guru	Invicta, Pioneer, Kalamia, Inkerman	*797*	83,888	8,492,601
Proserpine	Proserpine, Cannonvale, Airlie Beach	Proserpine	256	24,716	1,956,154
Mackay	Glenella, Mackay, Marian, Walkerston	Farleigh, Pleystowe, Racecourse, Marian	1,174	97,287	6,627,998
Sarina	Sarina	Plane Creek	214	23,086	1,768,288
Bundaberg	Bargara, Bundaberg, Childers, Gin Gin	Fairymead, Millaquin, Bingera	836	53,003	3,806,672
Maryborough	Hervey Bay, Maryborough, Tin Can Bay	Ists, Maryborough	410	34,595	2,326,409
Maroochy	Caloundra, Coolum Beach, Maroochydore-Mooloolaba, Nambour	Moreton	165	9,701	451,824
Brisbane	Beenleigh, Helensvale, Redland Bay, Victoria Point	Rocky Point	105	9,047	334,555
Tweed	Bogangar, Gold Coast-Tweed Heads (Tweed Hds Pt), Murwillumbah	Condong	142	8,324	668,818
Broadwater	Ballina, Casino, Lennox Head	Broadwater	192	13,994	983,390
Harwood Island	lluka, Maclean, Yamba	Harwood	262	12,056	811,678
Ord	Kununurra, Wyndham	Kununurra	20	3,585	411,658

More information and analyses are required to uncover the depth and subtleties of regional variation, nonetheless, overall regional characteristics can be found, even in these data.

Using the values for population, number of cane suppliers, area and tonnage, we can identify four principal types of cane-growing regions:

1. Major sugar-growing regions including Herbert, Bundaberg, Burdekin, and Mackay;
2. Sugar regions adjacent to large urban populations, including Moreton, Maryborough, and Mulgrave;
3. Medium-sized sugar regions, such as Mossman, Harwood (NSW), Tully, Proserpine, Sarina, Innisfail; and
4. Small sugar regions, including the Tablelands, Ord (WA), Brisbane, Tweed (NSW), and Broadwater (NSW).

Even at this very simple level of inspection, highlighting these different types of regions immediately provides insights into some of the different opportunities open to different regions. Regional differences could also have been defined in terms of irrigated or non-irrigated, reef catchments, types of drainage basin, acid sulfate soils and so on.

How can we describe and compare and contrast regions in a way that is useful for planning? It is important to explore the differences between regions that may be significant in terms of industry sustainability and development. One way of characterising regions is to explore the distinctive capabilities of individual regions in responding to industry challenges. Chapter 5 presents an indicator-based structure for exploring the particular characteristics of sugar-growing regions in comparison with the industry as a whole. This provides a structure for assessing the specific circumstances and future prospects of individual cane-growing regions.

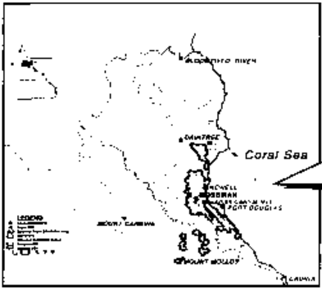
3.1.2 Regional variation - some examples

This book uses examples from three distinct industry regions to explore different approaches to regional planning. The Herbert River, Maroochy and Mossman regions are used as case studies throughout this document as they reflect much of the broader-scale regional diversity of the sugar industry. Table 3-2 and Figure 3-2 provide a brief introduction to these three regions and illustrate some of the variations apparent at the regional scale.

Table 3-2 An overview of the three case study regions.

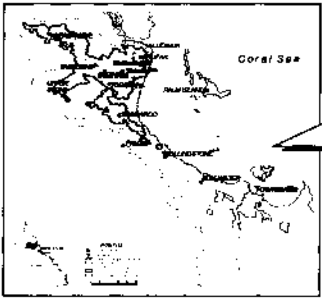
Characteristics	**Case Study Region**	
A mid-sized sugar-growing region, caught in the profitability squeeze.	The Douglas Shire	In the Mossman region, 275 farmers use about 15,000 ha of land to produce about 1,000,000 tonnes of cane for the Mossman mill each year. Farmers in this area are determined to generate plans for the future that not only assure a sustainable future for the industry, but also integrate with goals for the region as a whole.
A major sugar-growing region,caught in the profitability squeeze	The Herbert River District	In the Herbert region, 814 farmers grow cane on over 65,500 ha of land, - which deliver more than 4,000,000 tonnes of cane annually to two mills in the area. In spite of the magnitude of the industry and the determination of its farmers to continue their current activities, the viability of the mills has been questioned and there has been a desire to generate a consultative process to address this issue, to develop an information service and to analyse socioeconomic issues and opportunities.
A small sugar-growing region, close to urban expansion	Maroochy / the Sunshine Coast	In the Sunshine Coast area, 165 farmers grow cane on approximately 9,000 ha, which deliver about 450,000 tonnes of cane annually to the Moreton mill. The area has seen massive expansion of residential land-use in recent years, which has virtually surrounded the sugar industry. In response to the current economic pressures, the regional industry had identified a need to expand production (by growing more cane) in order to maintain the viability of the mill (and hence the local industry). Identifying suitable land for this became a major planning focus. Since the closure of the mill, the established community-industry planning process has been able to use its capacity to explore alternatives to milling raw sugar, such as a dedicated ethanol plant.

Figure 3-2 A Comparison of Mossman, Herbert and Maroochy regions based on 1998 and 1999 census information.



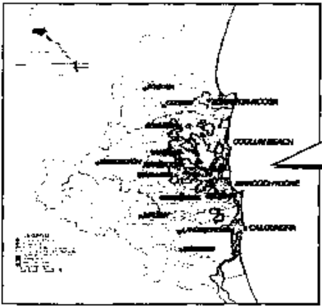
MOSSMAN

Local Government Area:	Douglas
Main Resdential Areas:	Craiglie, Mossman, Port Douglas
Population:	14,594
Mills:	Mossman
Number Cane Suppliers:	275
Assignment area (1999):	15,162
Tonnes cane (1999):	1,062,084



HERBERT

Local Government Area:	Hinchinbrook
Main Resdential Areas:	Allingham, Ingham, Lucinda
Population:	15,579
Mills:	Macknade, Victoria
Number Cane Suppliers:	814
Assignment area (1999):	65,582
Tonnes cane (1999):	4,151,742



MAROOCHY

Local Government Area:	Caloundra, Maroochy
Main Resdential Areas:	Caloundra, Coolum Beach, Maroochydore-Mooloolaba, Nambour
Population:	15,579
Mills:	Moreton
Number Cane Suppliers:	165
Assignment area (1999):	9,701
Tonnes cane (1999):	451,842

3.7.3 *The purpose of planning*

The purpose of planning is to exert some control over how the future unfolds. Planning requires identifying the desired outcomes ('where are we trying to get?') and what is required to achieve them ('how do we get there?'). In the case of regional resource-use planning, the desired outcomes might include maintaining or improving the overall standard of living, enhancing environmental performance or services, generating or maintaining a robust economy, and so on. Regional individuality will determine the specific nature of outcomes. The specific nature of outcomes is likely to vary substantially between regions according to the values and aspirations of the people in those regions. Therefore, a crucial aspect of planning is to determine the fundamental values and aspirations guiding a region such that the planning process can be used to define desirable outcomes and establish strategies for achieving those outcomes.

To deliver outcomes, those involved in planning may require new information, develop new strategies and policies, modify existing plans or policies, or employ new tools to facilitate the implementation of change. The distinction between the outcomes of planning and the processes of planning is important, and the presence of certain characteristics of each is key in promoting the overall success of planning.

Above all, planning is a means to an end, and not an end in itself. Planning is only ever as good as the outcomes it delivers!

3.2 What are the features of regional planning?

Regional-scale planning approaches are tools that have emerged to deal with sustainability challenges facing rural regions and, in particular, to deal with the specific challenges posed by problems of uncertainty, conflict and mistrust. Having defined desired outcomes, planning activities define strategies and actions to achieve outcomes. In the same way that desired outcomes may be regionally specific, the means and methods for achieving those changes will also vary according to the options and capacities available within regions.

Regional planning is broader than managing individual components of one industry and it is fundamentally a *strategic* rather than an operational activity (Box 3-1). Regional planning from an industry perspective looks at the industry's activities in their economic, social, and environmental contexts - and is a somewhat new concept. The key difference between regional planning and other types of planning is it is focused on issues at the regional scale. This is distinctly different from planning at the paddock, farm, or local scale.

Planning is a means to an end. The specific objectives (or ends) of regional planning processes for the sugar industry depend on the needs and aspirations of individual regions. The broad aim is to determine regional goals or desired outcomes (e.g., financial achievements, infrastructure development, best management practices, community development), and to put in place strategies for achieving these in ways that also strive to achieve, where possible or appropriate, mutual benefits for other regional stakeholders.

Regional-scale planning sometimes confronts complex issues where delicate tradeoffs may be needed to achieve some of the desired outcomes. Therefore planning at the regional scale may involve a significant element of negotiation between different stakeholder groups in order to embrace and satisfy the broadest range of stakeholder interests.

Box 3-1 Strategic vs. operational planning and decision-making.

Operational planning and decision-making involve routine, though not necessarily simple, decisions that may be repetitive and formulaic; decisions on pesticide selection and application strategy for example. Strategic decision-making is about long-term goals and planning and strategies that may require group decision-making through negotiation.

3.3 Outcomes of successful regional planning

Planning is a way of directing change towards negotiated goals. To be successful, planning outcomes must therefore accord with goals. In addition, successful planning outcomes also need to be equitable, accountable, adequate, effective and timely.

Equity - Regional-scale planning will inevitably involve multiple stakeholders. As a consequence, the perception that the outcomes are fair and reasonable sits at the core of successful planning. The sugar industry has embraced this concept in various ways during its history, including arrangements such as: cane land allocation, single desk marketing, distribution of transportation costs, and harvesting arrangements. With the expanding range of stakeholders concerned about natural resource planning, the need for planning outcomes perceived as fair and reasonable, not only for industry participants, but also to the broader community is particularly important. Planning decisions that are not equitable, or not perceived as equitable, are unlikely to engage the cooperation needed for achieve implementation.

Accountability - Planning is undertaken on behalf of and by industry bodies, government agencies at all levels, community groups, individuals and so on. As a consequence, the outcomes achieved by the planning process are fundamentally answerable to these 'sponsors'.

It is not uncommon for planning processes to come unstuck because stakeholder interests are not adequately represented and the resulting outcomes therefore lack accountability. Demonstrating accountability may require formal documentation or procedures that indicate this compliance or it may require fundamental shifts in decision-making power.

Adequacy - Successful planning is characterised by defining and promoting change towards improved outcomes that satisfy the participants, in extent as well as direction. Planning therefore needs to result in outcomes that are not only 'on the right track', but also sufficient to produce improvement. The 'needs' or requirements of planning are ideally determined early in the planning process (or clearly renegotiated during the process), so that the adequacy of planning outcomes can be assessed in terms of meeting those needs.

For example, setting aside land to preserve biodiversity requires not only selecting the most suitable land, but, to be effective, also requires a sufficient area of land. Poor planning could result in a reserve that is too small, or a one set aside in the wrong place, neither of which would maintain biodiversity.

Effectiveness - There are two types of effectiveness relevant in planning; effective *plans* and effective processes. In this instance we are concerned with the former - the effectiveness of plans in delivering outcomes. In Section 3.5, we consider effective planning processes in detail.

Planning has to achieve something more than just the generation of planning documents. To be successful planning needs to make a real difference. For the sugar industry, successful planning means significant improvements to the way that the industry and its resources are managed, such as improved soil and water management, improved profitability, conservation of biodiversity, and improved regional economic resilience. Planning is frequently, and not unreasonably, criticised for the number of plans that appear to be very expensive to develop and, once completed, simply sit on a shelf gathering dust. One of the key determinants of planning effectiveness is the extent to which plans are able to handle uncertainty. Uncertainty arises from our incomplete or inadequate knowledge about, and control over, natural and human systems. It applies not only to the analysis and interpretation of information, but also to the validity or suitability of methodologies employed in gathering information. The sugar industry faces uncertainty about the impact of the industry on environmental resources, the global market place, weather and climatic conditions, and institutional arrangements. A high proportion of the pressures for change that were identified earlier (in Section 2.3) relate to issues of uncertainty. Dealing with uncertainty is therefore a fundamental challenge of planning.

Adaptive processes, institutions and management procedures are emerging to deal with the necessity to make decisions about natural resources in the face of uncertainty. Adaptive processes accept that the suitability of farm practices and policy decisions is unknown, but that initiatives can be planned and implemented to optimise the trade-offs between short-term outcomes and enhanced knowledge (which confers long-term advantages). Initiatives can be adjusted in the future in light of new knowledge.

Timeliness - Planning outcomes are only valuable if they are timely. It is key to address issues that have (or will) become and remain important, rather than 'shutting the gate after the horse has bolted'.

3.4 Successful planning processes

Having explored the key characteristics of planning *outcomes,* we also need to consider the characteristics of effective planning *processes.* The distinction between process and outcome is an important, but tricky, one worthy of consideration.

Until only relatively recently, the only planning recognised as legitimate was that undertaken by government agencies. Traditionally government agencies undertook planning for economic development, social policy or natural resource conservation and management, in full control of the planning process. Secure in this position, planners could choose whether or not to consult or negotiate with affected stakeholders, and to what extent. Ultimately, however, decision-making stayed firmly within the agency's control, regardless of the consequences.

The *theoretical* view of what is good planning has shifted from this rational and technocratic style of planning practice by government agencies, towards a more sophisticated, communicative, view of planning which recognises that there are, and have always been, many planning 'voices'. This approach proposes that planning is a complex web of bargaining and negotiation among many interest groups, often with uneven power relationships, and that engaging the elements of that web is essential for successful implementation of planning. In practice, however, there remains an ongoing mix of those who apply planning as a technical process and others who adopt a political process of negotiation among interests competing for resources.

This shift in theory and, to a lesser extent, practice, revolves around generating adaptable, adequate, inclusive, effective, accountable and integrated planning processes.

Adaptability - This is the capacity to learn from experience to achieve on-going improvement. In complex systems, where knowledge and technology are continually improving, unforeseen circumstances may conspire to change the planning context. An in-built capacity to detect and respond to these changes is necessary in successful planning processes. A precise definition of 'adaptive planning' is not easy, but it treats resource-use planning as an iterative process of review and revision, not as a series of fixed prescriptions.

Importantly, each stage of the process is designed to provide insights which will, in turn, further improve the overall process of change.

Adequacy - It is critical that planning processes and activities be sufficient to attain the desired outcomes. Inadequate planning may result in poorly targeted or inappropriate activities or processes that are deficient and therefore have little chance of achieving the desired goals. It is worth noting the distinction between the adequacy of outcomes in meeting planning goals, mentioned in the previous section, and adequacy of the process undertaken to attain those goals. For example, if the intent of the process is to generate a plan of action that requires commitments from the whole community, but the process doesn't include representatives of the whole community, it is unlikely that the process will succeed.

Efficiency - The balance between the costs of planning and the value of the outcomes of the planning process determines the efficiency of the process. Although efficiency is important, it is often hard to measure the full costs and benefits of a planning process. The time spent by community participants is often overlooked but, equally, the benefits accrued from community involvement can easily be underestimated. What appears inefficient from one perspective may seem quite the opposite from another. For example, an apparently highly inefficient process (such as endless talking!) can sometimes have a real impact - the trade-off between efficiency of process and effectiveness of outcome is a difficult one.

Inclusiveness - For a regional-scale planning process to succeed, perhaps the most critical feature is that it includes the necessary diversity of views, experiences and concerns. The inclusion of different stakeholders from the beginning is more likely to result in planning that reflects overall community desires, and to generate a sense of ownership of the process. Even planning efforts focused on the sugar industry will benefit from the involvement of participants from the community, service industries, and other special interest groups - all of whom have a stake in the resources used by the industry.

For example, a sugar industry initiative aimed at tackling off-site impacts will need to include not only farmers, but may also need to include representatives of the scientific community, local urban regions, governments and their instrumentalities, coastal management organisations, conservation groups, indigenous groups, fishing and tourist industries, and so on.

Participatory planning uses communication and collaboration techniques to negotiate planning outcomes between stakeholder groups, and to define and explore trade-offs between social, economic, and environmental outcomes. It involves consensus building through group deliberation, argument, discussion and negotiation and can achieve joint implementation of planning and management arrangements. It provides a mechanism to develop strategies that require stakeholders to make choices, trade-offs and agreements about the acceptability of complex social, economic and other factors and the technical feasibility of actions.

Figure 3-3 **Involving the broadest range of participants is key for successful regional resource-use planning.**

Communicative approaches are particularly effective in situations characterised by high levels of uncertainty and conflict. These include cases where there are no clearly defined goals for strategies, where value-based definitions of goals are required, and where there are diverse or unclear stakeholder interests in relation to power or representation. Participatory approaches seek to establish working relationships between parties, and to establish processes for stakeholders to effectively represent their own interests in planning and policy-making situations.

However, communicative approaches to planning do not provide a universal remedy. There are many confounding factors. Time may not allow full discussions, agreement may not be possible, and power relations may now allow this approach. Rather, these approaches are proposed as a way of dealing with complex and uncertain environments where participants are open to exploring alternative futures.

Accountability - Ideally, a planning process is instigated by people or organisations intent on improving future outcomes. To this extent, the process needs to be answerable to its initiators and its participants, and to be able to demonstrate that it is fulfilling its mandate. Planning can become seriously derailed and ineffective if it disengages from this primary responsibility. This aspect of the process extends naturally into the accountability of the outcomes of planning mentioned in the previous section. Furthermore, within the overall planning process, representatives from different stakeholder groups may also need to demonstrate to their constituents that they are being properly represented. For example, a regional planning group that purports to represent industry and the community, but fails to include representation of a special interest group, is not truly representative and would fail to be accountable to its mandate.

Integration - The planning process provides an opportunity to recognise and assimilate a complex blend of interests and objectives (often in conflict with one another) and knowledge and information (that are inevitably incomplete) in pursuit of its goals. The most successful planning process will embrace economic, social and environmental aspects of resource-use issues for the broadest range of stakeholders.

3.5 Trust and planning processes

In the previous sections, we have discussed the characteristics of successful planning outcomes and processes. Planning processes that have these characteristics are more likely to be trusted, relevant and practical, and therefore, to be implemented, and hence, to achieve successful outcomes. Trust is particularly important to regional planning where we are faced with the reality of a rising distrust of government and other institutional arrangements including political institutions, legal systems, corporations, media and science. There has been a significant amount of speculation about why trust relationships are declining:

> *"This loss of trust has resulted from many things: socio-economic divisions in society, the rise of populist politics, failures by the media to inform rather than inflame, failure by science to explain itself, globalisation and market reform and consequent rapid institutional change, and a lack of political literacy or 'civics' that is required for political engagement"* (Dovers 2000).

In the context of the sugar industry there has clearly been limited trust between the supply chain partners, especially between growers and millers. Trust has also been lacking amongst the industry and the government, the media, environmental groups, scientists, and urban populations.

Trust is critical to partnership formation and the future success of cooperative and collaborative ventures. Uncertainty, vulnerability, history, and risk all influence trust. Trust is fragile and develops gradually. The process of building trust is a self-reinforcing process, where trust creates trust, or distrust spawns more distrust. Trust is difficult to initiate, slow to grow, easy to break and, once betrayed, is difficult to mend.

Trust affects the willingness of stakeholders to participate in planning processes and to agree to engage with other stakeholders to negotiate goals (desired outcomes). Trust in institutional processes also influences the willingness of stakeholders to disclose their self-interests and internal decision-making processes to external stakeholders (including the public).

While trust is of enormous value in a planning process it is not always attainable. A lack of trust based on misunderstanding or ignorance of different perspectives can be avoided, but sometimes a lack of trust is unavoidable. After all, planning processes often ultimately lead to dealing with conflicts.

Conflicting values and ideologies about the management and use of resources provide challenges for sugar industry planning. This is especially apparent when trying to negotiate mutually acceptable outcomes between parties with different agendas. Real conflicts (as opposed to misunderstanding) can include conflicts of interest and/or ideology (Table 3-3). Conflict can result when interests concerning scarce resources clash or beliefs about the nature of the world differ, or both. Planning processes that adopt participatory and adaptive frameworks have the potential resilience to overcome the challenges with uncertainty, trust and conflict.

Table 3-3 Sources of conflict - ideology vs. values.

		Conflict of Interest (scarce resources)	
Conflict of values (ideology)		No	Yes
	No	No conflict Parties agree on issues and ideology	Scarce resource conflict Parties disagree about resource allocation but agree ideologically about the nature of the dispute
	Yes	Ideological conflict Parties disagree about nature of world, correct view, what should or ought to be, no disagreement concerning resource allocation.	Complex conflict Parties disagree about resources and about ideology

Source: Alie Thompson and Gonzalez 1997

3.6 Requirements for planning

Having considered what successful planning outcomes and processes look like, this section explores what is involved in achieving such planning. To deliver an effective, efficient, equitable, accountable and integrated industry-focused planning process, and plans that can be implemented, we suggest that planning needs:

- an appropriate **decision-making environment** for planning and implementation,
- access to **information** pertinent to industry planning and its impacts, and the 'tools' to make effective use of that information,
- the **capacity** of participants to make appropriate use of that information and those tools in planning, negotiation, conflict resolution, decision-making, and implementation, and
- the means of evaluating the outcomes of planning activities and decisions to enable the planning process to **adapt** to a changing arena, and hence remain effective.

None of these elements, on their own, will ensure a successful planning process because they are interdependent. Each element has an impact on the effectiveness of the other. For example, the best-informed and most up-to-date plans will be ineffective if a counter-productive legislative environment or lack of sectoral support hinders their implementation.

In the following sections we expand on each of these four requirements in turn.

3.6.1 An appropriate decision-making environment

The decision-making environment affects, and is affected by, the way individuals and groups behave and interact, which, in turn, has important implications for planning processes and outcomes. In the specific context of the sugar industry, the human dimension of the decision-making environment includes public and private stakeholders, such as millers, growers, refiners, government bodies, and special interest groups. The institutional aspect of the sugar industry's decision-making environment includes government plans, industry and government policies, environmental codes, legislation and bureaucracies at all levels of government. Their sphere of control covers everything from resource allocation, farm and environmental management, to organisational representation, roles, responsibilities and relationships. See Appendix 2 for examples of some of the key arrangements impacting on the environmental aspects of sugar-cane production in Queensland.

Regional planning by the sugar industry is nested within this decision-making environment. The decision-making environment is administratively complex - a web of agencies, programs, rules and responsibilities so diverse that even the administrators probably do not fully understand their scope. Antagonistic programs are common and agency cooperation cannot be taken for granted.

However, the decision-making environment is not static. In order to resolve economic, social, and ecological problems and to deliver desirable outcomes for the industry and other stakeholders, it may be necessary to deliberately make changes to the broader institutional environment. This might involve reconciling multiple objectives or blending local, national and sometimes international interests and institutions.

The broader institutional context in which regional planning in the sugar industry occurs in Queensland is discussed further in Chapter 7.

3.6.2 Information and tools - the foundations of evidence-based planning

Rising community interest in the sugar industry and its future, rising community concern about the environmental impact of resources used by the industry, and increasing industry-community engagement in policies have given rise to an increasing expectation that the plans and policies affecting the industry should be based on a robust analysis of issues and their potential solutions.

Many issues impacting the industry now need to be considered in a broader context than they did in the past, and this is increasing the range of relevant information, the array of analytical tools required to process it, and the breadth of skills needed to interpret this information and use these tools. While decisions about resource-use and planning ultimately come down to issues of values, power and persuasion, there is little doubt that better quality decisions can be generated using high quality information. For example, acid sulfate soil (ASS) management in New South Wales was an important catalyst in improving farmer awareness of ASS risks and for motivating a change in management practice.

Key questions about integrating information into the planning process include: Who integrates it? How is this process best achieved? How might information be misunderstood or misused? Effective use of information in underpinning resource decisions demands a relatively sophisticated understanding of the nature and value of information: Where does it come from? How accurate, precise and reliable is it? Is it credible? Who owns it? How may it be used?

For many applications, it is not desirable, practical or cost-effective to collect new information to support the decision-making process - it makes more sense to use existing information. Locating and obtaining information requires exploiting knowledge networks, contacting local government organizations and groups, and investigating online directories. Existing information from non-government sources may only be available with restrictions on their use or dissemination.

Many of the issues associated with rural land-use have geographic or spatial dimensions that can be effectively captured, integrated, interrogated and evaluated using Geographic Information System (GIS) technologies. Aside from the fast, effective and repeatable analysis of vast amounts of data, simply being able to visualise the information can make it more meaningful, and hence, more useful.

Large amounts of information are often assembled and stored as databases, which require careful management of access and on-going maintenance. Establishing structures, standards and protocols (including security, documentation of data, analyses, and data exchange) promotes safe and effective database management and reduces the opportunities for data loss or duplication.

Understanding the scope and limitations of data used to inform decision-making is also a key issue. Data are only an approximation of the reality they describe, and as such, they vary in accuracy (how close they are to that reality) and precision (how much error is associated with that approximation). Various factors can influence the precision and accuracy of data. It is important to keep track of as many of them as possible, because they ultimately dictate limits to analysis and interpretation (i.e., what can be learnt from them). In addition to obvious factors, such as the nature of the variables, their units, who collected the data, the date and location of data collection, the methods that were used, and so on, the quality of geographic data is also impacted by 'mapping errors' associated with the location or description of points, lines and areas. **Metadata** are records that include all the relevant information about data, and applying metadata standards to datasets and databases enables meaningful interrogation of the information they contain, both now, and in the future. For databases to remain up-to-date and reliable, they need to be secure and maintained. A data custodian (or database manager), who can assure that the data are only used in accordance with inherent or explicit restrictions, should regulate access and protect the rights and sources of copyrighted information.

Basing decisions on evidence may be more complicated than it sounds. Determining the type of information needed, locating or collecting relevant data, organising them into usable forms, performing appropriate analyses, and understanding the interpretation, applicability and limitations of the results all require a degree of expertise. Various approaches can be employed to overcome this problem, and some of them, collectively known as 'decision support tools', play an important role in expanding the uptake of evidence-based approaches to decision-making. They provide ways of dealing with ever-increasing information, coping with increasingly complex decisions and validating resource management systems.

We revisit some of these issues in following chapters in the context of actual planning activities in sugar industry regions in Queensland. Suffice it to say here, linking information and analyses into planning is not easy, but if informed decision-making in planning seems expensive - try uninformed decision-making!

3.6.3 Capacity

Faced with an expanding planning arena and information base, decision-makers increasingly need new approaches, skills, expertise and so on, to tackle regional resource-use planning. Together these attributes are often known as *capacity.* Capacity includes the human, technical, intellectual, organisational, and financial dimensions needed to formulate and articulate goals, collect information, and develop and implement plans (including processes, such as representation, negotiation, coordination, communication, and politics, which affect these activities). Capacity also includes the ability of industry groups, or others, to carry out the actions necessary to implement plans or policies. So, the capacity to carry out successful regional resource-use planning applies to the people involved as well as the process itself.

The sugar industry has demonstrated the capacity to integrate experience and local knowledge (e.g., about soils, rainfall patterns, crop varieties, and so on), with social and economic pressures. It is now being asked to extend the scope of this capacity to deal with issues of potential off-site impacts, cumulative resource degradation, divergent community aspirations, influences of global markets and environmental treaties. On top of the demands for knowledge and expertise that this may require, there is the simple issue of time and energy these things add to already busy lives. Engaging the broadest range of stakeholders in the planning process is one approach that spreads the burden across the beneficiaries and maximises the likelihood of acceptable outcomes. It can do this by generating a much deeper understanding of the trade-offs between economic, social and environmental dimensions, and private and public needs, and costs and benefits.

Communities and issues are inherently unique and, therefore, there is no set recipe for formulating participatory planning processes. Approaches that work well in one setting may stall or flounder in another. But, generating a custom-made approach doesn't mean starting from scratch; there are well-tested principles for creating processes that work (Table 3-4).

Foundations of effective participatory planning processes.

Core elements	**Application in participatory planning**
Diversity	For successful planning, perhaps the single most critical feature of a regional or community planning process is that it includes the broadest diversity of participants with differing viewpoints, experiences and concerns. In planning for changes in the sugar industry, this means including participants from outside the industry - from the community, service industries, other special interest groups, and so on - in addition to the industry participants. Even the best plans are unlikely to succeed if only a small subset of people have a sense of 'ownership'. If different groups are included from the beginning, it is more likely that planning will reflect overall community knowledge and needs, and less likely that any section of the community will feel 'railroaded' by other groups.
	Even when there is a strong groundswell behind a movement for change, there is still a need for effective leadership to get a process going and keep it on track. It is important that this leadership not be seen to be biased or to have a hidden agenda because this could discourage broad participation and derail the process. Individuals from particular sectoral interests may provide leadership despite vested interests, but they would need to be clear and open about personal objectives.
	Generating broad participation will usually involve attempting to reach as many different people as possible, and this process will need to be ongoing; especially with a long-term process. While professional, community and other organisations can provide ready access to many community members, using other avenues such as newspapers, television, flyers, educational networks, may also provide important avenues for locating interested people.
Respect and Conflict management	When people with diverse points of view try to work together, there is a risk that the process can be derailed by conflict. As a rule, treating each other with respect can reduce the likelihood of these problems, and if the situation is particularly volatile, a trained facilitator or mediator can help maintain a positive and effective process.

In order to foster the inclusiveness we have described above, attention may need to be directed to how, when and where planning processes are carried out. For example, scheduling meeting times in a fixed time slot or location may automatically exclude some potential participants, as could reliance on a technology that is not universally available (e.g., exchanging all correspondence on email).

Establishing participatory processes to address regional resource-use issues can enhance the regional capacity to address these issues in meaningful ways. It may also provide an environment that can enhance the capacity of individuals and organisations involved to contribute constructively to the process. Many planning processes are time-consuming in terms of problem definition, information collation, integration and analysis, and in plan preparation and implementation. Developing access to relevant expertise may involve sub-contracting or employing staff from existing planning agencies, secondments from government or research agencies, developing skills within the community-planning group or using consultancies. In Chapter 4, examples of participatory planning processes used in the sugar industry are discussed further.

3.6.4 Adaptive planning processes

Regional resource-use plans are only as successful as the impact they have on outcomes, so it's not surprising that failure to link plans to outcomes is a widely recognised failing of many planning processes. Given that the driving forces for change (e.g., markets, technologies, environmental conditions, and societal values) are constantly evolving, no prescriptive plan can ever specify an enduringly optimal blueprint for resource-use. Most plans have clearly specified time horizons; nevertheless, the impact and learning from planning processes can inform and enhance the conduct and delivery of future planning processes.

Adaptive planning processes are designed not only to generate desired outcomes, but also to maximise the opportunity to gain insights into the system. They are particularly suited to situations where the system is not well understood, or is too large or complex for classical replicated experiments.

Ensuring that the lessons learnt from one process are carried forward to other processes can be an enormous challenge. Monitoring can generate information about the efficacy of policies, practices and outcomes, but to be useful, it must actually feed back into the planning process. Monitoring should track and evaluate changes in the economic, social and environmental conditions of the planning arena, and it should evaluate whether plans are delivering the intended goals or are capable of doing so.

While, in principle, formal approaches to evaluation and improvement can be adopted, in practice, these are demanding and expensive for those involved in planning and can divert attention and energy from the core planning tasks. This suggests that enduring planning structures (such as local government or regional bodies) are needed as vehicles for, and custodians of, experience and expertise for the continuous improvement of planning processes.

3.7 Regional planning - opportunities and challenges for the sugar industry

Having looked at regional planning from the perspective of processes, outcomes and requirements, this chapter ends with some thoughts on what regional planning means for the sugar industry and the challenges it raises in contributing to managing change.

3.7.1 Planning is becoming everybody's business

The traditional view, often held by planners and the community alike, is that planning is carried out by 'planners' who belong to a discrete profession and generally work for government agencies. It is widely assumed that governments undertake planning in response to regional need. However, as the decision-making environment of resource-use planning and management has expanded, planning practice has evolved into a highly participatory process in which resource-users and managers, governments and other stakeholders play substantial roles. These planning approaches are gaining popularity in Australia, especially to deliver better outcomes for rural regions. Technicians, administrators, farmers, entrepreneurs, advocates and others are becoming the community's planners, so planning has become a general approach to decision-making, not tied to the activities of any profession or government department. Increasing numbers of agricultural groups, community groups, regional bodies and catchment management groups, reflect the rapid growth of planning in Australia.

3.7.2 Planning opportunities for the sugar industry

Although the sugar industry has a long history of planning and regulation, it has focused on relatively narrow objectives (profitability and equity) among relatively few stakeholders (principally growers and millers). The current Australian sugar industry is the product of industry development and change over the past 21 6 years. Planning and institutional arrangements, such as cane land assignment, continuous crushing agreements, industry levies, and single desk selling, provide the framework that defines the industry's operation. Current planning arrangements include business, capital and investment planning by growers and millers, labour agreements, marketing arrangements and so on. They have nurtured a bureaucratic and technical planning approach focused on the immediate needs of the industry.

While critical to the industry's management and future, these arrangements are unlikely to be sufficient, on their own, for interfacing with the many elements of a broader planning system that now includes a wider range of stakeholders and issues. When the planning community has many, dispersed stakeholders, their competing objectives need to be satisfied to a reasonable degree for planning outcomes to be equitable and acceptable. Planning processes that suit a highly centralised context are unlikely to succeed. It is widely argued that changes to the sugar industry's operating environment necessitate a change from a top down to a more regionally focused view of the planning process (see Hildebrand 2002).

3.7.3 Planning - opportunities and associated challenges

We have talked at length about what planning does and how it can contribute to the future of the sugar industry, but we also need to consider some of the challenges faced by planning in the broader process of change. Meeting the challenge of increasingly complex decision-making processes, often occurring in a highly politicised environment, can cause significant stress for both individuals and the industry. The following illustrate points of concern.

Planning as an exercise in frustration. The challenges facing sustainable development are significant. Although there is considerable enthusiasm and commitment from communities and regions, ineffective institutional arrangements and the workings of government frustrate those involved in regional planning. *"Poor coordination, increasing responsibilities which are not matched by adequate powers and resources, and a lack of continuity of policies, funding, programs and staff"* (Dore and Woodhill 1999, p1 3) often frustrate leaders, facilitators, practitioners and contributors to regional initiatives.

The gap between principle and practice. Emerging concepts of sustainable development have called into question the efficacy of many existing institutional arrangements, the appropriateness of current distributions of power and equity, and the adequacy of decision-making processes. Regional planning has developed as a means of addressing these challenges through more holistic and integrated consideration of issues, meaningful stakeholder involvement to reflect changing societal goals and objectives, collaborative decision-making and flexible and adaptive institutions. However, the people who become involved in regional planning are often overwhelmed by the difficulty of translating this logic into practice (see Margerum 1997).

Responsibility without adequate resources or capacity. Devolution of planning and management responsibilities to regions and the emphasis on community-based, self-reliant approaches to natural resource management aims to give greater powers and responsibilities to regional groups to manage their affairs and achieve desired outcomes. The notable benefits are in participative democracy and local planning to meet local needs and aspirations. However, there are considerable pressures (financial, human capacity and skills base) on regional planning institutions that affect their ability to implement planning arrangements. There are also power and influence issues facing regional planning groups that affect their ability to solve complex ecological, institutional and economic problems and to control the behaviour of complex organisations.

The relationship between planning and other institutions. Many of these approaches assume that local initiatives will effectively resolve complex ecological and economic problems. Realistically, the goals of regional planning are complicated and organisationally challenging and require a careful and difficult blending of local, national, and sometimes international interests and institutions, as well as reconciling multiple and sometimes conflicting objectives. Many issues facing industry regions are beyond the control of the industry itself. Therefore, a major and consistent obstacle is the inability of the industry to control and guide the behaviour of complex organisations, particularly bureaucratic and local institutions (see Kellert et al. 2001).

In practice, the success of regional planning is varied and most initiatives face numerous practical challenges, including:

- generating local and regional support, and ownership of planning initiatives,
- local political issues, stakeholder conflict, and the need to manage conflict constructively,
- hostility towards planning intervention,
- local and regional representation of stakeholder groups,
- external environmental factors (e.g., global trade markets, international agreements etc.),
- capacity of individuals, groups, agencies and corporations (e.g., human resources and financial resources) to achieve desired planning outcomes, and
- remoteness and difficulty of accessing professional support services.

Where to go for more information:

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Dale, A. and). Bellamy (1998). Regional resource use planning in rangelands: An Australian review (Occasional Paper No 06-98). Land and Water Resources Research and Development Corporation, Canberra.

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Productivity Commission (2003). Industries, land-use and water quality in the Great Barrier Reef catchment: Research Report. Productivity Commission, Canberra.

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4 Regional planning in action

In the previous chapters, we reviewed the development of the sugar industry and the characteristics of its regions. We suggested that regional planning processes are important in managing change within the industry, and discussed the characteristics of regional planning processes and outcomes.

In this chapter, we move from exploring ideas about regional planning to examine practical experience. We review a range of recent, current and proposed regional planning processes within the industry and briefly discuss the different characteristics of key examples. In particular we discuss three regional initiatives in the *Sunshine Coast,* the lower *Herbert* and *Douglas Shire* regions. These case studies are presented as a means of exploring, in a practical way, the characteristics of planning processes and outcomes discussed in the previous chapter.

4.1 Regional planning initiatives in the sugar industry

There is a broad range of past, present and proposed regional planning activities that are relevant to the sugar industry. In Table 4-1 we list, and briefly describe, some current regional planning initiatives resourced by or mandated by state and federal governments of relevance to the sugar industry. This is not a comprehensive summary of planning processes but, rather, illustrates the breadth of approaches, motivations and experiences that contribute to regional planning relevant to the sugar industry.

Table 4-1 Some regional planning processes relevant to the sugar industry.

I Initiative	**Summary description**
The Sugar Industry Reform Package (2002-2003)	The federal and state governments' Sugar Industry Reform Package places a strong emphasis on the development of regional plans for change in the sugar industry. Recognition of the different needs and priorities of sugar-producing regions is one of the key concepts underpinning the package, as is the recognition that there is a role for government to provide assistance at this level to nurture industry restructuring. Government assistance will target regional initiatives aimed at medium- to long-term changes and be administered as Regional Projects sponsored by Regional Guidance Groups. These guidance groups report to the federal government and the Industry Guidance Group.
Landcare, Integrated Catchment Management and the Natural Heritage Trust (1990-ongoing)	Ten years of Landcare and Integrated Catchment Management in Queensland have, in recent times, evolved through the National Action Plan for Salinity and Water Quality (NAP) and the new Natural Heritage Trust program (NHT2) to having a strong focus on the development of accredited regional natural resource management plans. At the time of writing, none of these new planning processes have yet been accredited but, given that the plans are a prerequisite to accessing considerable federal and state funding, there has been a significant investment in planning. Regions of particular relevance to the sugar industry include: Burdekin Dry Tropics, Burnett-Mary, Mackay-Whitsunday, Wet Tropics, and South-east Queensland, each of which has established Regional Bodies. At a smaller scale, catchment management processes still exist. For example, 14 sub-catchments make up the South-East Queensland Regional Resource Unit, six of which are along the coast in areas potentially important to the sugar industry.

[Initiative	Summary description
River Improvement Trusts and Water Boards (1940-ongoing)	Lon- established planning and management processes potentially have an increasing role to play in regional planning and management. For example, the functions of the River Improvements Trusts (e.g., Burdekin Shire, Cairns, Douglas Shire, Herbert River, Johnstone Shire and so on) are long-established, and are increasingly becoming involved in regional planning processes. The same is true of groups such as drainage and water boards, such as the Babinda Swamp Drainage Board and the North Burdekin Water Board.
Planning committees (ongoing)	Various statutory and non-statutory committees, such as the Burdekin-Bowen Integrated Floodplain Management Advisory Committee; Landcare Support Strategy Indigenous Working Group; Landcare Support Strategy State Working Group and State Steering Committee and Wet Tropics Regional Vegetation Management Committee, are involved in activities relevant to regional planning.
Statutory regional \ planning initiatives	A range of regional development initiatives, such as the Far North Queensland (FNQ) Regional Plan, South East Queensland - SEQ 2021, the Whitsunday, Hinterland and Mackay - WHAM 2015 plan and Wide Bay 2020, address broad -scale regional development issues that are clearly relevant to the sugar industry.
Integrating activities e.g., i Reef Water Quality Protection Plan (2003-ongoing)	Not surprisingly, many plans and planning processes cover common issues. Consequently, the representatives of one planning initiative may become stakeholders in other processes. This coordination across plans into a planning system can require significant investment in its own right. For example, the Great Barrier Reef Water Quality Protection Plan, sponsored by the state and federal governments, was primarily concerned with harnessing linkages between a range of policies, plans and government investments relating to the Great Barrier Reef.

4.2 Case studies

We want to tie the principles of regional planning processes and outcomes that we presented in Chapter 3 to practical experiences through discussion of three particular case studies: planning for change in the Moreton Mill district on the Sunshine Coast; developing a resource base for evidence-based planning in the Herbert, and linking sugar industry futures into sustainable development of a region in the Douglas Shire. We have chosen these three case studies because we were involved and therefore know a good deal about them, and because they represent three very different regional manifestations of current pressures and types of regional planning processes.

The Sunshine Coast initiative stemmed from serious concerns about the viability of the mill and, therefore, the industry in the district. The key to the initiative was the development of new partnerships within the industry (between the millers and the growers) and between the industry and the community (particularly local government) in the face of extraordinary economic pressures.

The establishment of the Herbert Resource Information Centre in Ingham was not intended to tackle a single overwhelming question about the industry's future, but was related to a suite of sustainability concerns stemming from industry expansion. It was focused on building the skills and infrastructure to give the different sectors within the industry and the community access to high quality information about the region, and the skills and tools to use this to enhance the many and varied decision-making processes in which they are involved.

The Douglas Shire initiative (centred, from a sugar industry perspective, on the Mossman Mill) has focused a good deal of attention on the long-term sustainability of the sugar industry in the region - from economic, social and environmental perspectives - and has sought to link these considerations into an understanding of the same issues for the whole community of the Douglas Shire.

These initiatives have achieved quite different outcomes, but have a few important elements in common. For example, they were all motivated by a regional-scale perspective of the sugar industry and its management (remembering that much implementation will only happen at a farm-scale). They also shared the, maybe surprising, feature that none of them actually developed a plan, in the sense of a written document, although we argue they are all regional planning processes.

4.3 The Moreton Mill region on the Sunshine Coast

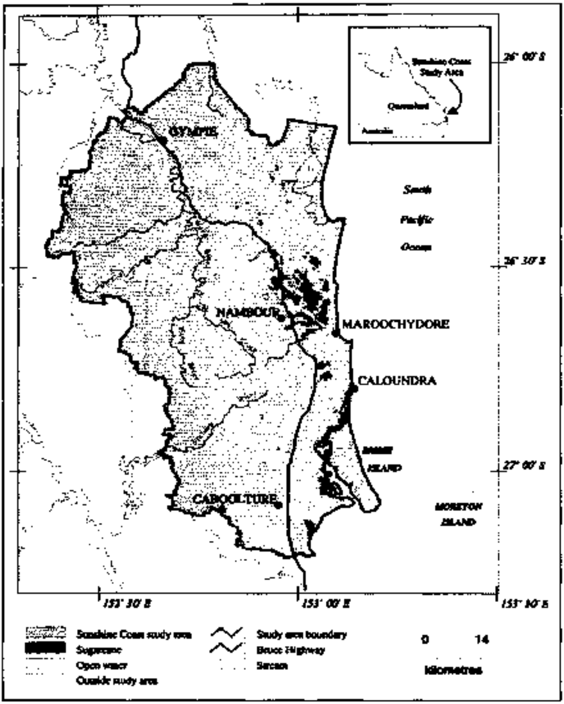
In the late 1990s, declining world sugar prices and declining productivity combined to threaten the profitability of the Moreton Mill at Nambour, in the Maroochy Shire (Figure 4-1). Established in 1893, this mill was owned and operated by Bundaberg Sugar Ltd., and was supplied by cane grown in the surrounding areas of the Maroochy Shire and Caloundra City. An additional 2,504 ha of land was assigned to cane production following changes to the *Sugar Industry Act* in the 1990s, taking the available cane land from 7,334 to 9,838 ha. However, this apparent expansion was offset by other losses, so that only 485 additional ha actually contributed to the harvest. With the prevailing sugar prices in the late 1990s, the production of approximately 350,000 - 650,000 tonnes of crushed cane was inadequate to sustain the profitability of the mill. However, growers and millers believed that increasing the amount of cane crushed would enable the mill to regain viability. Selecting land suitable for expansion of cane growing was a challenge because the invasion of urban and rural-residential developments had caused cane land to become fragmented and isolated from the mill. The key questions were, therefore: where would cane grow well enough to be profitable, and could it be delivered from these new locations to the mill cost-effectively?

Using funds from the Sugar CRC, researchers at the CSIRO were developing ideas to improve the process of natural resource-use planning in the sugar industry. The challenge facing the Moreton Mill provided an opportunity to apply some of these ideas, while at the same time, providing practical assistance to the industry. Land and Water Australia (LWA) and the Sugar Research and Development Corporation (SRDC) also provided financial support for the project. It was important to the mill that its operations were not open for inspection or negotiation, so the initiative was limited to operations outside the mill gate, including cane land, transport and the grower/miller interface.

Within their own ranks, the growers were connected through the CANEGROWERS organisation that provides growers with representation, communication and information dissemination through meetings and its regular newsletter. The interactions between the mill and the growers were restricted to negotiations with the Mill Suppliers' Committee. This committee brokered determinations of cost- and profit-sharing between the mill and the growers, in particular, related to cane harvesting and hauling or transportation.

The key challenges faced by participants in moving forward included: poor communication between growers and millers; low levels of engagement amongst the industry and state government, local government, and the community; in some cases, mistrust of the industry by local and state governments and community sectors; inadequate information about prospects for the future in terms of pressures and options; and substantial disagreement about the implications of the available information.

Figure 4-1 The Moreton Mill sugar-cane growing region (CSIRO, 2000).

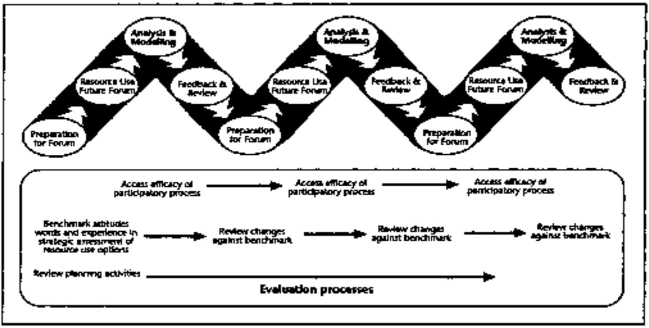


4.3.7 Engaging stakeholder involvement in planning

The Sunshine Coast initiative focused on developing a stakeholder-driven approach to resource-use planning to promote the viability of the Moreton Mill. This approach was used in response to the challenges posed by communication issues within the industry, different views about how the industry should develop (including strong views by some that it should not) and to enable stakeholders to actively participate in planning processes. It emphasised communication of aspirations, negotiation of mutual understanding of their implications, and using a broad range of data and analytical tools to inform emerging plans.

The approach to resource-use planning adopted here was based on a series of Resource Use Futures meetings (Figure 4-2). At these meetings, key stakeholders came together to negotiate and renegotiate aspirations and actions on the basis of growing information. The framework involved a series of steps (not necessarily applied in a strict sequence, but involving several iterations) as summarised in Box 4-1.

Figure 4-2 The conceptual framework for the participatory planning process used in the Sunshine Coast area initiative.



Box 4 .1 Steps in the planning process.

Step 1. Negotiation of resource-use aspirations within the industry. One of the aims of this initiative was to assist the sugar industry and other relevant stakeholders to plan for future development of natural resources used by the industry. This was to be achieved by a series of 'plan-to-plan' workshops and Resource Use Futures Forum meetings, which thrashed out aspirations for the industry that might be acceptable to all stakeholders.

Step 2. Assessment of the resource base in relation to aspirations. The biological, physical, financial, social and human capital that the industry has at its disposal determine the extent to which aspirations are achievable. Some of the types of analyses described in Chapter 5 were used to support this assessment.

Step 3. Dialogue with other key stakeholder groups. The framework was structured to accommodate the increasing number of stakeholder groups that had an interest in natural, social and economic capital used by the sugar industry. To be as flexible as possible, it included stakeholders and organisations in a progressive process. Once the groups already involved saw a need and had sufficient confidence and information, new groups were drawn into the process. Such inclusive participation, requiring dialogue and negotiation, was seen to be critical for successful strategic planning and implementation

Step 4. Integrated consideration of economic, social and environmental impacts. One of the key intentions of this initiative was to seek improved integration of the economic, social and environmental implications of resource-use. For example, land suitability and rainfall models were developed with specific consideration of environmental impacts, while a transport model was developed to determine the economic and social implications of changes to the transport system, as well as the needs of the sugar industry (see Chapter 5).

Box 4 .1 (continued)

Step 5. Principles for resource-use plans - How to... rather than what to... The framework was based on the view that resource-use planning needs to be highly participatory and responsive to the ever-changing operating environments of the industry and the community. While strategic planning needs to be achieved through debate, negotiation and consensus across a broad range of sectors and stakeholder groups, implementation of elements of the plan will occur in a less integrated way as each sector meets its individual needs through conducting their core business. As a consequence, the framework focused on developing consensus on principles for design of future resource-use strategies rather than the development of rigid and formal planning outcomes.

Step 6. Seeking effective implementation. The approach taken in this initiative involved collaborative decision-making, establishing trust by building relationships between participants, and enhancing communication between industry, government and community representatives. All initiatives and analyses were agreed to and supported by stakeholders. The process and analytical framework have ensured that all decisions were made according to the needs of stakeholders. This provides a robust foundation for successful implementation of the resulting plans.

Building stakeholder relationships was a key component of this process. Relationships needed to be built between all stakeholders in the region, including mill management, growers, local government, environment groups, community groups and economic sectors within the local community. This was achieved by personal visits to inform, advise and seek ideas and feedback in relation to the project.

Initially, the Moreton CANEGROWERS, Moreton Mill Management Team and the Management Committee determined the direction of the process through a series of meetings, the land-use planning forum meetings and plan-to-plan workshops. Later, other interested groups were included in the planning process, and contributed to the setting of future directions. The additional stakeholders included: environmental and catchment groups, and municipal councils and the Bureau of Sugar Experiment Station (BSES). By the end, the initiative involved twenty-five organisations, representing interests in social, economic and environmental issue in the region (Box 4-2).

Box 4-2 Extent of representation covered by participants in the final Sunshine Coast forum in March 2002.

Industry: Individual growers, Moreton CANEGROWERS, Brisbane CANEGROWERS, and Moreton Mill/Bundaberg Sugar.

Local Government: Maroochy, Cooloola, Caloundra & Noosa Councils.

State Government: Local Member for Nambour, NR&cM, DPI - Policy Analysis & Industry Development Group, State Development, Premier's and Cabinet, EPA Sustainable Industries.

Environment Non-Government organisations: Mary River CCC, Maroochy CCC, Noosa CCC, Sunshine Coast Environment Group, Noosa Environment Committee, Landcare, Qld. Biodiversity Network.

Business Interests: Mary Valley Enterprise & Tourism Association, Cooloola Regional Development Bureau, Nambour District Chamber of Commerce, Gympie Business Association, Regional Communities Committee.

Research and Development organisations: BSES, CSIRO, CRC Sugar, SRDC.

4.3.2 The continuing process

During the initial phase of the initiative, the stakeholders determined that they needed information about the extent and location of land suitable for cane-growing, and CSIRO sought to provide this information. As a foundation for further investigations, land cover for the Moreton Mill study area was mapped using remote-sensing and GIS techniques augmented with supplementary data where additional resolution or information was needed. Following this, land suitable for sugar-cane was identified and mapped to establish whether there was sufficient suitable land available for expansion. The addition of environmental criteria, such as retaining riparian buffer zones, refined the analyses to focus on land suitable for sustainable cane-growing (explained in further detail in Chapter 5).

Having identified potential areas for expansion, the stakeholders then determined how the potential profitability of these areas could be affected by the local availability of adequate and reliable rainfall, and that existing rain gauge data were not adequate to determine this. The initiative therefore assembled information to develop a better understanding of the spatial and temporal variation of rainfall in the region. This was achieved by generating average annual and average monthly rainfall surfaces (in the form of data and maps) to interpolate a best-fit surface to rainfall station and digital elevation data.

However, the stakeholders recognised that even the best cane-growing land is of little value if the cost of getting the cane to the mill completely offsets profitability. To provide the stakeholders with pertinent information about transport costs, the researchers generated analyses to estimate the probable costs associated with hauling cane from potential areas of expansion. The analyses generated a map of distances and travel times between the mill and proposed areas of production (see Chapter 5).

About halfway through the initiative, the Moreton Mill was sold, shifting the ownership from Taite and Lyall (a multinational company trading in Australia as Bundaberg Sugar Ltd.) to Finasucre (a family-managed company). This resulted in a need, by the new owners, to assess the financial viability of the mill. As a multinational company, Taite and Lyall had been able to absorb the Mill's losses in its extended operations; Finasucre did not have the same latitude. While initially this did not seem to affect the initiative, there was a sense of urgency from management at Moreton Mill to have a concrete plan in place that they could present to the new owners.

As the initiative progressed, the involvement of local government and environmental groups shifted the discussions from economic (profitability and viability), to social and environmental issues (broader sustainability). In other words, the emphasis shifted from 'how can we keep the mill going?' to 'how can we continue growing cane and maintain all the community activities underpinned by this industry?'

The sugar industry in the Moreton Mill region has and continues to face substantial challenges to its medium to long-term viability. The planning process described hasn't solved these problems. However, it has built relationships across the industry and a **capacity** to address difficult issues through more effective dialogue and negotiation. This is likely to be fundamental to managing the local industry's transition into its future structure (whatever that looks like) in the most **efficient** and **equitable** way as possible. The partnerships established have proven to be reasonably **adaptable** to changing circumstances and seem to have strengthened and become more **integrated** as they have become more **inclusive.** Despite continuing uncertainty about the future, most participants have valued the process and feel that it has helped reduce conflict and avoided the costs, missed opportunities and stress that can arise from sustained conflict.

Although the participatory planning process began with one agenda, it has progressed as a key resource for dealing with the next. Importantly, establishing a process to *tackle* problems, rather than attempting to generate specific solutions, enables the participants to contribute to longer-term planning in the sugar industry. By engaging a broader range of stakeholders than just those in the industry, the directions and outcomes are more likely to suit the broader regional community, and to have the capacity to continue to keep pace with new situations and challenges. While the Moreton Mill's announcement to cease operation could have been a complete blow to the sugar growers to the area, the strength of the collaborative processes that had been created in the region enables the growers to forge ahead with other plans to market their product, and fostered community confidence in the industry's decision-making ability.

As the initial process drew to a close, a task force (made up of industry stakeholders, representatives from local government, environmental groups, and community groups) was established to ensure that the process would continue in the region, and that plans for continuation of the industry in the region could be established and implemented. Although the Mill announced that it would close at the end of the 2003 crushing season, the cane growers are optimistic about finding alternative markets for their cane, principally by developing an ethanol plant in the area. Coming under the 'changing to new industry' component of the recently-announced industry assistance scheme, the growers are hoping to either lease the Mill for the next season (with substantial financial support) or broker a plan to ship their cane to other nearby mills (Rocky Point or Maryborough) (also with financial support). The growers have entered negotiations with a construction company to build an ethanol plant in the region which, hopefully, will begin commercial operation in 2004. The growers are working on this proposal with local government, the Chamber of Commerce, environmental groups and various state government departments. The task force has been involved in these negotiations with both the Mill and growers in relation to both issues (mill closure and the new ethanol plant). A task force was established to find ways of ensuring the livelihood of the growers was maintained until the ethanol plant was established. As well as the ethanol plant, the task force investigated other options for growers, such as hemp production, or farm forestry. A key role of the task force has been providing the community with regular updates about negotiations and issues through the local newspapers.

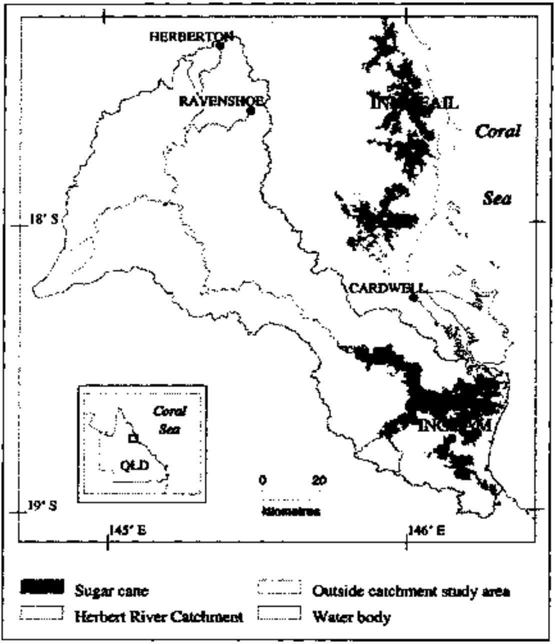
4.4 The HRIC, a case study in regional spatial data management

The Herbert region (Figure 4-3) is dominated by the sugar industry, producing as much as AU$235 million worth of sugar in the booming 1996-97 season. Since the early 1990s there has been increasing concern that the sugar industry may be having significant environmental impacts on the Herbert catchment and its associated offshore area. However, this concern has been balanced by regional and national recognition of the importance of the sugar industry. To achieve ecological and economic sustainability vithin the Herbert catchment means to manage and reconcile industry imperatives with requirements of other users of the catchment (including conservation and environmental services). As with many other districts, stakeholders in the catchment sought to address this challenge through an Integrated Catchment Management (ICM) planning initiative.

Advances in information technology, such as GIS, have brought new opportunities for improving local capacity and participation in planning. Fostering effective use of GIS and other technologies amongst a broad range of stakeholder groups, and in the broader community, requires investment in people and technologies. In Chapter 3, we touched on some of the challenges to achieving evidence-based planning. Although we explore this theme further in Chapters 5 and 6, in this section, we focus on one particularly successful case study in evidence-based planning. The Herbert Resource Information Centre (HRIC) is an example of an unincorporated collaborative joint venture. It involves CSR Sugar (Herbert River Mills), Herbert Cane Productivity Services Ltd, Hinchinbrook Shire Council, CANEGROWERS (Herbert River District), CSIRO (Division of Sustainable Ecosystems), and Queensland Department of Natural Resources and Mines. The joint venture has been very effective in building the industry's planning capacity.

The HRIC case study contrasts markedly with the Moreton Mill case study in so far as it focuses on the technical basis of decision-making as opposed to the relationships and structures required for planning. Consequently, the following discussion focuses on relationships and structures required to establish, manage, and share analytical capacity.

Figure 4-3 Location and extent of the Herbert River catchment (CSIRO, 2001a).



4.4.1 Creation of the Herbert Resource Information Centre (HRIC)

In mid-1993, key stakeholders in the Herbert catchment initiated discussions to address the first of the constraints to integrated catchment management - inadequate data. As a result, the Herbert Mapping Project (HMP) was developed by 11 industry, community and government agencies. The HMP was successfully completed in July 1996, having funded the acquisition of:

- digital ortho-photography.
- a series of 1:10,000 orthophoto maps, and
- a GIS vector dataset including contours, streams, vegetation cover roads, railways, buildings and bridges.

One of the lessons arising from the HMP was that tighter specifications could improve the usefulness of the GIS vector dataset produced. For example, the dataset captured by the HMP had gaps in roads where there were bridges, did not have labelled vegetation data, did not have stream direction or stream connectivity. The dataset had been captured almost as a picture rather than a topologically correct GIS dataset ready for spatial analysis.

As the project drew to a close, it was apparent to many stakeholders, that the use of the information could only be maximised through advanced analysis of the data in digital form. GIS provided the best means of satisfying both the need to analyse data and to present results in an appropriate form to facilitate planning. To meet these objectives, it was proposed that a further joint venture, the Herbert Resource Information Centre (HRIC), be developed and that CSIRO researchers assess its appropriateness and viability through needs and cost-benefit analyses. They determined that a collaborative GIS facility most suited the organisational characteristics of the probable participants, and that it would be a worthwhile private and public investment.

Based on this information, six stakeholder groups in the catchment began to negotiate a formal agreement. Four of the stakeholders (CSR Sugar Mills, Herbert Cane Protection and Productivity Board, Hinchinbrook Shire Council and CANEGROWERS Herbert Executive) represented local industry and community, while the other two, (Queensland Department of Natural Resources and Mines and CSIRO) represented state and federal Governments respectively. In spite of the differences and existing conflicts amongst these stakeholder groups, a desire and need to improve their business through better management of resources brought them together. In August 1996, the stakeholders signed a 10-year collaborative agreement to formally establish the HRIC. The agreement secures the support of its stakeholders and binds them to uphold the HRIC's status as a non-profit, community-based, collaborative GIS facility designed to support both economic and ecologically-sustainable development in the Herbert catchment.

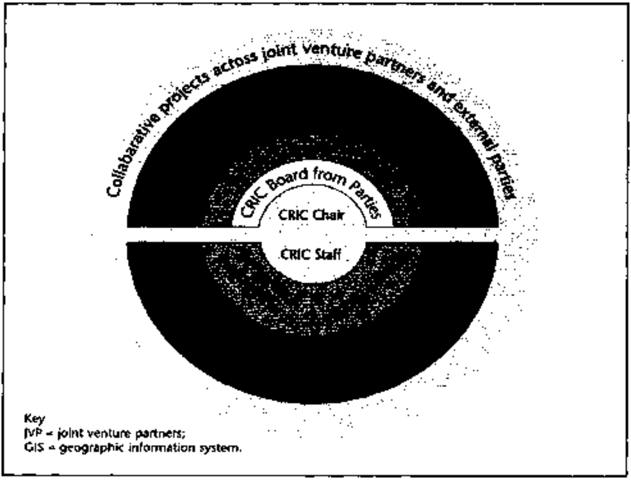
4.4.2 The nature of the HRIC

The HRIC is a catchment-based GIS facility supporting the management of natural resources in the Herbert River catchment. It does this by assembling and providing access to geographic information, GIS tools, and expertise. The organisation aims to facilitate a common geographic view of the catchment, and to foster collaborative planning between the six HRIC stakeholders and the community. The HRIC also acts as a conduit for delivering research products to other local decision-makers.

The four HRIC community and industry-based stakeholder groups provide funding for the HRIC, while the two external stakeholders provide matching in-kind contributions in the form of data and technical and professional support (Figure 4-4). Two full-time GIS specialists staff the HRIC, providing expertise and skills to facilitate the collection, storage, maintenance, and analysis of natural resource data. They act as a conduit for the transfer of relevant research and development products to ensure that the products of these activities are genuinely available to HRIC stakeholders, and to provide consulting services and project management skills. The HRIC staff also builds GIS capacity in the region by assisting stakeholders to implement GIS as part of their business operations (e.g., property management planning, local government planning, mill planning), and by promoting improved communication and collaboration between HRIC stakeholders.

In addition to the active participation of community stakeholders, the HRIC has a strong community focus, exemplified by the strong school program and documented use of HRIC services by a range of community organisations, including clubs and aboriginal representative bodies. In this sense, HRIC builds on rural Australia's strong history of active community and representative groups that play a key role in local politics and governance. Figure 4-4 presents the generalised structure of a Community Resource Information Centre (CRIC) as implemented in the Herbert Resource Information Centre.

Figure 4-4 A community resource information centre structure (Walker et al. 2002).



The outcomes sought by the HRIC were:

- improved quality of data available for the Herbert catchment,
- improved access to data,
- better-informed decisions in planning and implementation of projects to collect and use data,
- better-informed decisions in natural resource management, and
- improved collaboration.

In its seven year life, the HRIC has undertaken a range of projects to help meet these objectives (Table 4-2).

Table 4-2 Some examples of HRIC Partner Projects.

HRIC project	**Project description**
Cane block mapping project	To map existing sugar-cane blocks and sub-blocks in the lower Herbert River catchment from aerial photographs.
Satellite yield estimation used	Satellite imagery, namely Landsat Thematic Mapper (TM),to estimate crop yields with relatively high accuracy.
Master land and water management plan environmental	A major planning study facilitating optimal sugar-cane productivity from suitable agricultural land, taking account of the needs of the systems of the area.
Hinchinbrook Shire Council flood mapping project	A user-friendly graphical interface to easily and readily obtain flood data.
Herbert River Improvement Trust flood study	A flood study to establish guidelines and policies for the long-term management of the flood risk in the Lower Herbert.
CSR soils project	Approximately 65% of the Herbert River cane area mapped to a scale of 1:20,000, and supported by a soil analytical database (with soil physical and chemical data for over 1,000 soil profiles). It represents the most comprehensive soil dataset for any sugar-cane area in Australia.

4.4.3 Evaluating the HRIC

After three years of HRIC operation, two formal evaluations were performed (Walker et al. 2002; Hardman 1999). The economic evaluation came to the following conclusion:

> *"From an economic viewpoint, the HRIC is a highly profitable operation which is beneficial to all joint Venture Partners, although the benefits are not evenly distributed. It will probably generate quantifiable benefits of approximately $ 19M over its ten-year life, based on current knowledge. This is almost certainly an underestimate, given the limited developments to date in the use of the HRIC data by at least some]VPs"* (Hardman 1999).

The broader process-based evaluation (Walker et al. 2002) identified a range of outcomes from the HRIC as summarised in Table 4-3.

Table 4-3 Summarised results of the HRIC evaluation (after Walker et al. 2002).

HRIC outcomes	Value in the Herbert	Participants views
Improved quality of data available for the Herbert catchment and improved access to those data.	Data access improved dramatically. Participants became more aware of the range of data available and had access to all data except confidential commercial information. There were still significant differences in perception between individuals regarding the general quality of data available in the Herbert, particularly between active and less active users. Nevertheless, many participants developed an improved understanding of the limitations of key datasets, including the implications of scale on the usefulness of data. Greater understanding of the data, combined with knowledge that all parties shared common data, resulted in higher levels of confidence in using the data.	"Totally replaced and enhanced previous data." ..."A significant impact on data access...Not only have we been accessing data, but government agencies as well."
Better-informed decisions in planning - projects to collect and use I data implemented.	Although processes for data collection were only moderately impacted for most parties, in the first three years of operation, the need for data-sharing and compatibility had a significant impact on data storage and management, both collectively and individually. For some activities, such as field surveys and ortho-photo and satellite imagery, radical changes in data	"Changed from pen/paper in drawers and files to digital form ..." "The staff expertise really came through in the technical advice on how to go about our project."

HRIC outcomes	Value in the Herbert	Participants views
	collection occurred. In general, although interviewees saw compatible data collection and storage as important, they considered other factors—such as the opportunity to discuss differences in interpretation of shared data—more important.	
Better informed decisions in resource management	Formal spatial analyses were used in planning decisions, often with substantial cost savings, and resulted in a perception that decisions were as good as, and frequently better than, those achieved using traditional procedures. Although negotiations regarding resource-use increasingly relied on GIS-based products, decisions on resource management issues cutting across sectors and stakeholders had not progressed. However, this was considered a question of time rather than a function of more fundamental constraints.	"Efficiency and quality of decisions gets better..." For example, "Without (the) HRIC (we) could not make decisions for (sugar) crushing agreement effectively because we did not know the exact area under cane."
Improved collaboration	In terms of motivation for involvement and strategic direction, many participants initially saw the HRIC as a data source and a means of cost-sharing. Over time, however, the HRIC became instrumental in changing planning processes, sharing and developing skills, and brokering projects rather than as simply a technical service. For the people interviewed, involvement in HRIC meant additional work, meetings, and rapid skills development in emerging fields. In some cases, it meant developing new working relationships where none existed previously. All participants saw this as a positive experience for themselves and their community, and took pride in the HRIC's achievements. Willingness to work together increased amongst the Centre partners, and external use of the HRIC by businesses and the broader community began to occur (although issues of user payment for HRIC services and third party data remained a complex challenge). Although improved collaboration between agencies was not universal, there were no reported cases of worsening relationships. Nevertheless, some groups felt that they were marginalised because they were not formally involved in the Centre.	"HRIC has made me more aware of the...way people think and other people do business...drawn into a lot of projects."..."Everyone's willingness to share...it has changed attitude...not 'what's mine is mine' but 'what's ours is ours'...to get a large public company and a shire council to work together is incredible..."

Although at the time of writing, these evaluations are about four years old, the HRIC has continued to grow and evolve successfully over that time.

4.4.4 Principles for establishing resource information initiatives

Prior to the developments reported here, GIS had not been widely applied to natural resource management in rural Australia. The prevailing perception had been that such data were too expensive to collect and maintain, and that GIS required human and financial resources beyond the reach of most groups and communities. In addition, the business opportunities provided by GIS in rural settings were not clear. The HRIC provides an example of the use of GIS in a rural community to deliver clear financial and social benefits. The HRIC experience provides a valuable working model for other communities in Australia. This model has received widespread attention across Australia, and other regions can adapt this model to meet the needs of other settings.

Based on the experience outlined above, a set of 'best practice guidelines' were developed for the establishment of Collaborative Resource Information Centres (CRICs) such as the HRIC (Table 4-4).

Table 4-4 Principles of a Community Resource Information Centre (CRIC) (Walker et al. 1999).

Principles	Description of Principles
	A CRIC is a joint venture that may include: local, state, and federal agencies; businesses; and community and industry representatives. The CRIC model derives its advantages from sharing data and costs through collaboration, improved linkages and better working relationships between stakeholders. A CRIC that is broadly representative includes stakeholders with diverse (even conflicting) perspectives, and is more likely to become trusted than one with a restricted, or partisan, membership.
A team approach	A CRIC is comprised of both the Centre's staff and management, and the GIS users within the stakeholder organisations. Staff from the joint venture partners undertakes much of the application of GIS to their core business. Investment in training and mentoring for these people, as well as CRIC staff, brings many disciplines and perspectives into a broad-based and expanding team responsible for implementing the CRIC's objectives.
Independence	Because collaboration is the lifeblood of a CRIC, it is important that the CRIC remain independent of joint venture partners. This might mean employing professional staff directly within the Centre, having an independent Chair to the Board, or independently housing data. CRIC staff face fundamental challenges in maintaining equally effective working relationships with all the joint venture partners, while CRIC board members need to find an appropriate balance between representing the interests of their organisation and seeking to foster the best interests of the joint venture.
Community ownership	The CRIC structure provides for a high level of community ownership. If the membership of the CRIC is broad and represents a mix of organisations, a large proportion of the community should have effective involvement in the initiative through one or more of the partners. Shared community ownership of information reduces some of the uncertainty in analysing resource-use conflicts.
Private and community	A CRIC meets the business needs of joint venture partners and has a charter for broader community benefits. A community-focused approach that integrates private and public good by including government, private industry, small businesses, and local communities is highly desirable in rural Australia. Each sector of the community is dependent, to a greater or lesser extent, on the vitality of the other sectors. Thus, providing that the joint venture partners get enough out of their CRIC participation to justify their investment, benefits to other sectors in the community are an additional return.
Dual roles in data management and capacity building	A CRIC has dual roles: in managing and sharing data, and in building the capacity of joint venture partners and other groups to make effective use of those data. This approach contrasts markedly with a 'data warehousing', in which more data are made more widely available, but interest groups receive no assistance when using new data. A CRIC that provides only information analysis services, rather than building capacity for analysis within partner organisations, will fail to capitalise on the inherent opportunities of the CRIC model.
Linkages and roles	A CRIC fosters improved linkages between stakeholders and may therefore change the roles traditionally assumed by stakeholder organizations. For example, a CRIC may facilitate constructive relationships between groups where none have traditionally existed. This can be a positive development if it leads to improved institutional arrangements in an area, but it may also threaten groups or individuals who are comfortable with current arrangements.
Data exchange	A CRIC can foster exchanges of data between stakeholders to generate extensive spatial databases capable of meeting the broader needs of the joint venture partners and producing value-added data sets. The biggest threat to the sharing of data sets has come from the revenue-generating potential of data. However, the market for data sets in rural areas is limited, so not sharing data because others may sell them is often a poor business decision.

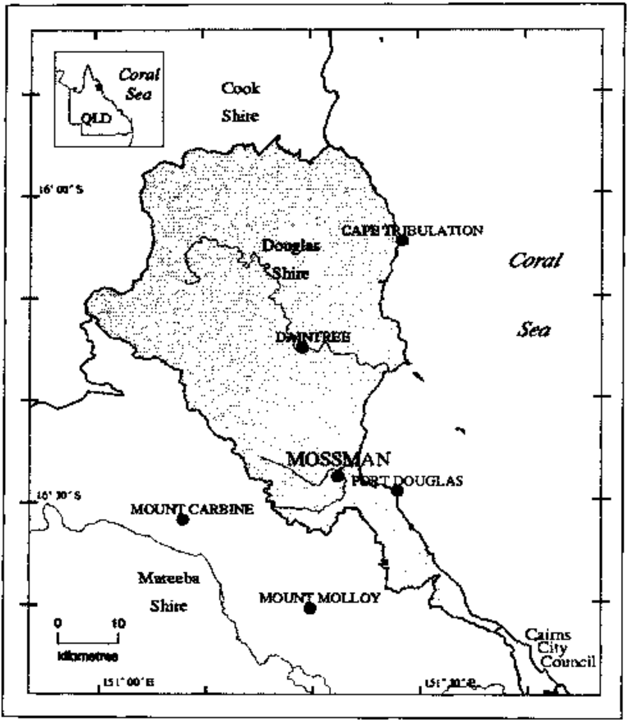
	Description of Principles
Best practice data management	A CRIC plays a central role in managing the aggregated data sets of the Centre's joint venture partners and, under some circumstances, those of other stakeholders, through reciprocal data-sharing arrangements. Data sets must conform to high professional standards. A CRIC needs to maintain spatial data and meta data directories and comply with industry standards such as the Australian Surveying and Land Information Group (AUSLIC) and Australian Spatial Data Infrastructure (ASDI) standards. Roles of a CRIC also include helping others to manage data better, ensuring appropriate use of data, and prioritising future data collection. Developing such an understanding among CRIC stakeholders is essential to best practice data management and use.
Project brokering	A CRIC has a limited role to play in project work, but a key role in brokering projects within and between partner organisations and external agencies. Over-commitment to specific long-term project work can undermine the ability of CRIC staff to support projects of partner agencies. CRIC staff should assume the roles of project coordinator, facilitator or manager, while staff within the joint venture partners should undertake implementation. This arrangement ensures that the skills of the CRIC staff are most effectively used.
Funding	A CRIC is self-funded. Expectations of specific results and accountability should accompany financial input into a CRIC from joint venture partners. An externally funded CRIC as a public service is unlikely to be dynamic and vibrant. This is not to say that there is no role for external seed funding to get a CRIC off the ground. Similarly, subsidies distributed across joint venture partners are, in general, worth avoiding. Although apportioning benefits and working out appropriate levels of contribution is complex, the general principle of proportional contribution is important.
Lifespan	A CRIC is a medium to long-term commitment; ideally, planning should be on a 10-year timeframe (certainly not less than five). The task of collecting, synthesising, and managing data and building capacity to make better use of this data within partner organisations takes time and requires a substantial investment. For this reason, it is hard to envision a CRIC realizing its full potential in less than five years. However, a CRIC does not need to be a permanent and on-going organisation. As the skills within the partner groups grow and technologies evolve, it may be appropriate, at some point, to replace the CRIC with a simpler data-sharing structure. Through its community-based collaborative structure, a CRIC can effectively respond to changing regional demands and remain relevant to the local community and venture partners.

4.5 The Douglas Shire Joint Venture Partnership

The Douglas Shire, also referred to as the Mossman region (Figure 4-5), responded to Hildebrand's (2002) assertion that major restructuring was needed to achieve sugar industry sustainability by exploring different options. Spokespeople from various industry and community bodies came together to seek out common ground for an approach that could ensure a secure future. The case study reported here explores the origins and application of this proactive approach to regional change.

The sugar industry is not the dominant land-user in the Douglas Shire (80% of its 2,473 km^2 is Wet Tropics World Heritage rainforest), nor is it the dominant sector of the economy (Douglas Shire's resident population of 11,500 is augmented by 700,000 tourists annually). However, the sugar industry is fundamental to the Shire's rural landscape, and its economic and social fabric. As with other sugar regions, sugar production in the Douglas Shire is experiencing sustained economic pressure and faces scrutiny in terms of its environmental impact. The social impacts of these pressures are being felt within the community.

Figure 4-5 The Douglas Shire region (CSIRO 2001b).



Managing change in the sugar industry is intimately linked to the broader sustainability agenda in the Douglas Shire. A community consultation, run by the Douglas Shire Council with 40 stakeholder groups, meeting monthly for six months in 2001, developed 248 desired actions relating to biodiversity and habitat, the built environment, communities and social wellbeing, and the economy and employment.

4.5.1 The process - a partnership approach

The Douglas Shire Agri-industry Sustainable Futures Joint Venture Partnership (the JVP) was established to facilitate a coordinated approach to maintaining a viable agri-industry base for the local economy while minimising negative environmental impacts. The partnership has, as expected, brought synergies between the skills, roles and mandates of the different partners in addressing the immediate and strategic opportunities and threats facing the community in general, and the sugar industry in particular. It has provided an invaluable forum in which JVPs have been able to learn from each other and provide mutual support.

The JVP operations are supported by a three-year financial commitment by each partner, which employs a coordinator to manage internal and external liaison. The current partners include:

- Douglas Shire Council (DSC) - is responsible for planning and management of the built environment and associated community infrastructure under the *Local Government Act 1993.* In addition, the Council is responsible for land-use planning and a range of facilities and services that contribute to orderly resource-use and quality of life for ratepayers and visitors.
- The CSIRO - has a mandate to facilitate forward-planning on regional and local scales, by integrating research products (such as models which incorporate socio economic outcomes with ecological productivity and stability) into planning processes, and to foster innovation in sustainable management of land-use and agricultural systems.
- Mossman Central Mill (MCM) - This is the major value-adding and processing organisation responsible for converting the sugar from the coastal plain into competitive marketable end products. This partner is a producer co-operative, and as such, is responsible to local shareholders. The welfare of family farms producing sugar-cane is therefore a major objective. The past arrangement of the Mill being confined to one buyer of its product (raw sugar) is a constraint on the actions, initiatives and investments of this partner.

- The CANEGROWERS Organisation - is the producer partner that is the most northerly branch of the industry-wide growers' organisation, which operates a centralised policy-making structure that has regional representation. This partner also has, as its prime objective, the wellbeing of its producer members, although not all producers are members of CANEGROWERS. The wellbeing of producers includes recognition of the need for conservation of productive land and stabilisation of the ecosystem on which the sugar industry depends. Off-site impacts of land-use are recognised by CANEGROWERS.
- Mossman Agricultural Services (MAS) - is the partner responsible for the extension of goods and services for cane production. These services focus on extension of unimproved conservation farming techniques and information transfer of innovations in agricultural practice. Services are provided to coastal growers and approximately 25 producers on the Atherton tableland.

In addition to the jVP, Tourism Futures work has been going on for several years. An initiative began in October 2000, with support from the CRC for Sustainable Tourism, Griffith University and the Queensland EPA, to embark on Greenglobe 21 accreditation for the entire destination - the first of its kind in Australia.

4.5.2 What has this achieved?

In response to the Hildebrand Report (2002), the jVP met individually with its stakeholders before agreeing to a combined action plan for restructuring. This proposal was then submitted to government in a consolidated document (Joint Venture Partners 2002) as a basis for negotiating federal and state support for regional restructuring. Managing changes in the local sugar industry has been a major priority of the JVP. A key outcome from the partnership has been co-operative planning of sugar industry restructuring by local sugar industry stakeholders (Mossman Central Mill, CANEGROWERS, Mossman Agricultural Services and Douglas Shire Council), with support from the CSIRO. The JVP based its proposal on the actions listed in Table 4-5.

Table **4-5** Actions for industry change in Douglas **Shire** (Joint Venture Partners **2002).**

	Farm aggregation including leasing and share farming, Inter-mill cane production areas rationalisation, Farm equipment standardisation, Developing and encouraging best business practice, Development of protocols for downstream direct marketing, Instituting a system of accreditation for the adoption of sustainable practices, Fostering the adoption of best practice farming systems, and Administrative and extension assistance to facilitate the above.
Factory level	Toll crushing at the Tableland Mill, Reversion to a five-day crushing week, Optimisation of the harvest/transport system, Rationalisation of the company workforce, and Pursuit and evaluation of downstream products and value-adding.
Local government	Rate payment procedures beneficial to producers, Facilitation of farm amalgamation through excision of homestead blocks as separate titles, Cost-sharing with industry on transport infrastructure, Amendment of noise abatement regulations relating to 24 hour harvest, Provision of Financial Planning Workshops for farm families, Organisation of Regional Options Modelling, and Facilitation of Triple Bottom Line accounting through the Shire Joint Venture Partnership.
Community level	Participation in research projects with outcomes of community benefit, Involvement with the establishment of 3,000 hectares of plantations for carbon sequestration, Revegetation of 300 hectares of farm land for biodiversity and habitat value, and Development of an Implementation Plan for the Shire Sustainable Futures Strategy.

Beyond the specific domain of industry concerns, the convergence and synergy between the 'futures' approaches has built a common ground between tourism (the major employer), the agricultural industry (the traditional employer) and the wider community, all of whom recognise that sound environmental management is the foundation of the Shire's economy and lifestyle.

The JVP has started from a strong premise of **integrating** change and development in the sugar industry into the broader regional sustainability agenda. It has sought to develop an **inclusive** partnership which has built on local government's role in representing the interests of the broader community. The initiative has been strongly driven by the need to demonstrate **effective** outcomes and to be **accountable** to industry and the community (through local government). Finally, the JVP is an excellent example of an on-going and **adaptive** planning and change-management process.

Specific projects resulting from these initiatives include:

- A Greenhouse Gas Abatement Program (G-GAP) project that has three integrated subprojects in ethanol production, including the growing of sweet sorghum as a second feedstock, co-generation of electricity at the sugar mill to make the Shire self-sufficient in energy, and establishment of 3000 ha of plantations for carbon sequestration.
- An Ecosugar Project for the production of environmentally accredited sugar.
- The Sustainable Organic Production Project that aims to develop accreditable environmental systems for the production of each major commodity in the Shire, through minimising the use of chemicals and maximising good husbandry practices.
- The Bush Foods Project that aims to assist the local indigenous community towards self-sufficiency through contracting with Coles Supermarket to produce local bush foods from plantations and from the wild.
- The Water Quality Control Project that aims to identify all point sources and diffuse sources of pollution in Shire catchments and to recommend and monitor the adoption of pollution-minimisation strategies by rural and urban communities.

Specific activities associated with these initiatives or outcomes include:

- Agreement to introduce a conservation management levy for buying-back threatened habitat on the Daintree coast,
- Vegetation mapping, clearing controls and rehabilitation that have resulted in a net gain in vegetation cover over the whole Shire,
- Fifty conservation agreements signed so far and a large range of available incentives for additional agreements,
- About 5% of households on renewable energy systems,
- A commonwealth contract to sequester 230,000 tonnes of carbon per year through the conversion of sugar by-product (molasses) to transport fuel and electricity within four years.
- Completion of a Council-constructed tertiary saltwater treatment plant, the first in Australia, to treat effluent from the marine tourism industry (about 1,200 people per day on the Great Barrier Reef).

The resulting activities emphasise the connections between the environmental, social and economic aspects of the region and how each depends on the other. This process has led to the instigation of an integrated sustainability strategy, to be developed by CSIRO.

4.6 Summary of case study experiences

The three case studies presented in this chapter have illustrated some of the elements of regional planning outlined in the previous chapter as they are applied in practice. This chapter demonstrates the power of planning in directing change (as proposed in Chapter 1). Although none of the planning initiatives described in this chapter have solved all the problems facing each region, they form part of a series of initiatives seeking change, and each in their own unique ways, has been important in helping the industry to take more control of the future.

This chapter has also illustrated the importance of embracing diverse views within communities to generate goals that encompass environmental, economic and social needs and gives examples as to how a specific industry (the sugar industry) can benefit from planning in a broader context. The industry can use communicative planning approaches to manage stakeholder relationships, manage stakeholder conflict, and negotiate desired outcomes that could be acceptable to various stakeholders. Finally, this chapter introduces the need to bring in the best and broadest range of information possible to inform planning processes. Methods for addressing this last issue will be discussed in further detail in Chapter 5.

Where to go for more information:

Berwick, M., D. Walker, J. Taylor, B.R. Keating, R. Muchow and P. Walker (2001) CSIRO-local government partnership in the Douglas Shire. Proceedings of the National Outlook Conference, Canberra, 27 February-1 March 2001. 4: 59-64

Hardman, J.R.P. (1999) The Herbert Resource Information Centre: An economic assessment. Queensland Department of Natural Resources on behalf of the Queensland Spatial Information Infrastructure Committee.

Walker, D.H., D.R. Chalmers, V.A. Webb, KJ Vella, T. Mallawaarachchi, and A. Johnson (2002) Integrated resource planning in the Australian sugar industry: Project number 1.2.2, Final Report. Sugar CRC, Townsville.

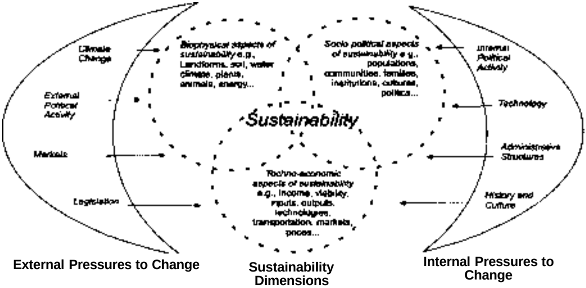
Walker, D.H., A.M. Leitch, R. de Lai, A. Cottrell, A.K.L. Johnson and D. Pullar (2002) CIS through community-based collaborative joint venture: An evaluation of impacts in rural Australia. In: Community Participation and Geographic Information Systems (eds). William J. Craig, Trevor M. Harris and Daniel Weiner. Taylor & Francis Ltd.

Webb V.A. and D.R. Chalmers (2001) Improved integrated resource use planning in the Australian sugar industry. Creating a climate for change? Australasia-Pacific Extension Network National Conference. Melbourne, 26-27 October 2000.

5 Information and analyses to underpin regional planning - applications and examples

To be effective, planning needs to be able to detect and respond to changing issues and pressures, some of which are identified in Figure 5-1. To respond to these pressures, planning needs to be well informed. This chapter explores information and analyses to foster effective planning.

Figure 5-1 Dimensions of sustainability aspects and pressures for change.



Clearly, different kinds of information are needed to support different tasks and will be relevant at different phases of the planning process. For example: (1) to facilitate the 'pre-plan' assessment of issues; (2) to underpin the formulation of planning options; and (3) to facilitate the evaluation of different planning strategies before selecting an option for implementation, or to evaluate the efficacy of a planing project once it is already in place. To further develop concepts and methods for collecting information and using it to underpin regional planning, this chapter samples the range of analytical techniques available to support different information needs. We draw on examples from our case study regions to illustrate approaches, opportunities, issues and principles for collecting information and feeding it into the planning process (Table 5-1).

Table 5-1 Types of analyses providing information to support natural resource planning processes.

Information needs	**Analytical** techniques	**Examples**
'Pre-plan' assessment of issues	Non-spatial data synthesis	Social characteristics of sugar districts
	Spatial data synthesis	Herbert River Mapping Cane block mapping
Formulation of options	Spatial analysis	Land suitability for cultivation of cane Analysing a limiting factor - transport modeling
	Multiple criteria analysis	Evaluating cane allocation scenarios using a multi-criteria analysis tool
Evaluation of planning strategies	Spreadsheet-based analysis Making predictions through simulation	Cost-benefit analysis of riparian re-vegetation Exploring regional changes through modelling

5.1 'Pre-Plan' assessment of issues

In Chapter 2, we suggested that planning can enable the industry to respond to emerging pressures and opportunities in a proactive manner by developing plans and strategies to maximise gains and minimise risks. For the sugar industry, this requires information about the pressures facing individual regions and the impact of these pressures on environmental resources, regional economies, communities, individuals, farming businesses and milling interests. It also demands using that information to identify the main concerns that can be tackled through regional planning processes (bearing in mind that not all pressures impacting on the sugar industry can be solved through regional industry planning - for further discussion of the pressures that are outside the scope of regional planning see Chapter 7). Information can help in identifying and prioritising the issues to be addressed and ensuring that the planning process is cognisant of prevailing environmental, economic and social contexts.

Towards this end, information about pressures, impacts, and contexts can be derived from existing sources, or new data can be collected where data are non-existent or inadequate. The collection of new data is more expensive than the analysis of existing data, consequently many planning processes try to draw on existing data sources rather than embark on expensive data collection.

In a later section, we review non-spatial and spatial data synthesis methods used to provide information to underpin planning. We draw on two examples to illustrate processes for analysing existing data sources: the first relates to social characteristics of sugar regions, and the second, to cane block mapping in the Herbert River catchment.

However, before we go into the detail of collecting different types of data, we present a structure for assessing the specific circumstances and future prospects of individual cane growing regions. This structure will allow the industry to explore the nature of the differences between regions that may be more significant, in terms of industry sustainability and development and the distinctive capabilities of regions, in responding to industry challenges. In the discussion, we present a framework used in the CSIRO submission to the Hildebrand review (CSIRO 2002a) to explore the differences between industry regions. It uses diagnostic indicators designed to cover economic, social and environmental aspects of the industry. We present this framework to illustrate the questions that need to underpin regional plans relevant to particular regional characteristics. The methodology and indicators proposed here may, or may not, be relevant in all circumstances, however, this approach could help the industry to tailor its data gathering during the early stage of planning to its specific regional needs.

5.1.1 Defining diagnostic indicators suited to sugar regions

Diagnostic indicators are aggregated measures of industry performance or characteristics of the current state of the industry in a region, and they can help to identify issues that need to be addressed for an industry to advance. With appropriate data collection and analysis, and community and industry participation, these indicators could be quantified for sugar industry regions.

You could use the following seven indicators to encapsulate the situation in a sugar-growing region:

1. Per-hectare profitability of sugar-cane
2. Farm profitability
3. Mill profitability
4. Capacity for change
5. Regional importance

6. On-farm resource health
7. Consistency with broader community values

Other indicators may also be important to sugar regions, such as: the extension environment, pressures on sensitive environments, networks (within the industry, regional players, and external players), industry involvement in regional initiatives, regional champions (e.g., leaders committed to achieve change). However, for the purpose of this illustration, this discussion considers only indicators 1-7 listed above. Below is a definition of each of the indicators, an explanation of the underlying rationale for its inclusion, and a method for generating a numerical value or score for each indicator. Please note that there are different ways for measuring these indicators. Most of the methods proposed here use information that is, or should be, readily available, although community forums or expert panels may be required in some cases.

• ***Indicator 1*** - *Profitability of sugar-cane*

This diagnostic indicator addresses the question: assuming optimal production systems, can cane growing be profitable in a region? In other words, it explores whether the productivity of growing cane in a region can support profitable businesses within the constraints of: region-specific growing conditions (such as soil productivity, climate, and availability of irrigation water), best available production methods, cane yields and CCS.

It is important to separate the issue of potential profitability of cane growing, which is absolutely fundamental to the future viability of the sugar industry in a region, from structural aspects of that sector, which can be dealt with by another indicator. It is also important to note that in Queensland, the pricing formula is an important institutional determinant of profitability, as it determines the proportion of revenue from raw sugar sales going to growers. Potential profitability of cane growing (indicator 1) and profitability of milling (indicator 3, see below) combine to determine the economic viability of the sugar industry in a district, based on current technology and product marketing approaches.

Per-hectare gross margin (revenue minus variable costs) offers a convenient way for measuring area profitability. Average potential gross margin from cane growing across a region serves as a measure for potential profitability. This measure also includes future low, and possibly long-term declining, product prices, and deteriorating terms of trade off-set by productivity gains, and considers the variability of conditions between years and across a sugar region. Translation from calculated gross margin to a regional score could work this way: Regions where potential gross margin is zero or negative receive a low indicator score. Mid-range scores would be assigned to regions where the gross margin can be expected to cover fixed costs if optimal production structures are in place. Regions where gross margins can generate returns on input of capital and labour, comparable or beyond to those received from other commercial investments, receive the highest scores.

• ***Indicator 2*** - *Farm profitability*

Building on the previous indicator, this indicator provides an assessment of the current cane production structures in a sugar region. It is important to separate profitability of production (indicator 1) from current production structures, as inefficient farm structures may cause un-profitability, despite good per-hectare profitability. Also, production systems on many farms may not currently be optimised, i.e., many farmers may not have not adopted and implemented best available knowledge, technology and operating standards.

Farm profitability summarises the financial performance of the current supply structure and cane production practices in a region. It encapsulates the full range and distribution of farm sizes and equity distribution. Assuming equal per-hectare profitability, the profitability of different farms depends on the size of their operations, fixed cost and the requirement to service debt.

As a measure for profitability of cane supply at the regional scale, we propose 'incomeearning capacity of farms in region'. Regions with low scores of potential profitability of cane production would necessarily also receive low farm profitability scores, as business profitability is reliant on area profitability. Regions with good per-hectare profitability could still have low or medium farm profitability scores if farm size is generally low and/or equity position of a large proportion of farms is poor and/or many farms operate inefficiently. Top scores require a combination of high productivity, efficient production structure and a good equity position.

This indicator signifies the extent of structural adjustment that may be necessary for cane suppliers in a region to make their sector profitable. For regions with high scores, ongoing productivity improvements and 'natural' structural adjustment may suffice to maintain industry viability and competitiveness at a global scale. Industry viability in regions with low scores is clearly questionable as a continuation of current practices and structures is inefficient and, to be economically viable, growers would require on-going income support by government.

• ***Indicator 3*** - *Profitability of mills*

The profitability of a mill summarises the returns for that sector in relation to inputs, specifically the large amount of capital invested in a highly specialised infrastructure. Profitability at a given price for raw sugar is fundamentally determined by the volume of cane a mill receives, and therefore by its supply area. A threshold amount of cane throughput and its associated raw sugar production are required to ensure profitability. The cost of transporting cane from the field to the mill is the major economic constraint on supply area expansion. In Queensland, the pricing formula determines the share of revenue from raw sugar sales to the mill or the growers.

A way to assess profitability of mills, in their regional context, is by establishing the volume of cane (potentially) harvested within the transport radius of the mill. The transport radius is defined by the point at which the marginal transport cost for cane equals the marginal profitability of crushing that cane.

Sugar areas that are unable to produce sufficient raw material for the mill(s) to ensure viable operation receive a low score. Areas where mills operate at or near capacity and/or have the opportunity to expand their supply area receive high scores. Regions could deliver an expanded supply area either through cane area expansion or consolidation of sugar mills. In general, regions with one mill, small sugar volumes and declining cane areas would rate lower than regions with multiple mills, large assignment areas and the potential for cane area expansion. Regions characterised by highly fragmented areas and old infrastructure with resulting high transport and processing costs would score lower. Regions/mills that have embraced diversification of production into co-generation and value-adding would also score higher.

• ***Indicator 4*** - *Capacity for change*

Ongoing change in the industry is required to maintain or improve profitability and environmental performance. You could use a regional community forum or similar mechanism to provide information on industry capacity-for change, such as:

- the degree and rate of change required across the sectors of the regional supply chain to maximise and/or ensure viability of the sugar industry,
- the capacity of the industry to change at the required rate and to the required degree, and

- the degree to which the industry is participating in programs and processes that aim to improve the region's environmental condition and community wellbeing.

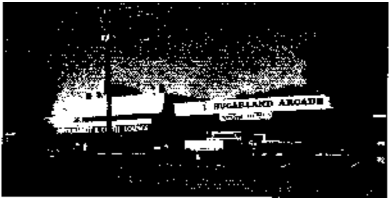
Regions with high profitability scores would, in general, score higher on this criterion owing to the financial capacity of the industry to engage in change (such as, continued technological innovation and diversification). Proactive industry engagement in development processes can also deliver high scores against this criterion. Regions with a low score on profitability indicators and without a pro-active social and environmental agenda would attract a low capacity-for-change score.

This is one way of considering capacity for change. Another measure relates to industry structures, such as whether mills are cooperative or privately owned, and the impact of this ownership on negotiation and grower-miller relationships.

• ***Indicator 5*** - *Regional importance*

This indicator encapsulates the degree of influence that the industry exerts on the regional economy and community. It combines two aspects, the overall size of the sugar industry and its relative importance to the regional economic and social fabric. Cane area, size of harvest, number of cane suppliers and total industry employment are some measures of industry size. The proportion of regional gross domestic product generated by the sugar industry and proportion of regional workforce employed in the industry are other measures of regional importance. These measures put the industry into the context of the regional community and the regional economy (and its degree of diversification). The sugar industry can use input-output analysis to measure direct and indirect output and employment contributions.

Regions with a large industry, which is of major relative importance to the regional economy, would receive high scores using the profiling method adopted here. For such regions, a potential loss of the sugar industry, irrespective of its profitability, would have severe economic and social consequences. In this case, careful management combined with government-supported social and economic initiatives would be required to minimise individual and community hardship.



An indicator score at the lower end of the scale would indicate a small industry and/or a negligible contribution of the sugar industry to the regional economy. A potential loss of the industry would not have major regional repercussions and traditional support packages could be sufficient to minimise hardship to individuals by associated change.

• ***Indicator 6*** - *On-farm ecosystem health*

This diagnostic indicator provides a measure of the maintenance and renewal of natural resources on farms required to sustain their productivity into the future. Qualitative or quantitative values of this indicator would reflect an aggregate score of the effectiveness of management practices used by growers to safeguard the productive capacity of their land. Practices would include protection against soil erosion and ASS, renewal of soil fertility, water quality, buffering and detoxification of agrochemicals, pest abundance, weed abundance and protection against salinisation and soil acidification. An analytical framework to assess industry performance against this criterion could use ecosystem services provided at the farm scale.

Scores against this criterion are low where farm management practices result, for example, in rapid degradation of soil and water quality or loss of resilience to pests and noxious weeds. High values indicate that management of soil, water and vegetation on farms maximises benefits from ecosystem services.

• ***Indicator* 7** - *Consistency with broader community values*

This indicator investigates the degree to which the sugar industry is consistent with broader community goals and other industries. Currently, conflicts exist specifically when there is a perception that off-farm environmental impacts may jeopardize conservation objectives, interfere with the commercial activities of other industries (such as tourism and fishing), and/or reduce other non-commercial values of downstream ecosystems. They also include conflict over infrastructure use (e.g., the impact of added trucks on residential roads, re-use of milling infrastructure), and conflicts over management practices such as cane fires and 24-hour harvesting.

In relation to these values, the 'consistency' indicator specifically encapsulates the risk of environmental harm to riverine, coastal and marine environments through off-farm effects of sugar production, and the associated environmental harm that affects conservation values, as well as other commercial and recreational users of the land and water resources. Sugar-growing areas adjacent to the Great Barrier Reef and its catchment are a particular focus of this concern. Assessment of the environmental harm requires aggregation of information about the various types of impacts, including contaminant behaviour and mechanisms for movement, effectiveness of containment measures, and susceptibility and resilience of ecosystems to damage, and implications of damage for commercial and other uses of those ecosystems.

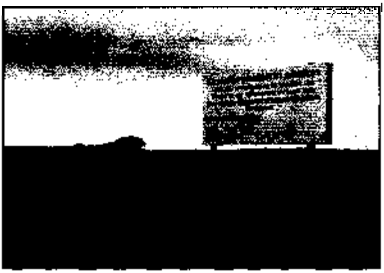


Photo courtesy of Mark Smith

Regions where the industry has potentially large (detrimental) downstream effects and impacts on commercial uses or natural resources would receive a low score if resource management does not meet community expectations. For example, were it not for satisfactory industry regulations devised and managed to reduce acid sulfate soil (ASS) risks, ASS could have threatened sugar production in New South Wales. Industry management of ASS was open and transparent and very strongly supported by the community because it satisfied community concerns.

Of course community values are not only about environmental issues, they are also about economic and social dimensions such as local jobs and the local economy. Therefore information about the role of the industry in supporting local jobs, and local economies, youth training, social infrastructure, local heritage and so on, are other measures that can be used to define industry performance.

S.I.2 Creating the regional profiles - some hypothetical examples

The previous section explored one set of indicators you could use to assess the characteristics of an industry region. This section shows how the industry could combine diagnostic indicators into 'regional profiles', which help to:

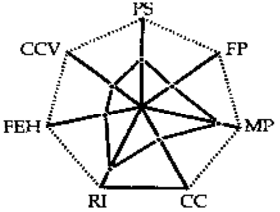
- assess the specific circumstances of a sugar region,
- identify areas of industry performance where improvement is a priority, and
- help devise a set of measure, policies, programs and processes to enable development of regional action plans for the industry.

To demonstrate this process, we generate profiles for three **hypothetical** regions on the basis of an arbitrary assignment of scores against the diagnostic indicators identified in Section 5.1.1 (above). These regions are hypothetical and therefore the regional profiles are not based on real data, but on hypothetical inferences generated for the purpose of illustration. By plotting these indicators graphically (Figures 5-2, 5-3 and 5-4), it is easy to see the relative strengths and weaknesses of the region as revealed by the regional profile. The hypothetical profiles illustrate differences between regions, and suggest options for industry, government and the regional communities in shaping the future of the sugar industry. To perform this activity in reality, data from the regional assessments would need to be normalised so as to enable comparison of regions across indicators.

Hypothetical Region 1

Hypothetical region 1 (Figure 5-2) has medium potential profitability of cane-growing, but due to small farm sizes, farm profitability is quite low. It is a large cane-growing region and the profitability of the mills in the regions is good due to large cane volumes and increased vertical integration. The sugar industry forms an integral part of a diversified regional economy and employs a high proportion of the regional workforce. Farms have widely adopted green cane trash blanketing, but are not engaging in other environmental management practices. There have been reports of potential water-quality related fish kills, but due to low river discharge volume and large distance of the catchment from the Great Barrier Reef the sugar industry does not constitute an immediate risk to the reef and/or other industries.

Figure 5-2 Application of diagnostic framework to hypothetical sugar region 1 (CSIRO 2002).



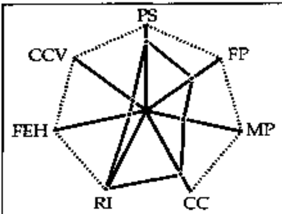
The seven indicators are recorded as points on axes of a radar graph, joined by connecting lines. Axes are: PS = profitability of sugar-cane; FP = farm profitability; MP = mill profitability; CC = capacity for change; RI = regional importance; FEH = on-farm environmental health; CCV = consistency with community values. Scores range from lowest at the origin to highest on the outer margin.

A regional action plan for hypothetical region 1 might emphasise that the sugar industry may be viable in the long-term if it can translate potential profitability into supplier profit through accelerated farm consolidation or vertical integration and other ways of optimising the supply chain. Productivity needs to be enhanced with specific emphasis on production benefits from environmental on-farm improvements. Cost-sharing arrangements with government and other industries could help implement environmental measures that could achieve reductions in off-farm environmental impact. Industry leadership would be well advised to engage with the community, government and other industries on broader issues of improving the regional state of the environment and other issues related to sustainable regional development.

Hypothetical Region 2

Hypothetical region 2 (Figure 5-3) has quite high potential profitability of cane growing due to the high soil fertility and availability of irrigation water. Farms are large and economies of scale generate farm profitability. However, past area expansion and installation of irrigation infrastructure has been largely debt-financed and repayments and interest affect the profitability of a significant proportion of farms. There are several mills operating in the region, which are competing for suppliers as none of them is operating near capacity. Representatives of the industry are actively participating in regional and environmental planning processes. The overall capacity for change of the industry is good. The industry is the major generator of income for the region and employs a large proportion of the regional workforce. Groundwater irrigation practices and high-yield production methods have degraded soil health, and the river system is loaded with sediments, nutrients and pesticides from run-off and leaching, which pose a threat to coastal and marine ecosystems. This is stifling attempts to develop the tourism industry and purportedly affects the catch of commercial fishers in the region.

Figure 5-3 **Application** of diagnostic **framework** to hypothetical sugar region 2 **(CSIRO 2002).**



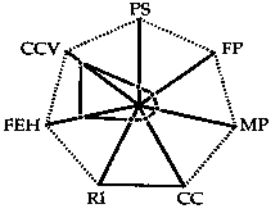
The seven indicators are recorded as points on axes of a radar graph, joined by connecting lines. Axes are: PS = profitability of sugar-cane; FP = farm profitability; MP = mill profitability; CC = capacity for change; RI = regional importance; FEH = on-farm environmental health; CCV = consistency with community values. Scores range from lowest at the origin to highest on the outer margin.

The sugar industry in region 2 is in a financial position to support its own future. A regional action plan might recommend that consolidation options for mills should be pursued and some consolidation, with government assistance, might be required in the supply sector. Technological improvement and institutional reform would be part of the change process. Environmental performance of the industry is a major concern, but the industry is already engaged in environmental target-setting and social planning processes. Through this involvement, cost-sharing arrangement for comprehensive riparian revegetation and weed control activities can be negotiated. The regional cane growers could engage in an education/implementation program for better groundwater management. Financial support from government for infrastructure investment is available.

Hypothetical Region 3

Hypothetical region 3 (Figure 5-4) is a small and fragmented sugar-growing region where cane land is increasingly replaced by urban expansion and the sugar industry plays a minor role in the regional economy. Profitability at all levels of the supply chain is low and most cane-farming families have substantial off-farm income to complement household income.

Figure 5-4 Application of diagnostic framework to hypothetical sugar **region** 3 **(CSIRO 2002).**



The seven indicators are recorded as points on axes of a radar graph, joined by connecting lines. Axes are: PS = profitability of sugar-cane; FP = farm profitability; MP = mill profitability; CC = capacity for change; RI = regional importance; FEH = on-farm environmental health; CCV = consistency with community values. Scores range from lowest at the origin to highest on the outer margin.

There is little capacity by any sector within the industry to engage in structural adjustment, but the industry is actively participating in a wide range of catchment, economic and social planning processes. Farmers generally do not maximise profits, being more motivated by lifestyle considerations, and do provide environmental services for other sectors of the community.

The sugar industry in region type 3 requires careful consideration, and there would appear to be two potential directions for this. In the first option the industry, in consultation with the regional community, decides to wind up and sets in place processes to affect a shut-down of the industry. A region-specific structural adjustment package would be negotiated with the government in order to facilitate the transition. Policies and programs would be implemented that help farmers who cannot realise capital through subdivision and sale of land receive assistance for agricultural diversification and training for off-farm employment. Alternative uses of mill and transport infrastructure are investigated and potential buyers approached,

In the second option the industry commissions a cost-benefit analysis of product diversification into higher-profit organic refined sugar, combined with co-generation of energy and partial use of the mill infrastructure for production of fruit juices. Forums would be held to inform growers, the mill and traders about changes required to comply with organic code-of-conduct requirements. Pending confirmation of a commercially attractive medium-term rate of return, farmers and the mill would negotiate new cane land allocation and harvesting arrangements and seek government support to co-fund necessary refurbishment of the mill.

Having examined one approach to assessing the specific circumstances and future prospects of individual cane-growing regions, we now look at non-spatial and spatial data synthesis methods which can be used to provide further information to underpin planning in cane-growing regions.

5.1.3 Non spatial data

A variety of data can be assembled and analysed to provide contextual understanding of sugar industry regions. Contextual information includes, for example, information on the socio-political and economic aspects of farming and regional activities. Such information can be derived from census data (both time series data and current material), financial / economic data, reviews of reports and scientific literature, local government planning studies and regional studies, and interviews with individuals and groups.

Exploring the socio economic *context* of change and potential social and economic impact of change is important information for decision-makers. Depending on the process of collecting social information, it can also include people in the planning and decision-making process, and thus help the impacted populations prepare for change. The most successful regional development projects are those that are sensitive to social issues. Tackling the social dimension of regional change is important because it is frequently social, rather than biophysical, concern that both drive and constrain change. Although this is widely recognised in theory, it is often forgotten in practice, with analyses focusing largely on economic and environmental issues. Social issues often fall behind, especially when social costs or benefits to local communities are set against sectoral, regional or national economic goals.

•Example 1: *Social characteristics of sugar districts*

One way of defining the context of sugar industry regions is simply to work through widely available statistics, such as the Australian census, to explore what they tells us about sugar regions. Table 5-2 contains definitions of census data categories that might be used as a starting point for this approach. For regional planning and management, this type of information can assist in identifying community vulnerabilities, drivers for change, and specific targets for change.

Table 5-2 Definitions of typical socio-demographic information (Australian Bureau of Statistics 2000).

Census information	
Number of occupied private dwellings	
Resident population	
Occupancy rate	Resident population/Number of occupied private dwellings.
Percent rental accommodation	As a percentage of all private dwellings.
Percent public housing	As a percentage of all private dwellings.
Percent aged 14 years and below	As a percentage of the total resident population.
Percent aged 15 years to 65 years	As a percentage of the total resident population.
Percent aged 65 years and above	As a percentage of the total resident population.
Dependency ratio	Ratio (as a percentage) of the percentage of the population below 14 years of age and above 65 years of age to the percentage aged between 15 and 65 years.
Unemployment rate	The number of all unemployed persons expressed as a percentage of the workforce.
Unemployment rate (15-19 year olds)	The number of unemployed persons between 15 and 19 years of age expressed as a percentage of the workforce aged between 15 and 19 years of age.
Workforce participation rate	The number of persons in the labour force expressed as a percentage of the total number of persons aged 15 years and over.
Weekly income less than $299	Percentage of all one family households with a weekly household income less than $299.
Percentage separated or divorced	The number of all separated and divorced persons expressed as a percentage of all persons over 15 years of age.
Percentage speaking English	The number of persons indicating they do not speak English or speak English poorly as a percentage of all persons aged over five years.
Percent left school aged less than 15 yearsor never attended	The number of persons who left school less than 15 years of age or who never attended as a percentage of all persons over 15 years of age.
Percent aged 15 years and over with no qualification	The number of persons aged 15 years and over with no qualifications as a percentage of the number of people aged 15 years and over.
Percent one parent families	The number of one-parent families in occupied private dwellings as a percentage of all families in occupied private dwellings.
Percent of one parent family households with no motor vehicle	The number of one family households with no vehicles as a percentage of all occupied private dwellings.
Percent of labourers and related workers	The number of labourers and related workers as a percentage of all employed persons
Percent Aboriginal and Torres Strait Islander	The number of persons indicating Aboriginal, Torres Strait Islanders or both Aboriginal and Torres Strait Islander origin as a percentage of all persons.
Percent unemployment rate (25-44 year old males)	The number of unemployed males between 25 and 44 years of age expressed as a percentage of the workforce aged between 25 and 44 years of age.
Percentage of workforce employed in agriculture	The number of persons working in agriculture, forestry and fishing expressed as a percentage of the workforce.
Percentage of workforce employed in mining	The number of persons working in mining expressed as a percentage of the workforce.
Percent unemployment rate (20-64 years of age)	The number of unemployed persons between 20 and 64 years of age expressed as a percentage of the workforce aged between 20 and 64 years of age.

If we consider socio demographic characteristics in the three case study regions, we would find that these regions are fairly typical of Queensland in many ways. However, where regional characteristics diverge from the Queensland average, the regions appear to be unique and do not share these differences with each other. Compared with Queensland as a whole, Mossman had a lower proportion of residents in the 'non-dependent' categories (between 15 and 65 years old) associated with a relatively higher proportion of people in the 'dependent' category (younger than 15 and older than 65). In the Herbert region, the rates of separation and divorce were notably lower than in either of the other case study regions and Queensland as a whole, more people were engaged in agricultural, forestry or fishing and worked as labourers or related workers, and they had been subjected to less formal education. The most notable characteristics of the Maroochy region related to unemployment rates, with higher overall levels of unemployment than in other regions, or Queensland as a whole (Australian Bureau of Statistics 2000).

In terms of housing, the dominant *dwelling type* in all three case study regions was a separate house, although a separate house was significantly less dominant in the Mossman region (Douglas Shire) (52% of all dwellings) than in the other regions (84% and 72% for the Herbert and Maroochy, respectively). Flats, units or apartments and caravans, cabins or houseboats were much more prevalent in the Mossman region than for the Herbert or Maroochy regions (Australian Bureau of Statistics 2000). These dwelling differences reflected the different mix of industries across the regions. The Mossman region had a stronger tourist industry than the Herbert and Maroochy regions and dwelling types reflected these differences in tourism.

Differences between the regions can also be seen in terms of the *occupancy* of private dwellings. A fully owned dwelling was most common in the Herbert or Maroochy regions (52% and 43% respectively), rental accommodation was most common in the Mossman region. The percentage of rental dwellings in the Mossman region (38%) was significantly greater than in the Herbert or Maroochy regions (25% each) (Australian Bureau of Statistics 2000). Socio demographic differences have important implications for industry decision-making. Community structures vary regionally, and hence community knowledge of the industry, acceptance of industry decisions, attitudes towards sugar production and support of the industry will vary in individual communities, and it has important implications for stakeholder engagement and communication strategies.

Another characteristic of housing that may be important to consider is what proportion of primary dwellings (homes) have been built on land that is inseparable from the farmed land. Consider two hypothetical regions with different title structures: one in which house and farm titles were predominantly separate, and the other, where houses tended to be sited on land under the farm title. In the second scenario, an industry restructuring that involved amalgamation of properties could have considerable collateral damage for families losing their homes, whereas in the former, the transition may have a greatly reduced disruptive impact on the families involved, especially if some of the residents could continued to be employed on the new 'mega-property'.

The key challenge in using non-spatial data from existing sources is finding parameters that provide useful insights. The examples provided here illustrate the very simplest of social assessment based on freely available census data. Although it provides information about social characteristics of sugar regions, the indicators that it uses may not provide a level of information that is useful. Hence, data from secondary sources may need to be combined with other data from financial institutions, local governments or regional and national audits, or supplemented with primary data collected specifically to underpin regional planning. Much more sophisticated analytical techniques are available and may be useful, particularly where more detailed survey-based data sets are available or can be collected.

5.1.4 Spatial data

Regional planning for the sugar industry encompasses a wide range of social, environmental and economic issues. Many of these issues, particularly the environmental issues, can be described by geographic or spatial dimensions, and may take on new dimensions or significance according to their location and proximity to other things. GIS technology has the ability to capture, integrate, interrogate, evaluate and display the spatial aspects of any issue that can be geographically described. GIS enables the fast, effective, and repeatable analysis of large quantities of geographic data, as well as the efficient visualisation and communication of spatial information. This technology has a significant and demonstrated potential to support planning by providing research into a broad range of environmental, agricultural and social issues, including land management and planning.

• ***Key spatial datasets***

Industry planning needs spatial data to define physical resources and pressures within regions, such as those relating to land-use and transport, and the natural environment. The number and kind of spatial datasets that are available for catchments and regions varies quite substantially across Queensland. This is a function of varied development and conservation interests in Queensland through time. Consequently some cane-growing regions are more likely to have access to detailed soil, transportation, and land cover data than others. These data may come from a range of sources including local government, state government, sugar mills, other regional industries, catchment groups, and agencies (e.g., Wet Tropics Management Authority). Although this information may not have been collected for the specific purpose of informing regional sugar industry planning, it may still provide useful background information to define the context of planning and to identify issues and pressures for change.

However, there are some basic datasets that are available more broadly across Queensland. These data exist at different scales and in different formats, but they can provide a useful starting point for regional planning. For example the unique mapping area (UMA) dataset held by Department of Natural Resources and Mines (DNRM) contains fundamental land-based information including soils, geology, landforms and vegetation. For each UMA, the suitability of land for various agricultural crops is rated according to a variety of land-based limitations (e.g., erosion, rockiness). This dataset has a scale of 1:50,000, which is useful for strategic-level planning. The digital cadastral database (DCDB) also held by DNRM contains a register of the boundaries that delineate different types of land ownership including national parks, reserves and private land, and is useful for more detailed planning (e.g., where it is important to know who is responsible for managing land and implementing specific changes).

However, existing data by themselves may not be adequate or accurate enough to meet specific needs. Consequently mapping projects may need to be commissioned to gather new information and/or to integrate existing information into a GIS to facilitate spatial analyses. The Herbert River data collection example illustrates the kind of information that can be collected for a specific region to support industry planning. Although this information is particularly relevant to the 'pre-plan' assessment of issues, it has ongoing value throughout the planning process to formulate appropriate planning options and to test the suitability of planning options in resolving issues and meeting various needs.

• ***Example 2:*** *Herbert River data collection processes*

As already noted, excellent spatial data are available for the Herbert catchment. This has arisen because concerted investments were made in the Herbert to improve the quality and breadth of information about sugar-cane and about biophysical resources in the catchment. Improved information was needed because the information that was widely available was not sufficiently accurate or detailed to support assignment planning, farm management planning or regional planning.

Data collation in the Herbert has been achieved through three main projects that we discuss here: (1) the Herbert Mapping Project, (2) Land Cover Mapping, and (3) Cane

Block Mapping. These projects generated improved information about elevation, road and rail infrastructure, vegetation distribution, vegetation change over time, land-use, water features, utilities and cane field boundaries, as well as rainfall surface interpolation and mapping (monthly and annual) from rainfall and elevation data.

The *Herbert Mapping Project (HMP)* was a project funded by a consortium of government and agency groups with an interest in the Herbert region. The project provided detailed spatial information for the lower Herbert catchment flood plain. The project was initiated in order to overcome the lack of accurate and detailed data on the Herbert floodplain. The project assembled information from 64 map sheets including a series of orthophoto maps, digital images, and associated digital spatial data. The data were captured from aerial photographs taken in November 1995, and refined with ground truthing. The data were collected at the scale 1:10,000, with accuracy within five metres horizontally and within half a metre vertically. The maps include information on elevation, road and rail infrastructure, vegetation boundaries, water features, utilities and cane field boundaries. This detailed spatial dataset provided a comprehensive base layer of data to support decision-making in the region.

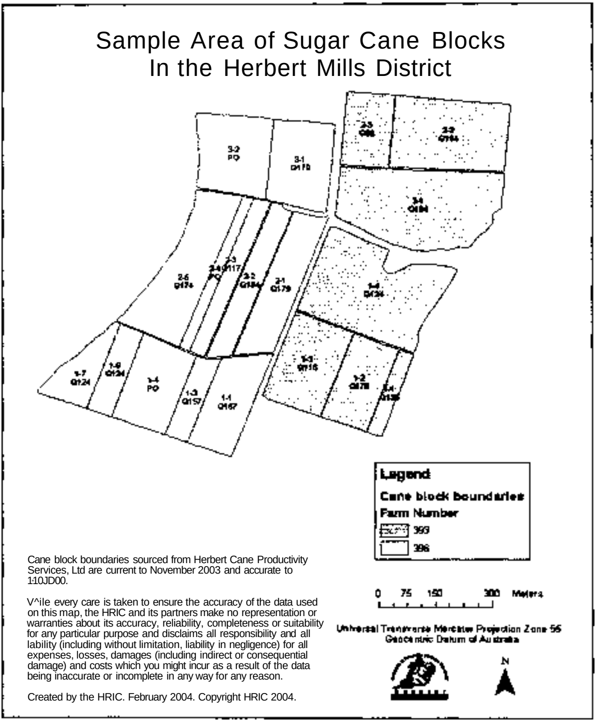
Land cover mapping of the Herbert River catchment was completed by CSIRO for every decade since the 1940s (except for the 1950s in the lower catchment). An estimate of pre-European vegetation distribution was also completed using soils data and other supporting information. This detailed series of datasets supported the rigorous investigation of land-use change in the Herbert area. Both public and private lands were included and the mapping was completed at a scale of 1:100,000. Vegetation mapping (from 1993) was incorporated into the dataset with the EPA (then Department of Environment) vegetation classes being summarised into the broad vegetation classification system and used in the land cover mapping. Available soils information was also used to assist the vegetation mapping. The land cover mapping was completed using standard air photograph interpretation techniques. Large-scale (1:25,000) air photographs were the principal source of information; colour where available. The upper and lower parts of the catchment were mapped independently due to the limited availability of contemporaneous aerial photography for both parts of the catchment. In the upper catchment, Spot satellite imagery with a 10m resolution was used to assist the 1996 land cover mapping. Linework from the DNRM digital cadastral database (DCDB) was used to establish property boundaries. It was later determined that this linework was not all within 1:50,000 accuracy tolerances stated for the dataset. The least accurate areas tended to be distant from urban areas where survey control was limited. The DCDB has since been amended. As the cost of linework correction was prohibitive for the land cover mapping, the scale of the dataset was downgraded from an initial scale of 1:50,000 to 1:100,000. With regards to the classification system used, there was some overlap between land cover and land-use classes that were somewhat mixed e.g., grazing and grasslands. This could be addressed in any future revisions of the dataset to more clearly distinguish between land-use and land cover.

Spatial information on cane blocks, or *cane block mapping,* is key for many regional planning applications in the sugar industry. For some of our early work in the Herbert, CSR mills in the Herbert Sugar District provided sugar-cane block boundaries to describe 1996 cane assignment locations, and cane assignment details for the years 1993 to 1996. These data supported research into the spatial and temporal aspects of allocation equity and environmental impacts of the assignment of land to sugar-cane. Linework amendments and the linking of the assignment data to the spatial data were completed to produce a 1:50,000 scale dataset that supported the strategic level research. The HMP cane field boundary dataset provided accurate linework, however the farm blocks (polygons) were not labelled with cane assignment data and were dated 1995, and so they did not include 1996 farms.

The Herbert Resource Information Centre (HRIC - see Chapter 4) became involved in cane block mapping in response to these, and many more-critical, operational planning problems associated with the existing cane block mapping.

The two sugar mills in the Herbert district were using out-of-date (two years old) and inaccurate (up to 80 metre errors) land-based mapping methods to map farm blocks of sugar-cane. The HRIC and four of its joint venture partners collaborated to commission high quality ortho-photographs of cane land in the Herbert. The HRIC staff then trained non-GIS specialists to define the cane blocks within these and to add relevant attributes to the map (Fig 5-5). This project saved the sugar mills from carrying out nine years of work at a cost of AUS$1 million. It also provided the four joint venture partners with a dataset that met the needs of every partner, and provided the community with a core dataset that has a broad range of uses including: estimating cane crop, positioning cane train sidings and rubbish bins, valuing land, differential rates analysis, and mapping potential mosquito-breeding sites.

Figure 5-5 Sample area of sugar-cane blocks in the Herbert Mill district.



Appendix 1 provides a more comprehensive list of key spatial datasets that CSIRO assembled for the Sunshine Coast and Herbert case studies discussed in Chapter 4.

5.1.5 Managing spatial data

Spatial data are central and valuable assets in many planning processes, but they need to be carefully managed in order to maintain their integrity and value, and to comply with issues of ownership and liability. In this section, we introduce some data management concepts through reference to the core principles and producers used by the Herbert Resource Information Centre in managing their data (for full details see http://www.hric.org.au/HRIC_site/HRIC_info/Policies/Data_princ/Data_princ.asp).

The HRIC approaches spatial data management from the perspective that spatial data are assets. Furthermore, the Centre operates on the principle that the value of spatial data increases the more they are used. As a consequence, the HRIC endeavours to ensure that their spatial data are easily accessible and useable, keeping in mind pertinent restrictions. This includes being compliant with relevant national and state data exchange policies as specified by ANZLIC and QSIIS, and with data exchange policies for satellite imagery as specified by the Australian Centre for Remote Sensing (ACRES).

Consequently, the HRIC's data management procedures cover management of data acquisition, data storage, data capture, data distribution, data licensing and metadata management. Principles are summarised under these headings in Table 5-3. Table 5-4 summarises the metadata template used by the HRIC in compliance with ANZLIC standards.

Table 5-3 A summary of the Herbert Resource Information Centre's data management principles.

Data acquisition	The HRIC obtains a Data License Agreement and Metadata records for all data acquired, with all Data License Agreements recorded, filed and maintained. Keeping these records and attaching them to the data means that the HRIC and all users of HRIC data can abide by any conditions and restrictions placed on data supplied.
Data capture - justification	Generally, the HRIC will only get involved with geographic information capture if a commitment is made to maintain the data. Prioritising requirements and costing data capture AND maintenance are therefore important strategic considerations.
Data capture - Intellectual property	Intellectual property needs to be established in writing before any geographic information is captured. The HRIC uses a Digital Data Capture and Update Agreement for this purpose - this ensures Intellectual property remains with the organisation paying for data capture, and clearly sets out rights and responsibilities.
Data capture - Quality control	Each data capture project develops a quality control process for data captured to ensure data integrity and that data captured have associated metadata records.
Data distribution	In the HRIC, data can be transferred to Joint venture partners freely, keeping in mind restrictions. Data custodians for each geographic dataset are maintained in the MS-Access database in the QSIIS Metadata Tool; in CeoMine (web-based spatial database directory); and, if practicable, in the Australian Spatial Data Directory (ASDD). All non-JVP data supplied to the HRIC are for HRIC and **JVP** use only. If another organisation wants **a** copy of non-JVP data on the HRIC system, they must provide written authorisation from the data custodian **of** the data they want **to** the **HRIC,** upon which they may be given access to the **data,** or contact the **data** custodian to obtain the data directly from them. Metadata records accompany any data distributed. **Ail** data distributed are accompanied by an appropriate Data License Agreement.

The ANZLIC core metadata elements.

Title:	
Custodian Details	
	Name:
	Jurisdiction:
Description	
	Abstract:
	Search Words:
	Graphic Extent Names:
	Graphic Extent Polygons:
Currency and Status	
	Beginning Date:
	Ending Date:
	Metadata Date
	Progress:
	Maintenance and Update Frequency:
Access	
	Stored Data Format:
	Available Format Types:
	Access Constraints:
Data Quality	
	Lineage:
	Positional Accuracy:
	Attribute Accuracy:
	Logical Consistency:
	Completeness:
Contact nformation	
	Organisation Name:
	Position:
	Mail Address 1:
	Mail Address 2:
	Suburb or Locality:
	State:
	Country:
	Post Code:
	Telephone Number:
	Facsimile Number:
	Email Address:
Additional Metadata	

5.2 Formulation of planning options

Once information that describes the regional context and issues has been collected, the next major step in the planning process is to formulate planning options. However, additional information may be needed as the planning process progresses to further develop planning options that will effectively meet regional needs.

It is difficult to be prescriptive about the kind of information that may be relevant at this stage. It could be spatial, non-spatial, or both, and will vary for each planning process. For example, information may be needed to identify the expectations and aspirations of industry stakeholders, identify constraints and opportunities for growth and development, or develop viable and desirable industry options.

To illustrate the ways in which *spatial* information can help to underpin the formulation of planning options, this section presents a number of examples of spatial analyses and a multi-criteria analysis approach that have been successfully employed in the Herbert and Maroochy case studies to underpin planning. In these two case study examples, a range of techniques were used to identify constraints on and opportunities for industry expansion. Although Herbert and Maroochy case studies provide examples of the spatial aspects of the work that may be undertaken, it is important to note that this particular work was strongly linked to the specific needs of these regions, revealed through communicative planning approaches (these approaches are defined in Chapter 3 and described in the context of the case studies in Chapter 4).

5.2.1 Spatial analysis

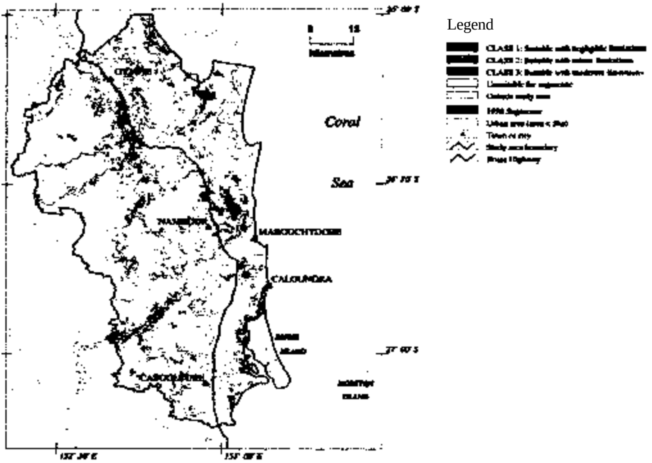
Regional planning challenges include complex spatial issues such as environmental degradation, landscape fragmentation and land-use conflicts. CIS is used extensively to analyse the spatial and temporal aspects of such issues to better understand and quantify the related elements, and the extent and dynamics of the issues. The presentation of results as maps has proven to be an effective tool for collaborative decision-making by providing common source of information with which all groups can meaningfully interact. Digital spatial analyses and maps move beyond the textual or numeric details of issues by providing graphic representations of the issues. GIS therefore not only supports planning information needs, but can also improve the collaboration between stakeholders in the planning process. Collaboration and dialogue between stakeholders is important for developing linkages and efficiencies, and for communicating some of the more complex and intangible aspects of information and opinions. This is vital to ensuring the holistic use of GIS data which themselves offer a 'summary' of the original features or systems being represented.

• **Example 3:** Land suitability for sustainable sugar-cane production in the Sunshine Coast and hinterland area

Assessment of the land suitable for cane expansion on the Sunshine Coast illustrates the application of spatial analyses and their potential role in planning. Land suitability for sugar-cane was assessed over the Sunshine Coast and hinterland study area using GIS technology (Figure 5-6). The main objective of this work was to assist the sugar industry with strategic land-use planning through the adoption of more integrative and analytical approaches to planning. Land suitable for sugar-cane expansion was systematically identified and mapped to establish whether there was enough suitable land to consider sugar-cane expansion as a viable option for the Moreton Mill in the Sunshine Coast area.

Datasets from many different sources including national, state and local governments were used in identifying land suitable for sugar-cane. An important difference between this assessment and other previous assessments was the inclusion of criteria that would support the identification of land suitable for *sustainable* sugar-cane production. Criteria were

Figure 5-6 Land suitability for sugar-cane in the Sunshine Coast study area (CSIRO, 2000b).

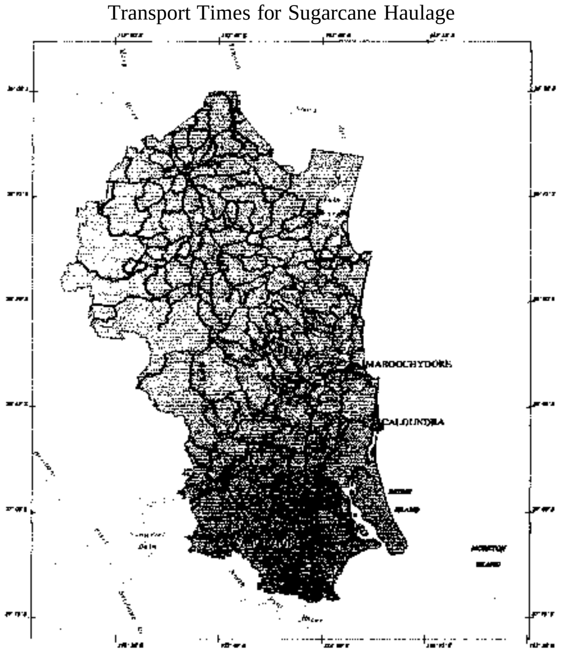


added to describe a broader range of environmental constraints (beyond the more traditionally used slope (erosion) or flooding limitations), including criteria such as riparian buffer zones and remnant vegetation. This was a major change in the approach to traditional land evaluation methods. The approach was intended to provide strategic planners with information on environmental considerations, in addition to the agricultural considerations, so that they could more comprehensively and cautiously identify areas suitable for sustainable agriculture.

The datasets used in the spatial analysis were sourced from a number of different agencies including DNRM, DPI, EPA, GeoScience Australia (formally AUSLIG) and local shires. Datasets included land tenure, flood risk, vegetation cover, elevation, streams, pine plantations and acid sulfate soil risk. The datasets were stored, manipulated and analysed using ArcInfo software. Many of the datasets required some preparation for analysis. For example, the streams dataset was buffered to a width of 40m either side of major streams (e.g., Mary River) and 20m either side of minor streams. The tenure data were reclassified according to whether the tenure type was potentially available or unavailable for farming. The elevation data comprised one of the primary datasets because it was used to derive slope classes. Slope is a primary limitation to the farming of sugar-cane. And furthermore, slope could be used as a surrogate for soil information (which was otherwise unavailable) as it was found that gentler gradients frequently coincided with high quality soil areas. The requirement for soils information was further supplemented with a soil survey of the study area.

The CIS was used to overlay the spatial datasets describing different limitations to sugar-cane farming and to produce a composite dataset describing land areas suitable for growing sugar-cane. The land suitability classification was scaled from class 1 land (land suitable for sugar-cane with negligible limitations), through to class 5 land (land unsuitable for sugar-cane production). The land suitability classes were determined according to **a** range of different criteria, for example class 1 land was defined as land that had the following attributes; it was not prone to flooding, was free of vegetation, had less than 2% slope, was higher than 3m above sea level (highest astronomical tide), was outside riparian buffer zones, had suitable tenure and was not in a pine plantation area. A pine plantation exclusion criterion was included because of the low probability of these areas being converted to sugar-cane given the investment in forestry; however this criterion could be changed if there was shift in opinion or other significant changes related to the forestry

Figure 5-7 Road transport times to the Moreton Mill in the Sunshine Coast study area (CSIRO, 2002a).



industry. A broad exclusion criterion was used for all existing areas of native vegetation in order to support the precautionary principle that essentially supports environmental and biodiversity (flora, fauna) protection aims. The use of this criterion would further assist the planning process by providing a conservative estimate of land suitable for sugar-cane. As the Sunshine Coast study area already has highly fragmented vegetation it was deemed that this would be the most appropriate approach. Assessment of the flora and fauna values would be needed before any vegetated areas could be classified with a sugar-cane suitability rating which might have implications for removal of vegetation.

Some of the limitations associated with the analysis arose from the scale and accuracy of the spatial datasets used. The spatial data used for the GIS analysis ranged in scale from 1:10,000 to 1:250,000. This mixture of scales created problems with spatial overlay, where the different linework accuracies can cause misalignment. Also, use of 1:250,000 scale stream linework, with a typical horizontal linework accuracy of +/- 50m, was not appropriate for use with a 20m or 40m buffer, as the buffer may fall outside the area intended. Consequently, the stream buffers were only representative of portions of riparian reservation area, not precise indications. The completed composite dataset had a minimum scale accuracy of 1:250,000, and it was therefore only appropriate to use it for strategic planning. The dataset was verified with field observations and by consulting sugar industry representatives who had expert knowledge of local areas. Following the first field trip, slope mapping was upgraded with the use of a more detailed elevation dataset to more accurately capture smaller hill slope areas. Overall, the dataset was found to satisfactorily capture the patterns of land suitable for growing sugar-cane.

The results from the analysis and consultation with sugar industry representatives established that there was sufficient suitable land to consider sugar-cane expansion, with areas in the Mary River valley and west of Lake Cootharaba showing the most promise. In addition, there were surprisingly large areas of land identified as suitable for sugar-cane in the Maroochy area, although it was anticipated that at least some of the areas identified as suitable for cane may not have been viable because existing land-uses were not captured in the analysis, the proximity of land to urban areas and because the areas were often composed of many small fragments of land. The area of land identified in the Maroochy region was cross-checked to ensure it was correct; the total area measured was confirmed and it was found that due to the shape and size of the fragmented land areas, visual assessments of total land area indicated on the map tended to be underestimates.

Variations of the mapping of land suitable for sugar-cane were subsequently completed in response to sugar industry queries. They included the introduction of larger minimum land area limits of 30 ha and 60 ha to assist in identifying larger and more viable pockets of suitable land. These analyses and resultant maps supported the fast and effective identification and assessment of large areas of land. An important finding of the project was that the way that the information is delivered is as important as the content of the information itself. Another important finding was that GIS analyses delivered as part of a collaborative planning framework contributed to the discussion and development of more comprehensive solutions. When combined with expert advice from sugar industry representatives, this analysis contributed to the discussion of potential expansion options for the sugar industry.

• **Example 4:** Road transport network analysis for the Sunshine Coast area

Economic viability of sugar-cane expansion in the Sunshine Coast study area is dependent on the accessibility of potential expansion areas to the sugar mill. A survey was done to determine what land was accessible to the mill via road transport. Land that was distant to the sugar-processing mill or difficult to access (due to rough terrain or road quality) was less viable than land that was more accessible to the mill. All factors that inhibit transport between the paddock and the mill carry financial costs. The road network existing in the Sunshine Coast study area was assessed according to distance to the mill, terrain, road quality and urban zoning. Approximate travel times were calculated according to these factors and along with an estimate of drive-time delays at intersections and at the mill. The analysis was designed to provide information about the suitability of land for sugar-cane according to its location relative to the Moreton Mill and existing road transport networks. Used with supporting information (e.g., maximum distance limits, transport subsidies, petrol costs) and expert knowledge from the sugar industry, this information provided support for the exploration and discussion of various transport scenarios.

The road transport assessment was provided to the sugar industry as part of a suite of spatial information designed to support the identification and assessment of land potentially viable for expanding the growing of sugar-cane in the Sunshine Coast study area. Information was provided about land suitability, rainfall distribution, as well as road transport, and all had implications for a range of environmental, economic and social issues. Of the mentioned analyses, the road transport assessment contained one of the more direct links to economic limits. Economic limits could be indirectly determined according to the physical limitations of the available road network. Road transport was also associated with a number of contentious social issues including road maintenance funding, pollution, aesthetics and traffic density increases; however, these social issues were beyond the scope of the spatial analyses. These types of social issues were being addressed through collaborative initiatives, which were part of the same research project. Also, the road transport analysis did not directly consider the economic benefits of servicing higher quality agricultural land areas or of the efficiencies of servicing larger clusters of cane fields. Although there is a cane railway system in the Sunshine Coast area, this study only considered road transport. Assessment of the future of the cane railways was provided by a specialist focus group.

The analysis of the road network was completed using digital spatial data describing roads (1:250,000), elevation (1:100,000) and cadastral data (1:25,000). The elevation data were used to derive a slope classification in 2-degree sections up to a maximum of 16 degrees. Road classes were assigned approximate travel speeds according to the speed limits associated with the road quality (e.g., 110 km/hr on freeways). Cadastral data were used to further weight the travel speeds according to proximity to urban areas and urban block sizes. Other factors, such as intersection delays and turn-around times at the mills, were also included in the overall estimate of travel times across the study area. Estimates were also based on the capacity of the average cane truck to carry an average load of cane to the mill, although specific details of the physics of truck movement were beyond the scope of this strategic level assessment. Spatial analysis of the road network was completed using ArcInfo software, in particular using AML programming and the power of a network.

The information provided by the road transport analyses gave a useful overview of road transport access between the Moreton Mill and its sugar-cane catchment area, and the viability of land for sugar-cane expansion. The use of a digital programmable system, such as a GIS, allowed the efficient revision of repeatability of road network analysis. Used in conjunction with expert advice from sugar industry representatives, this analysis has contributed to the discussion of transport options for the sugar industry.

5.2.2 Multiple criteria analysis tools

In earlier chapters, we described how regional planning often involves multiple criteria and multiple objectives - that is, it includes consideration of trade-offs between different options to identify solutions that best meet a set of objectives ('optimal with constraints'). Multi-criteria analysis methods can be fruitfully employed in such situations because they provide a structured approach to decision-making where the decision problem is complex and the amount of information exceeds the integrative capacity of the human brain. Multi-criteria analysis has three major applications in planning: (1) it provides a process for identifying the desirable criteria and expectations for planning, (2) it provides a process for developing a number of planning options, and (3) it provides a method for ranking the options according to how well they satisfy the criteria. The following example illustrates a broad multi-criteria analysis approach to evaluate cane land allocation scenarios to identify land planning options for the sugar industry.

• **Example 5:** Evaluating cane allocation scenarios using a multi-criteria analysis approach

Cane land allocation seeks to allocate a certain amount of feasible land for cane production. Multi-criteria modelling provides a quantitative framework that can integrate information on planning goals and objectives, along with the values of stakeholders, to evaluate cane land allocation scenarios and assist planning. GIS tools can manage and integrate spatially referenced data (spatial data), and offer a means of visualising resultant land allocation scenarios generated with the multi-criteria analyses.

To assist industry, community and government resource managers to explore and evaluate different land allocation scenarios for sugar-cane production, we used a multi-criteria analysis technique, SMARTER (a modified Simple Multi-Attribute Rating Technique), to manipulate the proportion and locations of land for growing cane based on a set of allocation criteria and stakeholders' value judgements on the relative importance of these criteria. SMARTER is an approximate method for multi-attribute utility measurement based on an elicitation procedure for weights (Edwards and Barron 1994) (refer Box 5-3). It can help users to identify criteria that are important for cane land allocation, make subjective assessments of the relative importance of those criteria, and convert the assessments into a set of weights. SMARTER involves a judgemental step of ranking criteria in order of importance and does not require users to put hard numbers (weights) to subjective judgements. Using this type of analysis, different cane land allocation scenarios can be developed using different sets of criteria, imposing different sets of land-use constraints, providing different rank orders of importance to the selected criteria, and by setting different targets for cane production. We used a GIS to develop map data layers to represent the identified allocation criteria and potential constraints for cane land-use, to combine these data layers through spatial modelling, to identify the suitable land for sugar-cane production by applying the SMARTER weights, and to generate map presentations of land allocation scenarios.

The resulting multi-criteria analysis tool can use either the optimal production targets derived from existing models, or those set by users for the spatial allocation of land for sugar-cane production. The tool aims to spatially allocate land for cane production at the landscape level. The integration of multi-criteria modelling and GIS allows decision-makers to explore and evaluate different cane land allocation scenarios effectively and efficiently.

The steps described in Box 5-3 and Table 5-5, illustrate the process for evaluating the desirability of land for growing sugar-cane. This procedure describes how multiple allocation criteria and land-use constraints can be integrated to find appropriate land for sugar-cane production and shows how it can be combined with GIS modelling to manipulate data, and represent land-use constraints and allocation criteria visually.

This is an example of cane land allocation in the lower Herbert River Catchment, in which we assign the following allocation criteria: land suitability for sugar-cane, slope, proximity to existing mills, proximity to roads, shape compactness of cane land blocks, and fragmentation of landscape. The shape compactness of a cane land block is measured as $4\sqrt{A}/P$ (Bogaert *et al.* 2000) where A is the area (km^2) and P is the perimeter (km) of a

Box 5-3 Generating weightings using the SMARTER multi-criteria analysis technique.

SMARTER uses a linear additive model (Equation 1) to calculate multi-attribute utilities, which can be used as overall scores for spatial units in cane land allocation. The score X, for a spatial unit on the /th criterion is estimated on a 0-100 scale, with 0 as the minimum plausible value and 100 the maximum plausible value. For continuous variables, a straight-line function can be developed. For qualitative measures, scores can be assigned to reflect relative performance. W7 is derived based on the rank order of criteria. In SMARTER, after the rank order of a set of criteria or objectives is obtained, it is used to estimate the set of weights using the centroid method. The centroid method assigns weights as follows:

Assume W_1 is the weight of the most important criterion or objective, W_2 is the weight of the second most important criterion or objective, and so on. For n criteria or objectives:

Wj =(1 + 1/2 + 1/3 + ... + 1/ *ri) I n*

W_2 =(0 + 1/2 + 1/3 + ... + 1/ *ri) I n*

W_n =(0 + 0 + 0+ ... + *M ri) I n*

Generally, *\f* $W_1 > W_2 > ... W_n$, then the weight of the ith criterion or objective is:

$$W_i = (1/n) \sum_{j=1}^{n} (1/j) \qquad \textbf{0)}$$

On the basis of homogeneous land attributes, the spatial disaggregation algorithm for cane land allocation (Walmsley et al. 1999) divides a region into spatial units. For a particular type of land use, each spatial unit is evaluated against a number of criteria, each of which is assigned a weight. An overall score is calculated for a spatial unit and a land use type using the linear value function:

$$S = \sum_{i=1}^{n} W_i \cdot V_i \qquad (2)$$

where 5 is the overall score of a spatial unit, *Wj* is the relative weight of the /th criterion (i.e., . ZW,-= 1), *V-,* is the score of a spatial unit on the /th criterion, and *n* is the number of criteria.

The algorithm starts the allocation process with the selection of the spatial unit with the highest overall score and assigns it as cane land. The algorithm then recalculates the overall scores for all remaining spatial units using equation 2, selects the spatial units with the next highest overall score, and adds them to the list of the assigned cane land. This process is repeated until a set amount of land is assigned for cane.

Table 5-5 Procedure for land-use allocation.

Step	Description of Process
Step 1: Define land-use constraints and allocation criteria.	Land-use constraints are restrict ons imposed on areas for sugar-cane production. They are defined by biophysical and environmental conditions that render land unsuitable for sugar-cane or allocate land to other uses. Examples of constraints to sugar-cane growing include inappropriate soils, temperatures or rainfall, steep slopes, and land of high nature conservation value. Allocation criteria represent the desired conditions for growing sugar-cane and are used to determine relative land values for growing sugar-cane.
Step 2: Prepare spatial data to assess the implications of land-use constraints.	Land-use constraints defined in step 1 can be mapped and represented as a data layer in a GIS. Constraint maps are created by eliminating land that is characterised by attributes, or certain values of attributes, from consideration (e.g., land on slopes >3%). These maps categorise land into two classes: feasible and infeasible according to the particular attribute being mapped. Feasible land is assigned a value of 1 (e.g., land on slopes <3%), and infeasible land is assigned a value of 0 (e.g., land on slopes >3%).
Step 3: Prepare data to measure the allocation criteria.	To identify appropriate areas for cane expansion, the allocation criteria can also be spatially represented as a map data layer in the CIS. Criteria maps determining relative land values for growing sugar-cane, can be created according to appropriate qualitative or quantitative measures. However, because allocation criteria can be measured on a variety of scales, the values of the criteria need to be standardised so that the various data layers can be overlaid (combined). To achieve this we converted the values of the the criteria into standardised scores on a 0-100 scale using the following formulae: $Score_i = \frac{X_i - X_{min}}{X_{max} - X_{min}} * 100$ (3) if the value of a criterion is to be minimised, $Score_i = \frac{X_{max} - X_i}{X_{max} - X_{min}} * 100$ (4) Where $Score_i$ is the standardised score for the criterion for the ith spatial object (an area on the criterion map), x_i is the value of the criterion for the *i*th spatial object, x_{max} is the maximum value of the criterion, x_{min} is the minimum value of the criterion, and $Score_i$ ranges from 0 - 100. More attractive criterion values are represented by higher values of the score.
Step 4: Combine constraint and criterion maps to create a spatial unit map.	The spatial unit map excludes the restricted areas by applying the land-use constraints, Each spatial unit represents an alternative area for sugar-cane production, and contains the score values for all the allocation criteria,
Step 5: Rank the allocation criteria in order of importance.	This is accomplished by asking decision-makers: 'Image you have a cane land block that had the worst possible performance on all criteria. You are selecting an alternative area, You can improve the value of one criterion to achieve the best possible attainment level of sugar-cane production. Among all the n criteria, which value would you improve to make the alternative most desirable?' The decision-makers would then select one of the n criteria. This criterion would be removed from the list and the decision-makers are asked to select one criterion from the remaining list, whose value would be preferred to be improved to make the alternative most desirable. This continues, with the outcome that a rank ordering of criteria is obtained. The most important criterion was the first selected in this operation, and the last selected the least important.
Step 6: Estimate weights	This step estimates and assigns numerical weights to the allocation criteria based on their rank order of importance obtained in the previous step by applying the equation 1 (Box 5-3).
Step 7: Calculate overall scores for each spatial unit.	The calculation is accomplished by applying equation 2 on all spatial units on the spatial unit map.

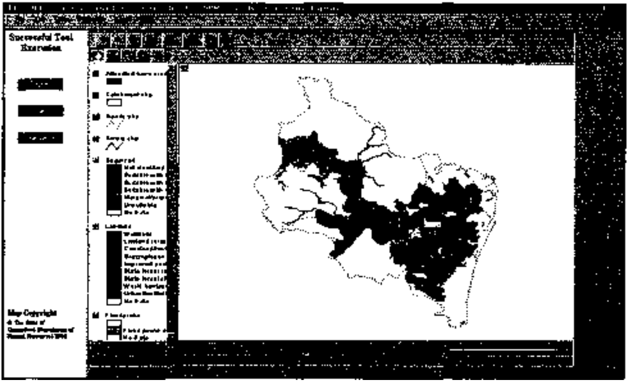
Step 8: Allocate the most feasible land for sugar-cane production.	This is achieved using the spatial disaggregation algorithm in equation 2 (refer Box 5-3).
Step 9: Generate a future sugar-cane land-use plan.	The allocated cane land is presented as a sugar-cane allocation map. Steps 1 to 8 can be repeated to develop different land allocation scenarios by defining different land-use constraints and allocation criteria, and by providing different rank orders of the criteria. By comparing land allocation scenarios based on the criteria and weightings, decision-makers can explore the implications of different policies in an attempt to meet targets without violating constraints on expansion and minimising conflicts with other land-use aspirations.

cane land block. The fragmentation of landscape is measured as *2logA/logP* (Milne 1988) where *A* is the area (km^2) of the land allocated to cane and P is its perimeter (km). The land-use constraints could exclude those areas where state forests, national parks, wetlands or flood-prone areas are located. For further information on the processes for measuring these criteria please consult the additional resources at the end of this chapter.

Two hypothetical scenarios for cane land allocation in the Sunshine Coast area are illustrated below. The criteria and weightings used are hypothetical and do not represent expressed stakeholder values. In the first hypothetical scenario, the plan is to allocate about $600km^2$ of land to cane production. The selected allocation criteria include and are ranked in the order of perceived importance: *land suitability for sugar-cane > slope > distance to mills > distance to roads > fragmentation of landscape > shape compactness of a cane land block.* National parks, state forests, and those areas with a slope of 8% or more are reserved. Figure 5-8 shows the result of cane land allocation under this scenario. The figure shows the new cane allocation is distributed along the major rivers due to the importance placed on the criterion 'land suitability for sugar-cane'.

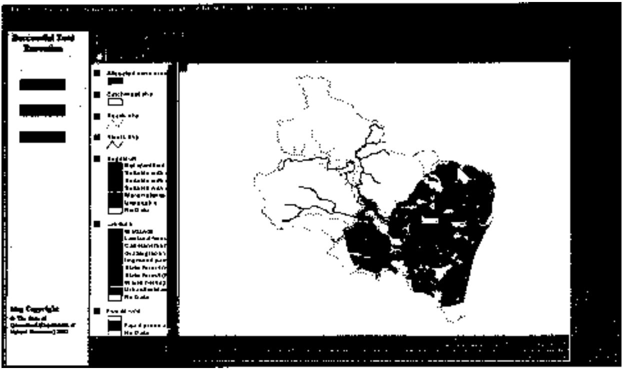
In the second hypothetical scenario, the same amount of land is planned for cane expansion ($600km^2$). A different set of allocation criteria is selected and ranked in the order of perceived importance: *distance to mills > fragmentation of landscape > land*

Figure 5-8 Cane land allocation for scenario 1.



suitability for sugar-cane. The same land-use constraints as the first scenario are imposed. The result of cane land allocation for this scenario is shown in Figure 5-9. In this scenario the new cane allocation is skewed towards the east due to the importance placed on the criterion 'distance to mills'.

Figure 5-9 **Cane land allocation** for scenario **2.**



These examples provide an illustration of how this analytical tool can be used to assist industry, community and government resource managers to explore and evaluate different land allocation scenarios for sugar-cane production. They demonstrate not only the flexibility of the approach in the selection and ranking of allocation criteria, but also the divergence of planning outcomes (land allocations) that can be explored using this type of analysis.

5.3 Evaluation of planning strategies

Although regional planning strategies are likely to be developed at the regional scale, they will invariably be implemented at the local level, and in the sugar industry this means they will often be implemented at the farm scale or mill district level. In order to ensure that regional planning options are feasible and that planning strategies deliver outcomes that are desired by all stakeholders, the probable impact of different planning strategies may need to be evaluated. Sometimes, options that appear to be effective at the regional level have unanticipated consequences at the farm or mill scale, or have unanticipated consequences for social and economic elements in the regional environment. Various information tools exist to improve understanding of the possible implications of different planning options on farms, local communities and regional systems. This section highlights two particular approaches that we used to evaluate the impacts of industry planning strategies: the use of spreadsheet analysis to assess the costs and benefits of riparian revegetation, and the use of regional system modelling to assess the regional implications of a range of changes to the sugar industry.

5.3.1 Spreadsheet-based analysis

Some tasks in resource management involve large numbers of calculations that are not conceptually complex, but are beyond the scope of manual approaches. Spreadsheets are widely used for these tasks, particularly for financial analyses. The example provided here uses spreadsheet-based analyses to estimate costs and benefits of riparian revegetation on cane lands. Although this example considers an enterprise scale analysis, it is important for regional planning because the implementation of activities on farms will often be required to achieve objectives at the regional scale, in this case, catchment scale revegetation of riparian areas.

• **Example 6:** Assessing the costs and benefits of riparian revegetation

In the past decade, the sugar industry, along with other land-users, was being encouraged to revegetate or extend areas of vegetation on their farms, with an emphasis on revegetating areas adjacent to streams and waterways, otherwise called riparian vegetation. An Australian Bureau of Agricultural and Resource Economics (ABARE) survey of broadacre and dairy farms in 1990 (Wilson et al. 1995) showed that, although there has been an increase in tree planting, the percentage of farmers in Queensland who had planted trees at some time in the previous three years was markedly below the Australian average - 6% instead of 35%. After an audit in 1995, CANEGROWERS recommended that more information should be provided to growers on sustainable farming practices in general and, in particular, on revegetating riparian zones and areas serving as wildlife corridors. In 1998, they also sought to raise funds to support a major tree-planting program in catchments currently growing cane but were unsuccessful except for a small portion of funding that was restricted to tree planting in the Burdekin. Furthermore, several of the ICM groups in sugar districts have identified riparian revegetation as a priority.

The perceived potential benefits of riparian revegetation have been categorised and listed in many ways by various authors. A good summary is available in CANEGROWERS (1996) publication "Is There a Rat in Your Hip Pocket?" The nineteen benefits of revegetating identified in that publication are listed in Table 5-6. However, while some of these benefits directly impact on the farm, many of them may be described as 'public good' benefits, with only indirect benefits conferred on the farmer. Therefore, the analysis of riparian revegetation undertaken by CSIRO was designed to look at the farm financial costs and benefits of riparian revegetation on a case-by-case basis.

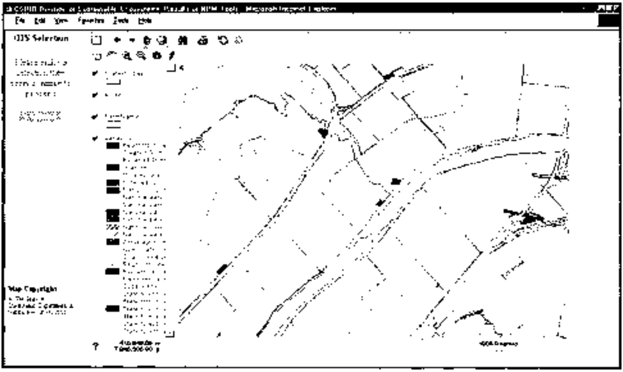
Table 5-6 Benefits of revegetating cane lands.

Benefits of Revegetating Cane Lands
Rat control
Stabilised river courses
Healthier ecosystems
Savings on pest control
Opportunities for diversification
Retention of nutrients
Increased fish stocks
improved safety
Re-instatement of corridors for wildlife
Reduction in rates and taxes
Decreased erosion
Improved water quality
Decrease in insect pests
Increased capital values
Better climate protection
Lower water tables
Decreased algal growth
Enhanced aesthetic appeal
Improved public profile of cane growers

Assessing the costs and benefits of revegetation is complex because both monetary and non-monetary costs and benefits are incurred or accrued, and they produce both direct and spill-over (indirect) effects. Given that significant areas of the riparian zone are already under cultivation, cost-effective options have been sought that take into account public and private interests and responsibilities, community obligations, lost opportunities, cost-sharing and the appropriation of benefits. Ideally, a cost-benefit analysis would take into account all of the factors listed in Table 5-6; however data to support this are unavailable. In fact, few of these factors can be quantified sufficiently for direct inclusion in a cost-benefit analysis. Consequently, we used key quantifiable determinants as a basis for our cost-benefit analysis.

Our on-farm revegetation tool performs an elementary cost-benefit analysis using a simple Excel spreadsheet. The spreadsheet was linked to input data from spatial databases held in the Herbert Resource Information Centre (e.g., cane blocks, cadastral information and land-use), and packaged the linked data and spreadsheet together with a web-based user interface implemented in a package called NRMtools (Figure 5-10). This additional investment enabled us to expand from a one-off analysis of average costs and benefits to a multitude of analyses accommodating different circumstances.

Figure 5-10 Mapped-based interface for the riparian revegetation tool.



The tool was invoked from the NRM tools web site (now defunct), with subsequent interaction through the web-browser. A CIS was opened on the server and the user navigated a map (such as that in Figure 5-10) to identify the block of land of interest. The use of the ArcView mapped-base interface within the riparian vegetation tool allowed users to search (pan, zoom, etc.) maps for resources of interest. Data pertaining to that block were returned to the user to confirm that the correct selection had been made. The user was then prompted for a number of input values, with realistic or plausible default values provided as starting points. All user inputs were via HTML forms that were generated dynamically at run time.

These user inputs and data from the GIS were then passed to an Excel spreadsheet on the CSIRO server which then ran a cost-benefit analysis. The results were returned to the user and displayed within the web browser (Figure 5-1 0,1 1). On completion of the on-farm revegetation tool, the user could download a full report with explanatory material, site maps, spreadsheet inputs and explanation.

Figure 5-11 Cost-benefit report from the revegetation analysis.

You have chosen 100% of 43.9 hectares of Sugar Cane land to revegetate.
The costs/benefits calculations will be applied to 43.9 hectares of revegetation.

A. Area of land to be revegetated

Total area of Sugar Cane land selected in CIS polygon -	43.9 hectares
Percentage of this area that you wish to revegetate -	100%
Area of Sugar Cane land to be revegetated -	43.9 hectares

B. Estimate of Revenue lost through reduced Cane Production

Cane Stalk production - per hectare	100 tonnes per hectare
Cane stalk price - per tonne	$27 per tonne of cane
Cane income - per hectare	$2700 per hectare
Average variable costs of production - per hectare	$1300 per hectare
Calculated gross margin - per hectare	$1400 per hectare
Lost revenue due to 43.9 hectares being revegetated	$61460 annually (or $1400 per hectare annually)

C. Estimate of Costs of Revegetation (Establishment & Ongoing)

Area of Sugar Cane land to be revegetated -	43.9 hectares
Total establishment cost for 43.9 hectares is:	$219500 in total (or $5000 per hectare)
Maintenance costs for first 3 years for 43.9 hectares is:	$13170 annually (or $300 hectare/annual)
Maintenance costs for later years for 43.9 hectares is:	$6585 annually (or $150 hectare/annual)

D. Estimates of Benefits from Revegetation using 4% and 8% discount rates over 30 years

	4% disc. rate	8% disc. rate
Present Value of Timber Production (20, 25 & 30 years partial harvest)	$27264 for 43.9 hectares	$10874 for 43.9 hectares

E. Summary Present Value Table using 4% and 8% discount rates over 30 years

	4% disc. rate	8% disc. rate
Cost: revenue foregone from lost cane production	-$1,124,228	-$753,363
Cost: establishment costs of revegetation zone	-$219,500	-$219,500
Cost: ongoing maintenance costs	-$132,142	-$91,103
Benefit: timber production	$27,264	$10,874
Total NPV for the 30 year timespan	-$1,448,607	-$1,053,092
The Benefit/Cost Ratio is: (benefits outweigh the costs if ratio greater than 1)	0.02	0.01

F. Additional Annual Benefits Needed to Break Even on Your Investment are:

	4% disc. rate	*8%* disc. rate
For the total area of revegetated land of 43.9 hectares	$83773 per year for 30 years	$93543 per year for 30 years
Per hectare of revegetated land	$1908 per year for 30 years	$2131 per year for 30 years

Applying the on-farm revegetation tool to a range of sites within a test catchment (the Herbert River catchment of north Queensland) with a range of input data, demonstrated that, for most farmers who use the tool, revegetation would not be financially viable and should only be undertaken with other goals in mind. It is important to note that it did depend on specific circumstances and on whether the costs applied were estimates or averages. However, the tool illuminated details and quantified the gap between the costs and benefits, giving an indication of the levels of subsidies or incentives (from the farm business or from the wider community) that might be needed to promote revegetation of riparian land.

5.3.2 Making predictions through simulation.

Implementing widespread change can be very costly, consequently predictions of the likely responses to drivers of change or outcomes of proposed actions in rural resource management and agriculture are often made using biological, economic, hydrological and or other models. Simulation models are mathematical representations of the dynamics of economic and/or biophysical systems. Many models provide resource managers with cost-effective means of addressing the issues of complexity and variability in economic and biophysical systems.

By necessity, although models represent a simplification of reality, they need to retain the significant features or relationships of reality to be useful. Successful application of models in planning depends upon: model verification; validation of outputs; statement of the core assumptions of the model, and its limitations and applicability. This is particularly important with computer-based simulation models that are so complex that only specialists can understand or criticise them. We provide an example of modelling of regional trajectories based on social and economic outcomes arising from farm-scale financial pressures and decisions.

• **Example 7:** Predicting regional dynamics

The purpose of the Regional Dynamics Model (RDM) is to provide local industry stakeholders, community leaders and decision-makers with access to an integrated natural resource model that allows them to investigate probable regional, social, economic, and environmental consequences of changes in the sugar industry. It can be used by farmers to analyse the economic returns from sugar-cane production, and by planners to analyse the demands on social and community services, and to provide all stakeholder groups with tools and information to support decision-making. Modelling a system to generate 'what if...?' scenarios can provide a means of assessing the probable outcomes of a range of potential actions. In response to concerns in the Herbert River region, the RDM was generated to explore the outcomes from projected changes to its sugar industry.

The model is based on key drivers of sustainability for the industry including: sugar price and commercial content of sugar (CCS), level of debt (equity), sugar-cane yield and access to land. The impacts of different combinations of these drivers are considered through a farm-scale production and financial analysis (area of production, equity and farm income) over a given time period. The information from this farm-scale financial sub-model is then aggregated (total number of farms and land planted to cane) to provide regional-scale information on finances (regional sugar income and expenditure) and sugar production. The implications of various scenarios can be modelled to demonstrate potential impacts on primary employment (cane growers, mill employees, harvest contractors), secondary employment (service providers) and impacts on environmental/natural resources.

Design of Regional Dynamics Model

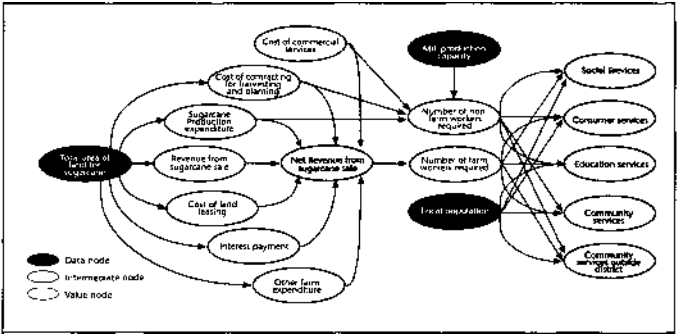
The RDM was designed to provide an effective means of managing and reconciling industry imperatives at the farm and regional scales, and to broadly summarise some key environmental factors that can be used as to indicate catchment health. The key components of the model (Figure 5-12) can be split into three broad categories:

- farm-based operations and the supporting infrastructure in the production of sugar-cane,
- the flow-on effect of sugar-cane production to community services, and
- the resulting effect of sugar-cane production on the environment and the proposed benefits of allocating/reallocation of land once a farm business has ceased.

The model was based on the input of key 'drivers' of sustainability for the industry, including sugar price, CCS, farm equity, yield and access to land. The implications of different combinations of these drivers were considered through a farm-scale financial sub-model, which considered area of production, equity, and farm income over a given period of time. The information from the farm-scale sub-model was then aggregated (total number of farms and assigned land) to provide regional information on financial regional sugar income and expenditure and sugar production. The implications of various scenarios could then be modelled to demonstrate potential impacts on primary employment (growers, mill employees, harvest contractors), secondary employment (service providers), and the environmental-natural resource base.

This model assumes that there are only two dominant types of land-use in the region: sugar-cane and grazing. It does not assess risks and uncertainties associated with unpredicted events (such as, costs and values at the time of harvest, availability of contract

Figure 5-12 A broad overview of the Regional Dynamics Model showing key drivers for the production of sugar-cane and its flow-on effect to the community and the environment (Mayocchi et al. 2003).



labour, machinery breakdown, technological change, legislation change and weather conditions). In the model, cane production is limited to assigned land, however cane land is not homogeneous and falls into two categories namely (1) Class 1 - suitable with no limitations and Class 2 - suitable with minor limitations, and (2) Class 3 suitable with moderate limitations and Class 4 marginal. It is possible to off-set land quality with increased fertiliser applications, but these incur added costs. The allocation of equity in the model is based on Queensland Rural Adjustment Authority (QRAA) Rural Debt survey (sugar regions) and the allocation groups are shown in Table 5-7. Equity is randomised against groupings throughout the catchment and distributions can be altered to reflect changes in income throughout the catchment.

The model also assumes that cane production is the sole income-generating activity. Regional farm revenue is calculated using: land area, average sugar-cane yield, CCS, mill levies and deductions, and average cane price. Regional costs represent the costs of producing cane plus other farm expenditure including: variable costs, fixed costs, harvesting costs, and interest on debt. Combining these provides an estimate of annual profits or losses.

The main social assumption of the model is that the primary community impact would be through unemployment or increased employment (direct, indirect or induced, see below for further explanation). Furthermore, the model assumes that farms become available after two consecutive years of negative income combined with less than 60% equity. Reallocation of the farms requires that the land is neither marginal nor adjacent to existing wetlands or riparian areas, and that the 'new' farm has greater than 60% equity and positive net income for the year preceding and the year following the reallocation.

The major links between elements of the regional economic system, and their interdependence, are illustrated using dependency diagrams (Figure 5-12). These diagrams represent the relationships between the components of the RNM at its most abstract level. They enable users to navigate through the components of a system, and to modify the relationships between elements or the components of the system to generate outcomes of 'what if ...?' scenarios. For detailed discussions on the dependency diagrams, the relationships between the components of the system, and the workings of the model, please refer to the additional resources listed at the end of this chapter.

Table 5-7 Queensland Rural Adjustment Authority (QRAA) Rural Debt ratings and groupings for 1999.

Loan Rating cane growing regions	Equity	Percentage of borrowers in northern
A	75% or greater	53.3%
B+	65 - 75%	35%
B1 & B2	55 - 65%	11%
C	Less than 55%	0.7%

Results from the RDM

In 2000, there were 65,665 hectares of cane land producing 95 tonnes/ha (5 year average) or 882 farming enterprises in the lower Herbert region. Although farm sizes range between 30 and 2000 ha, the average farm size was 74 hectares. At the prevailing production rates and sugar prices, it was estimated that a farm size of about 100-105 ha was needed to provide a sustaining income for a family. This suggests that approximately 580 farms in the Herbert were projected to be economically non-viable in the long run. If these farms left the industry, about 30,000 hectares would become available for re-allocation. The possible social, economic and environmental impacts of this change raise a number of issues for regional planning. Would existing growers or new players in the industry purchase available land and amalgamate properties or might other land-uses take over the land? What implications would such changes have for mill viability? What would be the impacts on, say, regional employment, of a reduced number of farm businesses? What might flow on to community services? What might be the environmental effects of these changes?

Even though relatively simple, the RDM allowed exploration of a range of economic, social and environmental implications of various different scenarios of structural change. The model suggested that reduced yields and sugar prices would increase the size of the smallest viable farm and require existing enterprises to examine current production expenditure and revenue. Current levels of debt and inflation would compound this impact. The model also showed that larger enterprises were sustainable, and that they may find themselves well placed to strengthen their current operations by purchasing more land from the smaller, non-viable enterprises. Economies of scale should enable larger operations to retire the debit incurred in purchasing new land in a timely manner.

The model showed that the continued trend of reduced yields and sugar production would have significant impact on the current employment levels at the regional scale. As smaller farm enterprises ceased operation, there would be less social infrastructure available to support the larger remaining farms. In contrast, the model also shows a growth in off-farm labour demands, as larger enterprises require the services of extra staff in their expanded operations. These new labour demands would depend upon the surviving farms reaching certain critical sizes and production capacities.

One of the main beneficiaries of a possible rationalisation process could be the retirement of marginal farming land to natural vegetation. This would reduce the amount of fertiliser and pesticides currently being applied, and ultimately contribute to the health of the catchment - especially where such land was adjacent to wetland areas. However, there would clearly be a trade-off between this outcome and its economic and social ramifications.

5.4 Summary

In this chapter, we have looked further into the valuable role played by information and analysis in underpinning planning processes and generating effective outcomes. The set of examples that we have used is intended to illustrate the processes of data collation, integration and analysis available to inform industry planning. We have tried to explore some of the practical aspects of linking information and analysis into planning and develop these themes further in the following chapter.

Information integration and analysis of the type we have discussed is, of course, widely used in industry planning and management processes. Table 5-8 illustrates recent examples of initiatives that have had a major influence on industry planning and policy that have each used, in their own way, analytical approaches as core methods. These initiatives, like many others, provide valuable examples and experience that should be used to inform planning of analytical projects to inform future initiatives.

A key message of this resource book is that planning processes need to be integrated - information gathering, analysis, dialogue, negotiation and other communication activities all need to be conducted as part of a seamless whole in order to maximise the likelihood of successful outcomes.

Table 5-8 Some examples of analyses that have contributed to policy and planning change in the sugar industry.

Initiative	Analyses	Reference
Assessment of impacts of changes to the *Sugar Industry Act* 7999 by the Centre for International Economics (CIE)	Development of an economic model of the sugar industry (in five aggregated regions) and assessment of the impact of a number of scenarios based on the model.	Centre for International Economics (2002), Cleaning up the Act: The impacts of changes to the *Sugar Industry Act 1999*.
Assessment of the impact of resource-use (including cane production) on water quality in the Great Barrier Reef.	Synthesis of issues, synthesis and analysis of key social, economic and biophysical data, projections of future economic importance of sectors.	Productivity Commission (2003) Industries, land-use and water quality in the Great Barrier Reef Catchment.
Review of the impact of the sugar industry Code of Practice on perceptions and practice in farm management.	Survey-based data collection exploring industry awareness of, agreement with and application of the Code of Practice.	O'Grady and Christiansen (2000) Canegrowing and sustainability - A survey of Australian canegrowers with particular reference to the Code of Practice for Sustainable Cane Growing in Queensland.
Assessment of the sugar industry's future (the Hildebrand report).	Holistic assessment of the sugar industry from production through to marketing based on submissions, interview and analysis of key datasets	Hildebrand (2002) Independent Assessment of the Sugar Industry
Lower Herbert Integrated Water Management Project, (part of Sugar Industry Infrastructure Package).	Data synthesis and analysis to look at areas suitable for production in the lower Herbert and hydrological modelling to design water management strategies to facilitate sustainable production.	http://www.nrm.qld.gov.au/about/media/oct/oct 23 herbert water.html.

Where to go for more information:

Brouwer, D. and A. Clowes and B. Thompson (1999) Physical property planning: Farming for the future. NSW Agriculture, Patterson.

Burdge, R. j. (1995) A community guide to social impact assessment. Social Ecology Press. Middleton, Wisconsin.

Herbert Resource Information Centre (2003) Herbert Resource Information Centre Website: www.hric.org.au

Mayocchi C. D. Chalmers, and D. Walker (2003) Economic and environmental modelling, a case study: A systems approach to the analysis of the sugar industry in the Herbert catchment, Northern Australia. 5th International Symposium on Environmental Software Systems, 27-30 May 2003 , Semmering, Austria, Walker, D.H., P.Byron and C.j. Mayocchi (1999) Decision support for integrated natural resource management: Helping resource managers explore new issues. Proceedings MODSS'99 Conference, 1-6 August, 1999, Brisbane.

Walmsley, A.)., D.H. Walker, T. Mallawaarachchi and A. Lewis (1999) Integration of spatial land-use allocation and economic optimisation models for decision support, In: Les Oxley and Frank Scrimgoeur (eds). Proceedings, MODSIM 99: International Congress on Modelling and Simulation, Volume 4, University of Waikato, Hamilton, New Zealand, Modelling and Simulation society of Australia, Inc., Canberra, Australia.

Zhu, X., D.H. Walker and C.J. Mayocchi (2001) Integrating multi-criteria modelling and GIS for sugar-cane land allocation. In: F. Ghassemi, M. McAleer, L. Oxley and M. Scoccimarro (eds). MODSIM 2001: International congress on Modelling and Simulation. Integrating models for Natural Resources Management Across Disciplines, Issues and Scales. Volume 3: Socioeconomic Systems. The Australian National University, 10-13 December 2001. MODSIM, Canberra.

The Herbert Resource Information Centre (HRIC) Website: www.hric.org.au

The Herbert Resource Information Centre (HRIC) Data Principles and Guidelines: http://www.hric.org.au/HRIC__site/HRIC_info/Policies/Policies.asp

The Queensland Spatial Information Infrastructure Strategy (QSIIS) Website: www.qsiis.qld.gov.au

ANZLIC Spatial Information Council Website: www.anzlic.org.au

6 Linking analysis with planning

In Chapter 3, we talked about the role of information and decision-making tools in helping to structure and inform planning processes. In Chapter 5, we presented examples of analytical tools that have been used for regional planning. In this chapter, we further explore the idea of 'evidence-based decision-making', focusing particularly on managing analyses as a part of the regional planning process.

Practical experience shows us that a lot of planning processes make little or no use of these tools and approaches for gathering information and making decisions. Although this may be partly due to bad practice, it also tells us a good deal about the challenge of linking analysis with planning - this is the subject of this chapter. We discuss some approaches for working around such problems.

6.1 Why use formal analytical approaches in planning?

As we have discussed earlier, the growth and intensification of production in the sugar industry, and concerns relating to the environmental impacts of resource exploitation, have meant that all participants in the industry are expected to address an increasingly broad range of issues when making decisions. New skills, methods and tools (e.g., workshop facilitators, processes for dispute resolution), or analytical decision-support methods (see Box 6-1), may be needed to:

- deal with increased information,
- cope with increasingly complex decisions, and
- demonstrate clear and structured basis for decision-making planning processes.

Box 6-1 Decision support systems.

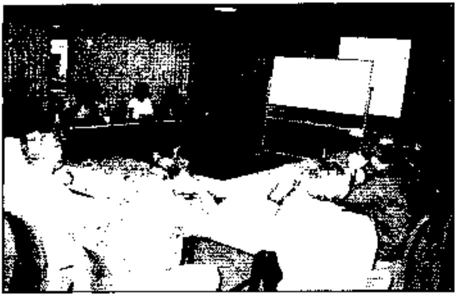
Decision support systems (DSS) are interactive computer-based systems used to support decision-makers and decision-making by generating alternative solutions to complex problems. Examples of DSS for complex problems in agriculture and natural resource management include, GIS mapping, CottonLOGIC (a tool used for cotton farming decisions relating to pests and nutrition), and NRMTools.

• *Processing more information*

With a greater understanding of resources, the environment, production systems, communities, and new technologies for information collection, management and communication, sugar industry stakeholders have access to greater volumes of data and information than ever before. While potentially useful for informing planning options and strategies, large quantities of information can also be overwhelming. Information sciences and technology can be applied in situations to help manage and use information more effectively.

• *Increasingly complex decisions*

Assessing the impact of sugar industry activities on production systems, the environment and society at different spatial (e.g., paddock, region) and temporal scales (e.g., seasonal, short-term, long-term), is a big challenge. In addition, planning that encompasses regional issues is more complex than plans that address problems facing individual industry sectors.



However, despite complexity, rapid economic and social change, and disagreement between different stakeholders over the nature of problems (e.g., environmental impacts) and desired objectives, decisions about how to use and manage natural resources must continue. Analytical decision-support methods may be important in helping stakeholders understand, respond, and cope with complex and unfamiliar challenges in planning and decision-making.

• *Demonstrating due process*

Analytical decision-support methods might not only improve planning and decision making, but they can also be used to demonstrate to governments and other stakeholders that the industry has followed a due process. With rising demands for accountability coming from governments, communities, and investment partners, being able to demonstrate 'best practice' decision-making in resource use and environmental management is becoming increasingly important. For example, keeping records of plans and activities that demonstrate adherence to industry or legislative standards can be used to demonstrate best practice. Similarly, records of decision-making processes can be used to justify decisions and demonstrate due process.

6.2 Overcoming obstacles to using analytical tools

It can be difficult for formal analyses to have a significant impact on planning approaches because tight timeframes and limited resources often mean that analytical approaches are simply never considered. However, when planning committees do decide to undertake an analysis, ensuring their incorporation into planning process can require careful attention to predictable barriers.

• *Completing decision support projects successfully*

Many analytical decision-support methods, or similar approaches, fail to produce outputs that fully meet the original specifications. This is particularly true for complex analyses based on information technology (IT). Investment in the innovative application of IT is particularly risky, and under-estimating the challenges can lead to budget blowouts and/or unsatisfactory delivery.

Putting aside the particularities of managing IT-based projects, awareness of the challenges associated with managing complex resource analyses is essential if they are to effectively support a planning initiative. It is important to adopt techniques or technologies with a specific application in mind, rather than for their own sake. This will strengthen the likelihood that adequate attention is given to the other skills, expertise and experience that remain critical for effective application of insights in planning. Serious disappointments and budget blow-outs have occurred when groups set up CIS initiatives to underpin planning without careful consideration of the precise objectives in employing these technologies and the way they relate to the broad decision-making process.

• *Relevance*

One of the biggest challenges in undertaking any analysis is making it relevant to decision-making questions and processes. Relevance is easy to achieve when an analysis simply explores an issue (e.g., regional profiling), but is much more challenging when attempting to identify the best way of doing something (e.g., modelling potential impacts of particular actions in complex systems). Unfortunately there are no 'correct' solutions to planning problems, and decisions cannot be based on irrefutable logic. Experience demonstrates that most decisions about the use of resources are open to a good deal of debate, and that different stakeholder groups might quite reasonably apply different logic to the same issues. As a result, it may be important to use an assessed logic that is more broadly accepted by participants in the planning process; otherwise 'information products' may be regarded as 'irrelevant'.

Relevance becomes more difficult to maintain with increasing technical or social 'distance' between analyst and the stakeholders involved in decision-making. There is a long history in community-based planning of technical experts producing outputs that prove to be irrelevant because needs were misunderstood, the diversity of goals and conditions were underestimated, and inventiveness of stakeholders had been overlooked.

• *Scope*

Analytical decision-support methods must not only be conceptually sound, relevant, accessible and otherwise well-designed, but must also address a sufficiently significant task to be useful. Experience suggests that individual and highly focused analyses often have little impact because they address too little of the issues in question to be useful - like meticulously polishing a brass door handle when the whole room needs cleaning.

• *Accessibility*

To facilitate their use in planning, information and analyses need to be accessible:

- physically - can all stakeholders in the planning process access the reports, analytical tools and data?
- technically - do the participants in the planning process have the necessary infrastructure (e.g., software) and skills (e.g., with information technology) to access and use the tools and analyses? and
- conceptually - are the tools or analyses presented in a way that is comprehensible to the people involved in the planning process or do they require specific expertise that is beyond the participants?

Differential access to information can skew stakeholder involvement, introduce power differentials and therefore introduce bias into the planning process. This may stem from the geographical location of the software systems, financial requirements (such as to purchase software and access information), differences between skills and resources available to use technology and appreciate its limitations, and political considerations (in terms of a systems role in power relations and processes for participation).

Physical and technical accessibility are normally simple to achieve. Conceptual accessibility is more difficult. For example, enabling non-economist decision-makers to make appropriate use of economic modelling and analysis techniques is a significant challenge. Planning processes and planning analyses must bear in mind the needs and capacities of users, otherwise they risk failure. By the same token, excessive simplification of an inherently complex situation in order to achieve 'accessibility' may render the outputs meaningless. The aim is to strike a balance.

• *Confidence/credibility*

Having met all other criteria, analyses are useful if the users are confident in the reliability of the results. The paradox here is that specialist analyses are designed to make expertise that is beyond the skill-level of the decision-maker available for the planning process, but analysis is only likely to be used where decision-makers 'understand' and therefore have confidence in, believe, or agree with, the analysis. For example, integrating scientific analyses into planning is as much a question of cross-cultural acceptance of ways of addressing a problem as differences in specific expertise.

- *Overcoming institutional and political barriers*

Finally, for analyses to be effectively integrated into planning processes, they must successfully negotiate a minefield of institutional and political obstacles - planning is, of course, about managing resource use to achieve desired outcomes, and it has winners and losers. Decisions may therefore threaten different interests which makes planning an inherently political process. However, analytical decision-support methods may help to improve decision-making in this context.

Support tools that try to improve the quality of decision-making processes and outcomes are unlikely to be free from political 'baggage' as they may threaten different interests. Therefore, political processes are a key part of planning in a democracy because planning is an inherently political process.

6.2.1 Evidence-based approaches and the risk of bias

In Chapter 5, we argued that analytical approaches have a good deal to offer planning. This is true, but there are dangers. In particular, selecting the analyses used (and therefore, those not used), can distort (or bias) the decision-making processes.

A common frustration for participants in planning processes is that the analyses used miss the point - that they are addressing in great and precise detail an issue that the people 'in charge' think is important, but aren't addressing the issues that groups or individuals with interests at stake think are really important. Planning outcomes can therefore be undermined by the way that the bias of those running the process and selecting the issues and tools for the analysis disenfranchises other participants.

'Socially embedded' bias reflects a commitment to a particular approach to analysis, whether at the level of the logic or the paradigm applied to the analysis, or to the particular method or even software implementation, used. Biased output may also result from the distortions associated with relying on incomplete, confused or inaccurate knowledge to underpin decision support or, more insidiously, non-communication of these uncertainties to the users.

Some forms of bias may be no more than an abuse of power (intentional or otherwise). Others may be more subtle. Untangling the potential distortions that any particular analysis might have, and managing these in negotiations with stakeholders are some of the most challenging aspects of the politics of planning.

6.3 How can analytical approaches to planning be designed to maximise their contribution?

The single most important issue in trying to take an evidence-based approach to planning is to integrate information from analyses into the planning *process.* We believe that evidence-based approaches can have a significant impact on *planning* practice if they are effectively designed according to the needs of the users, the capacity of the users, available information, the institutional context in which decisions are made, and the technologies and skills available to the developers.

So how can analytical approaches be designed to maximise their contribution to planning? We propose some principles for commissioning or conducting analyses that revolve around an approach of 'a problem seeking a solution' rather than 'a solution seeking a problem'. The principles consist of 6 steps: needs analysis; design; implementation; ensuring that the planning process can use the analysis; linking the analysis back in to planning, and monitoring and evaluation (Table 6-1).

Six steps for ensuring a positive impact of analyses on planning outcomes.

	Explanation of the process
1. Needs analysis	Many analyses suffer from inappropriate or muddled objectives. The first step is the formal development of project objectives and specifications. This ideally involves formal assessment of needs and constraints. This is difficult where the issues being tackled by the plan are complex and fluid and open to reinterpretation through time, and where a range of people and perspectives need to be involved in determining the KEY questions. Formal approaches to needs analysis or 'requirements capture' are well developed across a range of disciplines, including public service provision, manufacturing and software engineering. Issue or content analysis might be undertaken by the participants involved in the planning or contracted out. Regardless of who undertakes the analysis (participants or contractors), experience clearly shows that keeping it simple, ensuring clarity and retaining flexibility are important general principles for effective design. Developing clear specifications of exactly HOW the analysis will address the specified needs, before going to implementation, is an invaluable discipline.
3. Implementation	Clearly, this isn't the place to talk about details of undertaking analysis, but it is worth emphasising the critical importance of delivering analyses back into the planning process in time to be useful.
4. Ensuring that the planning process can/will use the analysis	Where complex analyses are being done, or where decision-support tools are being developed, investment may be needed to ensure that those involved in the planning process have the skills and understanding to use the tools or results of the analyses in decision-making. This might include documenting the processes used for analysis, thorough training of participants in interpretation, or investing in substantial capacity-building processes. Capacity building is a multi-faceted task covering the development of infrastructure and building technical skills and equally, if not more importantly, it entails learning, by the targeted decision-makers, to better understand needs, opportunities and implications of the analysis.
5. Linking analysis into planning	The participatory approach to design and development is intended to ensure application of the analyses and tools in the planning process. While the people undertaking tool development or analyses may well not be the decision-makers running the planning process, resources may need to be set aside to enable them to participate in planning processes to a sufficient extent that analyses can be practically integrated into planning.
6. Monitoring and evaluation	Regional planning processes tend to be, and should be, on-going and adaptive (Chapter 3). With this in mind there is always something to be learnt from the use of analyses to inform decisions that can contribute to 'doing it better next time'. The definition and measurement of the quality of decisions and of the decision-making process (and, therefore, improvements achieved through decision support) are context-specific, but will include factors such as validity, comprehensiveness and timeliness of analysis, equity of the process and outcome. Thinking these issues through and exploring their implications for next time is worthy of some investment.

Where to go for more information:

Walker, D.H., S.G. Cowell and A.K.L. Johnson (2001) Integrating research results into decision-making about natural resources management at a catchment scale. Agricultural Systems 69: 85-98.

7 Industry planning in the broader institutional context

Chapter 2 introduced a number of internal and external pressures that have seriously challenged the sugar industry's ability to remain viable and to persist. Following this, Chapter 3 introduced the concept of regional planning as a tool the industry can use in responding to these pressures to move the industry into a more desirable position. This chapter explores the broader context in which regional planning sits.

Regional planning by the sugar industry is only part of the broader resource governance picture. This has two implications for putting planning into practice. Firstly, it means that regional planning by the industry will interact with institutional arrangements operating at other levels and for other purposes (e.g., plans that define public expectations for the use and management of coastal resources and water resources). Furthermore, regional plans may also need to abide by the requirements contained within legislation (if relevant), such as industry legislation that stipulates operational aspects of growing, milling and marketing. Secondly, some of the external pressures facing the sugar industry are actually the result of ineffective and unsuitable institutional arrangements operating at other scales. For example, arrangements that encourage unsustainable behaviour and impinge on the industry's ability to implement change, such as inconsistent government policies for sugar pricing and environmental management, or regulations that constrain innovation. In this context, the distinction between internal and external pressures for change is important because the former are much more amenable than the latter to resolution through industry planning.

Although it is not likely that regional planning by the industry will be able to resolve institutional problems at state and national levels, the process of undertaking regional planning will assist the industry in identifying the external institutional challenges to change. The next challenge for the industry will be in devising a range of appropriate strategies to use this information to bring about external institutional reforms.

In this chapter we explore external institutional factors and the challenges they pose for industry planning.

7.1 What are institutional arrangements and why are they important for industry planning?

Institutional arrangements are tools for managing human behaviour to deliver desired outcomes. Regional planning, as described in this resource book, is a specific example of an institutional arrangement. However, many different kinds of institutional arrangements exist. They include formal arrangements defined in constitutions, policies, markets, plans and legislation instituted through parliamentary elections, opinion polls, community consultation, community engagement, political lobbying and demonstrations. *Informal* arrangements include perceptions, attitudes, and behaviour, and are inherent in social expectations, such as the rules governing relationships within families, firms or communities.

The institutional arrangements that influence the sugar industry include:

- informal *social* institutions at a local scale,
- institutions of the *market* of many kinds,
- *legal* institutions (common or statute law) with a range of purposes (courts, planning laws etc.),

- *public agencies* (departments, commissions),
- *informational* institutions (universities, CRCs, CSIRO) and commercial institutions (media),
- *cultural* institutions across a wide range such as religion or local customs, and
- *political* institutions (parliaments, ministerial councils, funding arrangements).

Different kinds of institutional arrangements interact together in systems and define attitudes, behaviours, and domains of choice. Institutional arrangements are important for industry planning because they both enable and constrain the industry in achieving desired outcomes.

In the context of the sugar industry, the institutional system includes stakeholders (such as millers, growers, refiners, advisers, policy-makers, and the community) and various other institutional arrangements that manage resource allocation, farm management, environmental management, organisational roles, responsibilities and stakeholder relationships (Table 7-1).

Table 7-1 The sugar industry governance system.

The parts of the system	Institutional elements
Land-use and dynamics	Rural expansion and contraction, resource conflicts, fragmentation, and diversification, emerging industries, urban development/decline.
Internal and external stakeholders	Attitudes, values, world-views, economic and social structure, capacity for change.
Technology and information	Research and development providers, extension services, barriers and opportunities to uptake.
Institutional arrangements	Governance regimes, rules and regulations, property rights, government agencies, financial incentives, government policies, plans etc.
Organisational change	Rural restructuring/readjustment, unionism etc.
External issues	Global markets, trading patterns and agreements, consumer preferences, climatic variables, domestic economy.

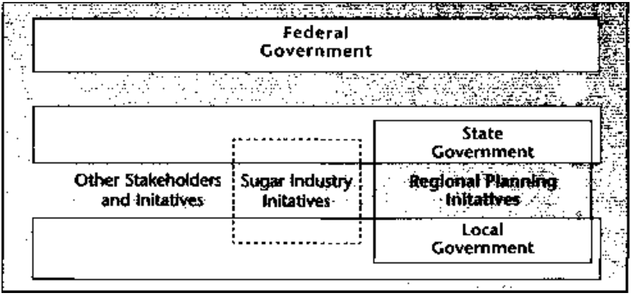
7.2 The institutional context for sugar industry planning

The sugar industry operates within an institutional context that structures political, social, cultural and economic transactions and relationships to balance competing demands for resources and to deliver outcomes desired by the sugar industry and broader society. These institutions define rights, roles and responsibilities for resource use and management ('who gets what?', 'what is the duty of care?') and they provide mechanisms for stakeholders to interact to define desired outcomes and make plans to achieve them.

The concept of regional planning presented in this document is a specific type of institutional arrangement that sits within a broader system of institutional arrangements generated by governments, other industries, and other sectors at national, state, regional and local levels (Figure 7-10).

In any given region (e.g., catchment) or context (e.g., the sugar industry) there are likely to be many planning activities occurring concurrently. Collectively, these activities comprise a planning system. A planning system involves multiple stakeholders (such as, industries, government agencies, indigenous communities, and environmental groups), all undertaking planning to achieve their own, value-based objectives. Since they are all focused on the use of a resource, or interconnected resources, their activities are naturally interconnected, each having an impact on the others. The ability of the planning system

Figure 7-1 Conceptual view of industry initiatives and the broader planning system.



to achieve sustainable and equitable outcomes for all participants depends on their collective understanding of natural resource management, the institutional arrangements available to help stakeholders negotiate through issues, and the capacity of these groups to participate in a complex and inherently political process. Furthermore, to remain effective, the system needs to be self-evaluating in order to adapt to a continuously evolving arena.

The implication of this, in practice, is that decision-making and resource management in the sugar industry are guided by a complex institutional system at multiple jurisdictional levels. Regional planning must be aware of institutional arrangements operating at different scales and how regional plans fit within the overall planning system.

In the following sections, we consider, in more detail, some of the formal institutional arrangements governing the sugar industry, in particular, arrangements pertaining to growing, milling and marketing, and environmental management. Although there are other kinds of institutional arrangements relevant to the industry's future (e.g., those relating to taxation and property rights) this discussion focuses on industry operation and environmental management because of the particular pressures and challenges these are currently imposing on the sugar industry.

7.2.1 Institutional arrangements for growing, milling and marketing

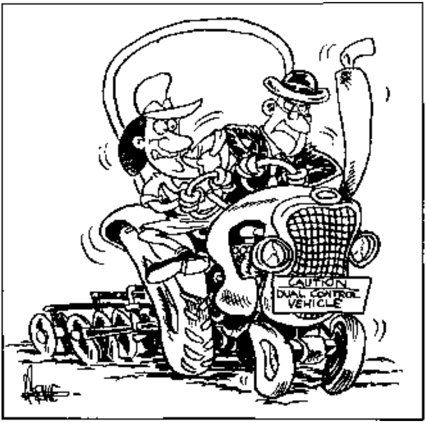
The original 'colonial' sugar industry regulations controlled almost every aspect of the growing and milling of sugar. They included the regulation of pricing policies (e.g., pool pricing, sugar tariff), marketing arrangements (e.g., single desk selling) and grower-miller agreements (e.g., transportation, pricing, assignment). These governance arrangements addressed the tensions which emerged between the various elements in the supply chain (e.g., farming, milling, refining, marketing and selling sectors) and ultimately almost every aspect of Australian sugar production was highly regulated (Drummond 1996). The resultant regulatory system was comprehensive, detailed, and complex. However, there was little government involvement in the day-to-day operation of the industry. Most statutory controls on the sugar industry have been enacted at the state level, but their operation was normally delegated to various industry bodies, such as the milling companies and producer organisations. In practice, the regulatory system functioned effectively because of the total interdependence of different industry sectors. This allowed a very high degree of control to be achieved with a limited number of measures.

The federal and state governments have progressively deregulated restrictive growing, milling and marketing regulations to improve the internal and external competitiveness of the Australian sugar industry. One of the most significant changes was the abolition of trade embargos and the sugar tariff. Before July 1989, the domestic market was protected by an embargo which prohibited imports of raw and refined sugar, golden syrup, and treacle (Danzi et al. 1997). During this time, the domestic market was regulated with prices determined by agreement between the Commonwealth and Queensland governments. In 1989 the Commonwealth government replaced the trade embargo with an import tariff on sugar (initially at the rate of $110 per tonne, later reduced to $55 per tonne). Domestic sugar was priced at import parity. This tariff was reduced to zero on 1 July 1997, and so now sugar sold on the domestic market is priced at export parity. Consequently, Australian sugar production is more closely aligned to world prices, and the domestic price of sugar and the price paid to growers for their cane is correspondingly lower than under a tariff regime.

ABARE anticipated that the removal of the sugar tariff would result in a fall in the average farm income of Queensland producers of around $3,000 per farm per year, and an income transfer would occur from farms in the northern and southern producing regions of Queensland to farms in the Burdekin and Central regions. ABARE also estimated that canegrowers might be able to maintain their incomes close to their 1995-96 levels if farm size increased and farm productivity rose (see Danzi et al. 1997).

In response to the impact of these changes to growers' incomes, the Australian government deregulated the sugar industry and, by 1994, many of the controls on the industry had been removed. Given the extremely high level of regulation that had existed within the industry, these changes have profoundly influenced the most basic structures of Australian sugar production. However, it was also predicted that these moves towards deregulation could have negative impacts on sugar industry sustainability -

> *"In all probability, deregulation will lead to even further intensification of production systems which in turn is likely to exacerbate both agronomic and environmental problems. It is also likely to increase pre-existing pressures on individual cane farms and thus it is likely to further prejudice the one feature which, more than any other, has allowed the industry to remain sustainable for so long"* (Drummond 1 996).



A contrary view to this is that the regulation of the sugar-cane industry has only affected land resources. According to this view, deregulation led to a more sensible balance between inputs and total factor productivity.

Even though some deregulation has occurred, the sugar industry has not been fully deregulated. Arrangements, such as the sugar-cane assignment system, the pool pricing system, and single desk still affect land allocation, grower and miller interests in cane supply and price, marketing and sales.

7.2.2 The environmental planning system

The institutions governing the sugar industry in Queensland were originally developed to manage the processing and marketing aspects of sugar production. Major institutional change in the sugar industry was catalysed in the late 1980s and early 1990s by moves to deregulate the operation of the industry and remove external and internal barriers to trade. To compensate for the increased risk and reduced profits heralded by these changes, legislation was enacted to allow the industry to expand production. The ecological consequences of such rapid and poorly planned growth sparked the development of land-use planning and management arrangements to deal with sustainability issues.

Australian governments have responded to environmental management issues by rapidly increasing the institutional arrangements (mostly legislation) for environmental management. Institutional arrangements for environmental planning and management will now be considered in further detail at each major jurisdictional level. Appendix 2 contains a more detailed account of the key institutional arrangements governing environmental management by the sugar industry in Queensland.

- *National arrangements*

At the national level the federal government is responsible for issues of national significance. Sustainable development was formally recognised in Australia in 1992 with the adoption of the *National Strategy for Ecologically Sustainable Development (NSESD).* The strategy defines ecologically sustainable development as "... *using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total guality of life, now and in the future, can be increased"* (Commonwealth of Australia 1992 p.6). Three core objectives were established to implement this strategy, to:

1. enhance individual and community wellbeing and welfare by following a path of economic development that safeguards the welfare of future generations,
2. provide for equity within and between generations, and
3. protect biological diversity, maintain essential ecological processes and life-support systems.

Federal arrangements pertaining to environmental management also focus on the discharge of Australia's international responsibilities. International treaties directly relevant to the sugar industry include the *Ramsar Convention on Wetlands of National and International Significance, Agenda 21, World Heritage Agreements, the Convention on Biological Diversity* and the *United Nations Framework Convention on Climate Change.* These arrangements provide national guidelines for decision-making that are implemented through local government. For example, the federal government is the signatory to *Agenda* 2 7, but local councils are the designated governmental bodies to implement *Agenda 21* in Australia.

In addition, the Commonwealth government has legislative power, through *Section 51* of *The Constitution* as it relates to 'external affairs', to enact laws within Australia which are in accordance with international treaties. Through *Section 51,* the Commonwealth can create legislation that may override existing state legislation that is inconsistent with international treaties. The *Environment Protection and Biodiversity Conservation Act 1999* which establishes procedures for Environmental Impact Assessment (refer to Appendix 2 for further information), and the *Australian Heritage Commission Act 1975* which enables the federal government to declare world heritage properties (e.g., the Wet Tropics and Great Barrier Reef) are examples of legislation enacted in this manner.

Policies, agreements, legislation, and strategies for sustainability including the National Strategy for ESD (described earlier), the Intergovernmental Agreement on the Environment (ICAE), the National Forestry Agreement; and the *Sugar Industry Act 1999* (in partnership with state government) are also important at the national scale. Federal government portfolios have significant roles and budgets for natural resource management. Key ministries include Agriculture, Fisheries and Forestry Australia (AFFA) and Environment Australia (EA), which deal with many natural resource management issues including pollution, environmental impact assessment, and environmental issues of national significance (e.g., salinity). Another important federal natural resource management entity is the Australian Bureau of Agricultural and Resource Economics (ABARE), which investigates strategic economic and institutional issues facing rural industries such as the sugar industry. The federal government provides many funding arrangements and is a financial partner to a number of state government programs including: the National Heritage Trust (NHT) and associated programs (such as, Landcare, Bushcare, Rivercare, the Farm Forestry Program, the Fisheries Action Program and part of the National Wetlands Program).

Non-government arrangements at the federal level also include industry representative organisations such as the National Farmers Federation as well as research and development organisations partly funded by the federal Government (e.g., the Co-operative Research Centre (CRC) program).

• *State arrangements*

Constitutionally, the power to manage the environment and to control land-use rests with state governments in Australia. At the state level, the activities of the sugar industry are influenced by government agencies that manage the environment, natural resources, and primary industries (e.g., the sugar industry, fisheries, and forestry), land-use planning, and local government. This occurs through legislation, policies, plans, and strategies targeted at particular environmental issues or specific resources. Some of these arrangements are implemented directly by the state government; however, many are delegated to statutory bodies (such as, *River Improvement Trusts* and *Water Boards)* or local governments for implementation. In Queensland, government interpretations of ecologically sustainable development (ESD) are formalised in arrangements such as the *State Planning Policy for Good Quality Agricultural Land (SPPCQAL)* and *Integrated Catchment Management (ICM).*

At the state level, sugar industry planning is achieved through two principal planning mechanisms. The first is the *Sugar Industry Act 1999,* which sets out requirements for the assignment of lands for sugar-cane production and, in doing so, allows environmental impact to be considered prior to the allocation of land for cane production. The second major tool regulating Queensland land-use is the *Integrated Planning Act 1997.* It provides a framework for integrated planning and development assessment, so that developments, and their effects, are managed in ways that are ecologically sustainable. The Act provides mechanisms for local strategic land-use planning, and coordinates and integrates multiple development assessment processes (state, regional and local) at the local level. This Act can regulate new areas developed for sugar-cane. Land management in the sugar industry is achieved through voluntary codes of practice, property management planning, and land management practices.

• *Regional arrangements*

The number of regional initiatives and arrangements impacting the sugar industry is rising in Queensland. Despite the absence of a formal, regional government, institutional arrangements at this level include statutory authorities defined in legislation, such as the *Regional Consultative Groups* defined under the *Coastal Protection and Management Act 1995, Regional Planning Advisory Committees* defined in the *Integrated Planning Act 1997,* and *Negotiating Teams* defined in the *Sugar industry Act 1999.* They also include government-supported groups (such as Integrated Catchment Management groups), and non-government groups that arise to target particular issues (such as the Sunshine Coast Rural Landholders Association, Sunfish, and Regional Conservation Councils). These groups can develop a range of arrangements with varying degrees of influence and legal standing.

• *Local arrangements*

Although many planning and management arrangements that influence the sugar industry are developed at the state and federal level (and, more recently, the regional level), they look towards local government and local statutory groups for implementation. Local government has responsibility for land-use planning in Queensland, and consequently, many of the institutional arrangements developed at regional level (e.g., regional coastal management plans, regional land-use plans, integrated catchment management plans) are being implemented through local government planning schemes (e.g., Hinchinbrook Shire Council Planing Scheme). Additionally, other legislation (such as the *Environmental Protection Act 1994,* the *Fisheries Act 1994,* and the *River Improvement Trust Act 1940)* rely on the local government and local statutory groups, defined in those acts, to achieve their intent. Furthermore, local boards have responsibility for land-use planning for the sugar industry, as defined in the *Sugar Industry Act 1991* (Queensland Government 1991).

7.3 Institutional challenges for the sugar industry

In recent years, institutional arrangements have been highly criticised for their failure to deliver sustainable development. We have already established that the institutional arrangements in the sugar industry define stakeholder rights to, and roles and responsibilities for, sustainable resource use and management.

However, institutional arrangements provide their own challenges for the sugar industry. The sheer number of institutional arrangements which are relevant to sugar industry affairs is a serious challenge. Countless arrangements affect every aspect of the operation of the sugar industry, for example, growing cane, transport, milling, employment, marketing, selling and resource use and management. Similarly a broad array of institutions are relevant to sugar production e.g., grower representatives, milling representatives, marketing groups, government agencies, media, chambers of commerce, banks, and so on. The problem is that the various institutional arrangements affecting the sugar industry are not pursuing similar objectives at present. The challenge for the industry is to try to bring about coordination and integration of different types of institutions to:

- reduce or eliminate conflict (e.g., eliminate arrangements that directly contravene each other),
- improve the legibility of institutional arrangements by decreasing institutional complexity and improving communication on institutional arrangements,
- achieve desired outcomes in a balanced way, and
- otherwise create an environment where institutions enable, rather than constrain, the industry in achieving desired outcomes.

Similarly, as we have already identified, institutional arrangements occur at different spatial scales to address different kinds of issues. One of the challenges for the sugar industry is to make sure that conflicts between institutional arrangements at different scales are not the source of instability and conflict (e.g., economic instability, or conflict over resource use and management). If this is the case, the industry needs to create ways to bring about institutional changes that remove these conflicts.

Another key institutional challenge for the sugar industry relates to industry involvement and representation in government polic- making. Government policy processes predominantly use peak body representatives when developing and testing major policy. This approach may be useful for broad issues that affect the whole industry in a fairly consistent way and the national body can effectively represent the whole industry. But, we know that industry regions can vary significantly, so sometimes individual regions need to be directly involved in discussions and negotiations with the government on major policies. The underlying challenge is for regions to be sufficiently organised to engage in government policy processes. However, a spin-off of having effective regional organisation and representation processes is in being better able to undertake regional planning and being better able to negotiate with other regional stakeholders.

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Appendix 1. Databases for planning - examples from case study regions

In undertaking analysis for regional planning, one of the challenges is knowing what data are out there and in what forms. To illustrate the types of information available, we list the datasets that were collated for regional planning initiatives with the sugar industry on the Sunshine Coast and in the Herbert.

*List of datasets (coverages) in the Sunshine Coast spatial database (Source: **CSIRO, 2002b).***

Tilde (~) indicates an estimated scale.

COVERAGE THEME	DESCRIPTION	SCALE	CUSTODIAN
ADMINISTATIVE BOUNDARIES			
Cooloola Shire	Cooloola Shire boundary. Subset of DCDB.	1:50000	CoolSC
Maroochy Shire	Maroochydore Shire boundary.	1:50000	MSC
Maroochy Suburbs	Maroochydore suburb areas.	1:50000	MSC
Noosa Shire	Noosa Shire boundary.	1:50000	NSC
Study Area	Study area boundary for REG CSIRO Sunshine Coast integrated resource planning project for sugar industry.	1:50000	CSIRO
CENSUS			
1986 Census	1986 Census figures for Maroochydore Shire.	1:2500 to 1:250000	ABS
1991 Census	1991 Census figures for Maroochydore Shire.	1:2500 to 1:250000	ABS
1996 Census	1996 Census figures for Maroochydore Shire. This dataset is incomplete, not all data entered.	1:2500 to 1:250000	ABS
CLIMATE			
Average Annual Rainfall	Average annual rainfall surface for the Sunshine Coast and hinterland area.	1:250000	CSIRO CSE
Average Monthly Rainfall	Average monthly rainfall surface for the Sunshine Coast and hinterland area.	1:250000	CSIRO CSE
GEOLOGY			
Geology ~ Caboolture	Geology for the Caboolture area. Generated in 1994 for the Atlas of Natural Resources.	-1:250000	CSC
Geology ~ Caloundra	Geology for the Caloundra area.	-1:250000	Caloundra CC
HYDROLOGY			
Catchments	Water catchments in the Caboolture area.	-1:50000	CSC
Dam Catchments	Catchments for major (3) dams in the Maroochydore area.	-1:50000	MSC
Dams	Major (3) dams in the Maroochydore area.	-1:50000	MSC
Drainage	Drainage in the south-eastern part of the Caboolture Shire, excluding Bribie Island. Includes dams.	-1:25000	CSC
Floods ~ Caboolture	One in 100 year floods levels for the Caboolture River, Burpengary Creek, Six Mile Creek, Gympie Creek and Saltwater Creek.	-1:50000	CSC
Floods ~ Caloundra	Flood levels for the Caloundra City area.	1:100000	Caloundra CC

COVERAGE THEME	DESCRIPTIONN .	SCALE	CUSTODIAN
Floods ~ Noosa	One in 100 year flood levels in the Noosa area. Linework from raster source.	-1:100000	NSC
Hydrology ~ Maroochy	Hydrology in the Maroochydore area.	-1:100000	MSC
Hydrology ~ Noosa	Hydrology in the Noosa area. Includes rough linework for Mary River.	1:25000	NSC
Hydro250	Hydrology on the Gympie 1:250000 mapsheet.	1:250000	AUSLIG
Islands	Islands on the Gympie 1:250000 mapsheet.	1:250000	AUSLIG
Ocean area	Ocean mapp ng in the Noosa area. Linework not detailed.	1:25000	NSC
Open Water	Open water mapped for the Gympie 1:250000 mapsheet.	1:250000	AUSLIG
Open Water - Cooloola	Open water mapped for the Cooloola area.	-1:100000	CoolSC
Rivers	Rivers in the Caboolture area.	-1:100000	CSC
Rivers	Rivers in the Cooloola area. Main streams only.	-1:100000	CoolSC
Shorelines	Shorelines mapped for the Gympie 1:250000 mapsheet.	1:250000	AUSLIG
Subcatchments	Subcatchments mapped for the Maroochydore area.	-1:50000	MSC
IMAGES			
1979 Landsat MSS Imagery	12 September 1979 Landsat MSS Imagery for the Sunshine Coast.Systematic level 8 corrections applied.	57m pixel	ACRES
1979 Classified Landsat MSS Imagery	1979 Landsat MSS Imagery for the Sunshine Coast classified according to land cover by UQ, as consultants for CSIRO.	57m pixel	CSIRO
1988 Landsat TM Imagery	29 September 1988 Landsat MSS Imagery for the Maroochy, Mooloolah and entire Sunshine Coast areas.	25m pixel	ACRES
1988 Classified Landsat TM Imagery	1988 Landsat MSS Imagery for the Maroochy, Mooloolah and entire Sunshine Coast areas, classified for land cover by UQ, as consultants for CSIRO.	25m pixel	CSIRO
IMAGES			
1991 Landsat TM Imagery	2 July 1991 Landsat MSS Imagery for the Sunshine Coast.	25m pixel	ACRES
1991 Classified Landsat TM Imagery	1991 Landsat MSS Imagery for the Sunshine Coast area, classified for land cover by UQ, as consultants for CSIRO.	25m pixel	CSIRO
1997 Landsat TM Imagery	6 September 1997 Landsat MSS Imagery for the Maroochy, Mooloolah and entire Sunshine Coast areas.	25m pixel	ACRES
1997 Classified Landsat TM Imagery	1997 Landsat MSS Imagery for the Maroochy, Mooloolah and entire Sunshine Coast areas, classified for land cover by UQ, as consultants for CSIRO.	25m pixel	CSIRO
LANDFORM			
Biounit	Biounit mapping for Cooloola area. All biophysical units on which veg, landform and soils were based are shown.	-1:50000	CoolSC
Landform	Landform mapping for the Caboolture Shire area.	-1:100000	CSC
Landscape	Landscape mapping for the Caboolture Shire area. Generated in 1994 for the Atlas of Natural Resources.	-1:100000	CSC
Land Resource Units	Land resource and terrain units for Cooloola Shire. Generated in 1994 for the Atlas of Natural Resources.	-1:50000	CSC
LANDUSE			
Agri Land Suitability ~ Caboolture	Agricultural land suitability in the Caboolture area. General classes only.	-1:50000	CSC
Agri Land Suitability ~ Caloundra	Agricultural land suitability in the Caloundra area.	-1:50000	Caloundra CC

COVERAGE THEME	DESCRIPTION	SCALE	CUSTODIAN
Agri Land Suitability ~ Cooloola	Agricultural land suitability in the Cooloola area.	-1:50000	CoolSC
Agri Land Suitability - Moreton	Agricultural land suitability in the Moreton Sugar Mill area, which overlaps Maroochydore & Caloundra areas. Refer to the 1987 Caplin Report, (categs 1-6).	-1:25000	QDNR
Agri Land Suitability ~ Noosa	Agricultural land suitability in the Noosa area. Note: linework from raster source.	~1:25000	NSC
Land-use ~ Caloundra	Land-use mapping for the Caloundra City Council area.	-1:50000	Caloundra CC
Land-use ~ Maroochy	Land-use mapping for the Maroochydore Shire area.	-1:100000	QDNR
Land-use - Noosa	Land-use mapping for the Noosa Shire area.	1:25000	NSC
UMA - Noosa	Unique Mapp ng Areas for the Noosa Shire area. Includes geology, soil, slip hazard and land suitability ratings.	1:25000	NSC
LOCAL TIES			
Airports	Airports on the 1:250000 Gympie mapsheet.	1:250000	AUSLIG
Localities	Localities on the 1:250000 Gympie mapsheet.	1:250000	AUSLIG
Urban Areas	Urban areas located on the 1:250000 Gympie mapsheet.	1:250000	AUSLIG
Urban Areas ~ Cooloola	Urban areas mapped for the Cooloola Shire.	1:50000	CoolSC
PLANNING			
1993 Strategic Plan	1993 Strategic Land-use Plan for the Caboolture Shire.	1:50000	CSC
QLID			
QLID ~ Maroochy	Queensland Land Information Directory (QLID) for the . Maroochydore area	Various	QDNR
RAIL			
Railways ~ Cooloola	Railways in the Cooloola area.	1:50000	CootSC
Rail250	Railways mapped for the Gympie 1 -.250000 mapsheet.	1:250000	AUSLIG
Cane Tramways	Moreton mill cane tramways		
RELIEF			
Contours	Contours for the Caloundra City Council area. Interval: 5m.	1:5000	Caloundra CC
DEM ~ Caboolture	Digital elevation model data for the north Caboolture area. Point elevation data measured to the nearest metre.	-1:50000	CSC
DEM ~ Caloundra	Digital elevation model for the Caloundra area.	1:50000	Caloundra CC
Elevation250	Spot heights for the Gympie 1:250000 mapsheet.	1:250000	AUSLIG
Slope ~ Caboolture	Areas with slope > 1 in 6 mapped in the Caboolture area.	-1:100000	CSC
Slope deg ~ Caloundra	Degree slope mapped for the Caloundra area.	-1:50000	Caloundra CC
Slope % ~ Caloundra	Percentage slope mapped for the Caloundra area.	-1:50000	Caloundra CC
Slope - Cooloola	Slope classified into general classes for the Cooloola area.	-1:25000	CoolSC
Slope % ~ Nooosa	Percentage slope classified into general classes for Noosa.	-1:25000	NSC
Spot Heights	Spot heights for the Sunshine Coast area, excluding Caloundra.	1:25000	QDNR
Topography ~ Caloundra	Contours for the Caloundra 1:25000 mapsheet.	1:25000	QDNR
Topography ~ Coolooola	Contours & spot heights for Cooloola 1:25000 mapsheet.	1:25000	QDNR
Topography ~ Coolum	Contours & spot heights for Coolum 1:25000 mapsheet.	1:25000	QDNR
Topography ~ Maroochy	Contours St spot heights for Maroochy 1:25000 mapsheet.	1:25000	QDNR
Topography - Noosa	Contours & spot heights for Noosa 1:25000 mapsheet.	1:25000	QDNR
Topography - Teewah	Contours & spot heights for Teewah 1:25000 mapsheet.	1:25000	QDNR

COVERAGE THEME	DESCRIPTION	SCALE	CUSTODIAN
ROAD			
Road250	Roads mapped for the Cympie 1:250000 mapsheet.	1::250000	AUSLIG
Roads ~ Cooloola	Roads in the Cooloola Shire area.	1:50000	CoolSC
Roads ~ Sunshine Coast	Main roads in the Sunshine Coast area and inland.	1::250000	DMR
SOILS			
Acid Sulfate Soil Risk ~ Caboolture	Areas of potential acid sulfate soils in the Caboolture area. Generated by QDNR in 1998.	1:50000	QDNR
Acid Sulfate Soil Risk ~ Caloundra	Areas of potential and affected acid sulfate soils in the Caloundra area	1: 50000	Caloundra CC
Acid Sulfate Soil Risk ~ Sunshine Coast	Potential acid sulfate soils mapped along the coast from Noosa to the Gold Coast.	1: 50000	QDNR
Soils - Cooloola	General soil types mapped for the Cooloola area.	1: 50000	CoolSC
Soils and Land Suitability	Soils and land suitability of the Kenilworth-Conondale area	1: 50000	QDNR
SUGAR			
1997 Sugar-cane	1997 Sugar-cane assignment boundaries mapped for the Moreton Mill.	- 1 : 50000	MSM
1998 Sugar-cane	1998 Sugar-cane assignment boundaries mapped for the Moreton Mill.	- 1 : 50000	MSM
Land Suitability for Sugar-cane	Land suitability for cane in the Caloundra area.	- 1 : 50000	Caloundra CC
Land Suitability for Sugar-cane	Land suitability for cane across the Moreton Mill sugar district and surrounds.	1:100000	CSIRO
Land Suitability for Sugar-cane	Land suitability for sugar-cane in the Maroochydore area. Based on Capelin, 1987.	- 1 : 50000	MSC
Land Suitability for Horticulture	Land suitability for horticulture in the Maroochydore area. Based on Capelin, 1987 (includes classes 1 - 6).	- 1 : 50000	MSC
Moreton Sugar Mill Boundary	Boundary of the Moreton Sugar Mill cane area.	-1:250000	QDNR
Sugar-cane Extent	Extent of sugar-cane areas along the Sunshine Coast, 1995.	1: 100000	QDNR
Sugar Transportation Times	Analysis of sugar transportation times across the road network servicing the Moreton Mill district and surrounds.	1:100000	CSIRO
Sugar-cane Productivity	Sugar-cane productivity data for 1991 - 1999 for the Moreton Mill growing area. See data supply agreement for conditions.	na	CANECROWERS
TENURE			
DCDB ~ Caboolture	Digital cadastral database for the Caboolture Shire.	1: 50000	QDNR
DCDB ~ Caloundra	Digital cadastral database for Caloundra City.	1: 50000	QDNR
DCDB - Cooloola	Digital cadastral database for the Cooloola Shire.	1: 50000	QDNR
DCDB ~ Kilcoy	Digital cadastral database for the Kilcoy Shire.	1: 50000	QDNR
DCDB - Maroochydore	Digital cadastral database for the Maroochydore Shire.	1: 50000	QDNR
DCDB - Noosa	Digital cadastral database for the Noosa Shire.	1: 50000	QDNR
MSC Crown Land	Maroochydore Shire Council crown land.	1: 50000	MSC
MSC Land sub 5K	Land parcels smaller than 0.5ha for Maroochy Shire.	- 1 : 50000	MSC
MSC Owned Land	Maroochydore Shire Council owned land. Derived from MSC Zones.	1: 50000	MSC
MSC Trustee Land	Maroochydore Shire Council trustee land. Derived from MSC Zones.	1: 50000	MSC
MSC Zones	Maroochydore Shire Council land zoning.	1:50000	MSC

•W^ftmiiflfll—	DESCRIPTION '^:;S:--*.^^-,A-,-:.\.	SCALE	CUSTODIAN
National Parks - Caboolture	National Parks in the Caboolture Shire area.	-1:50000	CSC
State Forest ~ Caboolture	State forest in the Caboolture area. Subset of the DCDB.	1:50000	QDNR
State Forest ~ Maroochy	State forest in the Caboolture area. Subset of the DCDB	1:50000	QDNR
VEGETATION			
Bioprov nces	Bioregions and provinces for Queensland.	1:100000	QDoE/EPA
Estates	Estates are the QDoE protected areas for Queensland.	1:100000	QDoE
Forestry Plantations	Queensland's forestry plantations.	1:10000	QDPI
Old Growth	Old growth forest classes defined by the SEQ Old Growth Forest Assessment Project (1998)	1:100000	QDNR
Parks & Gardens	All the areas maintained by the Maroochy Council's Parks section.	- 1 : 25000	MSC
Pine Forests	Pine forests mapped for the Caloundra area.	-1:10000	CALOUNDRA CC
Forestry Plantations May 2000.	Public plantatons, predominantly softwood. Current to	1:10000	QDPI
Remnant Vegetation	Remnant vegetation mapped for the Caboolture area. Note, much of this mapping is now out of date.	-1: 25000	CSC
Remnant Vegetation	Remnant vegetation mapped for the Maroochy Shire. Veg type, veg community and veg disturbance are described.	-1:25000	MSC
Vegetation ~ Caloundra	Vegetation mapped for the Caloundra area. Olsen vegetation classification used.	-1:10000	CALOUNDRA CC
Vegetation ~ Caloundra	Vegetation mapping completed in 2001 for Caloundra City.	-1:10000	CALOUNDRA CC
Vegetation ~ Cooloola	Vegetation units mapped for the Cooloola Shire.	- 1 : 25000	CoolSC
Vegetation ~ Moreton	Vegetation mapped for the Moreton Mill and Maroochy areas, includes a veg value classification.	- 1 : 25000	MSC
Vegetation - Noosa	Vegetation mapped for the Noosa area.	1: 25000	NSC
Vegetation ~ Rainbow	Vegetation units mapped for the Rainbow Beach area.	-1:10000	CoolSC
Vegetation - Tin Can	Vegetation units mapped for the Tin Can Bay area.	-1:10000	CoolSC
Veg Units ~ Maroochy	Vegetation units mapped for the Maroochydore area. Point data. Complements the Moreton vegetation mapping.	-1:25000	MSC
VEGETATION CLEARING			
1995 Pre-Clearing	Pre-clearing Vegetation Survey and Mapping of the South-Eastern Queensland Biogeographic Region (1997)	1:100000	Qld Herb
1997 Remnant Veg	Remnant 1997 - Vegetation Survey and Mapping of the South-Eastern Qld Biogeographic Region (1997)	1:100000	Qld Herb

List of data sets (coverages) in the Herbert spatial database.

HRIC Data Listing

Custodia	Title	Abstract
Canegrowers		
	Rain Gauge Distribution	Distribution points for rain gauges in the lower Herbert River Catchment.
	1:10 000 Index	The indexl 0 coverage shows the boundaries of mapsheets at 1:10000.
	1:20 000 Index	The index20 coverage shows the boundaries of mapsheets at 1:20000.
	1:250 000 Index	The index250 coverage shows the boundaries of mapsheets at
	1:250 000 map grid (Queensland)	Index of 1:250000 mapsheets covering the whole of Queensland.

Custodia	Title	Abstract
	1:5 000 Index	The index5 coverage shows the boundaries of mapsheets at 1:5000.
	1:50 000 Index	The index50 coverage shows the boundaries of mapsheets at 1: 50000.
	Abergowrie forest compartments	Abergowrie forest compartments
	Annotation - Hydrological features	Annotation indicates the names of major hydrological reference features. This dataset was created for map display and interpretation
	Annotation 1:10 000	Annotation indicates the names of major reference features, such as towns, roads and mountains. This dataset was created for map display and interpretation purposes.
	Annotation 1:100 000	Annotation indicates the names of major reference features, such as towns, roads and mountains. This dataset was created for map display and interpretation purposes.
	Annotation 1:25 000	Annotation indicates the names of major reference features, such as towns, roads and mountains. This dataset was created for map display and interpretation purposes.
	Annotation 1:250 000	Annotation indicates the names of major reference features, such as towns, roads and mountains. This dataset was created for map display and interpretation purposes.
	Annotation 1:50 000	Annotation indicates the names of major reference features, such as towns, roads and mountains. This dataset was created for map display and interpretation purposes.
	aquifer50	Line indicating the position of aquifiers on the Herbert River floodplain. Aquifiers are labelled as S1 to S4.
	b_met_rh	
	b_met_ws	
	catch 100	1:100000 catchment boundaries
	catch50	Water catchment boundaries for the lower Herbert River Catchment.
	coast_area	Land (including upper catchments) and sea separation between Rollingstone and
	coast50	The coastline extending from the Herbert River catchment to Cairns
	coastareageo	
	Groundwater observation	Location of groundwater observation bores which monitor both groundwater quality and groundwater levels.
	herb_bnd50	Herbert River catchment boundary.
	herb_coast50	The coastline of the Herbert River Catchment.
	Herbert River	Location of the Herbert River
	hinch_island	Outline of Hinchinbrook Island
	hydro50	Stream work for the Herbert River Catchment. This coverage contains all linework from the 1: 50 000 map sheets
	Hydrological features of the Herbert River Catchments	Main hydrolocogial features clipped out of the Herbert River Catchment area and most often used for cartographic presentations
	isohyet500	Mean annual rainfall (mm).
	isopleth_mga	Mean annual rainfall (mm).
	lan_com	Lannercost forest compartments
	Land Cover 1943	Land cover was mapped for the lower Herbert River catchment, North Queensland using 1:25000 aerial photography and Spot imagery at a scale of 1:100000. Mapping was completed for the year 1943. This key dataset has enabled the detailed investigation of spatial and temporal land use change in the Lower Herbert catchment.
	Land Cover 1961	Land cover was mapped for the lower Herbert River catchment, North Queensland using 1:25000 aerial photography and SPOT imagery at a scale of 1:100000. Mapping was completed for the year 1961. This key dataset has enabled the detailed investigation of spatial and temporal land use change in the Lower Herbert catchment.
	Land Cover 1970	Land cover was mapped for the lower Herbert River catchment, North Queensland using 1:25000 aerial photography and SPOT imagery at a scale of 1:100000. Mapping was completed for the year 1977. This key dataset has enabled the detailed investigation of spatial and temporal land use change in the Lower Herbert catchment.
	Land Cover 1977	Land cover was mapped for the lower Herbert River catchment, North Queensland using 1: 25000 aerial photography and SPOT imagery at a scale of 1:100000. Mapping was completed for the year 1970. This key dataset has enabled the detailed investigation of spatial and temporal land use change in the Lower Herbert catchment.

Custodia	Title	Abstract
	Land Cover 1988	Land cover was mapped for the lower Herbert River catchment, North Queensland using 1:25000 aerial photography and Spot imagery at a scale of 1:100000. Mapping was completed for the year 1988. This key dataset has enabled the detailed investigation of spatial and temporal land use change in the Lower Herbert catchment.
	Land Cover 1992	Land cover was mapped for the lower Herbert River catchment, North Queensland using 1:25000 aerial photography and Spot imagery at a scale of 1:100000. Mapping was completed for the year 1992. This key dataset has enabled the detailed investigation of spatial and temporal land use change in the Lower Herbert catchment.
	Land Cover 1993	Land cover was mapped for the lower Herbert River catchment, North Queensland using 1:25000 aerial photography and Spot imagery at a scale of 1:100000. Mapping was completed for the year 1993. This key dataset has enabled the detailed investigation of spatial and temporal land use change in the Lower Herbert catchment.
	Land Cover 1994	Land cover was mapped for the lower Herbert River catchment, North Queensland using 1: 25000 aerial photography and Spot imagery at a scale of 1:100000. Mapping was completed for the year 1994. This key dataset has enabled the detailed investigation of spatial and temporal land use change in the Lower Herbert catchment.
	Land Cover 1995	Land cover was mapped for the lower Herbert River catchment, North Queensland using 1:25000 aerial photography and Spot imagery at a scale of 1:100000. Mapping was completed for the year 1995. This key dataset has enabled the detailed investigation of spatial and temporal land use change in the Lower Herbert catchment.
	Land Cover 1996	Land cover was mapped for the lower Herbert River catchment, North Queensland using 1:25000 aerial photography and Spot imagery at a scale of 1:100000. Mapping was completed for the year 1996. This key dataset has enabled the detailed investigation of spatial and temporal land use change in the Lower Herbert catchment.
	landuse50	Landuse types in the Herbert River Catchment
	locn	Names of major places and features collected specifically to cover the Herbert River catchmnet.
	lstrm_qual50	Stream water quality sampling points in the Herbert River Catchment.
	Manual rainfall station names and locations	Manual rainfall station names and locations
	Pre-European vegetation	This estimation of pre-European vegetation is based on an indicative correlation between soil type and vegetation cover.
	qldstate	Qld state border and Herbert river catchment boundary.
	Rainfall Surface - Apr	These raster surfaces were created using ANUSPLIN software which used rainfall station statistics and digital elevation data to interpolate the surfaces. Surfaces were generated for mean monthly rainfall and for the mean annual rainfall.
	Rainfall Surface - Aug	These raster surfaces were created using ANUSPLIN software which used rainfall station statistics and digital elevation data to interpolate the surfaces. Surfaces were generated for mean monthly rainfall and for the mean annual rainfall.
	Rainfall Surface - Dec	These raster surfaces were created using ANUSPLIN software which used rainfall station statistics and digital elevation data to interpolate the surfaces. Surfaces were generated for mean monthly rainfall and for the mean annual rainfall.
	Rainfall Surface - Feb	These raster surfaces were created using ANUSPLIN software which used rainfall station statistics and digital elevation data to interpolate the surfaces. Surfaces were generated for mean monthly rainfall and for the mean annual rainfall.
	Rainfall Surface - Jan	These raster surfaces were created using ANUSPLIN software which used rainfall station statistics and digital elevation data to interpolate the surfaces. Surfaces were generated for mean monthly rainfall and for the mean annual rainfall.
	Rainfall Surface - July	These raster surfaces were created using ANUSPLIN software which used rainfall station statistics and digital elevation data to interpolate the surfaces. Surfaces were generated for mean monthly rainfall and for the mean annual rainfall.
	Rainfall Surface - June	These raster surfaces were created using ANUSPLIN software which used rainfall station statistics and digital elevation data to interpolate the surfaces. Surfaces were generated for mean monthly rainfall and for the mean annual rainfall.
	Rainfall Surface - Mar	These raster surfaces were created using ANUSPLIN software which used rainfall station statistics and digital elevation data to interpolate the surfaces. Surfaces were generated for mean monthly rainfall and for the mean annual rainfall.
	Rainfall Surface - May	These raster surfaces were created using ANUSPLIN software which used rainfall station statistics and digital elevation data to interpolate the surfaces. Surfaces were generated for mean monthly rainfall and for the mean annual rainfall.

1 Custodia	Title	Abstract
	Rainfall Surface - Nov	These raster surfaces were created using ANUSPLIN software which used rainfall station statistics and digital elevation data to interpolate the surfaces. Surfaces were generated for mean monthly rainfall and for the mean annual rainfall.
	Rainfall Surface - Oct	These raster surfaces were created using ANUSPLIN software which used rainfall station statistics and digital elevation data to interpolate the surfaces. Surfaces were generated for mean monthly rainfall and for the mean annual rainfall.
	Rainfall Surface - Sept	These raster surfaces were created using ANUSPLIN software which used rainfall station statistics and digital elevation data to interpolate the surfaces. Surfaces were generated for mean monthly rainfall and for the mean annual rainfall.
	rainfstn	Location of rainfall stations in the Lower Herbert River Catchment.
	strm_guage50	Stream height gauge locations in the Herbert River catchment
	temp250	Template features; eg major roads & streams for the Herbert River Catchment.
	ustrm_qual50	Stream water quality sampling points in the Herbert River Catchment.
	Waterways (Upper Herbert River Catchment)	Hydrological features in the upper Herbert river catchment.
	Weather station names and locations (CSIRO)	CSIRO automat c weather station names and locations
	y_rain	
CSR Sugar Mills Ltd		
	"All Merged" 1996 Caneblock layer	All the 1996, individually mapped farms merged into a single shape file.
	2000 Railline -Full attributes	Fully attributed version of the 2000 railline
	CSR Property	DCDB parcels owed by CSR
	CSR Railline (original ArcInfo Coverage)	CSR Herbert River Mills district cane rail line. Includes sidings, bridges and culverts.
	CSR Soils Aug 2002	CSR Soils data - mapped within caneblocks only. Raw dataset
	Flood Damage to Railline	Point locations of flood damage to CSRs railline - points hotlink to photos of damage. Hotlinks may not be completed.
	Macknade Derailments 1998	Point locations of derailments in the Macknade mill area.
	Macknade Derailments 1999	Points indicate places where derailments occurred throughout the 1999 season for the Macknade mill district.
	Macknade Derailments 2000	Location of derailments in the Macknade mill district
	Macknade Derailments 2001	Point locations of derailments in the Macknade mill district.
	More Victoria Derailments	More derailments in the Victoria mill district during 2000.
	More Victoria Derailments	Additional derailment points in the Victoria mill district.
	Plane Creek Railline	Plane Creek mill railline
	Plane Creek Railline Points	Points on the plane creek rattling
	Radio Survey Grids - Abergowrie (UHF)	UHF Radio signal strength grid along railline in the Abergowrie mill
	Radio Survey Grids - Abergowrie (VHF)	VHF Radio signal strength grid along railline in the Abergowrie mill
	Radio Survey Grids - Four Mile (UHF)	UHF Radio signal strength grid along railline in the Four Mile mill
	Radio Survey Grids - Four Mile (VHF)	VHF Radio signal strength grid along railline in the Four Mile mill district.
	Radio Survey Grids - Hawkins Creek (UHF)	UHF Radio signal strength grid along railline in the Hawkins Creek mill
	Radio Survey Grids - Hawkins Creek (VHF)	VHF Radio signal strength grid along railline in the Hawkins Creek mill
	Radio Survey Grids - Lucinda(UHF)	UHF Radio signal strength grid along railline in the Lucinda mill district.
	Radio Survey Grids - Lucinda(VHF)	VHF Radio signal strength grid along railline in the Lucinda mill district.
	Radio Survey Grids - Macknade (UHF)	UHF Radio signal strength grid along railline in the Macknade mill

Custodia	Title	Abstract
	Radio Survey Grids - Macknade (VHF)	VHF Radio signal strength grid along railline in the Macknade mill
	Radio Survey Grids - Mutarnee (UHF)	UHF Radio signal strength grid along railline in the Mutarnee mill
	Radio Survey Grids - Mutarnee (VHF)	VHF Radio signal strength grid along railline in the Mutarnee mill
	Radio Survey Grids - Stone River (UHF)	UHF Radio signal strength grid along railline in the Stone River mill
	Radio Survey Grids - Stone River (VHF)	VHF Radio signal strength grid along railline in the Stone River mill
	Radio Survey Points - Abergowrie	Radio signal strength survey points along railline in the Abergowrie mill district. Records signal strength for both UHF and VHF.
	Radio Survey Points - Four	Radio signal strength survey points along railline in the Four Mile mill district. Records signal strength for both UHF and VHF.
	Radio Survey Points - Hawkins	Radio signal strength survey points along railline in the Hawkins Creek mill district. Records signal strength for both UHF and VHF.
	Radio Survey Points - Lucinda	Radio signal strength survey points along railline in the Lucinda mill district. Records signal strength for both UHF and VHF.
	Radio Survey Points - Macknade	Radio signal strength survey points along railline in the Macknade mill district. Records signal strength for both UHF and VHF.
	Radio Survey Points -	Radio signal strength survey points along railline in the Mutarnee mill district. Records signal strength for both UHF and VHF.
	Radio Survey Points - Stone River	Radio signal strength survey points along railline in the Stone River mill district. Records signal strength for both UHF and VHF.
	Railline 2000 - Partially Attributed	2000 Railine with selected attributes.
	Railline points	Railline point features (culverts, turn-outs, signs, etc.).
	Railline Siding	Railline sidings.
	Soil Sampling Points (CSR)	Soil sampling points for CSR soil survey
	Soils (CSR) with descriptions	CSR Soils data - mapped within caneblocks only. Raw dataset with soil type name linked to the soil code
	Tonnes Harvest by CSR Herbert River Mills 2000	Tonnes harvested by subblock for both mill districts in 2000.
	Tonnes Per Siding	Preliminary tonnes per siding
	Transport Areas	Boundaries of each of the transport areas for the Herbert River Mills
	Victoria Derailments 1999	Points indicate where derailments occurred throughout the 1999
	Victoria Derailments 2000	Derailments points in the Victoria mill district.
	Victoria Derailments 2001	Point locations of derailments in the Victoria mill district.
Environmental Protection Agency		
	Bioregions and Provinces of Queensland - Version 3	Bioregions are defined by bioregional provinces, interpreted from various source data. The Bioregions and Provinces of Queensland - Version 3.0 coverage (bioprov) is a non-homogeneous dataset with variation in spatial precision and interpretive method. The Arc/Info coverage consists of regions defined in the interim bioregionalisation of Australia (IBRA) and the 13 bioregions defined in the report The Conservation Status of Queensland's Bioregional Ecosystems (Sattler and Williams) - draft, (bioprov.ibra and bioprov.doe)
	Canopy Gaps (API Polygons)	API cover delineating canopy gaps
	Clement State Forest	Images cover Tumulla Beach/Rollingstone area.
	Coastal Landscapes of Queensland	The coverage was part of a study to investigate the scenic resources of the landscape of the entire Queensland coast. The primary focus of the study was the visual experience i.e. the landscape that is seen and experienced. Landscape in this context refers primarily to the visual appearance of the land, including its shape, form and colour.
	Coastal Management Control	This layer contains the boundaries for the Coastal Management Control

Custodia	Title	Abstract
	District (CMCD) Boundaries	Districts of Queensland. It consists of arcs and polygons that were entered by comparing gazetted boundaries on official cadastral charts with DCDB boundaries. There are 25 Coastal Management Control Districts along the Queensland Coast. Under the Beach Protection Act 1968, a Coastal Management Control District is "a part of the coast that is declared or deemed to be declared by the Governor in Council upon the recommendation of the Beach Protection Authority to be a coastal management control district". The Beach Protection Authority has an interest in those areas of the coast that are covered by sections 41, 44, 45 and 47 of the Beach Protection Act 1968.
	Conservation areas	Conservation areas for the Herbert River catchment.
	Cultural Heritage National Estate lines, SEQ	This is one of three layers (dots, lines, polygons) which maps the places identified by the Cultural Heritage team, Forest Assessment Unit, Dept of Environment and Heritage, as being of National Estate significance. The identification and assessment was undertaken over1997 - 98 as part of the Comprehensive Regional Assessment (CRA) phase of the SEQ Biogeographic region Regional Forest Agreement (RFA) project. Detailed citations for each place can be found in the Cultural Heritage - SEQ Bioregion forested areas Non-indigenous Places Inventory Database (see Cultural Heritage Branch, EPA).
	Cultural Heritage National Estate points, SEQ	These are the places identified by the Cultural Heritage team, Forest Assessment Unit, Dept of Environment and Heritage. The identification and assessment was undertaken over 1997 - 98 as part of the Comprehensive Regional Assessment (CRA) phase of the SEQ Biogeographic region Regional Forest Agreement (RFA) project. Detailed citations for each place can be found in the Cultural Heritage - SEQ Bioregion forested areas Non-indigenous Places Inventory Database (contact Cultural Heritage Branch - EPA).
	Cultural Heritage National Estate polygons, SEQ	This is one of three layers (dots, lines, polygons) which maps the places identified by the Cultural Heritage team, Forest Assessment Unit, Dept of Environment and Heritage, as being of National Estate significance. The identification and assessment was undertaken over1997 - 98 as part of the Comprehensive Regional Assessment (CRA) phase of the SEQ Biogeographic region Regional Forest Agreement (RFA) project. Detailed citations for each place can be found in the Cultural Heritage - SEQ Bioregion forested areas Non-indigenous Places Inventory Database (see Cultural Heritage Branch, EPA).
	Designated Landscape Areas for Aboriginal Heritage	Designated Landscape Area (DLA) boundaries created from DCDB and other sources in some cases. Dataset consists of three coverages: DLA1 - contains land parcels that contain a DLA DLA2 - contains the actual boundaries of the DLAs (Boundaries do not always conform to the DCDB) DLA3 - contains DCDB parcels surrounding each DLA and several text containing information on each DLA: BLAK-DLA.TXT - Information for Blacks Palace DLA GRAN-DLA.TXT - Information for The Granites DLA MORV-DLA.TXT - Information for Morven DLA STAN-DLA.TXT - Information for Stanbroke Pastoral Development DLA WALL-DLA.TXT - Information for Wallaroo DLA GRES-DLA.TXT - Information for Gresley Pastoral Holdings DLA TOOR-DLA.TXT - Information for Toorbul Point Bora Ring DLA GATT-DLA.TXT - Information for Gatton Rock Art Site DLA MERI-DLA.TXT - Information for Meringandan DLA
	Directory of Important Wetlands Database	Wetland locations for Queensland wetlands described in Directory of Important Wetlands, 2nd Edition, ANCA 1996 by Wetland Inventory Team, Northern Region, EPA.
	Directory of Important Wetlands Database	Wetland locations for Queensland wetlands described in Directory of Important Wetlands, 2nd Edition, ANCA 1996 by Wetland Inventory Team, Northern Region, DoE.
	Drainage (Benlomand)	Drainage features.
	Drainage (Bluewater)	Drainage features.
	Drainage (Burdekin)	Drainage features.
	Drainage (Cardwell)	Drainage features.
	Drainage (Halifax Bay)	Drainage features.

Custodia	Title	Abstract
	Drainage (Ingham)	Drainage features.
	Drainage (Lower Herbert R ver Catchment)	Drainage coverage for the Lower Herbert River Catchment.
	Drainage (Mount Fox)	Drainage features.
	Drainage (Mount Graham)	Drainage features.
	Drainage (Mount Spec)	Drainage features.
	Drainage (Oakhills)	Drainage features.
	Drainage (Paluma)	Drainage features.
	Drainage (Rollingstone)	Drainage features.
	Drainage (Wallaman)	Drainage features.
	Dugong Protection Areas	On the 14th August 1997 the federal and Queensland Governments announced measures to save dugongs in the southern Great Barrier Reef and Harvey Bay regions. Central to these measures was the establishment of a system of dugong protection areas in these regions. The Areas are declared in legislation under the Queensland Nature Conservation Act 1992. Two types of protection areas were established: Zone A has more stringent controls over netting practices. Foreshore set nets and offshore set and drift nets are prohibited in most Zone A protection areas. In Zone B mesh netting is perm tted but with restrictions on the type, size and location of nets, and other requirements.
	Ecological maturity and forest disturbance areas	API coverage delineating ecological maturity and disturbance of forest
	Erosion Prone Areas For Far North & SE Queensland	The Erosion Prone Areas Project for Far North Queensland have been developed to determine the extent of the Erosion Prone Areas along the Coastline between; (1) Cardwell/|ohnstone LGA boundary South to Hinchinbrook/Thuringowa LGA Boundary. (2) From the Bloomfield River (Cook/Douglas LGA Boundary) to the Cardwell/johnstone LGA Boundary.
	Faunal habitats in the Lower Herbert River catchment.	Faunal habitats in the Lower Herbert River catchment.
	Field validated Air Photo Interpreted polygons	Field validated air photo interpreted polygons
	Grazed Areas (API Polygons)	API cover delineating grazed areas
	Koala Coast State Planning Policy (SPP 1/97: Conservation of Koalas in the Koala Coast)	The State Planning Policy addresses planning issues concerning the conservation of koalas and their habitat in the Koala Coast. This dataset contains the boundaries of the following three areas: Koala Conservation area, Other major habitat and Balance area.
	Logged and Grazed covers combined (API Polygons)	API cover combined with logging cover and grazing cover
	Logged Areas (API Polygons)	API cover delineating logged areas
	Mahogany Glider Conservation Plan 1999-2003 Habitat & Critical Habitat	Spatial representation of Mahogany Glider habitat and critical habitat as delineated in the DRAFT Mahogany Glider Conservation Plan 1999-
	Mahogany Glider Conservation Plan 1999-2003 Habitat & Critical Habitat	Spatial representation of Mahogany Glider habitat and critical habitat as delineated in the DRAFT Mahogany Glider Conservation Plan 1999-
	Mahogany Glider habitat	Spatial representation of Mahogany Glider habitat as delineated on the 1998 Draft Mahogany Glider Conservation Plan (Hinchinbrook Shire Council)
	Mangrove distribution in the Lower Herbert River	Mangrove distribution in the Lower Herbert River Catchment.
	Nature Refuges and Coordinated Conservation Areas (Version 4.0)	Nature Refuges are part or whole lot on plan and are gazetted on the basis of an agreement between the government and private land owner. Boundaries following creeks or irregular boundaries are digitised. DCDB parcels form the basis for the nature refuges.
	Pre-clearing vegetation survey & mapping	Vegetation mapping on a 1:250,000 map sheet basis, based on surveys of vegetation communities. Related polygon coverages include: pre-clearing vegetation, 1995/1997/1999 remnant vegetation, landcover and survey sites for the region. Other relevant coverages include: point coverages of survey traverses and detailed survey sites for the map sheet. Complete site data are stored in the Queensland Herbarium CORVEG database. National Vegetation Information System - NVIS Audit

Custodia	Title	Abstract
	Preliminary Draft Biodiversity Planning Assessments for the Southeast Queensland Bioregion (Version 2.1)	Biodiversity planning assessments in Queensland are based on a hierarchical framework described in Sattler, P.S. and Williams, R.D. (eds) (1999), The Conservation Status of Queensland Bioregional Ecosystems. This has been used to develop a state, regional and local biodiversity planning approach known as the Common Classification System (CCCS) as described in Chenoweth Environmental Planning St Landscape Architecture, Draft Common Conservation Classification System for Western Subregional Organisation of Councils (August2000). This approach develops a standardised methodology for defining areas of nature conservation value and addresses biodiversity at scales needed for regional and local planning. It is based on the use of the best available information at the time, which in the most part, is data derived from the EPA Queensland Herbarium vegetation and regional ecosystem mapping program. The diagnostic criteria used to define conservation value included Essential Habitat for 'At Risk' Species, Ecosystem Value, Remnant Size Relative Size of Ecosystem, Integrity, Community Diversity and Context and Connection. Supplementary criteria using an expert panel are also being
	Protected Areas	Polygons and protected area attributes of parcels of land in National Parks, National Parks (Scientific), Conservation Parks and Resources Reserves, gazetted under the Nature Conservation Act 1992.
	Ramsar Sites of Queensland	The Convention on Wetlands of International Importance was the first modern inter-governmental treaty between nations aiming to conserve natural resources. The signing of the Convention took place in 1971 in the small Iranian town of Ramsar (since then, it has taken the common name of the Ramsar Convention). Australia was the first nation to become a Contracting Party to the Convention.
	Remnant Vegetation Survey and Mapping	Vegetation mapping on a 1:250,000 map sheet basis, based on surveys of remnant vegetation communities and remnant regional ecosystems (REs). Set of polygon coverages in well-defined themes: remnant vegetation and remnant REs. A legend describing the map units was developed from the data collected at the detailed (tertiary) survey sites. Complete site data are stored in the Queensland Herbarium CORVEC database. Other relevant coverages include: point coverages of survey traverses (quaternary sites) and tertiary survey
	Rivers and creeks of the Lower Herbert River	Lower Herbert River Catchment with associated rivers and creeks.
	Roads (From SUP Vegetation Mapping)	Roads derived from unknown source. Acquired from NR&M Mareeba
	State Marine Parks of Queensland - Version 2.1	Polygons and attributes of the State Marine Parks of Queensland (including management areas and zoning provisions), gazetted under the Marine Parks Act 1982.
	Sun spot affected areas (API Polygons)	API cover delineating sun spot affected areas
	Topography (Benlomand)	Topography features.
	Topography (Bluewater)	Topography features.
	Topography (Burdekin)	Topography features.
	Topography (Cardwell)	Topography features.
	Topography (Halifax Bay)	Topography features.
	Topography (Ingham)	Topography features.
	Topography (Mount Fox)	Topography features.
	Topography (Mount Graham)	Topography features.
	Topography (Mount Spec)	Topography features.
	Topography (Oakhills)	Topography features.
	Topography (Paluma)	Topography features.
	Topography (Rollingstone)	Topography features.
	Topography (Wallaman)	Topography features.
	Tracks (Clemant State	Tracks/Roads in the Clement State Forest area
	Vegetation and Landuse classes.	Landuse and vegetation cover has been classified into 47 different classes with 37 of these refering to vegetation type. Included in the vegetation clsses is an indication of degradation.
	WildNet	WildNet is a database of the taxonomy and distribution of Queensland's plants and animals. It also contains textual information on the conservation status, management and ecology of these species.

Custodia	Title	Abstract
Ceoscience Australia		
	aero_pts	Part of the CeoData Topo-250k Series 2 Topographic dataset.
	Auslig Framework 2.5M topographic data - AUS_ FRAMEWORK_2500K (Australian States)	AUS_FRAMEWORK_2500K delimits the boundary of the digital data in each tile and provides a common reference framework for themes within TOPO-2.5M coastal tiles by depicting the coastline, sea and offshore islands. Contents of AUS_FRAMEWORK_2500K: polygon representation of
	Auslig road 250k geodata -	QLD_ROAD_250K_PT depicts those road bridges that are located on Queensland roads which are not of sufficient length to be represented QLD_ROAD_250K_PT as polylines. (The longer bridges are depicted in the QLD_ROAD_250K_UNE dataset) Content of QLD_ROAD_250K_PT: point representation, road name, road classification, road formation (eg sealed), national route number, state route number, Auslig data quality pointer & unique feature
	Auslig road 250k geodata (Upper Catchment)	QLD_ROAD_250K_LINE depicts Australian routes for the movement of vehicles, people etc. Included terms are vehicle track, highway, tollway and freeway. Road bridge and road tunnel features are also depicted in this dataset, depending on length. (Otherwise depicted in AUS_ROAD_10M_LINE:polyline representation, road feature type (i.e. road, bridge), road name, road classification, road formation (e.g. sealed), national route number, state route number, Auslig data quality pointer & unique feature identifier.
	Australian Maritime Boundaries Information System (AMBIS) 2001	AMBIS 2001 is a dataset depicting the limits of Australia's maritime jurisdiction as set out under UNCLOS and relevant domestic legislation. To this extent, AMBIS 2001 provides a digital representation of the outer limit of the 12 nautical mile territorial sea, the 24 nautical mile contiguous zone and the 200 nautical mile Australian Exclusive Economic Zone, as well as, the three nautical mile coastal waters. Where Australia has agreements with neighbouring countries these treaty lines are also included in the data. Australia's maritime boundaries are computed from the territorial sea baseline which has been mapped by the National Mapping Division around the entire Australian coastline. The territorial sea baseline is included in the product to provide users with a clear indication of the origin of the maritime boundaries. It should be noted that the territorial sea baseline supplied with the product is not intended to be mapping data and only contains features relevant to maritime boundary determination. It is not intended to be an accurate definition of the line of Lowest Astronomical Tide around the coast of Australia. The AMBIS 2001 data includes quality attributes which provide detailed information about the source material used to construct each segment of the territorial sea baseline and the derived boundaries. The origin of the maritime boundaries can also be referenced from the base points which generate those boundaries and which are also included in the product. Other maritime boundaries contained in the product include the Adjacent Area boundaries, the Coral Sea Territory and the various treaty boundaries. These treaties have generally limited Australia's exclusive economic zone and/or seabed boundary to less than 200 nautical miles.
	Australian States (Topo-250k Series 2)	Part of the GeoData Topo-250k Series 2 Topographic dataset. state & territory boundaries.
	bldg_pts	Part of the CeoData Topo-250k Series 2 Topographic dataset.
	blt_up_areas	Part of the CeoData Topo-250k Series 2 Topographic dataset.
	contours	Part of the CeoData Topo-250k Series 2 Topographic dataset.
	drainage	Part of the CeoData Topo-250k Series 2 Topographic dataset.
	Kennedy Highway (Upper Herbert River Catchment)	Subset of QLD„ROAD_250K_LINE depicting the location of the Kennedy Highway in the Upper Herbert River Catchment
	localities	Part of the CeoData Topo-250k Series 2 Topographic dataset.
	marine facilities	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	morphology	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	navigation	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	offshore	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	pipelines	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	powerlines	Part of the CeoData Topo-250k Series 2 Topographic dataset.
	rail	Part of the CeoData Topo-250k Series 2 Topographic dataset.

Custodia	Title	Abstract
	relief_areas	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	reserve areas	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	road	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	security areas	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	spot_hgts	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	survey_marks	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	utilities	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	vegetation	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	waterbodies	Part of the GeoData Topo-250k Series 2 Topographic dataset.
	waterpoints	Part of the GeoData Topo-250k Series 2 Topographic dataset.
Cirrigun Aboriginal Corporation		
	Land parcels with known Cultural Heritage value	Included land parcels are known to contain at least one site of cultural heritage value. Sites may exist on unmarked parcels. Inquires regarding specific parcels of land should be directed to Girringun Aboriginal Corporation to confirm the absence or presence of sensitive
| Great Barrier Reef Marine Park Authority		
	10 Metre Isobaths	Isobaths derived from a depth model at 10m intervals. The isobaths are estimates of the true isobaths and will be erroneous where the original depth model is not accurate. Interpolation from the depth model was via the lattice contour function in ARCINFO, followed by some manual editing. The isobaths are less accurate than recent nautical charts. They are a derived dataset and should be re-generated when the depth model of the GBR is revised. Refer to Lewis, 2001,re . the depth model from which the isobaths were derived.
	100 Metre Isobaths	Isobath contours derived from the depth model - 100m intervals
	Backshore Flats	Selected Backshore flats, claypans and marine swamps along the Queensland coast immediately adjacent to the Great Barrier Reef World Heritage Area
	Bioregions of the Great Barrier Reef	Reefs, Great Barrier Reef, Reef Habitat, Non-Reef Habitat, Reef and Non-Reef Bioregions
	Boundaries of the Great Barrier Reef Marine Park	Boundary of the Great Barrier Reef Marine Park, with internal Marine Park section boundaries.
	Catchment(s) adjacent to GBRMP	General coverage of Catchments/River Basins adjacent to or flowing into the Great Barrier Reef World Heritage Area.
	Coral Cays on the Great Barrier Reef	Coral Cay features on the Great Barrier Reef, within the Great Barrier Reef World Heritage Area
	Drying/Tidal Coral Reef Area	Tidal, Drying or Emergent reef areas of major CORAL REEF structures within the Great Barrier Reef World Heritage Area; details those reef areas which may be submerged or exposed during tidal fluctuations
	Dugong Protection Area Great Sandy Strait.	Gazetted Dugong Protection Areas along the Queensland Coast from Hinchinbrook to
	Foreshore flats along the Queensland coast within and immediately adjacent to the Great Barrier Reef World Heritage Area	Foreshore flats along the Queensland coast within and immediately adjacent to the Great Barrier Reef World Heritage Area
	Great Barrier Reef Marine Park Zoning	Federal Marine Park Zones within the Great Barrier Reef World Heritage Area.
	Islands within the Great Barrier Reef Region	Islands within the Great Barrier Reef Region; Island boundaries are intended to represent a mean of MHW and MLW, but are more closely related to HAT as they encompass no mangrove features
	Major CORAL REEFS within the Great Barrier Reef World Heritage Area	Major CORAL REEF structures within the Great Barrier Reef World Heritage Area as defined by the reef shoal edge.

Custodia	Title	Abstract
	Major Mangrove stands within and immediately adjacent to the Great Barrier Reef World Heritage Area	Major Mangrove stands within and immediately adjacent to the Great Barrier Reef World Heritage Area
	Queensland Built-Up Areas	Selected Built-Up Areas along the Queensland coastline adjacent to the Great Barrier Reef Marine Park.
	Rocks within the Great Barrier Reef Region	Rocks within the Great Barrier Reef Region.
	The Coastline of Queensland	Queensland Coastline from QLD/NSW border to QLD/NT Border
	World Heritage Area -	Boundary of the World Heritage Area (WHA) within and immediately adjacent to the relative to GBR Great Barrier Reef Marine Park (GBRMP); Marine segments of WHA boundary follows GBRMP boundary; Coastal segments of WHA boundary follow Queensland coast from Baffle Creek in the south to Cape York in the north, but excluding all rivers, creeks, estuaries, harbours and smaller embayments.
Herbert Cane Productivity Services Ltd.		
	I m CBMP Orthophotography	This imagery was collected to provide an accurate farm mapping base/backdrop for cane block mapping in the lower Herbert River. Pixel size = 1 m
	2m CBMP Orthophotography	This imagery was collected to provide an accurate farm mapping base/backdrop for cane block mapping in the lower Herbert River catchment. Pixel size = 2m
	5m CBMP Orthophotography	This imagery was collected to provide an accurate farm mapping base/backdrop for cane block mapping in the lower Herbert River catchment. Pixel size = 5m
	Areas serviced by Victoria and Macknade mills	Boundaries of Victoria and Macknade mill areas, which are different to mill districts.
	B uethunbergia weed d stribution	Distribution of the weed blue thunbergia
	Cane Block Mapping Project - Various dates	Herbert River district cane blocks, crop class and variety mapped to sub-block (paddock) level.
	Cane Block Mapping Project Boundary 1	Cane block mapping project boundary defined for tender.
	Cane Block Mapping Boundary 2	Second boundary defined for tender to collect cbmp aerial photography. Project Orthophotos for this boundary have been collected.
	Cane Block Mapping Project Boundary 3	Smallest area defined for tender to collect aerial photography (covers caneblock area). Orthophotos for this boundary have been collected.
	Giant Sensitive Plan (GSP) Weed Distribution	Distribution of the weed Giant Sensitive Plant.
	Grader Grass Distribution (Polygon)	Areas of Grader Grass weeds
	Gradergrass Distribution Boundary (Line)	Distribution of the weed Grader Grass
	Greyback Grub Damage	Distribution of Greyback Grub damaged cane in 2000.
	Hymenachne Distribution	Distribution of the weed Hymenachne
	inset	Inset polygons from HCPPBs weed directory. No useable attributes. Used to put inset diagrams on hardcopy maps.
	labels	Label points for HCPPBs weed information - No attributes.
	Mill Districts of the Herbert River Mills	Mill district boundaries for the Herbert River Mills which are different to mill areas.
	Orthophoto image tile grid (index) for the CBMP Orthophotographs	Locality grid for orthophotographs.
	Pachymetra distribution 1993	Point locations of the weed Pachymetra in 1993.
	Pachymetra Distribution 1999	Point locations of the weed Pachymetra in 1999
	Ripple Creek Drainage Area	Boundary of the Ripple Creek drainage area
	Sicklepod Distribution	Distribution of the weed sicklepod
	Weed distribution	Distribution of various weeds in the Herbert River Catchment including Hymenachne, Sicklepod, Gradergrass, and GSP
	Weed Distribution (Point locations)	Point locations of Hymenachne and GSP in the Herbert River Catchment

Custodia	Title	Abstract
Herbert Resource Information Centre		
	3 Meter Contours	3 meter contour outline. Derived from HMP DEM. Used to identify broad & general areas of potentially acid sulfate soils.
	500 m grid	Basic 500 m grid.
	Bridges (HMP)	Bridges collected during the Herbert Mapping Project, 1996.
	Bruce Highway	Location of Bruce highway (line)
	Buildings (Herbert Mapping Project)	Point location of buildings in the Lower Herbert River Catchment. Points are mapped with a polyline marker. Captured as part of the Herbert Mapping Project,
	Cane Expansion Areas	This coverage shows areas that are able to sustain sugar cane if future expansion in the Herbert River Catchment proceeds. The information was extracted from several layers of data, each specifying restrictions on the growth of sugar cane, either by biological or cultural means. This coverage was generated by (1) selection of suitable soils for growing sugar cane, (2) critical tenures, i.e. free-hold, action-pending and lease- hold, (3) removal of Mahogany Glider habitats, (4) removal of all areas under the 3m contour (as these areas are subject to potential acid sulfate soil problems), (5) removal of wetlands, and finally the removal of existing sugar cane in the Herbert River Catchment.
	Caneblocks (Herbert Mapping Project)	Cane blocks collected as part of the Herbert Mapping Project. Mapped from 1- :20 000 aerial photographs. No attributes attached to this
	Coast Line & Major Rivers	Land and water features.
	Digital Elevation Model (Herbert Mapping Project)	Digital elevation model for the Lower Herbert River Catchment. 30m spacing between elevation spot heights. Captured as part of the Herbert Mapping Project. Includes break lines.
	Herbert Mapping Project Control Points (Horizontal)	Control Points used for rectification of Herbert Mapping Project data and orthophotographs.
	Herbert Resource Information Centre Area of Interest	The HRIC's area of interest - Generally Cardwell to Bluewater.
	Hydro (Herbert Mapping Project)	Hydrological coverage for the Lower Herbert River catchment. Linework attributed with type of hydrological features (e.g. drain, creek, etc). Captured by the Herbert Mapping Project.
	Ingham Town Outline	Basic outline of the town of Ingham. Derived from DCDB land parcels
	places	Location of towns around Ingham
	Powerpoles (Herbert Mapping Project)	Location of power poles in the Lower Herbert River Catchment. Captured by the Herbert Mapping Project.
	Queensland Rails Railline (Herbert Mapping Project)	Line indicates the location of the Queensland rail railline as mapped by the Herbert Mapping Project
	Railline (Herbert Mapping Project)	Railway lines in the Lower Herbert River Catchment. Captured by the Herbert Mapping Project.
	Roads (Herbert Mapping Project)	Road coverage for the Lower Herbert River catchmnet. This coverage does not contain road names as attributes. Linework is attributed with road type (e.g. surface, unsurfaced)
	Topography (Herbert Mapping Project)	Topographical features for the Lower Herbert River Catchment. The contours have a one metre interval and can be displayed as either line
	Towns	Towns in the Ingham region
	Utilities (Herbert Mapping Project)	Utilities (eg. airports, buildings, poles, etc). Captured as part of the Herbert Mapping Project dataset
	Vegetation (Herbert Mapping Project)	Spatial distribution of vegetation in the Lower Herbert River Catchment. - one of the Herbert Mapping Project datasets
	Waterbodies (Herbert Mapping Project)	Spatial distribution of water bodies, such as lakes, wetlands and dams, in the Lower Herbert River catchment, from the Herbert Mapping
	Weather Stations	Points indicating the location of weather stations.
Herbert River Catchment Group Inc.		
	Blockages in the Herbert and Stone Rivers	Channel blockages in the Herbert and Stone Rivers.
	Erosion in the Herbert and Stone Rivers of bank height affected.	Erosion areas along the banks of the Herbert and Stone Rivers. Visibly eroding banks are ranked on their severity in relation to the proportion

Custodia	Title	Abstract
	Herbert and Stone Rivers	Herbert and Stone River systems.
	Owl boxes	Point location of owl boxes
	Riparian Vegetation	Recommended riparian width along the the Herbert and Stone Rivers.
	Trust assets	River trust assets (rock walls) along the Herbert and Stone Rivers.
	Vegetation (1996) along Herbert and Stone Rivers	Vegetation condition along the Herbert and Stone Rivers.
Herberton Shire Council		
	Biodiversity assessment (Herberton Shire)	Vegetation biodiversity assessment for part of the Herberton Shire area
Hinchinbrook Shire Council		
	91 images on HRIC system	Pt coverage linking to jpg images of flooding. Links are not set properly
	Abergowrie subcatchments	Abergowrie subcatchment boundaries delineated by the Cameron McNamara study in the Lower Herbert River Catchment
	Buildings (Halifax Mapping Project)	This layer is the building footprint of any structure in the Halifax
	Buildings (Ingham Mapping Project)	This layer is the building footprint of any structure in the Ingham catch
	catchdiv5	Catchment divisions interpreted by the Cameron McNamara study.
	categ1-2	Categories indicated for major and minor works required for drainage subsidy purposes
	Cattle Creek Subcatchments	Cattle Creek subcatchment boundaries delineated by the Cameron McNamara study in the Lower Herbert River Catchment
	cf1900	
	cofdl 900	Historical flood data (1900) for Cordelia. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	Contours (Halifax Mapping Project)	.5m Contour lines for Halifax Township
	Contours (Ingham Mapping Project)	Contour lines
	cor86pt	1986 flood heights in Cordelia. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	cordb	Historical 1977 flood data for the Cordelia area. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	cordbd67	Cordelia boundaries for 1967 historical flood data. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	cordc	Historical 1977 flood data for the Cordelia area. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	cordfd67	Cordelia 1967 historical flood data. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	cordp	Historical 1977 flood data for the Cordelia area. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	cordp77	Historical 1977 flood data for the Cordelia area. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	cordpt67	Cordelia height measurements for 1967 flood. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	drain	
	drain5	Drainage information for the Lower Herbert River Catchment. Mapped from the Cameron McNamara study.
	DTM (Ingham Mapping	This layer is the complete grid of ground spot heights. 10 x 10 square grid measured ground heights. Contours are derived from these.
	elph_cat5	Elphinstone subcatchment boundaries delineated by the Cameron McNamara study in the Lower Herbert River Catchment
	fixd_cat5	
	Flood heights (1967)	Flood heights - 1967. Data collected and developed by the Hinchinbrook Shire Council

Custodia	Title	Abstract
	Flood heights (1972)	Flood heights - 1972. Data collected and developed by the Hinchinbrook Shire Council
	Flood heights (1977)	Flood heights 1977. Data collected and developed by the Hinchinbrook Shire Council
	Flood heights (1986)	Flood heights 1986. Data collected and developed by the Hinchinbrook Shire Council
	Flood heights (1990)	Flood heights 1990. Data collected and developed by the Hinchinbrook Shire Council
	Flood heights (1991)	Flood heights 1991. Data collected and developed by the Hinchinbrook Shire Council
	Flood heights (1994)	Flood heights 1994. Data collected and developed by the Hinchinbrook Shire Council
	Flood heights (1997)	Flood heights 1997. Data collected and developed by the Hinchinbrook Shire Council
	Flood heights (1998)	Flood heights 1998. Data collected and developed by the Hinchinbrook Shire Council
	Flood heights (1999)	Flood heights 1999. Data collected and developed by the Hinchinbrook Shire Council
	Flooding Images - March 1977	Pt coverage linking to jpg images of flooding.
	Flooding images 1997	Pt coverage linking to jpg images of flooding.
	fungus_cat5	
	h90pt	
	hal86pt	1986 flood heights in Halifax. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	hbnd67	
	hbnd77	
	hcnt67	
	hcnt77	
	herb2	Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	herbfd67	1967 flood data for the lower Herbert catchment. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	hspt67	Spot height levels for the 1967 flood in the Lower Herbert River
	hspt77	Spot height levels for the 1977 flood in the Lower Herbert River
	hspt86	Spot height levels for the 1986 floods in the Lower Herbert River
	hspt91	Spot height levels for the 1991 floods in the Lower Herbert River
	in72dcn	1972 flood inundated areas.
	inundated-72	1972 flood inundated areas.
	lanbd67	Lannercost boundaries for 1967 historical flood data. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	lanfd67	Lannercost 1967 historical flood data. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	lanpt67	Lannercost flood heights for 1967. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	mar86pt	1986 flood heights in Marathon. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	mara2	Historical 1977 flood data for the marathon area. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	marab	Historical 1977 flood data for the marathon area. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	marap	Historical 1977 flood data for the marathon area. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	marap77	Historical 1977 flood data for the marathon area. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	Miscellaneous line features (Ingham Mapping Project)	This line layer has various feature information relating to the public areas in the Ingham township, eg guard rail, pipe, retaining wall
	Miscellaneous Points (Ingham Mapping Project)	This point layer has various feature information relating to the public areas in the Ingham township, eg bbq, park equipment, public seats,
	Miscellaneous polygon features (Ingham Mapping Project)	This polygon layer has various feature information relating to the public areas in the Ingham township, eg above/in ground pools, grandstand, cemetery, airstrips
	Non inundated areas of 1986 flood	1986 flood non-inundated areas.

Custodia	Title	Abstract
	Noninundated areas of 1967 flood	1967 flood non-inundated areas.
	Non-inundated areas of 1977 flood.	1977 flood non-inundated areas.
	Noninundated areas of 1990 flood	1990 flood non-inundated areas.
	Noninundated areas of 1991 flood.	1991 flood non-inundated areas.
	Non-inundated areas of the 1967 flood.	Duplicate data - see assoc coverages
	Non-inundated areas of the 1977 flood.	Duplicate data - see assoc coverages
	Non-inundated areas of the 1986 flood.	Duplicate data - see assoc coverages
	Non-inundated areas of the 1990 flood.	Duplicate data - see assoc coverages
	Non-inundated areas of the 1991 flood.	Duplicate data - see assoc coverages
	Old Ingham cemetery	Ingham Mapping project - cemetery plot outlines
	Overall potential constraints to sugar cane expansion. (Master Land & Water Management Plan)	Identifies overal potential constraints on sugar cane expansion
	palm_cat5	Palm Creek subcatchment boundaries delineated by the Cameron McNamara study in the Lower Herbert River Catchment
	Phone (Ingham Mapping Project)	This layer has some information relating to the telephone network in the Ingham township, eg Only telephone columns, pits, manholes and
	plan4	Historical 1977 flood data. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	plan5	Historical 1977 flood data. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	plan6	Historical 1977 flood data. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	plan7	Historical 1977 flood data. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	plan8	Historical 1977 flood data. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	plan9	Historical 1977 flood data. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	Potential constraints on sugar cane expansion due to ACID SULFATE SOILS (Master Land & Water Management Plan)	Identifies potential constraints on sugar cane expansion due to potentially acid sulfate soils.
	Potential constraints on to ACID SULFATE SOILS (Master Land & Water Management Plan)	Identifies potential constraints on sugar cane expansion due to important aquatic habitat conservation requirements.
	Potential constraints on sugar cane expansion due to LAND SUITABILITY (Master Land & Water Management Plan)	Identifies potential constraints on sugar cane expansion due to suitability of land for sugar cane expansion due to LAND SUITABILITY (Master Land & Water Management sugar cane cropping.
	Potential constraints on sugar cane expansion due to LAND TENURE (Master Land & Water Management Plan)	Identifies potential constraints on sugar cane expansion due to land tenure

Custodia	Title	Abstract
	Potential constraints on sugar cane expansion due to LOWLANDS FLORA (Master Land & Water Management Plan)	Identifies potential constraints on sugar cane expansion based on the conservation priority of land types and regional ecosystems in the Herbert River floodplain which were determined (and mapped) by Kemp ef *al.* (1998) - see the dataset herbre.
	Potential constraints on sugar cane expansion due to TERRESTRIAL FAUNAL HABITAT conservation. (Master Land & Water Management Plan)	Identifies potent al constraints on sugar cane expansion due to the presence of several species occur including the endangered mahogany glider, red goshawk, and the vulnerable rufous owl and ******
	Power points (Ingham Mapping Project)	This layer has some information relating to the electricity network in the Ingham township, eg street lights, transformer etc
	Power polygons (Ingham Mapping Project)	This layer has some information relating to the electricity network in the Ingham township, eg street lights, transformer etc
	pt3113	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3114	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3118	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3119	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3120	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3122	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3123	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3124	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt312S	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3127	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3129	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3130	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3133	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3134	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3135	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3136	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt3137	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt4537	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt4538	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt4539	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt4540	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt4542	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt4546	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt4547	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	pt508	? Data created for the Cameron McNamara study in the Lower Herbert River Catchment
	Sewer lines (Ingham Mapping Project)	The sewer lines coverage shows the location of the Ingham township sewer pipe infrastructure, eg Mains, rising mains.
	Sewer points (Ingham Mapping Project)	The sewer points coverage shows the locations of the Ingham township sewer infrastructure .eg Sewer manholes.
	strms	
	Subcatchments in the Lower Herbert River Catchment Subcatchments included in the coverage are Abergowrie, Cattle Creek, Palm Creek and Trebonne Creek.	The ALL_CAT5 coverage indicates all subcatchments delineated by the Cameron McNamara study in the Lower Herbert River Catchment.
	townplan	Town plan data for the Hinchinbrook Shire.
	townplan99	Town plan data for the Hinchinbrook Shire (1999)
	tre86pt	1986 flood heights in Trebbone. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.

Custodia	Title	Abstract
	treb_cat5	Trebbone Creek subcatchment boundaries delineated by the Cameron McNamara study in the Lower Herbert River Catchment.
	treb2	Historical 1977 flood data for Trebonne Creek. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	trebb	Historical 1977 flood data for Trebonne Creek. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	trebp	Historical 1977 flood data for Trebonne Creek. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	trebp77	Historical 1977 flood data for Trebonne Creek. Data created for the Cameron McNamara study in the Lower Herbert River Catchment.
	Water Connections (Ingham Mapping Project)	The water meter connections to individual properties for the Ingham Township.
	Water Infrastructure Lines (Ingham Mapping Project)	The water mains coverage shows the location of the Ingham township water pipe infrastructure.
	Water Infrastructure Points (Ingham Mapping Project)	The water points coverage shows the location of the Ingham township water infrastructure, eg. Stop value, Fire Hydrant, Air Valve.
North Queensland Afforestation Association		
	Herbert River Upper Catchment Boundary	Boundary of the upper portion of the Herbert River Catchment
	Weeds (Upper Herbert River Catchment)	Locations of Rubbervine and Lantana weeds in the Upper Catchment.
Poweriink Queensland		
	Poweriink Approved	These area features define the approved route for transmission lines.
	Transmission Routes	They provide an indication of the location of actual easements acquired for transmission purposes, by Poweriink Queensland(and former bodies) and other electrical transmission and distribution
	Poweriink Substations	The location sites or land parcels containing Poweriink substations
	Transmission Lines	The approximate location and extent of Poweriink Transmission lines forming part of the Queensland transmission grid
	Transmission Structures - Queensland	Transmission Structures including towers poles that are part of the Poweriink transmission grid.
Queensland Department of Natural Resources		
	Agricultural Suitability of the Herberton Shire (HSS)	This project was undertaken following a request from the Herbeton Shire Council. It arose from a need to identify agriculturally valuable land for the Shire's Strategic Plan and from a general perception that there existed a large amount of undeveloped land with agricultural potential within the Shire. The agricultural potential of the land in the western or semi-arid parts of the Shire was broadly recognised in (Weston *et at.,* 1981) who delineated 157 600 ha of land in the Shire with potential for sorghum cropping. Within this area, holders of large leases were beginning the free holding process and in some instances there was pressure for subdivision of land already in freehold. Consequently the Shire was interested in having the areas with cropping potential more clearly defined. Intensive agricultural development has already occurred in the north east of the Shire on the basaltic soils of the Evelyn Tableland and the Kaban area. Due to the proximity to population centres the competition for this land between agricultural and other uses is more intense. This project consists of digital data, a report and 1 published map. The report - * Agricultural Land Suitability of Herberton Shire - QO86006' is authored by Grundy, M.|. and Reid, R.E.
	Digital Cadastral Database - Full HRIC AOI Extent Digital Cadastral Database - Shire Extent (Various Dates)	Digital cadastral database for the HRIC's Area of Interest. The DCDB is the spatial representation of the property boundaries and the related Digital cadastral database (DCDB) for the Hinchinbrook Shire. The Hinchinbrook Shire Councils rates database has also been attached to the attributes of this DCDB, so that the rates assessment number and property owner are attributed to each property (parcel). The DCDB is the spatial representation of the property boundaries and the related property descriptions of Queensland. The DCDB provides the map base for systems dealing with land and land related information and provides data in order to generate hard copy map products.
	Digital Cadastral Database (Upper Herbert River Catchment)	Subset of the DCDB covering the upper Herbert river catchment. The DCDB is the spatial representation of the property boundaries and the related property

Custodia	Title	Abstract
	Easements of the Hinchinbrook Shire	Easements are extracted from the Digital Cadastral Database dataset. The DCDB is the spatial representation of the property boundaries and the related property
	Indicative Mapping of Acid Sulfate soil - Ingham to Cape Tribulation (ASSP)	A desktop interpretation of the likely location of acid sulfate soil (ASS) based on existing soil type and aerial photo interpreted elevation assessment. No field assessment was undertaken to validate acid
	Land Assessment and Land Management - Dry Tropics -	This project describes the land resources of 300 000 hectares of land surrounding the towns Ravenshoe and Mt Garnet in north Queensland.
	Ravenshoe-Mt Garnet Area (RAV)	This is the second stage of a study funded by the National Soil Conservation Program (NSCP) into the land resources of the dry tropics. The first stage resulted in an overview 1:250 000 study - Land Resources of the Einasleigh/Atherton Dry Tropics (SAT). A survey of the Ravenshoe 1:100 000 map sheet (1 of 12 map sheets within the overview mapping) is the second stage of the study. This area was selected for more intensive mapping based on various criteria. The specific aims were to map areas of suitable soils, develop a detailed land suitability framework to match crop requirements with soil and land attributes and to identify specific hazards and other land management issues. This involved field survey, detailed soil analysis, the establishment of monitoring sites for soil water dynamics and land suitability analysis incorporating crop modelling. This project consists of two reports, digital data and published maps. The reports - Land Resources of the Ravenshoe - Mount Garnet north Queensland Vol 1 - Land Resource Inventory - QV94006" and "Land Resources of the Ravenshoe Mount Garnet north Queensland Vol 2 - Land Suitability - DNRQ980122" are authored by Heiner, l.|. and Grundy, M.j.
	Land Resources of the Einasleigh/Atherton Dry Tropics (SAT)	An exploratory study was undertaken of the land resources of the Atherton and Einasleigh 1:250,000 map sheet areas west of Cairns. The result, an overview of 3.5m ha of the dry tropics, is an aid to the setting of priorities for more intensive resource assessment. The work was funded by the National Soil Conservation program. Twenty-two soil landscape units consisting of 87 soil associations were identified. Of these, 33 soil associations were considered suitable for rain fed summer grain production with few, slight or moderate limitations. They covered an area of 533,000 ha with 2,981,000 ha unsuitable. Of the suitable soils, soil associations dominated by red earths occupied 166,000 ha, non-calcic brown soils and red podzolic soils 70,500 ha, black earths and grey and brown clays 72,000 ha and various suitable soils on alluvium 46,000 ha. The climate including rainfall which is of moderate reliability is discussed. Research and development needs and degradation hazards are identified. Priorities for further resource survey are assigned based on the twelve 1:100,000 map sheet areas found within the Einasleigh-Atherton dry tropics. This project consists of digital data, a report and two published maps. The report - "Land Resources of the Einasleigh-Atherton Dry Tropics - QO89004" is authored by Grundy, M.J. and Bryde, N.j. This data has been superceded in part by TAB - Soils and Land Suitability of the Atherton Tablelands North Queensland, RAV - Land Assessment and Land Management - Dry Tropics - Ravenshoe-Mt Garnet Area and DLR - Preliminary Assessment and Survey of Land Degradation in the Einasleigh/Atherton Dry Tropics.
	Landuse (Upper Herbert River Catchment)	Selected parcels from the 1996(?) DCDB in the Upper Herbert River Catchment.
	Mine Zones (Upper Herbert River Catchment)	Mine zones in the upper Herbert river catchment. Derived from the Land Assessment and Land Management - Dry Tropics - Ravenshoe-Mt
	Garnet Area (RAV)	
	Mined Sites (Upper Herbert River Catchment) Ravenshoe-Mt Garnet Area (RAV)	Location of mined sites in the upper Herbert river catchment. Derived from the Land Assessment and Land Management - Dry Tropics -
	Protected Land Parcels (Upper Herbert River)	Protected land parcels selected out of the 1996(?) DCDB in the Upper Herbert River Catchment.
	Roads of the Hinchinbrook	Road features extracted from the Digital Cadastral Database.
	Soils and Land Suitability of the Atherton Tablelands North Queensland (TAB)	The Atherton Tablelands soils and land suitability project extends from Walkamin in the Northwest to the Lamb Range in the Northeast (including Tinaroo Dam). The project was jointly funded by the National Land Care Program and the Department of Natural Resources (DNR), The main objectives of this project were to - map the soils of the Atherton Tableland at 1:50 000 scale and produce a Geographical Information System (GIS) coverage.- assess the suitability of the area for a range of sustainable agricultural land uses increase the capability of state and local government agencies to address emerging land use and rezoning issues. - to provide information to land care and other community groups.

Custodia	Title	Abstract
		Over 2000 site descriptions were made identifying 34 different soil profile classes (SPCs). All major soils were sampled for chemical analysis. Morphological and physical soil properties pertinent to the assessment of land suitability for agriculture were also recorded. The suitability of land for 19 agriculturally sustainable land uses has been assessed according to a range of limitations. This project consists of a report - "Soils and Land Suitability of the Atherton Tablelands, North Queensland - DNRQ98009V authored by Malcolm, D.T., Nagel, B.K.A., Sinclair, I., Webb, I., and Heiner, I.), and four maps.
	State of Rivers - Herbert River Subcatchments	The State of the Rivers project aims to undertake snapshot surveys of Queensland streams to provide a determination of the ecological and physical condition of these streams. The surveys are being undertaken on a catchment by catchment basis with datasets comp eted for, Maroochy River, Upper Condamine River, Herbert River, Dawson River, Lockyer Creek, Mary River, Bremer River, Cooper Creek/Thomson and Barcoo Rivers, Tully and Murray Rivers and Border Rivers. At June 1998 surveys were underway in the Burnett River, Mooloolah River, Caboolture River and Pumicestone Passage Streams and Comet, Nogoa and MacKenzie Rivers, with proposals to survey the Maranoa-Balonne Rivers and Warrego and Paroo Rivers in the coming year. Survey sites are selected to represent stream and catchment subsections using a workshop procedure and are located across the catchment. The technique relies on having a large number of sites surveyed rapidly as a one off assessment, resulting in between 185 and 460 s tes in a catchment depending on catchment size. Data are collected on stream characteristics of; site description, reach environs, channel habitat diversity, channel cross-section, bank condition, bed and bar condition, riparian and aquatic vegetation, aquatic habitat and scenic, recreation and conservation values. These data are analysed to produce condition ratings for the streams of a catchment. The dataset also contains a series of at least five photographs of each survey site across the catchments. Results of these surveys are published and readily available in major libraries.
	State of Rivers - Rivers	The State of the Rivers project aims to undertake snapshot surveys of Queensland streams to provide a determination of the ecological and physical condition of these streams. The surveys are being undertaken on a catchment by catchment basis with datasets completed for, Maroochy River, Upper Condamine River, Herbert River, Dawson River, Lockyer Creek, Mary River, Bremer River, Cooper Creek/Thomson and Barcoo Rivers, Tully and Murray Rivers and Border Rivers. At June 1998 surveys were underway in the Burnett River, Mooloolah River, Caboolture River and Pumicestone Passage Streams and Comet, Nogoa and MacKenzie Rivers, with proposals to survey the Maranoa-Balonne Rivers and Warrego and Paroo Rivers in the coming year. Survey sites are selected to represent stream and catchment subsections using a workshop procedure and are located across the catchment. The technique relies on having a large number of sites surveyed rapidly as a one off assessment, resulting in between 185 and 460 sites in a catchment depending on catchment size. Data are collected on stream characteristics of; site description, reach environs, channel habitat diversity, channel cross-section, bank condition, bed and bar condition, riparian and aquatic vegetation, aquatic habitat and scenic, recreation and conservation values. These data are analysed to produce condition ratings for the streams of a catchment. The dataset also contains a series of at least five photographs of each survey site across the catchments. Results of these surveys are published and readily available in major
	State of the Rivers - Sampling Sites	The State of the Rivers project aims to undertake snapshot surveys of Queensland streams to provide a determination of the ecological and physical condition of these streams. The surveys are being undertaken on a catchment by catchment basis with datasets completed for, Maroochy River, Upper Condamine River, Herbert River, Dawson River, Lockyer Creek, Mary River, Bremer River, Cooper Creek/Thomson and Barcoo Rivers, Tully and Murray Rivers and Border Rivers. At June 1998 surveys were underway in the Burnett River, Mooloolah River, Caboolture River and Pumicestone Passage Streams and Comet, Nogoa and MacKenzie Rivers, with proposals to survey the Maranoa-Balonne Rivers and Warrego and Paroo Rivers in the coming year. Survey sites are selected to represent stream and catchment subsections using a workshop procedure and are located across the catchment. The technique relies on having a large number of sites surveyed rapidly as a one off assessment, resulting in between 185 and 460 sites in a catchment depending on catchment size. Data are collected on stream characteristics of; site description, reach environs, channel habitat diversity, channel cross-section, bank condition, bed and bar condition, riparian and aquatic vegetation, aquatic habitat and scenic, recreation and conservation values. These data

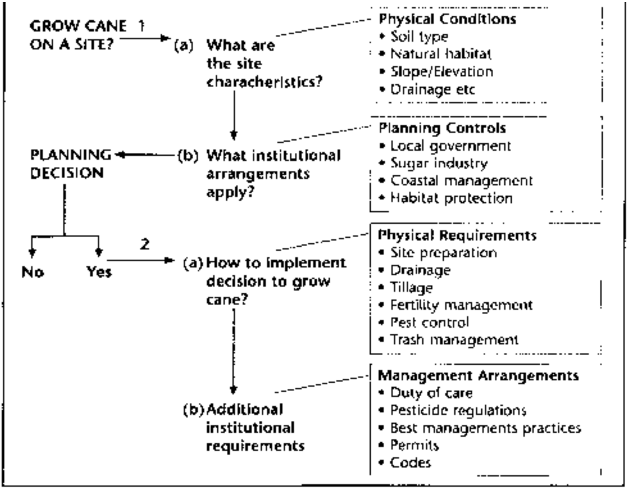
Custodia	Title	Abstract
		are analysed to produce condition ratings for the streams of a catchment. The dataset also contains a series of at least five photographs of each survey site across the catchments. Results of these surveys are published and readily available in major libraries.
	Sugar Industry Infrastructure Package boundaries	Mandam Sugar Industry Infrastructure Package boundaries.
	Sugar Industry Infrastructure Package boundary (Loder Creek).	Loder Creek Sugar Industry Infrastructure Package boundary.
	Sugar Industry Infrastructure Package boundary	Macknade Sugar Industry Infrastructure Package boundary.
	Sugar Industry Infrastructure Package boundary (Ripple Creek).	Ripple Creek Sugar Industry Infrastructure Package boundary.
	Sugar Industry Infrastructure Package boundary (Titree Creek).	Titree creek Sugar Industry Infrastructure Package boundary.
	Sugar Industry Infrastruture Package boundaries.	Sugar Industry Infrastruture Package boundaries.
	Sugar Industry Infrastruture Package boundary (Lagoon Creek).	Lagoon Creek Sugar Industry Infrastruture Package boundary.
	Sugar Industry Infrastucture Package boundary (Forrest Home).	Forrest Home Sugar Industry Infrastucture Package boundary.
	Towns (Queensland)	Towns locations
	Towns and stations (Upper Herbert River Catchment)	This dataset is a subset of the Town250a dataset held by DNR. It has been clipped to the Upper Herbert River Catchment boundary.
	Wet Tropical Coast - North Queensland - Ingham and Herbert River section (WTC)	This project describes and catalogues the land resources of the Wet Tropical Coast from 50 km south of Ingham to 40 km to the north. It is a companion to other reports/projects on the Wet Tropical Coast. The resources are described in terms of climate, geology, geomorphology, hydrology, natural vegetation and soils. A total of 43 soils were identified and mapped, and cover 160 270 ha of coastal lowland. The resources were assessed to determine their suitability for growing sugar-cane, bananas, papaw, mango, lychee, citrus, avocado, rambutan, tea, vegetables, curcurbits, pineapples, maize, sorghum, sweet corn, soybean, peanut, sweet potato, rainfed rice, Pinus caribbaea and improved pastures. Each of the 1626 unique map areas (UMAs) identified during the study were individually assessed for their suitability for each crop using a land suitability classification scheme. The limitations examined were climate, water availability, soil nutrient supply, salinity, wetness, flooding, landscape complexity, soil physical condition, topography, rockiness and water erosion. The report identified the areas of land suitable for agricultural development and the management needs of these lands for agricultural uses and the likely impact of other land uses on these lands. The guidelines are aimed at promoting improved productivity while avoiding degradation of the land resources. This project is the result of a study which began in 1980 in response to land use concerns affecting the sugar industry with regard to competition between forestry and sugar growing interests for land in state forests, and management of the cane growing. This project consists of a report, digital data, two published maps and various dyeline maps. The report - Soils and Agricultural Land Suitability Suitability of the Wet Tropical Coast North Qld - Ingham
Queensland Department of Primary Industries		
	Creeks and drains in the Cardwell State Forest area.	Creeks and drains in the Cardwell State Forest area.
	Creeks and drains in the Ingham State Forest areas.	Creeks and drains in the Ingham State Forest areas.
	Fish habitat reserves in the Lower Herbert River	Fish habitat reserves in the Lower Herbert River Catchment.
	Plantation resource assessment plots for Ingham State Forest areas.	Plantation resource assessment plots for Ingham State Forest areas.

Custodia	Title	Abstract
	Plantation resource assessment plots in the Cardwell State Forested	Plantation resource assessment plots in the Cardwell State Forested
	Planted compartments for the Abergowrie State Forest Plantation.	Planted compartments for the Abergowrie State Forest Plantation.
	Planted compartments for the Cardwell State Forest Plantation.	Planted compartments for the Cardwell State Forest Plantation.
	Planted compartments for the Lannercost State Forest Plantation.	Planted compartments for the Lannercost State Forest Plantation.
	Powerlines in the Cardwell State Forested areas.	Powerlines in the Cardwell State Forested areas.
	Railways in the Cardwell State Forested areas	Railways in the Cardwell State Forested areas
	Railways in the Ingham State Forest areas.	Railways in the Ingham State Forest areas.
	Roads in the Ingham State Forest areas	Roads in the Ingham State Forest areas
Wet Tropics Management Authority		
	Boundary of Hinchinbrook	Boundary of Hinchinbrook Island
	Contour lines of Hinchinbrook Island	Contour lines of Hinchinbrook Island
	Contours for the Wet Tropics	Contours for the Wet Tropics Management Area from Ingham to thesouth and Cairns to the north
	Dams in the Wet Tropics	Dams in the Wet Tropics Management Areas of north Queesland.
	Hydrology 1:50 000	Stream work for the Herbert River Catchment. This coverage contains all linework from the 1:50 000 map sheets
	Main hydrological features of the Herbert River Catchment	Main hydrological features clipped out of the Herbert River Catchment area and most often used for cartographic presentations.
	Main streams	Main streams in the Herbert River Catchment area and areas to the???
	Powerline in the Wet Tropics	Power lines in the Wet Tropics Management Areas.
	Queensland Boundary	Queensland boundaries
	Rail lines in the Wet Tropics	Rail lines mapped for the Wet Tropics region of North Queensland
	Rivers of the Wet Tropics	Major rivers mapped for the Wet Tropics Region of North Queensland
	Roads of the Wet Tropics	Roads mapped for the Wet Tropics region of North Queensland
	Walking Tracks in the Wet Tropics	Distribution of recreational walking tracks in the Wet Tropics Management Area in northeastern Queensland.
	Webb & Tracy Vegetation of the Wet Tropics	Vegetation of the Wet Tropics
	Wet Tropics Management Boundary	Wet Tropics Management

Appendix 2. Key arrangements impacting sugar-cane production in Queensland

Sugar-cane production is influenced by key institutional arrangements designed to address integrated resource management, land-use planning, habitat protection, water resource management, environmental quality and on-farm management. Institutional arrangements for sugar industry environmental management can be divided into those that apply at the planning stage and those relevant for ongoing management.

Key planning and management arrangements for sugar industry NRM.



These arrangements form a significant part of the decision-making environment facing regional resource-use planning. To enable such planning to be cognisant of this aspect of the planning arena, we have provided an overview of the institutional arrangements as they relate to significant environmental issues.

7.3.1 Land-use planning

There has been a rapid increase in the number of planning arrangements for the sugar industry over the past 10 years. It has been generated to deal with problems ranging from the loss of good quality agricultural land to loss of natural habitats and impacts on water quality. Many of these arrangements were institutionalised in response to rapid, broad-scale sugar industry expansion in Queensland in the mid-1990s. In particular, these arrangements were established to prevent the social and environmental problems which arose from being repeated. Given that sugar industry expansion slowed towards the end of the 1990s, and that many of these arrangements have been instituted in the past several years, many of these arrangements have not yet been tested in sugar areas and there are few protocols to guide the way.

Land-use planning in Queensland is regulated by various arrangements including the *Sugar Industry Act 1999,* the *Integrated Planning Act 1997,* and the *Coastal Protection and Management Act 1 995.*

- *Sugar Industry Act* 7 999 *(Queensland Sugar Corporation, Queensland Department of Primary Industries).*

The first major land-use planning tool is administered by the sugar industry through the *Sugar Industry Act 1999,* which provides the capacity to minimise environmental impact through planning of industry expansion. This planning system has been in place since 1991 (initially as the *Sugar Industry 1991 Act)* and has expanded the domain of considerations to include environmental concerns more directly. It specifically includes provisions for consideration of environmental and sustainability aspects of the expansion process prior to the allocation of land for cane production.

Assignment is a key component of sugar industry arrangements. It effectively confers the right to crush cane grown on defined areas of land. On granting assignments, conditions can be imposed on sugar-cane development, and it is through assigning conditions to assignments that environmental considerations can be integrated into the development process. This process provides the opportunity to influence freehold land development and provides a very useful management tool for industry planning towards ecological objectives. On granting assignments, conditions can be imposed on sugar-cane development and it is through these conditions that ecological objectives (e.g., wetland conservation) can potentially be achieved, for example by preparing farm management plans, and directing development away from key wetland areas, etc. (Creighton *et al.* 1994).

Cane production boards have an important role in achieving sustainability by developing guidelines concerning land-use, the environment and transport. These boards are also required to establish that there is a genuine need for the proposed expansions. Negotiation teams use the guidelines generated by the cane production boards when assessing individual applications for cane production areas. Negotiation teams are required to consider the suitability of the land for cane production when assessing applications, including land capability, appropriate agricultural practices and any relevant environmental guidelines (e.g., maintaining riparian lands, or avoiding acid sulfate soils).

Prior to the *Sugar Industry Act of 1 999,* the *Sugar Industry Act of 1991* also regulated the sugar industry, and its expansion, and was in force during the rapid phase of sugar expansion discussed previously. Like the *Sugar Industry Act of 1999,* the *Sugar Industry Act 1991* also provided the opportunity to regulate the use of resources through the cane land assignment process. However, this process was not implemented as intended, and consequently, the land-use planning process hindered sustainable environmental management. The integrity of the assignment system was seriously criticised because, in some catchments, the rapid expansion of the sugar industry resulted in significant losses of ecological resources, including important wetlands and riparian vegetation. Not surprisingly, these land allocation decisions led to conflicts between environmental groups, the industry and cane assignment boards.

The sugar industry assignment process has been extensively criticised for its failure to regulate expansion properly in the early 1990s. During this time, the sugar industry underwent significant expansion, causing major environmental impacts in regions such as the Herbert River. These impacts included the loss of wetland and riparian habitats and habitats of rare and threatened species, including the Mahogany Glider. Rapid caneland expansion also impacted erosion and sedimentation patterns, freshwater runoff, and salinity regimes and tidal flow patterns, as well as the introduction of waterborne pollutants, distribution of submerged and fringing vegetation, inlet structure and dynamics and the quality and quantity of fishery habitat. The problems and impacts of sugar assignment have been the subject of detailed assessments (Shrubsole 1997; Shrubsole and Johnson 1999).

Provisions in the 7 999 *Sugar Industry Act* tightened the focus on environmentally sustainable decision-making, however, as expansion has slowed in recent years, the amended decision-making process has not been widely tested.

- *Integrated Planning Act 1997 (Local Governments, Queensland Department of Local Government and Planning)*

The second major tool regulating Queensland land-use is the *Integrated Planning Act (IPA),* which provides a framework for integrated planning and development assessment to promote ecologically sustainable management of development and its effects. The *IRA* provides mechanisms for local strategic land-use planning, and coordinates and integrates multiple development assessment processes (state, regional and local) at the local level (State of Queensland 1997).

Planning schemes are established under *IPA* to control land-use within local government areas. The planning scheme is the primary mechanism for land-use planning and control in Queensland. The key features of planning schemes are that they:

- seek to achieve ecological sustainability,
- establish desired environmental outcomes for a local government areas,
- coordinate and integrate core planning matters,
- have a strategic component that is developed in consultation with the community,
- establish development assessment processes, which call for community input into development assessment,
- establish codes which provide criteria to assess developments, and
- are required by the Act to be periodically reviewed and updated (State of Queensland 1997).

Instead of prescribing the environmental, economic and social aspects of sustainability to be incorporated into planning schemes, the *IPA* prescribes the process for planning (e.g., consultation and advertising requirements, inter-governmental coordination requirements etc.) and provides some key element of planning schemes (e.g., desired environmental outcomes, performance mechanisms). This approach provides local governments with the flexibility to define their own specific substantive goals and targets.

Although the object of planning schemes is to achieve ecological sustainability, this has not been widely tested in rural areas because of the newness of this *Act,* the limited number of IPA planning schemes in Queensland and their limited coverage of rural development assessment issues. Concern has already been expressed about the terms of this *Act,* with an overriding concern that the environment may be more adversely affected under the *Act* than it was under previous legislation. These concerns relate to impact assessment provisions, which do not include specific reference to the impact of the development on the environment (Cripps et al. 1998). In addition, the clearly states that vegetation removal does not constitute 'development', and consequently, planning schemes can not regulate tree clearing.

However, through broad interpretations of what constitutes 'development', local governments have begun to use planning schemes to regulate sugar industry expansion. This is possible in instances where there is a material change in the intensity of land-use, such as the change in intensity from 'agriculture' (e.g., grazing) to 'intensive agriculture' (e.g., sugar production). Local governments are taking these steps in areas where sugar assignment committees have failed to consider the environmental impact of further sugar assignment e.g., Herbert River region (Vella 1 997; Vella 1 999). Local governments, such as Hinchinbrook Shire Council, through the planning scheme, have declared sugar production as 'intensive agriculture', thus distinguishing it from other forms of agriculture. This means that, according to the planning scheme, the conversion of land from grazing to sugar-cane production causes a material change in the scale and intensity of the land-use. As a result councils can assess the projected impacts and effects of proposed changes through normal development assessment processes (e.g., approvals processes for urban land uses such as industrial land, residential land and commercial land etc.), and can regulate (e.g., place conditions on) the development approval to minimise environmental risks (e.g., maintain minimum riparian widths or restrict production on steeply sloping land). Local governments can require impact assessment if a development has a high risk of adverse environmental impact. In addition, local governments can refuse developments that, following impact assessment, are found to threaten the environment.

Another important mechanism established under IPA is the Integrated Development Assessment System (IDAS). The IDAS aims to rationalise the multiple planning approval processes into one single assessment process. As a result, local governments have additional responsibilities for coordinating assessments triggered under other legislation through the IPA (e.g., licences under the *Environmental Protection Act 1994, Transport Infrastructure Act 1994).* To date, only a limited number of approvals coordinated through IDAS are relevant for sugar land development. These relate mostly to the expansion or development of new sugar mills or the loss of good quality agricultural land. The expansion of a sugar mill would trigger a 'material change of use' application according to the planning scheme as well as assessment by the Environmental Protection Agency under the *Environmental Protection Act 1994,* as well as, the Departments of Main Roads and Transport under the *Transport Infrastructure Act 1994.* It is expected that IDAS will influence sugar development in the future as more shires regulate intensive agriculture through the planning scheme and as additional legislation becomes integrated with the IPA, including vegetation management and water management. Unfortunately, a primary problem with IDAS currently is that it provides a procedural linkage, rather than truly integrating the decision-making process. Hence the approvals required in different legislation (e.g., transport, environment, heritage) are assessed by individual agencies rather than a truly integrative assessment of benefits, impacts and trade offs.

The IPA establishes other relevant tools. These include regional land-use plans (e.g., Far North Queensland 2010 Regional Plan, SEQ 2021, and Wide-Bay 2020) which provide long-term land-use strategies. Regional land-use plans are designed to provide long-term regional strategic guidance to local governments when developing (sub-regional) strategic plans, and to provide guidance on issues of regional importance during local development assessment. Numerous regional plans are relevant to the sugar industry along Queensland's eastern seaboard. State planning policies, such as the policy for the protection of good quality agricultural land and acid sulfate soils, provide policy advice on issues of state interest. Local governments implement both mechanisms through planning schemes and the development assessment processes.

Regional planning mechanisms and state planning policies rely primarily on local governments for implementation through strategic and operational planning provisions. Firstly, implementation of regional plans occurs via local government strategic planning and the development of planning schemes (e.g., desired environmental outcomes, constraints mapping). Secondly, implementation of regional plans occurs through the integrated development assessment process (e.g., referral coordination). Consequently, regional plans have a powerful ability to shape and control land-use and land management, through the substantive demarcation of land suitable and unsuitable for development, and conditions for development. Relevant legislation is the *Coastal Protection and Management Act 1 995,* the *Vegetation Management Act 2000* and the *Water Act 2000.*

- *Coastal Protection and Management Act 1995 (Queensland Environmental Protection Agency)*

The *Coastal Protection and Management Act 1995* was introduced to protect, conserve, rehabilitate and manage the coast. Coastal management planning is very relevant to the sugar industry given that most of the Queensland industry is located within the narrow coastal zone defined in this *Act.*

This *Act* establishes state and regional strategic planning tools called Coastal Management Plans (CMPs). Coastal Management Plans establish principles and policies for coastal management, identify key sites and resources in the coastal zone, plan for their long-term protection and management, and declare control districts for areas that require special development controls and management practices. They also provide recommendations for land-uses within the coastal zone and influence environmental assessment processes.

The state coastal management plan (CMP) (established under the *Act)* identifies areas of state significance for coastal management and sets out a broad framework to prevent the net loss of public access to the coast, to protect coastal wetlands, to retain the natural landscape values of the coast, to retain and manage vegetation in riparian corridors, and to rehabilitate, restore and enhance degraded coastal resources. The plan establishes 11 coastal regions for which regional coastal management plans are to be prepared.

Examples of coastal regions relevant to the sugar industry include: Cardwell-Hinchinbrook, Wide Bay Burnett, Wet Tropics and south-east Queensland (SEQ) regional coastal management plans. Looking more closely at the Wide Bay region as an example, the coastal management plan identifies several key coastal management issues to be considered in the plan for the Wide Bay Coast. They include:

- deterioration of water quality,
- water extraction from sand marshes,
- degradation of seagrass beds in Hervey Bay,
- resolving conflicts within multi-use strategies for coastal-based tourism industries or other user groups, and
- loss of natural habitats and cultural sites due to rural and urban expansion.

The south-east Queensland regional coastal management plan is already under development and a draft regional coastal management plan has already been prepared for Hinchinbrook-Cardwell Region. Some of the primary planning issues relevant to sugar industry sustainability include:

- maintaining and enhancing coastal habitats (especially wetlands), significant species and environmental flows,

- maintaining and enhancing water quality, including ground water extraction and acid sulfate soils, and
- planning and managing any new artificial waterways.

Strategies are likely to include policies to retain and rehabilitate vegetation, amendments to local government planning and development approval processes for riparian and freshwater wetland retention, conservation agreements with landowners, conservation plans and recovery plans for important habitat. Therefore the *Coastal Protection and Ma nagement Act I 995* provides for additional controls over sugar industry expansion and can potentially affect the management of sugar growing areas.

7.3.2 Habitat protection and management

In addition to controls on land-use, important habitats are accorded formal protection under a variety of Acts, and voluntary guidelines encourage habitat protection on private land.

- *Environment Protection and Biodiversity Conservation Act I 999 (Environment Australia)*

The *Environmental Protection and Biodiversity Conservation Act 1999* is a Commonwealth legislation introduced by Environment Australia to rationalise federal government provisions for impact assessment and matters of national environmental significance. Consequently the *Act* provides impact assessment processes for activities impacting on matters of national significance. These are assessed in terms of:

- all on-site and off-site impacts,
- all direct and indirect impacts,
- the frequency and duration of the action,
- the total impact which can be attributed to that action over the entire geographic area affected and over time,
- the sensitivity of the effected environment, and
- the degree of confidence with which the impacts of the action are known and understood.

Development proposals will also require federal government approval if they are likely to impact on issues of national significance (e.g., Ramsar Wetlands, or species or ecological communities presumed to be extinct, endangered or vulnerable). Ramsar Wetlands significance is assessed in terms of:

- areas of the wetland being destroyed or substantially modified,
- a substantial and measurable change in the hydrological regime of the wetland - for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland,
- the habitat or lifecycle of native species dependent upon the wetland being seriously affected,
- a substantial and measurable change in the physio-chemical status of the wetland - for example, a substantial change in the level of salinity, pollutants, water temperature or nutrients in the wetland which may adversely impact on biodiversity, ecological integrity, social amenity or human health, or
- the presence or increasing abundance of an invasive species that is harmful to the ecological character of the wetland.

Where proposed activities are likely to have significant impacts on extinct (presumed), endangered or vulnerable species or ecological communities, they will also require approval from the Environment Minister.

- *Nature Conservation Act 1994 (Queensland Environmental Protection Agency (EPA))*

The Queensland Environmental Protection Agency administers the *Nature Conservation Act 1992.* which has wide reaching powers for habitat protection. This *Act* seeks to conserve nature using integrated and comprehensive strategies for the dedication, declaration and management of protected areas and wildlife, based on the cooperative involvement and education of the community. The mechanisms established under the *Act* to achieve this for the whole of Queensland include:

- eleven classes of protected areas including national parks (scientific), World Heritage management and international agreement areas, national parks (Aboriginal land), nature refuges and coordinated conservation areas involving private property,
- six classes of wildlife: presumed extinct, endangered, vulnerable (collectively known as threatened wildlife), rare, common (these classes are collectively prescribed as protected wildlife), and international and prohibited wildlife (these classes relating to non-native

species),

- a legislative basis that protects the rights of Aboriginal and Torres Strait Island people to hunt and gather protected wildlife for traditional purposes,
- 'conservation plans' that can allow for the ecologically sustainable taking and use of protected wildlife from the wild for commercial or non-commercial purposes,
- codes of practice describing standards and procedures with which a person must comply if taking, keeping and using specific species of protected wildlife,
- controls on the commercial and non-commercial taking, keeping and use of protected wildlife;
- regulations on the keeping and use of restricted wildlife,
- 'interim conservation orders' to conserve, protect or manage wildlife, habitat or areas threatened by a process which is likely to have significant detrimental effect, and
- administrative processes including the appointment of conservation officers, maintaining registers, and publishing annual reports.

Although its primary target is nature conservation through the dedication, declaration and management of protected areas and wildlife, it also provides mechanisms for vegetation protection on private land. 'Interim conservation orders' are initiated under the *Nature Conservation Act 1992* to protect important, threatened, habitat areas. These can be served on freehold land if it is under pressure for development, including pressure from sugar industry expansion.

The *Act* also affects private landowners through 'conservation agreements', which can be used to conserve vegetation and control the use of resources on freehold land for long-term public benefit. Conservation agreements are used for areas supporting rare and threatened wildlife, critical wildlife habitat, protected area or areas of significant nature conservation interest. Private landowners manage these designated areas according to the specific terms of agreement. Conservation agreements are negotiated between the Environment Protection Agency and the landowner, and are binding on the landowner.

- *Vegetation Management Act 2000 (Queensland Environmental Protection Agency)*

The *Vegetation Management Act 2000* came into effect (on the 15 September 2000) to regulate the clearing of vegetation on freehold land. This *Act* is to be implemented through local government planning schemes, through extra codes for assessment, as well as through the enforcement of vegetation clearing provisions. The *Act* provides for the retention and maintenance of vegetation to prevent land degradation, maintain/increase biodiversity and ecological processes, as well as for the retention of riparian vegetation and vegetation clumps or corridors. The /Act will be implemented through regional vegetation management plans, land declarations and additional planning scheme assessment processes.

7.3.3 Water and related resources

Water resource management is particularly relevant for the sugar industry. Key pieces of legislation include the *Water Act 2000, Fisheries Act 1994* and *River Improvement Trust Act 1940.*

- *Water Act 2000 (Queensland Department of Natural Resources and Mines)*

The *Water Act 2000* is a piece of state legislation enacted to manage the sustainable use of water. The *Act* establishes tools to regulate the planning, allocation and use of water, and is relevant to environmental management in general, and to irrigated sugar production in particular.

The *Water Act 2000* requires the preparation of *water resource plans* and, if required, *resource operation plans.* A water resource plan describes what the government aims to achieve for a catchment's social, economic and environmental needs (e.g., for towns, industry, irrigation, mines, and natural processes). A resource operations plan details how these objectives will be achieved. It is the aim of both plans to:

- allow transparent sharing of water to protect environmental and human interests,
- make sure water users' allocations are secure for the life of the water resource plan,
- ensure that new allocations will be issued only if they can be sustained without undue environmental harm,
- establish a basis for water allocations, in nominated areas, to be permanently traded (transferred to another site or use), subject to certain conditions, and
- protect the health of rivers and underground water reserves.

Water resource plans will be prepared for each catchment and will apply to rivers, lakes, dams and springs, and they can also regulate the use of underground water and overland flow. Each plan is based on an assessment of the size and nature of the water resources in a catchment, and allocations are given to a variety of human and environmental uses (e.g., maintaining natural environmental flows) within each catchment. Strategies to improve water-use efficiency, measures to secure allocations, and monitoring and reporting reguirements are to be key features of water plans. Water-resource plans will be published as subordinate legislation to the *Water Act 2000.*

Resource operations plans will establish the rules for water trading, and how water use will be managed (for example water release from dams, water distribution to users, and environmental flows). High water-use areas will be the initial focus of these plans, however attention may be extended to cover entire catchments.

- *Fisheries Act 1994*

The *Fisheries Act 1994* establishes planning mechanisms for fisheries habitat protection and management, including the management of land-uses that impacts on the integrity of fisheries habitat areas. It provides for the allocation, use and management of fisheries resources and the 'protection, management and conservation of the marine environment' through licensing and establishment of Fish Habitat Areas (FHA) (State of Queensland 1994a). The *Fisheries Act 1994* regulates the management, use, development and protection of fisheries resources and fish habitats and the management of aquaculture activities. It also protects mangroves, and prohibits the disturbance of marine plants, shallow water sandbanks and tidal wetlands. While the *Act* has jurisdiction over marine resources it fails to account for fresh water wetlands (a key fisheries habitat), resulting in significant administrative difficulties. For example, it is unclear whether the DNR, DPI and DoE are responsible for the management of this habitat.

The Fish Habitat Code of Practice for cane growers *(FHC 003)* (Tapsall et al. 2000), for on-farm maintenance of fish habitats, has been developed for the statutory protection of fish habitats and marine plants on cane farms. It applies to marine fish habitats, specifically relating to the statutory protection of marine plants, under *Section 123* of the *Fisheries Act 1994. Section S 1* of the *Fisheries Act 1994* provides for permits, which must be held as authorisation for any disturbance of marine plants. In order to address the requirements of the *Fisheries Act 1994* for fish habitat protection, and to cater for drainage requirements of cane growers, a strategic permit system has been developed as an alternative to the traditional individual permit system. The Fish Habitat Code of Practice details the code of practice for cane growers to follow as a condition of the CANECROWFRS strategic permit. Accredited growers potentially benefit from the reduction in time and costs involved in the individual assessment of permit applications for on-farm drain maintenance, while fisheries potentially benefit from a shared understanding of fisheries values, improved drainage practices and fish habitats. Compliance with the *Fish Habitat Code of Practice (FHC003)* meets the requirements of the *Fisheries Act 1994.* Compliance with this Code of Practice may not equate to compliance with the 'general environmental duty under the *Environmental Protection Act 1994.* This *Act* will have an impact on riparian vegetation management where marine plants are involved.

- *River Improvement Trust Act 1940*

The *River Improvement Trust Act 1 940* seeks to protect and improve the bed and banks of rivers. This can involve directly repairing or preventing damage to the bed and banks, reducing risks of flooding and reducing the impacts of floodwaters on inundated land. The *Act* establishes *River Improvement Trusts (RITs)* to undertake works within the river improvement area. Examples of works include:

- preventing soil erosion from the bed or banks of a river or adjacent lands,
- repairs of river bank damage caused by floods or cyclones,
- planting and maintaining trees, grass, or other plants,
- alteration or stabilisation of the course of a river, or defining the course of a river traversing poorly drained land,
- deepening, widening, straightening or improving the course of a river,
- preventing siltation in the river,
- preventing or mitigating the inundation of land by floodwaters from a river, or
- preventing erosion by tidal waters or waters of a coastal lake or lagoon.

Therefore, developing land for growing sugar that requires these types of works should be coordinated through the *River Improvement Trust.*

- *Environmental Protection Act 1994 (Queensland Environmental Protection Agency and Local Governments)*

The *Environmental Protection Act 1994,* while not a strategic planning act, is aimed at minimising pollution and other forms of environmental damage and is administered by the Queensland Environmental Protection Agency. It integrates into local government development assessment processes through the integrated development assessment system (IDAS). The *Environmental Protection Act 1994* focuses primarily on the control and licensing of 'environmentally relevant activities' and has powerful provisions to prosecute any parties causing wilful 'environmental harm' (State of Queensland, 1994b).

Similarly, this *Act* plays an important role in the processing aspects of sugar production. Sugar mills are licensed as 'environmentally relevant activities', thus requiring that wastes and pollutants be monitored and kept within defined standards. 'Environmental protection policies' under the Act provide further detailed guidance for the management of specific aspects of the environment (e.g., air, noise, water and waste pollution). They set objectives, programs to achieve the objectives and indicators, parameters, factors and criteria to measure environmental quality.

The *Act* also establishes a 'general environmental duty', which means that a person must not cause environmental harm unless they have taken all reasonable and practicable measures to prevent or minimise the harm. A person cannot be prosecuted for failing to fulfil their general environmental duty. However, an environmental protection order may be issued to secure compliance with the general environmental duty and, if this is contravened, the person responsible can be prosecuted.

In addition, the *Environmental Protection Act 1 994* makes provisions for environmental codes of practice, such as the 'Code of Practice for Sustainable Cane Crowing in Queensland'. Farmers following the management provisions contained within the code are acting in accordance with their general environmental duty of care under the *Act.* However farmers that do not act in accordance with the Code and cause environmental harm could be liable under the *Act.*

- *Pesticide Regulations*

The *National Registration Authority for Agricultural and Veterinary Chemicals* (NRA) is the Australian agency responsible for the assessing and registering agricultural and veterinary chemical products prior to sale, as well as their regulation up to, and including, the point of retail sale. The NRA, with the active involvement of other Commonwealth agencies, administers the 'National Registration Scheme' (NRS) in cooperation with both states and territories. The NRA's specific role, within the NRS, is to assess the performance of chemical products, and their impact on people and the environment. The NRA also determines any potential threat to international trade, and regulates the supply of agricultural and veterinary chemicals to the Australian market by approving product labels and specifying conditions of use. The national registration legislation comprises the following seven Acts:

1. *The Agricultural and Veterinary Chemicals Act 1 994* [No. 36 of 1 994],
2. *The Agricultural and Veterinary Chemicals Code Act 1 994* [No. 47 of 1 994],
3. *The Agricultural and Veterinary Chemicals (Consequential Amendments) Act 1994* [No. 37 of 1994],
4. *The Agricultural and Veterinary Chemical Products (Collection of Levy) Act 1994* [No. 41 of 1994],
5. *The Agricultural and Veterinary Chemical Products Levy Imposition (Customs) Act 1994* [No. 39 of 1994],
6. *The Agricultural and Veterinary Chemical Products Levy Imposition (Excise) Act 1 994* [No. 38 of 1994], and
7. *The Agricultural and Veterinary Chemical Products Levy Imposition (General) Act 1994* [No. 40 of 1994].

Through its 'chemical review program', the NRA conducts reviews of registered agricultural and veterinary chemicals. Reviews are conducted to ensure that chemicals registered in the past meet current standards of registration. Reassessment is important because regulatory standards have become more stringent over the years, as more scientific data pertaining to the possible effects and longer-term impacts of chemicals have become available. Chemicals are reviewed when there are concerns about possible effects on human health, worker safety and potential hazard to the environment.

Suppliers of these products can check the registration status of chemicals. Alternatively, the NRA allocates a unique registration number (that is printed on the bottom of the product label) that ^*jn* be used to verify a product's registration status. The words *"NRA Appro\al No."* always appears in front of the number. The last four digits indicate the date when the *NRA* most-recentiy assessed the product. Some older chemical products may not have an NRA number, but a supplier should still be able to check the registration status of any product. Generally, it is illegal to use farm chemicals lor a non-registered purpose. The label is a legally binding document, and anyone who uses a product, for purposes other than those listed on the label, is breaking the law. Permits are available from the NRA for minor off-label uses, or uses in special and emergency situations; anyone can apply.

7.3.5 Non-statutory requirements for land management

In addition to these legislative requirements, there are other arrangements, including non-statutory plans and programs, which have requirements for environmental planning and management. These arrangements are relevant to planning and ongoing management of the sugar industry. Examples of these arrangements include: Integrated Catchment Management Plans, Greening Australia, Conservation Foundations and Landcare. They include integrated catchment management, 'best management practices' (BMPs), such as the Cane Growing Code of Practice, and property management planning processes.

- *Integrated Catchment Management (ICM)*

ICM in Queensland is founded on a community-based approach to water-related natural resource management, and works by fostering voluntary changes in the way people use and manage their natural resources. ICM plans address a range of local environmental and land-use planning issues, such as: maintaining healthy streams and protecting riverine ecosystems; improving water quality; reducing catchment impacts to downstream environments; preserving and managing important wetland and riparian vegetation; integrated flood mitigation controls, etc. Catchment management groups have assisted in the implementation of land, water, stream and habitat management in sugar producing areas. Examples of activities and programs undertaken include the protection, rehabilitation and construction of wetlands, replanting of riparian /ones, water waich and acid sulfate soil programs.

The Department of Natural Resources and Mines is the lead government agency in Queensland for implementing ICM. Other state government agencies, such as Department of Primary Industries, Department of Local Government & Planning, and the Environment Protection Agency also play a role in promoting and supporting relevant aspects of the ICM policy initiative.

Since the inception of ICM in Queensland, successful implementation has been impeded by the inability of catchment management groups to influence land-use planning and management. Until the mid to late 1990s, local governments had a limited role in rural land-use planning and in the management of natural resources generally (McDonald and Bellamy 1997). More specifically, ICM principles and catchment management issues were not traditionally incorporated into, or acidressed by, local planning schemes. Historically, local government planning schemes have been applied mostly to urban areas and to the expansion of urban related uses into rural areas. Local governments have always been a significant provider of rural roads, and are key players in localised resource management matters, such as drainage and water resources. The development and management of rural natural resources for agriculture and forestry, and the protection of environmental quality and nature conservation has been historically a state agency matter in Australia (McDonald and Bellamy 1997). Additionally, the conservation and management of natural and rural lands has been achieved mostly through programs such as Landcare, that foster voluntary changes in the way people use and manage their natural resources (ICM/Landcare Review Committee 1997). There is no specific legislation for ICM and consequently catchment management groups do not have the statutory power to implement management strategies (Department of Primary Industries 1993).

Partnerships between catchment management groups and local governments are now being formed across Queensland, and local governments are taking greater responsibility for the implementation of ICM principles and strategies. This is occurring through local government planning schemes and through locally funded ICM projects. These partnerships are the result of improved communication between catchment committees and local governments, a better understanding of the principles and objectives of ICM within local government and an improved recognition of the role of local government in the management of natural resources (Vella 1999).

- *Code of Practice for Sustainable Cane Growing in Queensland*

The 'Code of Practice for Sustainable Cane Crowing in Queensland' was developed with input from a broad range of stakeholder groups. To help minimise the risk of environmental damage resulting from growing sugar-cane, it provides advice and instructions on the best procedures to be followed and pitfalls to be avoided. It aims to explain, in cane-growing-terms, some reasonable and practical measures for minimising the risk of environmental harm (CANEGROWERS 1998). In particular, it highlights issues related to developing new cane land (e.g., consideration of stream bank and remnant vegetation, wetlands, and drainage) and on established farms (e.g., vegetation management, fertiliser application methods and rates, and use of chemical). The Code is a legal defence under the *Environmental Protection Act 1994.* Farmers are encouraged to follow the Code unless they can discharge their 'duty of care' in other practicable ways (CANEGROWERS 1998).

- *Land-use Practices for Wet Tropical Floodplains*

The Book *Land-use Practices for Wet Tropical Floodplains* (Dawson 1 998) provides guidelines for best management practices specifically for development of agricultural land on Queensland's wet tropical coast. It focuses primarily on the agricultural development of floodplains (where cane land expansion is occurring), but is applicable to land management beyond the floodplain. The guidelines suggest specific land allocation and management strategies that reflect the principles of ecologically sustainable development. They suggest measures to overcome problems arising from new developments and ways to rehabilitate and manage degraded lands. It is anticipated that the information contained in the guideline will be incorporated into coordinated drainage plans, catchment plans and local government planning schemes for wet tropical floodplains.

There is an increasing public expectation that both growers and millers should abide by, and help to implement, these plans and practices. Failure to implement non-statutory requirements (such as the 'Code of Practice for Sustainable Cane Growing in Queensland') when planning for sugar industry expansion will affect the long-term viability and sustainability of sugar-cane growing.