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PREFACE

The papers included in this publication follow on, but are independent from, papers published in the booklets *Biodiversity - Broadening the Debate* published by the Australian National Parks and Wildlife Service (now the Australian Nature Conservation Agency) in 1992 (ISBN No. 0 642 17378 8) and *Biodiversity - Broadening the Debate 2* published by the Australian Nature Conservation Agency in 1994 (ISBN No. 0 642 20184 6).

The articles herein are in no way to be construed necessarily as representing the views of the Australian Government or the Australian Nature Conservation Agency.

Peter Bridgewater
Chief Executive Officer

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A NATIONAL BIOLOGICAL SURVEY FOR THE UNITED STATES? COMPARABLE AUSTRALIAN ACTIVITIES AT THE NATIONAL LEVEL

J.R. Busby and D.W. Walton

This is a modified version of that presented to the Committee on the Formation of the National Biological Survey for the National Research Council, U.S.A.

INTRODUCTION

Australia should be cautious in offering advice to the US on a National Biological Survey and the US should be equally cautious in assessing the lessons drawn from Australian experience. For all the similarities between our nations: comparable land area, a Federal-State structure, a first world scientific infrastructure, there are many differences. Unlike the US, the bulk of the Australian continent is very sparsely populated, the balance of federal-State responsibilities for management of the natural environment is quite different and the small population of scientists relative to the land area and high biodiversity is more akin to that of one of the western states of the U.S.

There are, however, some strategic issues, key concepts and implementation issues which we believe are shared and which have been fundamental to the way Australia is designing environmental information systems to underpin our efforts to achieve ecological sustainability.

STRATEGIC ISSUES

Biodiversity, conservation and management are all inherently multi-faceted issues. There is inevitably a large number of interest groups involved. In our view, unless all the players in the game (stakeholders) are able to contribute effectively, then such a program is unlikely to achieve its objectives. This suggests that the distributed network concept is the most appropriate model, where many groups contribute but with firm central strategic priority setting and coordination.

Nature conservation, the management of human impact on the environment, is not the private fiefdom of government agencies and is much too important to be left to a few scientists and administrators, no matter how dedicated. There is no need to repeat the previous experience with a biological survey. Unless there is public understanding and commitment to the conservation of biodiversity, the new proposal will be just another sink for resources. We are not aware of any significant component of the biological survey devoted to public education and participation. We have not yet managed to make that a sufficiently high priority in Australia, although there have been very successful national programs utilising volunteers to census birds (Blakers, Davies & Reilly, 1984) and banksias, a charismatic group of Australian Plants (Taylor & Hopper, 1988). A comparable program to monitor frogs is currently under way.

We note from the press release "USDOI: NBS Reorganizes Research" that "Its function will be to provide information for resource managers. The resource managers will retain responsibility for management decisions, and the decisions confronting them will largely shape the agenda of the NBS". The Draft of "A Proposal To Establish A National Biological Survey Within The Department of the Interior", dated

March 23, 1993, similarly notes "The foremost consideration of the NBS will be to meet the needs of operational resource managers". This focus is the one we have adopted and we strongly commend it to the NBS.

Overcoming the historical tensions between researchers and management will prove a formidable challenge, but one which is essential to meet. It would be all too easy for a biological inventory to become a stamp collecting exercise, albeit a very sophisticated one. An even bigger danger is that it becomes a program to support professional hobbies rather than priority national interests. Scientific excellence is but one necessary, but well short of sufficient, component of such a program. Unless an imperative to provide information essential to support environment policy makers and land managers is built in at the outset, a biological survey will be vulnerable to capture by special interest groups, in particular the research community.

Research provides information that may be used to gain greater understanding. Answers provided by research are, however, no better than the questions asked. These questions, because of the scientific method, are highly reductionist in character. Management, on the other hand, is fundamentally about people and therefore requires a holistic approach. No doubt more research is needed, but part of that needed research is the evaluation of what we already know. The point needs to be emphasised that we do not need further research to begin to improve water quality, air quality, waste management and land use allocation, to minimise species losses and ameliorate a wide range of deleterious human impacts.

Research results in any case are not necessarily incorporated into the decision making process. Decisions are run through a cultural filter which accepts or rejects information on other than 'objective' criteria. Until we begin to apply what we already know, however inadequate, and critically evaluate what we apply, research results will continue to be of secondary importance.

We detect already in the NBS proposals a focus on the collection of input data, with only general statements as to what the data will be used for and how the information will empower decision makers and land managers, let alone the wider community.

Ecological sustainability is, or should be, the overriding national goal to which a National Biological Survey must contribute. All the objectives of the NBS should be framed with this goal in mind. This goal must be foremost in the thinking of managers at all levels.

As we all know, plants and animals are not distributed randomly, but generally follow gradients strongly influenced by factors such as climate, topography and substrate. These patterns show little relationship to current political and administrative boundaries. Legislative, regulatory and administrative structures must come to explicitly accommodate biodiversity patterns as well as human perceptions of the environment. A bio-cultural regional overlay for management for a sustainable society should be considered. As noted above, the major problem is the impact of people on the environment and the level at which we must begin to manage this problem is at the landscape level.

Scientists can argue endlessly over what constitutes a landscape, but the final arbiters are the people who feel that they and the surrounding lands, waters, flora and fauna are the identity of a 'landscape'. People must 'own' the landscape, accept the responsibility for its maintenance and reap the benefits. If people become alienated from their landscapes then neither will survive.

One issue which we believe should receive special attention is that areas set aside as protected areas must be part of a larger plan, a part of a landscape or bio-cultural region. This explicitly recognises that all areas are important and have something to contribute to the maintenance of natural values.

There is little doubt that, unless protected areas are set within a greater regional management framework, they will become islands of isolation in seas of desolation. It is naive to believe that a statute and a fence will separate the protected from the unprotected and sustain all the values of the former in perpetuity.

We must be cautious about turning protected areas into experimental hobby farms, where scientists can continue to pretend that people and their impacts don't exist. In a world climbing to a human population of 10 billion, this view is unrealistic.

One of the fundamental characteristics of natural systems is change. There is an extraordinary tendency for human agencies not only to resist change but to deny it. Any organisational structure, policy or program related to the biosphere which fails to maintain adaptability or seeks to return to some real or imaginary past will serve future generations poorly.

RELEVANT AUSTRALIAN PROGRAMS

Apart from the Australian Geological Survey Organisation and the Bureau of Rural Sciences, the most significant environmental programs under way at the national level in Australia are encompassed within the Ministry of the Environment, Sport and Territories, in particular the Australian Nature Conservation Agency (ANCA) [formerly the Australian National Parks and Wildlife Service (ANPWS)]. There are numerous relevant regional-scale programs under way in the various Australian States and Territories which are not considered in this paper.

The Environmental Resources Information Network (ERIN) was initiated in 1989. ERIN's mission is "To provide geographically related environmental information of an extent, quality and availability required for planning and decision making". The role of the ERIN is to provide infrastructure support, not to make decisions.

The precise boundaries of the ERIN's sphere of interest are very difficult to define and we suggest that will also be the case with the NBS. The vision is to provide datasets and tools to end users, who will then use these to access information to solve their particular problems. Given the general low level of experience with, not to mention understanding of, the potential uses of environmental information systems among policy makers and land managers, this vision is proving very difficult to actually implement. The ERIN Unit has, therefore, become involved in running projects on behalf of clients. The intention is, however, to progressively transfer technology and expertise into client areas. This will empower clients, over the medium to long term, to address their own needs themselves using the resources of the network, rather than becoming reliant on a central service agency. The ERIN has 20 staff and a budget of A$2.4M.

The ERIN has a very similar role in Australia to that proposed for the NBS. We might add that we are rather envious of the $180M program budget and 1600 scientists and support personnel envisaged for your program.

The Australian Biological Resources Study (ABRS) was initiated in 1973. Its role is to coordinate the national effort to document the biodiversity of Australia and its external territories. The program has allowed Australia to marshal existing expertise in taxonomy and to focus on gaps. National surveys have revealed that taxonomic

expertise was concentrated in certain areas, namely vascular plants, vertebrate animals and those invertebrate groups of direct economic or public health significance. Other major groups are, by comparison, very poorly known.

Since the program's inception, some A$16M in research grants has been provided and 13 volumes of the *Flora of Australia*, nine volumes of the *Zoological Catalogue of Australia* and one volume (in two parts) of the *Fauna of Australia* have been published. A range of other publications has also been produced, including a four-volume *Australian Plant Name Index* of the vascular plants.

The most impressive achievement of the ABRS to date has been almost 20 years of unique cooperation between the national and state governments, and also with the scientific community. Most of the research and documentation of the flora and fauna has been undertaken by staff of museums, herbaria, universities and the CSIRO, not only in Australia but also elsewhere. The ABRS, meanwhile, has performed an accepted and acknowledged national leadership and coordination role. Next year, ABRS will have 20 staff and a budget of A$3.1M.

The Australian National Botanic Gardens (ANBG) grows and displays the Australian flora, with one third of the known vascular plant taxa in cultivation. It places special emphasis on rare and endangered species. Its research activities include Australian and related species. To fulfil its role, the ANBG uses an integrated botanical information system linking its living collections with preserved voucher specimens. The ANBG has a policy of providing all its base-line biological data freely in electronic form over the Internet and acting as a conduit for other biological information of relevance to the study, conservation and interpretation of the Australian Flora.

The ANBG uses, promotes and contributes to the development of internationally accepted standards and conventions in the exchange and storage of biological data. The ANBG participates actively in national and international networks of biological institutions in the collaborative development and exchange of information bases, data standards and analysis tools. Next year the ANBG will have 70 staff and a budget of A$4.7M.

The Endangered Species Program (ESP) aims to prevent the extinction, due to human causes, of endangered native flora and fauna; prevent further species and communities from becoming endangered; and to return endangered species and communities to a secure status in the wild. An Act of Parliament came into force on 30 April this year. Three strategic overviews have been prepared (birds, fishes and reptiles) and five are in preparation. Recovery plans are being implemented for 48 species. Plans are being prepared or research is under way on a further 66 species or ecological communities. Threat abatement projects have commenced for foxes, cats and fungus-induced plant dieback. Next year the project will have 11 staff and a budget of A$5M.

The Commonwealth Environment Protection Agency (CEPA) within the Department of the Environment, Sport and Territories has the responsibility of producing national State of Environment (SoE) reports. Design of the SoE framework is currently under way.

KEY CONCEPTS

In our view, the following concepts are essential ingredients for success:

- distributed network
- custodianship
- primary attribute data
- standards

DISTRIBUTED NETWORK

Network encompasses not only a physical communications network but also, and more importantly, organisational and peer networks. Responsibility for achieving a national biological survey must be shared among all the stakeholders throughout the country, even around the world. One node in the network, however, must be ultimately responsible for the national coordination and strategic development of the program. It is possible for this node to remain comparatively small, yet mobilise a workforce of literally thousands.

The network is the means by which biological and environmental information flows from those who have it to those who need it. Decisions affecting biodiversity and the environment are being made continuously at all levels of society in the government, non-government and private sectors. Information that is not readily available to decision makers at the time the decisions are made is irrelevant, regardless of its potential to contribute. Data that are poorly organised, inaccurate or too difficult or too expensive to access are equally useless, again regardless of potential.

CUSTODIANSHIP

Custodianship is the means by which responsibility for every dataset is assigned to the most appropriate agency. It provides a mechanism to ensure that each dataset is established, maintained and made available on the network by that agency best able to do so. Every dataset should have one and only one custodian. Copyright and intellectual property can be shared among agencies, custodianship cannot.

A custodian should consult with all users and potential users of that dataset and ensure that, as far as practicable, their requirements are taken into account. All datasets required in environmental spatial information systems are complex and specialist knowledge is required for their establishment and maintenance. The concept of custodianship also includes responsibility for appropriate modelling and analytical tools, including expert systems and decision support systems.

There is an important distinction between data themes and datasets. A theme, such as vegetation, can comprise a large number of diverse datasets. Responsibility for an entire theme could be allocated, for administrative convenience, to one particular agency. That agency may then become the custodian of one or many vegetation datasets. Such an administrative arrangement, however, must not preclude other agencies from developing vegetation datasets to meet their own objectives and for which they would then become custodians. A good example is the defence forces wishing to develop a vegetation dataset that would guide them in planning heavy vehicle training exercises. The attributes needed for that purpose would be different from virtually all other agencies. They would thus develop and maintain that dataset and, in principle and assuming there were no security implications, make it available to other agencies. Custodianship, therefore, applies at the dataset level; it cannot be applied at the data theme level.

Even superficially simple datasets like a digital representation of a coastline will prove, on even cursory analysis, to be highly complex. Issues such as: What is the optimum scale or scales to represent the coastline? (Because coastline is essentially a fractal phenomenon, its length increases dramatically as the map resolution increases). Should one map low water, high water or both? If so, which low and high water? How do you cope with estuaries and deltas, an arbitrary distance inland, furthest intrusion of saline water and, if so, on what kind of tide? Are mangroves regarded as terrestrial

or marine, *i.e.* on which side of the mangrove zone does the coastline fall? Are islands part of the coast, if so what size of islands are represented and does distance from the coast matter? How do you handle highly mobile sand bars that may only be exposed at low tide?

A standard coastline or series of coastlines is a nationally important dataset. The point of this example is to indicate that many of the datasets which will be fundamental to a national biological survey are equally complex and require specialist agencies to develop. It can be frustrating to have to wait for some strategically significant dataset to be developed by an agency over which one has no direct control but, in the meantime, interim versions or surrogates may be available. It is important, however, to discourage agencies from digitising or otherwise capturing data for which they are not and will not be the eventual custodians unless, of course, they do so by agreement with the custodian and according to the custodian's specifications. One only has to contemplate the inefficiencies of trying to integrate datasets from different agencies built on, for example, different and incompatible versions of the same coastline.

Nationally significant datasets require priority attention and should be maintained by some national custodial agency. An exception is where it is more efficient to regionally distribute designated subsets of the data, in which case the dataset must be coordinated and standardised by a national agency. On the other hand, datasets which are regional in focus should be maintained by an agency within or responsible for that region, rather than centralised in a national agency or the head office of that agency.

The bottom line is that each nationally significant dataset needs to have one and only one explicitly assigned custodian.

PRIMARY ATTRIBUTE DATA

All entities with which a biological survey will be concerned will have attributes. Some of these attributes are factual: latitude and longitude of the place where an observation was made, date of that observation, height of a tree, weight of an animal, number of petals in a flower, mean annual temperature of a site, water holding capacity of a soil profile. These are all primary attributes which can be measured or otherwise described against a stable, objective or widely accepted standard.

Derived attributes are those developed from primary attributes through some process of interpretation or classification according to some paradigm applied by an observer at the time, or subsequently. These can include: species name, soil type, vegetation height class, climate zone. In general, derived attributes should not be stored in an information system unless the primary attributes from which they were derived are also available. Why? Because, as concepts and paradigms change, derived data become severely degraded in value and may even become useless. For example, if the only representation of a species distribution is a polygon coverage in a GIS, this distribution becomes useless if that species is split or otherwise disaggregated following a taxonomic revision.

This principle needs to be applied intelligently. No one, for example, would refuse to store species names, even though they can be quite dynamic. It boils down to risk assessment. Given the high costs of recollecting data, particularly on a continental scale, we should minimise the risk of datasets becoming obsolete. We must not allow ourselves to be placed in the position of having to use datasets which are known to be deficient but which are too costly to replace or upgrade.

It is essential that explicit priorities be set for the collation, validation and maintenance of key national and regional datasets. In general, it is better to build nationally consistent datasets at coarse resolution and progressively refine the resolution than to try to bolt together higher resolution but non-congruent local-scale datasets. All existing datasets have a contribution to make, but only in the context of explicit strategic frameworks which control the timing of dataset incorporation into the national system. If priorities are not set, the program risks being bogged down in a data morass.

STANDARDS

Standards are the means by which information is communicated between people and are thus vital in any information system. Standards encompass the selection of attributes representing the phenomenon under investigation, the meaning of those attributes (nature and range of allowable values) and how those attributes are to be communicated among stakeholders. Priorities for standards need to be established with reference to the data input requirements of key modelling and analysis tools.

Standards need to be developed and require a real commitment of resources, largely intellectual resources. They cannot be ignored, taken for granted or left to a few technical experts in obscure corners of the odd agency. They require real management attention and persistence; developing standards will not be easy.

Recognising that the path to formally certified international standards is inevitably long and tortuous and that progress will be extraordinarily slow, each national system must develop its own interim standards, preferably building on experience available within the international networks.

Standards is one area where the ERIN has not performed well, although we actively participate in all relevant national and international fora, such as the Standards Subcommittee of the Commonwealth Spatial Data Committee and the International Organisation for Plant Information (IOPI). The ERIN has drafted a set of national standards for biological site data. The ERIN is also collaborating with the Australian National Botanic Gardens in the development of an exchange protocol for herbarium specimen data (HISPID). We should, of course, be doing much more.

IMPLEMENTATION ISSUES

Apart from the well accepted need for clearly and widely understood missions, goals, strategies, objectives and performance indicators, by far the greatest challenge to implementing a National Biological Survey are the organisational, ultimately people, issues.

Technology is unlikely to prove a major issue in terms of capacity to support such a program, at least in the medium to long term. It is vitally important, however, that the information management systems be well designed at the outset.

We don't propose to address the scientific issues: How do we model biological processes in space and time? How do we tackle landscapes? Exactly what is an ecosystem? Are the data of adequate quantity and quality to support some particular model or analysis? And so on. We assume these are being adequately canvassed within the U.S. scientific community.

Since biodiversity, ecosystem, habitats and landscapes are spatially distributed, a high capacity spatial information system is essential. This would comprise the following components:

- processing capacity (considerable)
- storage capacity (vast)
- database management system (relational or object oriented)
- geographic information system
- image analysis system
- publication (multimedia) and distribution system
- modelling and analytical toolbox (including expert and decision support systems)
- easy-to-use query interfaces that require little or no training

Considerable resources will need to be allocated to liaison, particularly client liaison.

In essence, the roles of the central agency should be:

- to set goals, strategies and objectives in consultation with the stakeholders, in particular land managers;
- to develop performance indicators and use these to monitor achievements;
- to act as an honest broker to all sides of conservation issues through a thoroughly professional approach to data acquisition, management, analysis and distribution;
- to develop or contribute to the development of standards of all kinds;
- to marshal the existing data estate and to validate and enhance information;
- to identify gaps and develop strategies to address them;
- to develop/facilitate appropriate modelling and analysis tools;
- to facilitate the interchange of data, information and analysis tools among the stakeholders.

The program goals should be framed in terms of ecological sustainability of the quality of life and intergenerational equity. The key to the overriding organisational and people issues is the concept of ownership. If the NBS can foster a sense of ownership in the program by the key stakeholders, including the wider community, then it will succeed. If not, it will fail.

ACKNOWLEDGEMENTS

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THE ROLE OF INFORMATION IN PUBLIC POLICY

Roberta Balstad Miller

This essay was originally presented in slightly different form at the Second International Conference/Workshop on Integrated Geographic Information Systems and Environmental Modeling, Breckenridge, Colorado, USA, on September 26, 1993.

Electronic technologies and communications are propelling us into a new era in human history. The use of the computer in word processing and information retrieval has been compared, particularly in its social and intellectual implications, to the invention of printing in the fifteenth century[1]. The advent of global communications networks and our rapidly expanding capacity to store, manipulate, model, and process data promise to have an even greater impact on human society and politics. We are, in essence, creating a new context within which the lives of men and women, and the fortunes of nations and empires, will be played out - a context unlike anything we have previously experienced.

This paper examines some of the implications of this new information era for public policy[2]. It is not my intention to try to predict the shape or the nature of society or policy in the future. Rather, I will discuss 1) some of the technological innovations that are making this new information era possible; 2) ongoing technical and scientific problems that inhibit our ability to make full use of these information innovations in public policy; and 3) the dangers and the opportunities that the information era poses for public policy.

I. WHAT IS NOW POSSIBLE?

Electronically, we can communicate in real time with people around the world. We have computers that can store and manipulate immense quantities of information. We can array this information in a geographic information system (GIS) that simultaneously incorporates data on economic and social attributes and on physical conditions above and below the surface of the earth. We can use models with GIS, and we can also share data, creating archives without walls - virtual data archives where the data are stored and updated in locations around the world, even as they are made accessible as part of the same global electronic data system.

Much of the new information-sharing technology is being developed within the scientific community for research on global environmental change. In part, this is serendipitous. The expansion of information technologies occurred at about the same time as political and scientific interest in global environmental change intensified. In part, however, this development is also quite logical. Global change research requires vast quantities of disparate data on a global scale. Twenty, even ten, years ago, much of the research currently underway could not have been undertaken because we lacked the capacity to either acquire, manipulate, or analyse such large data bases.

One example of the new data-sharing technologies is CIESIN, The Consortium for International Earth Science Information Network. CIESIN was created by the U.S. Congress to provide data on human interactions in global environmental change.

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Established during a period when the Administration was reluctant to invest in the infrastructure necessary to understand environmental change, CIESIN was placed within the Mission to Planet Earth program at the U.S. National Aeronautics and Space Administration (NASA). With its focus on socioeconomic data and information, CIESIN has been very much a foreign element in an agency devoted primarily to space technologies and secondarily to earth science. Nonetheless, it is a credit to NASA leadership that they took what was an unanticipated (and unrequested) mandate from the Congress and made CIESIN a part of the larger Earth Observing System Data and Information System (EOSDIS).

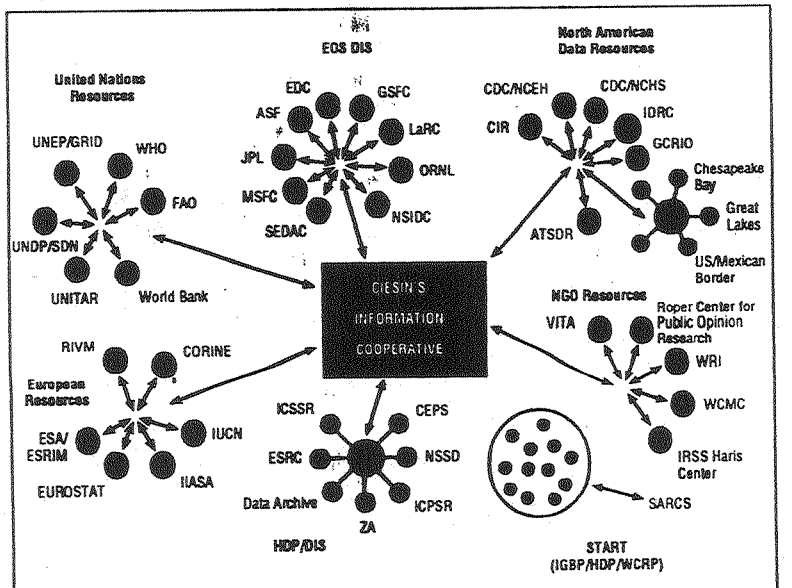
EOSDIS now consists of nine data and information centres, eight of which are charged with providing specific types of natural science data for understanding global change, and one, CIESIN's SEDAC (the Socioeconomic Data and Applications Center), charged with providing socioeconomic data on the anthropogenic causes and impacts of global change. These data are intended for use in research, in policy-making, and in education. Given the very different types of data and user communities in SEDAC and the other EOSDIS centres, it is to be expected that there would be some difficulties in coordination. Under the circumstances, however, there has been remarkable progress in moving toward interoperable systems.

CIESIN obtains data for SEDAC through the Information Cooperative, an international network of data collecting institutions and archives that have agreed to catalogue and share their data electronically through CIESIN. The Info Coop plays the role within SEDAC that the satellite Earth Observing System plays within the other EOSDIS centres. In a very real sense, it is the platform for another kind of earth observing system, one which is closer to earth, observing and recording the economic and policy climate, the ecology of transportation and settlement, and the dynamics of anthropogenic emissions and pollution. Members of the Information Cooperative range from United Nations agencies and regional statistical organisations to social science data archives and data collecting organisations with an interest in the environment (see attached diagram).

Given the rapidly advancing technology for data collection, analysis, and sharing - and our deepening scientific understanding of global environmental change - Dr. John Gibbons, Director of the White House Office of Science and Technology Policy (OSTP), has made public policy utility a priority for the U.S. Global Change Research Program. Implicitly using an argument that can be traced back to Plato, who envisioned a world where wise and informed men rationally discussed alternative policies, and only then determined affairs of state, Gibbon wishes to see U.S. global change research and data programs directed toward policy needs. In effect, this will require that the capacities of the information era be made available for use in environmental policy so that they can be instrumental in creating a world in which those who are responsible for policy and governance have ready access to the data and information they need for reasonable, just decisions.

This is the basic argument. Unfortunately, it is something of an unrealised Platonic ideal itself. In the real world, policy makers almost never have the luxury of disinterested contemplation in decision making. We have only to look at the recent debate and vote in the U.S. Congress on NAFTA to recognise that political decisions are an amalgam of long- and short-term priorities, the influence of constituents, and the need for political compromise. In this political arena, data and information often are eclipsed by the imperatives of the political process.

Diagram 1. CIESIN's Information Cooperative Development Plan



ACRONYM LIST

United Nations Resources

UNEP / GRID	United Nations Environment Programme / Global Resource Information Database
WHO	World Health Organization
FAO	Food and Agriculture Organization
UNITAR	United Nations Institute for Training and Research
UNDP / SDN	United Nations Development Program / Sustainable Development Network

EOS DIS — NASA's Earth Observing System Data and Information System

EDC	EROS Data Center
GSFC	Goddard Space Flight Center
LaRC	Langley Research Center
ORNL	Oak Ridge National Laboratory
NSIDC	National Snow and Ice Data Center
SEDAC	CIESIN's Socioeconomic Data and Applications Center
MSFC	Marshall Space Flight Center
JPL	Jet Propulsion Laboratory
ASF	Alaska SAR Facility

North American Data Resources

CIR	Center for International Research (U.S. Census Bureau)
CDC	Center for Disease Control
ATSDR	Agency for Toxic Substances and Disease Registry
IDRC	International Development Research Center
USDA	U.S. Department of Agriculture
MDNR	Michigan Department of Natural Resources

European Resources

RIVM	National Institute of Public Health and Environmental Protection (The Netherlands)
CORINE	Coordination of Information on the Environment
IIASA	International Institute for Applied Systems Analysis
EUROSTAT	Statistical Office of the European Communities
JRC	Joint Research Centre

HDP / DIS

ESRC	Economic and Social Research Council
CEPS	Centre d'Etudes de Populations, de Pauvrete et de Politiques Socio-Economiques
NSSDS	Norwegian Social Science Data Services
ICPSR	Inter - university Consortium for Political and Social Research
START	IGBP's Global Change System for Analysis, Research and Training
SARCS	Southeast Asian Regional Committee for START

NGO Resources Non - Governmental Organization

VITA	Volunteers in Technical Assistance
IUCN	International Union for the Conservation of Nature
WRI	World Resources Institute
WCMC	World Conservation Monitoring Centre
CITAS	China In Time And Space

Clearly, the goal of serving the national interest by providing a sounder informational base for public policy is one that everyone in Australia and the United States could support. Just as clearly, however, we need to go beyond the rhetoric of "meeting policy needs" to identify what these needs are. For example, policy analysts provide data and information to those who are in positions of policy responsibility. These policy analysts, some of whom work for elected officials and some of whom work in public, non-governmental capacities, are the real links between decision-makers and sources of data and information[3].

II. TECHNICAL AND SCIENTIFIC PROBLEMS

But before policy analysts can take full advantage of new information-rich technologies in environmental policy and assessment, we must first deal with a number of scientific and technical problems, for politics, as Bismarck reminded us, is the art of the possible, not necessarily what is desirable. This brings me to my second topic - the significant technical problems we face in developing policy-useful data systems. Among them: 1) the need to create merged data sets (*i.e.*, data sets which encompass both socioeconomic and physical/biological data); (2) the need to develop both time-series databases and baseline data; and (3) the need to expand data access and electronic capability in developing countries.

A. The need for merged data sets

Our capacity to create extensive, sophisticated data bases has developed within the traditional parameters of distinct scientific disciplines or fields of inquiry. That is, the data bases we construct are in most cases intended to answer specific research questions. These questions arise from both disciplinary research concerns and, increasingly, from multidisciplinary concerns in evolving research fields such as global environmental change. Because of these disciplinary origins, there is a significant gap between data bases constructed for use in the social sciences and those developed for research in the natural sciences. This divide persists, despite the fact that there is widespread recognition that if we are to understand the ways that human actions affect global change, it is necessary to create merged, georeferenced, time-series data bases that contain both socioeconomic data and physical data which reflect the interaction of human and physical forces over time. Moreover, before significant progress can be made in developing merged data bases, we must develop a matrix of carefully defined research questions.

The raw material for merged data bases is already available. Socioeconomic data have been collected by governments, churches, private organisations, and others for hundreds of years, and social scientists are extremely sophisticated in assessing and interpreting these data. But when social and economic statistics are combined with physical data, serious problems of scale and distribution arise. For example, socioeconomic data are often available only at the national level. That is, a single figure, whether aggregate or representative, is usually given for, say, a country's population or its income or its energy consumption. If there is finer resolution to the data, it is provided for smaller political units rather than for regular geographical units or on a grid scale as physical data are arrayed. This is because most socioeconomic data are intended for use within political systems, or are obtained from probability samples of the national population which cannot be disaggregated geographically without doing violence to sampling assumptions or violating privacy[4] and confidentiality restrictions. Thus, merging these data with georeferenced physical data in a GIS - and then analysing them - is often extremely difficult, and may be misleading.

B. The need for time series and baseline data

A second issue is the need for time series and baseline data. Time series data are those which extend similar measures over a period of time, and baseline data are those which establish a measure at one point in time for use in comparisons with future and past measurements. To be able to measure - as opposed to merely describe - human interactions in global change, scientists and policy makers need both baseline data and time series data over large areas of the globe. Baseline data will be used to create a standard from which future change and deviation can be measured and which can be used in future environmental monitoring; time series will provide information on the pace and trajectory of change, both in the past and in years to come. In modelling, time series data are essential. Process, change and causation cannot be modelled using cross-sectional data. Yet many extant data bases consist of data collected at a single point in time. Time series data can be constructed based on these data, but this is an expensive process that must be informed by scientific and technical understanding of the data. Much of the data collected in the past is already lost or irretrievable. In addition, a great deal of potentially valuable data were never collected. This puts a premium on preserving and rescuing the data we now have and using them to construct retrospective time series.

C. Expanding data access in developing countries

Still another problem is related to the need to work closely with scientists and statisticians in developing countries. The days when scientific research could be conducted entirely in one country - or in a small group of leading scientific countries - are over. Global change research and the construction of data bases for this research require the active participation of scientists from many countries. The diffusion of scientific talent worldwide, and the need to amortize the costs of equipment and instrumentation, education and data collection all demand the involvement of scientists in both developed and developing countries in global research projects.

An immediate problem that hinders this global collaboration is that scientists in many countries do not have easy access to the Internet. For example, the entire EOSDIS system of data archives, the U.S. Government's Global Change Data and Information System (GCDIS), and CIESIN's data catalogue system and Information Cooperative all depend on the Internet. Within the Info Coop, the Internet is critical both for obtaining data from developing countries and for sharing data with scientists in these countries. What is needed to permit cross-national collaboration in research on global environmental change is immediate and equal access to Internet-based information.

Unlike their colleagues in the developing countries, researchers in Australia, the United States and the more developed regions of the world have pervasive, high-speed access to the Internet for both communications and research. In most cases, this access is subsidised at the national level. In developing countries, even where there is Internet availability, researchers generally must pay for network access each time they use it. In many cases, such access is not even interactive, but is limited to electronic mail (e-mail) or simple "store and forward" solutions. An additional barrier in less developed countries is that Internet access is as much as one thousand times slower than it is elsewhere.

Because e-mail has become the *de facto* electronic lowest common denominator, CIESIN is seeking to provide "Catalogue Interoperability" for researchers in developing countries using Internet mail. This will effectively make it possible for everyone

with the capacity to send and receive e-mail to search a worldwide directory of information resources and databases relevant to global and environmental change issues. The system works by allowing a user to send a standard e-mail message to an information server that can extract a request for data, access data described in the request, and then deliver the data in an e-mail reply to the original message. Once a relevant data set has been identified through an exchange of e-mail, scientists could place an order (again, via e-mail) to have a custom CD-ROM with the data set sent to them. As a result of this access mechanism, it will be possible for scientists around the world to access the same pool of scientific data, regardless of the speed or nature of their Internet access. The next step will be to provide access to data resources for those who are in countries without Internet access.

III. THE DANGERS AND THE OPPORTUNITIES THE INFORMATION ERA POSES FOR PUBLIC POLICY

The history of scientific influence on public policy is replete with examples of the ways that scientific ideas and technological innovations have improved the general welfare. This is particularly evident in those fields of science that deal with human and institutional behaviour. One of the best examples is the extension of economic democracy in Sweden in the 1930s and 1940s based on social research and the arguments developed by social scientists such as Gunnar and Alva Myrdal. Another is the contribution of social science research to the intellectual rationale for racial equality in the United States, including the integration of the Armed Forces in the 1940s and the decisive arguments of Brown *vs.* Board of Education (1954), the Supreme Court case which ruled that separate but equal education was not equal. There is also a rich tradition of social science contribution to administration and governance in less frequently recognised ways, including the development of tools such as cost-benefit analysis, national income accounts, program evaluation, economic indicators, social surveys, and the measurement of unemployment and poverty, to give but a few examples.

Yet the public influence of science and new technologies has not always been benign. Science has been used to give a patina of credibility to policies that are morally and ethically reprehensible. Examples include the complicity of anthropologists and psychologists in the sterilisation of hundreds of thousands of Germans in the Nazi period through the work of the Kaiser-Wilhelm Institute in Berlin and the use of new computer technologies by the Nazi government to register, identify, and deport the victims of its racial policies[5]. In another part of the world during this same period, social science concepts were used to give a scientific underpinning to the legalisation of segregation and exclusionary racial policies in South Africa[6].

What can be learned from these disparate examples is that scientific research and technological innovations take on a life of their own; they cannot be controlled by those who developed them. This is a risk in all fields of science, but it is most significant in fields that directly relate to human behaviour and to social and political policy and institutions. It is also most dangerous in periods of rapid political change, where science and technology may either be used as the instruments of political change or may provide the rationale for such change.

Given what is known about past uses of science and technological innovation, it would be naive to assume that the new communications and information technologies and the rapidly expanding scope of environmental data would be exempt from uses that might subvert, rather than improve, the general welfare. Clearly, providing a

means of communicating in real time across great distances, such as that between Australia and the United States, and permitting open access to vast quantities of data could be used to influence or even control environmental policy. It is entirely possible that this control could be used to place the welfare of one political group, one set of interests, one nation, ahead of others.

On the other hand, the new data and information technologies could instead be a major tool for the expansion of democracy. Certainly access to data and information resources could expand the capacity of scientists and policy analysts to understand the environment and the capacity of policy makers to respond wisely to environmental data. In addition, it could provide governments with a means of measuring both the social impacts of environmental changes and the extent of compliance with environmental treaties. But access to data should not be restricted to scientists or policy makers. For if environmental data and information are accessible only to a few, they will be susceptible for use as instruments of power or influence. Data for policy makers must also be accessible to the public so that these data can be used for democratic oversight. In essence, if new types of data resources are to be a component of public policy, it should be a matter of course that those data should be made useable and available to all[7].

Clearly, the public use of new information technologies will not be cost-free. It will require user-friendly software that can be accessed by individuals who do not have the scientific training required for complex information systems. The commitment to making data for policy available to voters requires additional commitments: First, to education in statistical methods and the analysis of data and environmental information in secondary schools; second, to the continual development of software that permits interactive use by non-scientists.

The issue of data access has international ramifications as well. Environmental policy will be advanced if those who are responsible for policy in Australia, the United States and other countries are working from the same basic data and the same understanding of the scale, nature, and extent of environmental change. Similarly, solutions to global environmental problems will also be advanced. Disagreements will, of course, be inevitable, but they will be more easily resolved if discussion proceeds from a common base of knowledge and understanding. For example, both the Information Cooperative CIESIN created and CIESIN's data catalogue system will be internationally distributed and increasingly accessible internationally. Equally important for their credibility for research and policy, they are not controlled by the U. S. Government, but are being built as multinational data archives by representatives of contributing data centres - regardless of their country of origin.

If the new data and information technologies are to serve democratic purposes, then the infrastructure that makes this possible must be maintained. This is not an insignificant task. In his short essay "Of Exactitude in Science", Jorge Luis Borges writes of an attempt to provide scientific information at a level of absolute accuracy and the failure to maintain the information base[8].

> *"In that Empire, the craft of Cartography attained such Perfection that the Map of a Single province covered the space of an entire City, and the Map of the Empire itself and entire Province. In the course of Time, these Extensive maps were found somehow wanting, and so the College of Cartographers evolved a Map of the Empire that was of the same Scale as the Empire and coincided with it point for point. Less attentive to the Study of Cartography, succeeding Generations came to judge a map of such Magnitude cumbersome and, not without Irreverence, abandoned it to the Rigours of sun and Rain. In the western Deserts, tattered Fragments of the Map are still to be found, Sheltering an occasional Beast or beggar; in the whole Nation no other relic is left of the Discipline of Geography."*

Even without the absolute precision in our data and information systems such as Borges describes, we must recognise that these systems require ongoing support. If we hold that scientific data are a public resource, then we must be prepared to make data available free of charge.

But we must also find a way to maintain the system that does not impose controls over the data nor compromise its credibility. For if environmental data and information systems are to play a role in policy in the United States, Australia, and other countries, they must have a mixed base of institutional support. They must not be maintained by a single agency or a single government, lest they be controlled by it. Moreover, the support base should include private as well as government organisations. In addition to ensuring that no single set of interests can capture the data system, a diverse base of support for cooperative, publicly accessible environmental information systems will also mean that the cost can be both amortised across a number of sponsors and substantially reduced for each one.

The new information age that we have entered has widespread implications. Both policy makers and the public have the capacity to know more about the world than earlier generations thought of asking. We still face technical problems in obtaining and sharing data, but we are moving swiftly to solve these problems. Yet in the face of rapid advances in electronic data and information systems, we must not forget that scientific and technical innovations can be used for ill as well as for good. To ensure that data systems become an instrument of democracy rather than a tool for subverting it, we must insist on multiple sources of data, open and multiple forms of access to data, and user-friendly data systems. If they are to be freely and widely accessible, these data systems cannot be owned by one set of interests; indeed, they must be supported by a diverse constituency, and, in the final analysis, they must belong to the people.

End Notes

1. See, for example, Heim, Michael (1987). *Electric Language: A Philosophical Study of Word Processing.* New Haven : Yale University Press xi 305 pp.
2. There are any number of sources that examine implications of the new information age. A good starting point for establishing the background of the technology revolution is Hardison, Jr., O.B. (1989). *Disappearing Through the Skylight.* Culture and Technology in the Twentieth Century. New York : Viking xix 389 pp.
3. To examine this problem, CIESIN has established a Commission on Global Environmental Change Information Policy in conjunction with the Kennedy School at Harvard University. This commission, which will complete its work in 1994, is examining the data and information needs of policy analysts. It will make recommendations to CIESIN on data and information it should acquire and make available for policy uses.
4. There is some research on this topic underway through the Human Dimensions of Global Environmental Change Programme's work toward a Global Omnibus Environmental Survey (GOES).

5. See, for example, Milton, Sybil (1993). Re-Examining Scholarship on the Holocaust. Chronicle of Higher Education xxxix(33): A52; Burleigh, M. (1988). *Germany Turns Eastward: A Study of Ostforschung in the Third Reich*. New York : Cambridge University Press xi 351 pp. and Burleigh, M. & Wippermann, W. (1991).*The Racial State: Germany, 1933-1945*. New York : Cambridge University Press xiv 386 pp.
6. Miller, Roberta Balstad (1993). Science and Society in the Early Career of H.F. Verwoerd. *Journal of Southern African Studies* 19(4): 634-661
7. Johanson, S. (1991). *Mot en Teori for Social Rapportering* Stockholm : Onstitutet für Social Forsking (Rapport Nr. 2 från levnadsnivåprojekt. Stockholm 1979-09-15) 160 pp.
8. Borges, J. L. (1989). *Del Rigor en la Ciencia*. Obras Completa, 1952-1972 Barcelona : Emecé Editores 527 pp.

AUSTRALIA, CULTURAL LANDSCAPES AND OTHER AUSTRALIANS

Dan W. Walton

AUSTRALIA

The island continent of Australia is often described as the oldest landmass on the planet. Though not strictly accurate, rocks more than 3000 million years old are known from the Pilbara region of Western Australia. The range of landscapes does not include the dramatic and diverse range expressed on the other continents. Instead, Australia is a land of generally low relief and deeply weathered soils, from which nutrients such as potassium, phosphorus and nitrogen have been leached over millions of years. The slowly eroding continent has been a relatively stable platform which preserved elements of earlier environments over long periods of time. The break-up of Gondwana, the collision of Australia with the islands to the north, climate, mountain building and the timing of these events and phenomena are the background to modern Australian vistas (Frakes, McGowran & Bowler, 1987).

Australia is moving northward at a rate of some 60 mm per year. While the land mass of Australia and the adjacent marine area have provided relatively stable evolutionary arenas, the character of these areas has been shaped by a complex geological history different from that of other continents. Patterns and processes of biotic and abiotic change have operated in isolation, in large measure, from other continental arenas (Bunt, 1987).

The exact date of the earliest Aboriginal arrival in Australia is not known, but recent studies indicate that the date exceeds 50000 years before the present (ybp). There is evidence that there were successive waves of immigration, but detail of this picture is far from clear. More recently, people from the islands to the north came into Australian waters on fishing expeditions and, as evidenced by the presence of tamarind trees, at least landed regularly at certain places. Either settlement was not attempted, or that which was attempted failed or was repelled or absorbed by the Aborigines. The only vertebrate species known to have been introduced by people to Australia, excluding Tasmania, prior to the arrival of Europeans is the Dingo, *Canis familaris dingo*. The earliest known fossil date of the dingo is about 3400 ybp (Newsome & Coman, 1989).

No confirmed evidence of landings by Chinese is extant, but their presence is a reasonable assumption. Europeans began to appear in the 1500s: Spanish and Portuguese first, then the Dutch. The Dutch certainly landed; Francis Pelsaert in the *Batavia* was wrecked off Western Australia in 1629. The English and French arrived in numbers rather later and in 1788 settlers, albeit coerced, of the First Fleet arrived from England. Sydney Cove became the first permanent settlement by Europeans in Australia (Stanbury, 1987).

The climates of Australia are variants of tropical and temperate types. Seasons vary as do the perceptions of seasons. Australians of European origin may see only two (wet and dry) in northern Australia where Aboriginal Australians traditionally recognised five or six, or seven seasons (Bridgewater, 1987). As an island continent, Australia is

influenced by the weather systems, and the interactions of those systems, of the Pacific, Indian and Southern Oceans. The climate of much of Australia can be characterised as episodic rather than regular. Interannual variability in the range of temperature and rainfall can be great. Over the last 10 000 years, Australia has become warmer and drier. Whether this trend continues is difficult to distinguish from anthropogenic influences on local, regional and global climates. The present sea-level has prevailed for about the last 6 000 years.

Before the High Court deliberations of 1992, Australia was regarded as a *terra nullius*, a land that could be claimed and occupied by the first successful discoverer and colonist, a land apparently without occupants and which, therefore, lacked ownership. From a legal standpoint, Aborigines and Torres Strait Islanders simply did not exist at the time of European settlement of Australia and, therefore, lacked any prior claim to any part of Australia. That Aborigines and Torres Strait Islanders interacted culturally with the Australian environments and engaged in a form of area management was barely recognised until fairly recently.

Europeans that arrived in new places as colonists brought their cultural baggage, including a view of the culture of other peoples. Unlike North America, with its recognisable plants and animals in seemingly familiar landscapes, or New Zealand with a recognisable climate, Australia was a strangely alien place. The obvious flora was dominated by eucalypts and acacias, which retained their leaves throughout the year and stood in seemingly endless blue-green monotony. The fauna was dominated by equally unfamiliar species (Dunlap, 1993). The people present in this strange place were wanderers, hunter-gatherers who believed in strange spirits and identified with the landscape and its biota. The confrontation of these two cultures is not a pretty story (*cf.* Lines, 1991). More than anything else, the story is inseparable from the clash of an alien people with an alien land.

As part of an attempt to convert the alien land to the familiar, species of plants and animals were brought to Australia. Many. of course, were horticultural, food or fodder plants and domesticated food, sport or utility animal species. There were the uninvited as well, endo- and ectoparasites of people and the domesticated species and a variety of free riders, the peri-domestic species, which possessed the adaptations for exploiting environmental disturbance of human origin (Crosby, 1986; Thompson, Long & Horton, 1987). Some of these introductions have had startling consequences (*cf.* Myers, Parer & Richardson, 1989; Longmore, 1991; Rifkin, 1992).

In continental perspective, Australia has a very low average population density. Interestingly, the reasons recently offered for this situation "lie in the inhospitable environment in much of the continent, and in the fact that European settlement began only recently". Local concentrations of humans (including scientists and bureaucrats) can be high, with some 85% of Australians residing in urban areas and 63% in 12 major centres. Moreover, 80% live within 50 km of the coast (ESDIIR, 1992). The pastoral industry of the drier interior now comprises the largest unbroken monoculture in the world (Bridgewater *et al.*, 1992b). This also means that 15% or less of the population exercise control over the use of most of the continent. Apart from horses, donkeys, camels, goats as well as a few other species of camelids, bovids and cervids, the national herd of cattle is about 23 million head and the national flock of sheep varies between 160 and 200 million (ASTEC, 1993).

The arrival of Europeans dramatically altered Australian land- and seascapes (*cf.* Saunders, Hopkins & How, 1990; Mott & Bridgewater, 1992). While both Aborigines

and Europeans played a significant role in shaping what we now see, ne must be aware of another major factor: fire. People used fire in about every imagi able way for the last 50 000 years and there also have been many fires of non-h man origin. Significant elements of the vascular flora of Australia are pyrophytes. In ed, fire is a critical element for many native plant communities and landscapes (Pyn 1991).

Water is a limited and limiting resource. Rainfall over large po ions of the continent is highly episodic, an irregularly, unreliable drought-flood s uation. The expanding human population and changing land use patterns have i creased the demand on available surface water and on underground supplies. Land se practices have affected ground water and soil salinity is now a major proble in parts of Australia (ESDIIR, 1992).

Water in all its aspects (surface, ground, episodic rainfall) and f re, naturally occurring or through human intervention, were major factors influencing the changing pattern of Australian landscapes. Fire was and is a significant tool f Aboriginal cultural intervention in landscapes. Fire remained important, but with more varied aspect, following the arrival of Europeans. The imposition of E opean land management regimes, however, introduced new and different influen s related to water. Patterning of the landscape, therefore, has altered drastically d ing the past 200 years. Soil erosion over much of the continent rose to 10 tim the natural geological rate and 75%, 41 million hectares, of the nation's fores have been destroyed (Hawke, 1989).

Amid the concentrated attention on the land and fresh water, th coastal and adjacent marine areas are often over-looked. Coastal recreational act ities, which includes surfing, boating, sports fishing, beach activities and swimming, e thoroughly integrated into the present Australian lifestyle. Approximately 75% of he intensive agricultural and livestock production as well as the bulk of the national nvestment in real estate, industry and commerce occur within 50 kilometres of th coast. The drainage of wastes of diverse origin, deliberate, incidental or accident , is into the estuarine, wetlands, and other coastal elements and onto the cor nental shelf (ESDIIR, 1992).

During the last quarter of a century the Commonwealth Governme t has taken a lead in addressing problems relating to the environment. Important l gislation has been passed, programs initiated, agencies established, inquiries conducte , agreements negotiated and international conventions and agreements signed. N fair-minded person can doubt that Australia has been a significant contributor t the effort to achieve a sustainable biosphere. Nevertheless, in a world of instant c unication and a rapidly expanding population, environmental concerns and issu compete for attention and resources.

Much of the impetus given to environmental issues has come from a wide spectrum of non-government organisations (NGO's). Such organisati s have been most active and most influential in those countries, including Austra a, which fall under the heading of "developed". This phenomenon has led many t assumptions and conclusions regarding the relationship between development and nvironmental conditions. One conclusion, however, is accurate: those free from hu ger, that are healthy and well informed, are able to care about the environment and he quality of life of future generations and a society that allows its citizens to ca has the best chance of being a sustainable society. Wealth is not a synonym for levelopment, wealth is a statement of a set of values.

Those countries with the greatest environmental devastation and resource depletion are not the wealthiest and healthiest countries nor can those countries which provide the greatest care for their own environmental health and wealth avoid costs traceable to environmental degradation by others. Food and fodder crops can be produced in surplus where costly equipment and additives are available. Countries with devastated environments and depleted resources, however, do not produce a surplus and are unable to afford the purchase of the surplus of others.

Science and technology offer the opportunity to improve standards, but there is a limit to their contribution (TRSNAS, 1992). Genuine concern about the integrity of scientists and real alarm about competence of bureaucracy to deal with environmental problems have been expressed, but more importantly the question is asked about why the citizenry, so fundamental to a democratic society, is neither consulted nor kept informed (di Castri, 1993). Perhaps it is too much to expect scientists to be capable of concerns beyond their own sphere of research or bureaucrats to be competent managers. Certainly, the subcultures of the two professional spheres share few values or goals.

This brief review highlights certain things. The Australian continent has a geologic and biotic history which is unique. Australia is a weathered land with generally poor soils. People have had an impact on Australian landscapes for at least 50 000 years. Australia is slowly drifting northward and as it does it has grown warmer and drier. Much of the continent experiences a wide range of temperature and rainfall patterns that are episodic and unreliable. The human population is concentrated in a few urban areas and confined largely to the coastal zone. Fire and water have and do exert major influences on the patterning of Australian landscapes. The attempts to impose European style land use practices have not produced long-term favourable results, and the loss of topsoil and tree cover may well prove more costly that any benefits that have accrued. Valiant attempts have been made to address environmental problems in Australia. Production cannot be the only measure of a sustainable society for if the goods produced cannot achieve a return, production becomes waste. There are limits to the contributions of science and technology. The quality of life depends upon community participation and individual commitment, not just scientific research and bureaucratic exercise.

CULTURAL LANDSCAPES

There are few parts, if any, of Australia which have not experienced the impart of human activity for Australia has a long history of human occupation (Bridgewater *et al.*, 1992a; Walton *et al.*, 1992). Suggestions that areas are 'pristine' are largely meaningless and the debate about 'wilderness' or 'naturalness' is semantic. Not only do the biota, lands and waters reflect the association with people, but there are now rules and regulations supplied by three tiers of government which deal with the biota, land and waters. The landscapes (and seascapes) of Australia are truly cultural. The discussion of biological diversity of recent years has tended to focus largely on the flora and fauna as if the biota were somehow independent of the land, water and people. The recognition that the landscapes were cultural somehow seemed to emerge reluctantly. Nevertheless, an international convention on biodiversity to which Australia is a signatory, an international conference on biodiversity and development which Australia attended and the establishment of the UN Commission on Sustainable Development of which Australia is a part preclude the possibility that the cultural status of Australia's lands and waters can be ignored.

In Australia, like many other countries, there are different cultures (Aboriginal, European and Asian) with different land 'management' regimes with different goals. Aboriginal culture places greatest value on the land as a place while European and Asian cultures value resources, biotic or abiotic products, recoverable from the land or waters. Whether these come together in time remains to be seen. Imposed on both, however, are economic and legal systems which view land and resources as wealth, wealth ultimately measured in monetary units.

Monetary units are symbols, substitutes for reality. The real hazard in the use of symbols is that instead of restricted use as a substitute for reality, the symbol may replace reality and value is then transferred totally to the symbol, in this case monetary units. Money, essentially a tool to facilitate barter and a symbol for value, then becomes more valuable than land, resources or the people associated with the land or resources. Our lexicon is now replete with evidence that the symbol of money is rapidly and widely acquiring the status of icon. Scientists who know better tolerate the misrepresentation of non-linear biological systems as 'in equilibrium' and subject to the pursuit of 'level playing fields'. Scientists who know that any biological activity consumes energy and produces waste do not object to the total irrationality of 'free market' and 'sustainable development'. Scientists who know the results of poor or incorrect agricultural practices, who understand the relationship of soil and climate to a wide range of human activity are largely silent, or at best communicate only with colleagues, in the face of 'market forces'.

There undoubtedly will be those who regard the preceding observations as anti-business, anti-development or some such perjorative and largely emotive term. Nothing could be further from the truth. The symbols in use within a society and the status of those symbols are a measure of the vitality of that society. Society must understand clearly the relationships among symbols and their relationships to reality. The greater the transference of value to symbols, the greater the divergence from reality.

The importance of symbols and the values transferred to symbols should not be minimised or ignored. Much of the rigidity of society, the inflexibility that is anathema to a truly democratic society, is maintained through the values given to symbols. Symbols to which no one objects (or is willing to be seen objecting), often accompanied by rituals (which may be highly objectionable) can accumulate sufficient value as to freeze or divert cultural development in time and space. Caste or class privilege is based on rigid maintenance of symbols, not reality. Revolutions, social, political or cultural, involve the replacement of old symbols (and attendant rituals) by the new. The recent Australian adventure in Ecologically Sustainable Development with concern over intra- and inter-generational equity, the international recognition of the importance of biological and cultural diversity, attempts by Australia to address social justice and equity through some kind of reconciliation with Aborigines and Torres Strait Islanders and open discussion of a departure from the colonial past by the debate of a future republic indicate that Australians are face to face with changing values and symbols.

As noted above, Australia has changed throughout its history: the land, water, flora and fauna. People created change and they change. Change is an inseparable characteristic of the biosphere. But, somewhere in the Australian culture individuals not only acquire a great fear of change, a resistance to preparation for change, yet place great hope in the delivery by science and technology of a magic bullet or secret potion which

will make all things right, but not change anything. Advocates of environmental issues have seized upon 1788 as the Year of the Environmental Ideal without any knowledge of the environmental conditions, trends or cycles which prevailed or realistic expectation that there can be a return to those virtually unknown conditions. Economists discuss 'The Market' as if it were somehow a recent and totally independent arrival from an alien galaxy, even an Imperial Figure to whom we are all subjects. Scientists attempt to separate research into "pure" and "applied" as if all research is not carried out by and for people. On the pretext of sensitivity to the values and symbols of others, concern for the burgeoning global human population is neatly compartmentalised into elements such as food, health, energy or transport apparently independent of values or symbols related to population growth. By 1990, more than 90 nations were losing the economic race (based on declining gross national product *per caput*) with population (Westing, 1993). Despite the abundant evidence repeatedly displayed on our television screens, few leaders acknowledge the positive relationship between the quality of life and the quality of the environment. Australia deserves great recognition for adding "ecologically" before what otherwise may be little more than a denial of entropy: sustainable development.

Sustainable development without the Ecologically is not only a very shaky concept, but one that is culturally distorted by the excessive influence of economics. Is it development which we wish to be sustainable or do we really mean that we want a society which is sustainable and the only way we know (or have been lead to believe) is to have what might be more aptly termed controlled consumption of resources? Development is most usually taken to be a synonym for growth and progress through resource use and growth represented as the best way to create an equitable society. Others find this logic flawed and suspect (*cf.* Soulé, 1991; Gowdy, 1992; Abelson, 1993). Development in this flawed context may well represent the opening bars of the requiem for human society. The growing human population is on a collision course with growing human aspirations.

Environmentalist mythology, often with large proscriptive and exclusive components, also abounds. Listings of 'places of value' create, at a very basic level, a false dichotomy. 'Places of value' and 'endangered species' also are in part the creations of the propensity (as opposed to a broad concern with quality) for quantitative score-keeping. All of Australia and all Australians are important.

At the present time there is differential entitlement to consumption based on the ability to enter the consumption arena, *i.e.* The Market. Entry is based upon the ability to pay the entry fee, whether countries, communities or individuals (*cf.* Swaney & Olson, 1992). Those unable to enter The Market or only able to penetrate at a very marginal level are the poor, the untouchables, the out-castes. They invariably are inhabitants of areas which are accorded, usually by tacit agreement of society or their neighbours, a lack of value for the extraction of resources; they are the slums, skid-rows, the fringes of industrial areas or docks, waste lands, the banana republics. These inhabitants or countries not only have failed to enter the consumption arena, they are now the symbols of failure, the market rejects against which successful consumption can be measured. If we seriously wish to have a sustainable society, how many people and how much space can we write off and hold up as failure symbols against which The Market can display its forces?

The inability to enter The Market has a partner: the inability to enter the legal arena. There exists differential entitlement to access to the regulatory aspects of society for here, also, there is an entry fee of a similar kind. One may speculate, and the speculation is not

newly presented here, that the legal arena of a society is basically the creature for the protection of those best able to afford the entry fee to whatever that society deems The Market. No single segment of society, except possibly academia, is so immersed in antiquarian junk, archaic value symbols now historical rubbish, as the legal arena.

Interestingly, the market players periodically use the legal arena as a means of reclaiming land or other resources, under such headings as urban renewal, doing away with 'unsafe' buildings or even 'preserving heritage qualities', by relocating the poor. These same market players have been less successful in the reclamation of people for such terms as 'poverty line' and 'long-term unemployed' are not only accepted terminology, but accepted parts of society. Even the poor object to being given a monetary value so that they may be easily dealt with in the legal arena, but their existence as a symbol of the success of the market players has the apparent inviolacy of a treasured icon.

The fate of marginal market players is more complex. Status as a marginal player is vulnerability in the extreme. Our shopping malls and rural landscapes are littered with the bodies and debris of the failure to become secure market players. The transition to full market player status, almost without exception at some stage in the journey, requires the complicity or approval of those already secure market players. While sponsorship is critical, the quality of sponsorship is essential. The sponsor, for whatever the reason, may decide to let the novice, marginal player founder and, thereby, acquire greater market player status and resources (from the foundered novice), or provide the guidance and services to allow the novice to complete the apprenticeship. Perhaps such a study has been conducted, but an analysis of the turn-over rate of shop space in major malls, the turn-over rate (including duration of For Sale time) of rural properties, and the average monetary loss, and to whom, by the failures is needed. Waste does not represent economic success and an 'anything goes' mentality is indicative of an industry or society that lacks the construct for a tomorrow.

Much is made of the famous 'Bottom Line' of business as if it was a fixed hymenesque barrier between success and failure. The Bottom Line is certainly not fixed. Business success or failure is a function of many factors, not the least of which are the variable societal values such as tax structure, work ethic and corporate strategic intent. The 'bottom line' might be more aptly termed the point where human perceptions of viable options have failed or where an arbitrary decision had been made not to consider additional options.

What has all of this to do with cultural landscapes or such things as biodiversity, Ecologically Sustainable Development, conservation and the quality of life? Clearly, we have and are shaping the landscapes and seascapes of Australia by our own actions and through the actions of flora and fauna which we have introduced, whether deliberately or accidentally. Biodiversity, genetic to landscape level, has changed, is and will be changing. What we wish to sustain is our society, a society with healthy values and appropriate symbols. Conservation is the human endeavour of reducing deleterious human impact on the environment. Intra- and inter-generational equity are the measures of the quality of life, the life which we now share with the people, the flora and fauna of Australia and, more widely, the biosphere, and the life in Australia and the biosphere inherited by our children. The linkage between the quality of the environment and the quality of life is undeniable, but we have a very poor grasp of the complexity of the linkage and have yet to address some of the fundamental decisions required to support the linkage (*cf.* Daly, 1991).

The reports derived from the working groups on Ecologically Sustainable Development are interesting. These sectoral reports, no doubt, will be held up as guides to the game-plan for the future of Australia. The intersectoral issues, however, are the issues which will, in reality, shape the future of Australia: conservation of biodiversity, health, water, population, employment, risk, social justice and equity. A variety of ideas is being floated now about holding conferences or debates or developing strategies on one or more of these subjects. Few aspire to undertake the fundamental debates:

a.) who will decide our future, all the people or only those who can afford some entry fee, *i.e.* a preselected few;

b) can we develop a national community which thrives on change rather than retain one that fears change;

c) what are the broad values of Australian society and how can these be established and enunciated with that reality retained rather than replaced by symbols?

What kind of Australia do we want? By what national obsession do we wish to be known?

OTHER AUSTRALIANS

Science and scientists, despite the cloak of supposed objectivity, are as much the beneficiary and victim of prevailing cultural expressions as their counterparts in the arts, only the awareness of the participants and audience differs. Science and scientists generally are not regarded as having entertainment value or eliciting those responses associated with aesthetics. Science is newer, at least as a recognised profession with attached professionals, and composed of elements from a host of other vocations and avocations, legitimate or otherwise in their origin and performance. Not surprisingly, science has acquired its own mythology, a mythology which claims many scientists among its advocates.

Science is really the application of a method of inquiry. There are attempts to expand this view of science, to claim more intellectual territory that will increase the legitimacy and intellectual standing of scientists, but this is a discussion for another time and place. As a method of inquiry, the goal is to acquire information which has reliability and validity. An hypothesis must be testable, the test must be repeatable, yield the same result each time it is employed and test what it claims to test.

Great amounts of time, energy and resources are devoted to Research and Development (Demonstration has been added to make R&D, R,D&D), including inquiries by the Australian Science and Technology Council (*cf.* ASTEC, 1990a,b). Similar considerations have been undertaken elsewhere (*cf.* Lubchenko *et al.*, 1991; Solbrig, 1991; CFNBS, 1993).

Unfortunately, the assumption that bureaucrats (including their ruling politicians) and scientists (and their employers) are best placed to determine R&D priorities and programs has not been tested. Well conducted scientific inquiry will provide information, but how needed that information may be is another matter. This is not a denial of the right of scientists to participate in intellectual activity, simply the statement that the personal research interests of scientists, individually or collectively, are not axiomatically synonymous with the national needs.

Science does not solve problems. People perceive problems, people define problems and people solve problems. People use science as a method of addressing

questions, of defining a question and seeking an answer. The quality of solutions seldom exceeds the quality of the problem definitions. The scientific method provides information which may be trusted in the solution of problems, but science cannot control the accuracy or appropriateness of the application of that information to a problem.

Technology, often lumped or confused with science, is the application of information, usually incomplete, for the expressed purpose of solving problems. Science requires great intellectual rigour to achieve repeatability, reliability and validity. Technology requires great imagination, creativity and insight for the application of information in what frequently amounts to structured trial and error experimentation for solutions to problems.

Aitken (1992) cautions against unrealistic expectations of scientific research, as does Richmond (1993), and identifies problem areas for investigations in the national interest. The six areas identified are: industrial relations, geological survey, distribution of wealth and income, biotic survey, Australia's place in the world and language, literacy and intelligence. These comprise sound research directions for Ecologically Sustainable Development. Stripped of institutional propaganda and political hyperbole, are we making any research progress along these lines? Are we acquiring new information on these subjects to better address problems? How does this information contribute to Ecologically Sustainable Development?

Some very hard questions need to be asked, not about the quality of the research completed, but about the priority accorded various research topics, *i.e.* the management of research. There is a tendency for inquiries into research needs to recommend the creation of new bureaucratic structures or reorganisations (*cf.* ASTEC, 1993). Perhaps such recommendations are preferable to telling the researchers that they are running amok, doing work of interest only to themselves and a small admiring international audience and failing to supply information in a form and of a type useable by management. The contribution to any real national purpose of the costs of these new structures, new administrators and the failure to focus research is unknown.

Scientific research institutions or organisations established for a national purpose are perceived as: a) reflections of that national purpose; and b) reflections of how well the employed staff meet that national purpose. Institutions and organisations, scientific or otherwise, acquire over time corporate cultures and, unless leadership is of the highest quality, the corporate culture becomes the symbol which replaces the national purpose and the symbol to which the staff pay homage. Resources then are diverted to maintenance of the corporate culture (Enckell, 1982). Such a diversion is characterised by the proliferation of tiers and increased ramification of 'management' and administrators, greater emphasis on an identified need for 'coordination' of 'interdisciplinary' information exchanges and bursts of enthusiasm to be 'relevant' to some vaguely identified goal which is related to the national purpose only by chance. The management of scientific research is the management of creativity (Jeffers, 1993) and, despite suggestions to the contrary, no conclusive evidence exists that scientists are best equipped to manage other scientists. There is an equal absence of information that supports the view that bureaucrats are any better managers than scientists. Indeed, one should not make the mistake of confusing bureaucracy with management.

Bureaucracy, primarily the public service, is neither to be seen nor heard and is, therefore, rarely the subject of praise. Not surprisingly, the successful bureaucrat is one

that allows nothing likely to attract attention (innovative, creative or inventive) to emerge. Attention means change and change, therefore, is anathema. This situation does not imply that those in the bureaucracy lack ability, but the desire to be part of any success beyond personal advancement is not rewarded. The bureaucracy exists primarily to ensure that nothing ever happens for which anyone can receive praise or blame, so emphasis is on making sure that nothing happens. Management, in this context, is not about facilitating adaptations for cultural change, but ensuring the obstructive preservation and application of symbols of antique values, the very stuff of antiquarian junk.

The conflict between the value system of bureaucrats and that of scientists is one of the dominant elements with which any government has to contend. Status among scientists, their position in the scientific community, is measured by how much 'praise' they can accrue, praise based on making something happen - publications based on their own research, receiving research grants, training students who publish their research and get grants, etc. While this system is not without its flaws and injustices, it allows for individual worth, products and action. The bureaucracy, however, avoids recognition of the individual and nothing, achieved by many hours of labour and consumption of large volumes of paper, is its most important product. The recent submergence of the distinctiveness of 'professional officers' into the anonymity of 'administrative officers' reflects the prevailing attitudes towards products and individuals. This system produces reams of inactive strategies which occupy time, energy, funds and shelf space in archives.

Management, however, is vital and has very little in common with bureaucracy. Science is very much a part of management for they both share the vision of goals and rewards. Successful management places its greatest emphasis on the value of individuals, the cooperation of individuals in the attainment of goals and rewards to which they, as individuals, are committed. Commitment results from the identification of and agreement on what Hamel & Prahalad (1989) term strategic intent and, as they point out, this is more than just naked ambition. It is the focusing of the attention of the organisation, agency, unit or institution on positive outcomes, *i.e.* the essence of winning by communicating to individuals the value of the outcomes. Room must exist for the contributions from individuals and teams. Enthusiasm must be sustained by encouraging the excitement of change and redefining operational adaptations to change. Intent must consistently guide resource allocation. If emphasis is on defence of old symbols, planning to prevent or deter change, loss and failure are inevitable. Strategic intent should be valid over time and, therefore, firmly rooted in a non-economic value or values.

Indigenous Australians have been affected and changed by all those living systems which have arrived since 1788. The clock cannot be turned back. New associations and new combinations of species and cultures have developed and will continue to emerge. These new arrangements and circumstances are reality. Attempts to ascribe a moral or ethical quality to these changes are indefensible.

Species that are endangered or vulnerable are indicators of change, but so are the common and abundant. While extinction is a process, not an event, such a statement reveals nothing of the rate of the process. To assume that rarity differs significantly from abundance in the extinction process may be to create a false dichotomy. Attempts to oppose introduced species will always have an air of xenophobia. The number of native species under threat from introduced food (plants and animals),

fodder and fibre crops will almost certainly far exceed those native species at risk from the odd introduced predator or plant invader. The amount of area lost or permanently altered simply by construction of homes, businesses, transport routes, waste dumps, *etc.* must be added to the threatened and destroyed biodiversity.

Native species are important, as are all those species which are experiencing precipitous declines or explosive increases. The interactions of native and introduced species are very important. Many introduced and native species are peri-domestic, *i.e.* they flourish in the vicinity of people - on human disturbance. Rather than treat all as undesirable, can some of these species be used beneficially? The search for positive interactions and uses, as Crosby (1986) suggests, is worthy of serious consideration. Clearly, the people who have come to Australia regard Australia as home and are unlikely to suddenly depart *en masse*. Introduced species of plants and other animals are equally naturalised. Not all introductions will have some redeeming quality, so some criteria must be established, such as those discussed by Bridgewater *et al.* (1992a), for decisions on the control of exotic species. Wide-spread use of broad spectrum toxins cannot be regarded as a sustainable practice.

As the counting of monetary units dominates economics, scientists and social scientists have been drawn into the counting game. For biodiversity, counting species is somehow accorded great importance, but the context for the numbers is usually absent. Similarly, social scientists are captivated by the statistics of demographics. Conventional economics ignores, and is largely ignorant of, environmental consequences (Sarokin & Schulkin, 1992). Exploitation of resources is the prerogative of those who can afford the entry fee to The Market; care of resources until The Market 'dictates' their use as well as landscape rehabilitation and reclamation are the financial responsibility of all. The linkage between exploitation of resources and the creation of wealth is well understood; the linkage between the methods of exploitation of resources and the creation of poverty are less well appreciated. If numbers of species are a measure of biodiversity, then biodiversity is about insects (or nematodes) or if endangered species are the issue, then biodiversity risks trivialisation by fascination with select vertebrates and vascular plants. Concentration on the demographics of the exploding global human population does not assist local communities' understanding of the disruption of local conditions (Machlis, 1992).

Landscape planning and management have traditionally concentrated on the local level and this concentration has focused largely on the traditional three R's: roads, rates and rubbish. Planning and management, when carried out on a professional basis, have been the domain of engineers attempting to work in an arena dominated by short term political agendas. Regardless of the tier of government in the planning exercise, the relationships and exchanges between the economic, cultural and ecological sustainability goals are seldom discussed, understood or genuinely considered. The information needed to assess the ecological limits of the area is seldom available nor is any real attempt made to acquire that information. Engineering and economic considerations dominate planning and management within political boundaries which do not reflect cultural patterns (including land use practices) or ecological patterns and processes (Slocombe, 1993).

Planning and management are essential for cultural landscapes and plans can be effectively implemented only at the landscape level (Odum, 1992). The landscape level provides the diversity and dynamics for resilience, the opportunity for flexible management to deal with change, size for options in planning and management and,

most important of all, people who identify with, and are the culture of, that landscape. In this framework one must recall that resource problems are human problems, ones experienced by diverse cultures throughout human history.

No Australian should doubt that a major upheaval is in progress. Every village is part of a global economy and every individual is part of an exploding human population that will double to 10 billion before 2050. The amount of land per person on the surface of the Earth has declined from 3.6 hectares in 1970 to 2.5 hectares in 1990, a 30% decline in land availability over a 20 year period (Westing, 1993) and this same total space is shared with over one billion cows (Rifkin, 1992). Changes of every conceivable kind occur at a rate few really appreciate and even fewer assimilate. The old and battered Australian argument about State *vs.* Federal government control is trite, diversionary and wasteful. Neither is in control, anyway. Neither has yet come to grips with the very basic issue of the relationship of the quality of the environment to the quality of life.

Useful suggestions for management are provided by Ludwig, Hilborn & Walters (1993).

1) Human motivation and responses are part of the system for study. Short sightedness and greed underlie resource problems which are manifest as environmental problems.
2) Do not wait for some new scientific consensus, but apply the knowledge we now have. Calls for additional research may be delaying tactics or pleas for additional research funds.
3) Rely on scientists to recognise problems but not to remedy them. Scientists are influenced by the culture of their discipline and vulnerable to political pressure.
4) Distrust claims of sustainability. Past exploitation of resources has seldom been sustainable and claims of sustainability from the same or similar exploiters are suspect.
5) Confront uncertainty. Science and technology, no matter how lavishly funded, cannot solve every problem or resolve every dilemma. The approach should be positive, flexible, venturesome, but with careful evaluation of what we think we know and favour actions that are reversible.

There is a growing body of information (*cf.* Fortmann & Huntzinger, 1989; Hamel & Prahalad, 1989) which indicates that non-economic management goals are the key to sustainability. Despite the fact that The Market measures the worth of individuals in economic units and legal systems measure human relationships in economic units, successful human relationships and their rewarding value systems are based largely on a constantly renewable barter/exchange plan (feed-back) that cannot be expressed in economic units. The relationship of an Aboriginal Australian to his or her Dreaming Place has no economic equivalent. This should not be any surprise or regarded as unusual. European cultures ascribe parental qualities, including gender and totems, to their equivalent dreaming place. People of all cultures do great good or horrid evil in the name of love of their country. What price love? By far the most emotive derogatory words in any language have to do with the violation not of the rules of The Market or the legal system, but of non-economic values relating to the dreaming place and to further sully the violation one may express the violation as having been purchased for economic value (*e.g.* 30 pieces of silver). Ritual suicide or less terminal forms of self-abasement are cultural practices which cannot be replaced by economic units. Non-economic values appear amazingly consistent between societies and over time.

A society which encourages the pursuit of immediate satisfactions and short-term goals has an air of futurelessness, an atmosphere which contributes to social problems, abuse of resources, environmental degradation and a deep feeling of individual helplessness (Cohen & Polunin, 1990). Unfortunately, planning is dominated by what Shaw (1993) terms "the most unreceptive ear of all - the sovereign state". Resources for goals and programs are closely linked to term-of-office and changes to institutions and symbols are most likely perceived as threatening by the bureaucracy. Strategic intent is generally lacking or represented only as short-term gain of the pre-selected, re-elected few.

The challenge represented by the conservation of biodiversity and the search for ecologically sustainable development lead inevitably to the realisation that a society cannot be sustainable that is not an equitable society. To return to the questions of di Castri (1993): "When will we stop considering them [the citizenry] as unaware, unworthy of being informed, and without the capacity to react? Is this how we hope to strengthen the concept of democracy?" Is the 'development first', 'anything goes' philosophy a plan for the future or the expression of an absence of hope, a default on posterity's world? Is Australia a democratic country? Are The Market and the legal system democratic or manifestations of democracy? The options open to us are not limited just to what Debray (1993) describes as the technocratic myth that technological progress can solve all political and cultural problems or the ideocratic frenzy of a euphonious moral norm. Are we unaware, uninformed? Are we inert lumps lacking the capacity to react? What kind of Australia do we want? By what national obsession do we wish to be known?

The opportunity exists, as Australia approaches the centennial of federation (2001), to establish a national strategic intent, that which will be our national obsession. As Westing (1993) points out, only two international legal instruments, implicitly or explicitly, include an adequate environment as a human right. Australia has led the way by adding Ecologically to Sustainable Development. This lead must be captured as a fundamental right of every Australian to a healthy environment for an equitable, sustainable and healthy society. We need to be agents of cultural change if ecological sustainability and inter-generational equity are to be more than 'buzz' words. Hopefully, this paper will play a part in stimulating the debate, increasing the dialogue and, ultimately, initiating the necessary steps to address the hard, but crucial questions for Australia.

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