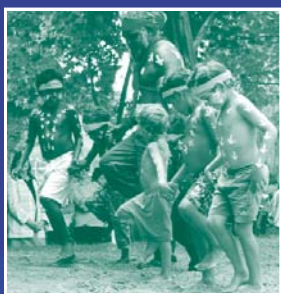
Environmental Health

The Journal of the Australian Institute of Environmental Health



…linking the science and practice of Environmental Health

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CONTENTS

EDITORIALS

ARTICLES

RESEARCH AND THEORY

PRACTICE, POLICY AND LAW

CUMULATIVE INDEX

Environmental Health

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Call for Papers

The Journal is seeking papers for publication.

Environmental Health is a quarterly, international, peer-reviewed journal designed to publish articles on a range of issues influencing environmental health. The Journal aims to provide a link between the science and practice of environmental health, with a particular emphasis on Australia and the Asia-Pacific Region.

The Journal publishes articles on research and theory, policy reports and analyses, case studies of professional practice initiatives, changes in legislation and regulations and their implications, global influences in environmental health, and book reviews. Special Issues of Conference Proceedings or on themes of particular interest, and review articles will also be published.

The Journal recognises the diversity of issues addressed in the environmental health field, and seeks to provide a forum for scientists and practitioners from a range of disciplines. Environmental Health covers the interaction between the natural, built and social environment and human health, including ecosystem health and sustainable development, the identification, assessment and control of occupational hazards, communicable disease control and prevention, and the general risk assessment and management of environmental health hazards.

Aims

- To provide a link between the science and practice of environmental health, with a particular emphasis on Australia and the Asia-Pacific Region
- To promote the standing and visibility of environmental health
- To provide a forum for discussion and information exchange
- To support and inform critical discussion on environmental health in relation to Australia's diverse society
- To support and inform critical discussion on environmental health in relation to Australia's Aboriginal and Torres Strait Islander communities
- To promote quality improvement and best practice in all areas of environmental health
- To facilitate the continuing professional development of environmental health practitioners
- To encourage contributions from students

Papers can be published under any of the following content areas:

Guest Editorials

Guest Editorials address topics of current interest. These may include Reports on current research, policy or practice issues, or on Symposia or Conferences. Editorials should be approximately 700 words in length.

Research and Theory

Articles under Research and Theory should be 3000-5000 words in length and can include either quantitative or qualitative research and theoretical articles. Up to six key words should be included. Name/s and affiliation/s of author/s to be included at start of paper and contact details including email address at the end.

Practice, Policy and Law

Articles and reports should be approximately 3000 words in length and can include articles and reports on successful practice interventions, discussion of practice initiatives and applications, and case studies; changes in policy, analyses, and implications; changes in laws and regulations and their implications, and global influences in environmental health. Up to six key words should be included. Name/s and affiliation/s of author/s should be included at start of paper and contact details including email address at the end.

Reports and Reviews

Short reports of topical interest should be approximately 1500 words. Book reviews should be approximately 700 words and Review Articles should not exceed 3000 words in length.

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Environmental Health

The Journal of the Australian Institute of Environmental Health

SPECIAL ISSUE

Sustainability in Environmental Health

Guest Editors

Valerie A. Brown, Pierre Horwitz, and Thomas Tenkate

Editor

Heather Gardner

Part A, Volume 3, Number 1, 2003

Sustainability in Environmental Health: Twin Re-inventions in Response to Systems Change

Every Journal always hopes to bring cutting-edge ideas to its subscribers. The two issues of *Environmental Health* (vol. 3, no. 1, Part A and vol. 3, no. 2, Part B) do exactly that. Together the Special Issue on Sustainability in Environmental Health holds articles that between them address the majority of the challenges faced by practitioners of a growing profession, a profession in the midst of the process of transforming itself in order to respond to the pressures on health and wellbeing from changing social and biophysical environments. If that mix of changes seems to signal that it is an overwhelming whirlpool, all the evidence confirms that it is. It is the strength of these two issues of *Environmental Health* that while confirming the magnitude of those changes, they bring to environmental health practice some of the most recently developed ideas, methods and tools that allow practitioners to continue to act effectively.

The on-ground issues arising from the continuing disruption of global ecological integrity, (the self-perpetuating life-support systems of the cycles of air, water, soil and life-forms), are leading to a reconsideration of the relationships between the local and the global, the social and the ecological, and the differing responsibilities of the responding professions. Taking the scale difference first, it has been accepted for some time now that the spreading of the effects of human activities over the entire planet, with the resulting disruption creating in turn new pressures on health, means that there is now a double agenda for environmental health. Long crucial in managing local responses to environmental risks, environmental health practitioners now find themselves reinvented as managers of social as well as biophysical activities, and of global as well as local change.

Previous volumes of this Journal have already signalled these changes in environmental health practice, with practitioners combining the tasks of maintaining their traditional expertise while responding to the new. This volume brings into focus the theoretical and practical implications of the direct experience of continuing global change for the reinvented profession. In the previous ten years, the thirty-year predictions of significant global changes have become actual records. In the previous five years it has become apparent that the rates of change continue to increase, in spite of what appeared to be major response programs put in place in the international meeting in Brazil in 1992, under the umbrella of sustainable development.

Last year, 2002, the tenth anniversary meeting of Brazil, held in Johannesburg, confirmed the shortfalls in the five strategies of sustainable development. Resource equity between generations is now unlikely, given the extent of existing change; equity within this generation is falling; and much of the global biodiversity of 1995 is irretrievably lost and global integrity seriously breached. Valuing social and economic costs of environmental disruption has led to greater concern rather than more action, and the precautionary principle has proved difficult to bring into legal and political reality. Rather than sinking into despair, the articles which follow uncover the many ways in which the realisation has energised changes in approach, in particular a reinvention of sustainable development as sustainability.

Far more than a mere name change, the now-frequent use of sustainability as an extension (not a replacement) for sustainable development signals a more concentrated, future-oriented and holistic approach to a viable long-term social and environmental future. Sustainability is a goal to be worked towards, rather than one to arrive at, since we do not know what the final form of a sustainable human/planet relationship may be. It is not an entirely open goal, however. The keynote speakers at the Indopacific Conference on Ecosystem Health in Perth in November last year, at which most of the papers here were presented, offered these definitions of and pathways for the journey towards sustainability.

Sustainability is:

- Reconciling development goals, social needs, and ecological resources (World Commission for Sustainable Development [WSSD])
- Supporting a life-sustaining Earth (USA EPA)
- A single bottom line (key Australian Local Government Authorities)
- Respecting and sustaining natural and cultural systems and the interplay between them (Australian National Biocentre)
- Business as very unusual (AtKisson)

Sustainability needs:

- Quantifying, monitoring and valuing the essential people/planet relationship (Costanza)
- Respecting and learning from first Australians' care for country (O'Donoghue)
- Combining the knowledges of key individuals, the community, the experts, and organisations (Brown)
- Integrated ministries, interlocking statistics and interdependent sovereignties (Rapport)
- A great collective narrative (Waltner-Toews)
- Taking account of the different effects on the poor and weak versus the rich and powerful (McMichael)

This is a mixed agenda, but a very comprehensive one. Many of the speakers at the Perth conference have papers in this collection; and others have papers in previous editions of the Journal. Without exception the papers assume that to work towards sustainability is to work with continuous change; and that practitioners need new and broader strategies and tools for the journey. Starting with the recognition that decision making in sustainability needs to be based, not on end-of-program evaluation, but as part of a continuing decision-making process, Jeong in "A Research Framework for the Empirical Analysis of Sustainable Development" develops a research framework that offers a practical tool for an environmental health practice that is an ongoing research and evaluation process.

Jeong suggests sustainability-based practice needs to be considered at three levels: ideas about the concept and its implications, options and approaches that assist its achievement, and the extent of unsustainable development to be overcome. Making a valuable distinction between the evaluating implementing sustainable development (the first two), and the outcomes of the process (the third), each requiring different monitoring processes and criteria, he emphasises that sustainability is a movement forward in time, and progress needs to be assessed not once, but as a feedback system at regular, prearranged intervals.

McGregor in "Is Australia Progressing towards Ecologically Sustainable Development?" picks up on the same three levels of action, that is, ideas, their implementation and their measurement. He applies the excellent Bellagio Principles for the optimum process for developing sustainability indicators to the evaluation of Australia's National Headline Sustainability Indicators, concluding that these indicators refer to a weak interpretation of sustainability and that even then, while social and economic indicators show improvement, environmental indicators report an adverse trend.

Taking further the theme of the essential role of monitoring, Ostry in "The Relationship between De-industrialisation, Community and Ecological Sustainability", describes how Canada, like Australia, has an economic history based on the development of natural resources. He extends the widely used land equivalent of resource use, the human ecological footprint, to including the ecological and social impacts of economic and technological change. In a case study of forestry restructuring he is able to use this tool to differentiate between international and local economic advantage and the rate of forest depletion before and after restructure.

Townsend et al. turn the tables on the traditionally limited view of health in the human/environment relationship with a study of the links between contact with nature and human health and wellbeing, an aspect of ecosystem services that is rarely fully explored.

In "Using Environmental Interventions to Create Sustainable Solutions to Problems of Health and Wellbeing" they review international research to confirm that simply viewing a natural scene or watching wildlife reduces stress and tension, improves concentration, remedies mental fatigue, boosts immunity, and enhances psychological health. This is aside from any physical health benefits flowing from reduced stress, increased exercise and improved respiratory air quality when contact with nature involves activities in natural environments.

"Watershed Torbay: Restoring Torbay Catchment" from Julie Pech uses a catchment study to provide environmental health practitioners with a working model for an integrative decision-making process constantly recommended but seldom found in practice. Through the collective work of researchers, agencies and community groups the project has established working guidelines for a mixed biophysical and sociopolitical research agenda, community participation as an essential project component, monitoring and evaluation which support ongoing adaptive management, and an overall action-oriented learning environment. Watershed Torbay is involving elements of change in traditional as well as new and exciting ways: local ownership, a strong support team, accessible science, web page and newsletters, a program of celebrations, locally-generated issue-based progress indicators, capturing local knowledge, applying best practice community change, and a community skills audit. This last uncovered potential contributions to the project from graphic design, web site production, accountancy, primary production, tourism, amateur biologists, historians, photographers, teachers and project managers.

In "A Risk Management Approach to Sustainable Water Reuse", Derry, Booth and Attwater return the discussion to a more traditional environmental health topic, water quality, expanded to include the sustainability issues of water conservation, water reuse and the consequent need for health risk management as part of a total environmental management system. The project they describe is the construction of a wetland system on degraded agricultural land to receive and polish low quality stormwater from the town of Richmond, with the aim of augmenting existing aquatic habitats, buffering large variations in tributary flow due to urban runoff, and providing an additional source of water for campus irrigation to replace the chlorinated town water. Risk management is the process in which traditional health risk assessment is contextualised in terms of social, political, economic, institutional, community and ethical considerations, as the basis for sustainable adoption of the water reuse process, a resource, which is present in most communities, but seldom tapped.

The description of "Creating a Living Environment" in the Sydney bushland shire of Hornsby is a contribution from Parsons, Harwood and Hassall. Hornsby is one of the few Australian councils to take a "strong" approach to Local Agenda 21, the global program of local government action on a sustainability for the 21st century, the only firm program to emerge from the 1992 Brazil conference. While Europe has embraced Local Agenda 21 programs, Australia has lagged behind. The main parameters of the Hornsby project are sustainability indicators developed by the community accepted as council performance indicators, and a holistic management tool which sets the sustainability agenda as a "whole of council" approach.

Taken together this set of papers offers a strategic toolkit for achieving the much-needed twin reinventions of environmental health and sustainable development. They provide a framework by which research, monitoring and evaluation, and managing organisational change can become an integral part of environmental health actions, not add-on extras. This holistic thinking places the ecological, economic and social impacts of environmental change within a whole of council sustainability agenda. Examples of councils and their communities working together on sustainability and health issues such as water reuse, environment as amenity, catchment management, and Local Agenda 21 establish that this reinvention is real and happening. And in volume 3, number 2, Part B of this Special Issue on Sustainability in Environmental Health there is much more.

Valerie A. Brown
Guest Editor
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Parallel or Intertwined under the Banner of Sustainability: Environment and Health?

A casual observer might be somewhat bemused by the overlapping wording and intent between two international umbrella organisations and processes - that governed by the World Health Organization and articulated most clearly for instance by the Ottawa Charter and subsequent meetings, and that initiated by the World Commission on Environment and Development and Summits in Rio (1992) and Johannesburg (2002). Both processes set out to address poverty and inequity in the hope that globally anyway we might have healthier people in healthier places. There are links across the two global processes, but they remain separate.

In another international agenda, the UN Millennium Summit adopted in September 2000, the Millenium Development Goals, setting targets for, inter alia, eradicating extreme poverty and hunger, achieving universal primary education, promoting gender equality, reducing child mortality, combating disease and ensuring environmental sustainability. But doesn't sustainability embrace all these issues, not just "the environment"?

In Australia, after a nationwide review, National Research Priorities were identified for the first time by the Australian Government and released by the Minister for Science in December 2002. Four priorities that will guide investment by Commonwealth science and research funding agencies were announced, and the first two were:

- An Environmentally Sustainable Australia;
- Promoting and Maintaining Good Health.

Again, sustainability and health are separated, this time in a national research agenda.

The question arises: where will health and the environment be integrated if "sustainability" is explicitly aligned with the latter? Does existing research, theory and practice dealing with sustainability really separate the two, or integrate them? This issue of *Environmental Health*, and the next one, dealing with Sustainability, might be a useful case study since the papers in them cover a spectrum of issues raised by this conundrum.

Jeong's paper develops a research framework for measuring how successfully sustainable development is being achieved at a local, national, or worldwide level. McGregor mounts an effective critique of the construction of Australian National Headline Sustainability Indicators, arguing that reporting against them can only be based on a dominant social paradigm: continuing economic growth. Australia, says McGregor, will require a new environmental paradigm to generate a better set of indicators that will show whether Australia is maintaining "the natural ecology on which our life-support systems and society depend".

Ostry's paper uses a case study to examine the dependencies, linkages and tradeoffs between a resource (timber) and a community, where issues of income levels, employment, youth migration, welfare costs, community stability and government interventions deal with health and social costs incurred in industrial restructuring. Townsend et al. make the strongest connection of all: "growing threats to the environment associated with climate change, resource depletion and environmental degradation are increasingly being recognised as threats also to human health, implying that 'ecosystem health issues' relate not only to access to nature but also to quality of nature".

The journal then turns to practical approaches to sustainability. Pech and Arrowsmith outline a program to provide a major improvement in the water quality and ecosystem health of the Torbay catchment system on the south coast of Western Australia. They cite six major areas of benefit: improved drinking water quality, reduction in algal blooms, improved property values, improved environmental values, improved social values, and improved primary production and income. Derry et al. tackle the significant issue of water reuse. They emphasise that all reuse requires the coordinated assessment of risk relating to human health, ecosystems and agriculture through an appropriate risk management methodology. Finally, Parsons outlines one local government's initiatives to enhance environmental health and pursue sustainability. In a strong partnership with its Local Agenda 21 Committee, the Hornsby Shire Council has embarked on a process involving the community to identify what it treasures about the Shire and what its visions and ideals are, in order to develop a set of community sustainability indicators.

In short health and environment are integrated under the banner of sustainability in all papers, but the degree to which this integration is explored, is variable. Perhaps a research challenge for sustainability is to pass this integration test?

Pierre Horwitz
Guest Editor
Consortium for Health and Ecology,
Edith Cowan University

A Research Framework for the Empirical Analysis of Sustainable Development[1]

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Sustainable development is a worldwide ideology for present and future social development. Since the concept emerged in 1987 from the World Commission on Environment and Development (WCED), much research has been done on sustainable development. Broadly, this is categorised into three areas - the concept and implications, options and approaches that are possible for its achievement, and unsustainable development in developing countries. However, there is little research on how successfully sustainable development is being achieved at a local or national level. We need a research framework for conducting empirical research on sustainable development. With such implications, this paper aims at developing a research framework for measuring empirically how successfully sustainable development is being achieved, and for measuring change in sustainable development between different points in time.

Key Words: *Sustainable Development; Sustainable Development Indicators; Environmental Impact; Structure of Sustainable Development*

Many activities have been undertaken to achieve sustainable development since the concept emerged in the 1980s. The examples include environmental policy by governments, green management by business corporations, environmental movements by non-government organisations, and academic research by scholars. In addition, environmentalism, which is the cultural imperative that demands we act in an environmentally sensitive way, is growing as a cultural goal in civic society due to the negative effects of science and technology (e.g. Giddens 1991; Lash et al. 1996). Another dominant culture in civic society is that in all cases, the effects of environmental degradation have encouraged people to participate in the environmental movement (McMichael 1996). In particular, even though much research has been done on sustainable development, much of the literature is about the concept and its implications. There are concerns about unsustainable development in developing countries. There are a number of different approaches that are possible for the achievement of sustainable development, in particular, in terms of technology and environmental policy.

There is also much research on the sustainable development indicator, which can be applied to the empirical analysis of sustainable development as a reality. However, empirical research is still comparatively rare on how successfully sustainable development is being achieved at a local or national level. Moreover, there is no empirical research on the change in sustainable development between time intervals. Empirical research requires a research framework applicable to the reality. This paper aims to develop a comprehensive research framework for measuring how successfully sustainable development is being achieved at a local, national, or worldwide level.

The research framework is defined as the fundamental cognitive mapping towards the reality of a research subject in terms of how to perceive it, what data to collect, how to analyse them (Jeong 1997a). The paper attempts to develop a framework for the empirical study of the achievement of sustainable development, with a focus on the following procedures. The empirical analysis of a reality should be done using the indicators representing the definition of the reality, and the indicators should be selected on the basis of the conceptual components included in the definition. Therefore, as the first step, the paper examines which conceptual components of sustainable development should be selected. The second step is the selection of the indicators for the empirical measurement of the conceptual components. The indicators enable us to identify the current state of development, but cannot tell us whether the current state is sustainable or unsustainable. Hence, as the third step, we need a reference to assess whether the current state of development is sustainable or not. Finally, this paper focuses on the development of a research framework to measure the change in sustainable development between time intervals.

Selection of the Conceptual Components of Sustainable Development

The first step for the empirical analysis of a reality is to extract the attributes of the reality, which are defined as the conceptual components of that reality. Then, the conceptual components are the dimensions of sustainable development. For this, it is necessary to review the existing concepts of sustainable development in a comprehensive way.

The WCED was the first to use the term sustainable development formally in *Our Common Future* in 1987. However, this idea can be traced back to 19th century neoclassic economics (Noorman et al. 1998). According to Noorman et al. in ideal circumstances, relative scarcity is reflected in the price; the market is considered to allocate optimally the scarce factors of production. However, the preferences for natural resources can only partly be reflected in the exchange relations in the market. Consequently, the importance of the natural environment as a contributor to increasing welfare has received only limited attention in economic decision processes.

Other proponents of the idea of sustainable development, even though they did not use this term, include the pessimistic and optimistic perspectives on industrialisation in the 1970s. The example of the former is *The Limits to Growth* (Meadows et al. 1972). This may be one of the first environmental reports to have had a profound social impact. Meadows et al. argued that there should be a limit to economic development in terms of population, energy, food, pollution, and psychological aspects, which at the time seemed to be leading to levels that would be unsustainable in the future. Meadows et al. (1992) maintained a pessimistic perspective on industrialisation in 1992, with 13 possible scenarios of the future until 2100 in terms of natural resources, industrial production, food, population, natural environmental pollution, and the material quality of human life.

Contrary to this, Kahn et al. (1979) argued that limits could be overcome by innovation in technology and economic development on the basis of reinvestment of capital into such industries as eco-businesses. In the early 1980s, the World Conservation Strategy/International Union for the Conservation of Nature (WCS/IUCN 1980) emphasised ecological constraints on human activities and advocated the maintenance of essential ecological processes, life-support systems, and the preservation of genetic diversity to ensure the sustainable utilisation of species and ecosystems. It was in 1987 that WCED promoted the concept of sustainable development as a yardstick for long-term environmental policies, describing it in broad terms as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987, p. 43). In accordance with this definition, WCED (1987, p. 3) maintained that:

> *It is impossible to separate economic development from environmental issues; many forms of development erode the environmental resources upon which they must be based, and environmental degradation can undermine economic development. Poverty is a major cause and effect of global environmental problems. It is therefore futile to attempt to deal with environmental problems without a broader perspective that encompasses the factors underlying world poverty and international inequality.*

WCED (1987) recognised that sustainable development does imply limits - not absolute limits but limitations imposed by the present state of technology and social organisation on environmental resources, and by the ability of the biosphere to absorb the effects of human activities. WCED's concept is a much broader, integrative interpretation than those of neoclassical economics. However, WCED adds poverty as a component of sustainable development to the two main components - economic development and the natural environment. The concept was confirmed and strengthened at the Rio Earth Summit Conference in 1992. The outcome of this Conference, Agenda 21, outlined the global actions that would need to be taken in order to achieve a sustainable world within the next century rather than defining what is sustainable development (UN Conference on Environment and Development [UNCED] 1992).

Negative arguments on sustainable development emerged in the 1990s. For example, Cohen (1995) argues that notions like sustainable development or carrying capacity are important but are not concepts with any objective and scientific utility. He continues that a question like "How many people can the earth support?" is inherently normative and value laden. Catton (1997) argues that the earth has a finite carrying capacity, and that we have already exceeded it. Lele (1991) argues that sustainable development is merely a concept implying different forms of economic development from the industrialisation that has been promoted since the industrial revolution, because economic development is not possible without the sacrifice of nature. With such negative implications, there has been hot debate on whether the concept of sustainable development is useful or not (e.g. Beckerman 1994, 1995; Daly 1995; Jacobs 1995).

Regardless of such arguments, definitions of sustainable development abound (Van den Bergh & Van der Straaten 1994). It is generally agreed that ecological sustainability has more clarity as a concept than sustainable development. The confusion usually arises from what is meant by development, and how broadly or specifically the term is defined. In accordance with this, the concepts of weak and strong sustainability have emerged, with the former being focused on economy, and the latter being focused on nature (e.g. Bell & Morse 1999; Rao 2000; Turner 1998).

Such negative or positive arguments might arise from the fact that sustainable development as it emerged in the 1990s is based on the relationship between two main components - economic development and the preservation of the natural environment. If we include only these two components, sustainable development may be only desirable for economic survival and utility (Pessey 1992) or for a successful economy (Lele 1991). There are, however, many other social factors determining the sustainability of economy and nature. This would mean that economy and nature could not be sustainable without the sustainability of other social factors. In other words, without considering the social factors, the concept of sustainable development cannot come close to its reality.

Thus a variety of new perspectives on the conceptual components of sustainable development emerged in the 1990s, including not only the two traditional ones - the economy and the natural environment, but also other social factors determining the sustainability of the two. These may be termed multidimensional. For example, Pessey (1992) discusses physical, ecological, economic, psychological, social, and historical sustainable development. Ekins (1994) argues biological, economic, and social components of sustainable development. Harper (1996) argues that there are seven kinds of requirements for sustainability; these are population, biological base, energy, economic efficiency, social forms, culture, and world order. Turner (1998) discusses sustainable development in terms of nature, socio-cultural system, and economy. Rao (2000) maintains ecological, social, and economic factors as the conceptual components of sustainable development. These multidimensional concepts could be seen as focusing on the sustainability of society as a whole. This is because the multidimensional perspective enables us to extract as many sustainabilities as the number of the components of society, such as economy, ecosystem, population growth, socio-cultural system, social structure, and technology.

Thus, the conceptual meaning of sustainable development implied by neoclassical economics, Meadows et al. and WCS/IUCN are based on the impact of economic development on the natural environment. This would mean that the two are the main conceptual components of sustainable development. For WCED, poverty, economic development, natural environment, technology, and social institutions are included in the conceptual components. However, WCED treated technology and social institutions as external factors determining the state of economic development and the natural environment, and poverty is implied by the economic wellbeing of the population. Thus, WCED's conceptual components are summarised as population, economic development, and the natural environment. WCED's perspective was reconfirmed and strengthened at the Rio Earth Summit Conference, without any attempts to re-extract its conceptual component.

In the 1990s, even though there was a debate on whether sustainable development is a realistic or utopian goal, population, economic development, and the natural environment are accepted as the main conceptual components of sustainable development. Multidimensional approaches include other components such as psychological, social, historical, technological, physical, and sociocultural. These conceptual components may be defined as the external factors determining the sustainability of the three main ones - population, economic development, and the natural environment. The multidimensional components, derived from the concept of sustainable development, should be used as the composite dimensions for the empirical analysis of how successfully sustainable development is being achieved.

Selection of the Indicators

The conceptual components, which are derived from the concept of sustainable development, are theoretical, therefore, as the next step, empirical ones representing their theoretical meanings should be derived for identifying the state of sustainable development. They are then the indicators of sustainable development. There are debates on what the indicators should be (for details, see The Statistical Office of European Communities [SCOPE] 1997). In general, however, an indicator has the following three dimensions (Jeong 1997a). First, it is a proxy measure of a reality, for example, the suicide rate is an indicator of social pathology. Second, it is sometimes used as a variable, for example, per capita income is an indicator measuring economic growth. Third, an indicator is used as a concrete and empirical measure representing an abstract concept, as when IQ is used as an empirical measure of intelligence.

When the indicator is applied to sustainable development, it may be maintained that sustainable development is a reality, the conceptual components reviewed in the previous section are variables, and the concrete and empirical proxy measures are the indicators representing the conceptual components. Such indicators are constructed using information that is readily available, or can be obtained at a reasonable cost. Therefore, indicators are unavoidably biased at least in two senses (SCOPE 1997): the availability of information is much greater in industrialised countries than in developing countries, and environmental factors are under-represented in the information routinely collected and reported. We therefore need to examine the ways in which the indicators should be selected for measuring how successfully sustainable development is being achieved. The indicators are called sustainability indicators or sustainable development indicators as identified below (hereafter called sustainable development indicators: SDI).

As identified, sustainable development began to focus on the impact of economic development on the natural environment, and was extended to broader and more integrative areas including other socio-cultural factors determining the sustainability of economic development and the natural environment. Environmental indicators had been developed before the development of SDIs was attempted, but environmental indicators and SDIs are conceptually different (Opschoor & Reijnders 1991). The former expresses (change in) the amounts/levels of emissions, discharges, depositions, interventions, and so on in a predetermined region. The former can be defined as quantitative descriptors of changes in either (anthropogenic) environmental pressure or in the state of the environment. Thus, the former is an indicator of pressure. However, the latter is not simply an indicator of the actual state but rather an indicator of states vis-a-vis some reference; the latter can either be some past environmental state, or a future one that is regarded as more desirable than the present. The latter is, thus, more than a mere descriptor of a state, but a normative measure of the distance between the current state and the reference situation. With such an implication, SDIs focus on the links between environmental impact and socio-economic activity (Department of the Environment, United Kingdom [DEUK] 1996).

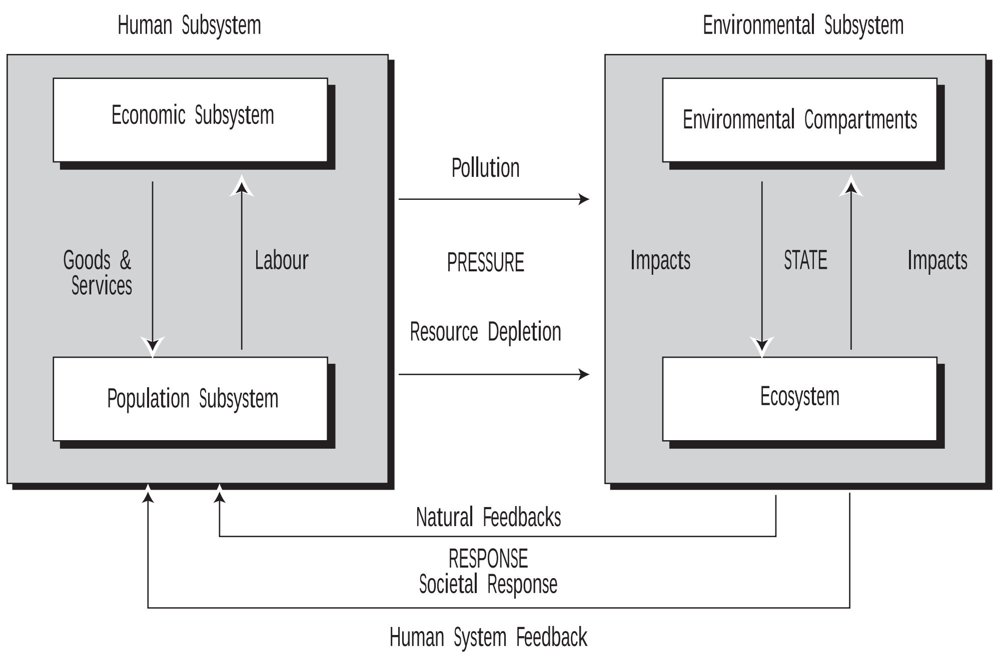
Environmental Indicators

We need an overview of environmental indicators before we examine SDIs, because existing SDIs are mainly derived from environmental indicators. For Japan (Jeong et al. 1997), indicators of pollution were developed in the 1960s, and followed by those of quality-of-life, environmental amenity, and environmental resources in the 1980s, with the purpose of identifying the state of and change in the environment.

The Netherlands developed environmental indicators as a means of measuring the achievement of the goal of a state without environmental problems, and for inducing change in the social structure towards this goal (Adriaanse 1993). Adriaanse divided the indicators broadly into two categories - theme and target group indicators. The former was based on the components of the natural environment such as climate, ozone, air, and soil, and so on, while the latter included agriculture, transportation, industry, energy, trade, and consumption. Thus, she has attempted to achieve a society without environmental problems through the analysis of the mutual mechanisms between the natural environment and socio-economic factors. She called her indicators environmental policy performance indicators.

The World Health Organization (WHO 1992) developed a set of environmental indicators in 1992. Its main concern was with economic development as a determinant of human health. The WHO

Figure 1: OECD Framework of Environmental Indicators



Source: World Resources Institute 1995, p. 11

indicators include nature, population, and socio-economic factors. Nature includes the indicators representing food, water, energy, biodiversity, and forests, while population includes the indicators representing population, death rate, birth rate, and migration. Social indicators cover poverty, occupational exposure to danger, housing, and so on. Economic indicators include resource use and industrial structure.

The Organisation for Economic Cooperation and Development (OECD 1994) constructed environmental indicators on the basis of a causal chain, using a framework of pressure-state-response (PSR) through a preliminary work (OECD 1991). Their causal framework is summarised as Figure 1.

Table 1 shows an example of some selected OECD (1994, p. 14) core environmental indicators on the basis of their causal framework illustrated in Figure 1.

Table 1: An Example of PSR Framework Developed by OECD

	Pressure	State	Response
Environmental Issues	Indicators of Environmental Pressure	Indicators of Environmental Conditions	Indicators of Societal Responses
Urban Environmental Quality	Urban air emissions Traffic density • Urban • National	Population exposure to: • Air pollution, Noise • Ambient water conditions in urban areas	Green space Water treatment & noise abatement expenditure
Soil Degradation (Desertification & Erosion)	Erosion risks: Potential and actual land use Change in land use	Degree of top soil losses	Rehabilitated areas
Biodiversity/Landscape	Habitat alteration & land conversion from natural state	Threatened or extinct species as a share of total species known	Protected area as % of national territory & by type of ecosystem

The OECD framework raises a number of questions (World Resources Institute [WRI] 1995, pp. 11-12):

> *What is happening to the state of the environment and our natural resources? Why is it happening? What are we doing about it? Indicators of changes or trends in the physical or biological state of the natural world (state indicators) answer the first question, indicators of stresses or pressures from human activities that cause environmental change (pressure indicators) answer the second, and measures of the policy adopted in response to environmental problems (response indicators) answer the third. More specifically, state indicators measure the quality or state of the environment, particularly declines attributable to human activities. Pressure indicators, in contrast, show the causes of environmental problems such as, for example, depletion of natural resources through extraction or overharvesting, releases of pollutants into the environment, or the conversion of natural ecosystem to other uses. Response indicators gauge the efforts taken by society or by a given institution to improve the environment or mitigate degradation. Thus, they measure how policies are implemented by tracking treaty agreements, budget commitments, research, regulatory compliance, the introduction of financial incentives, or voluntary behavioural changes.*

The development of environmental indicators has been approached from different perspectives. Japanese indicators are simply a checklist for identifying the state of and change in the natural environment in terms of pollution and/or destruction, and for assessing environmental amenities and the value of natural resources. The Netherlands has attempted to develop indicators, focusing on the linkage between the environment and socio-economic conditions. The OECD captures the indicators neither as a checklist nor simply as a broad linkage between environment and socio-economic conditions, but more as a comprehensive and integrative causal framework. However, Japan, the Netherlands, and the OECD are focusing on environmental issues in the development of environmental indicators, with little attention to other socio-cultural factors except economic ones. Core lists of environmental issues - and of relevant indicators - have been and are being developed by several organisations, building on the OECD's initial work. Such indicators, focused on environmental issues, have been organised within the PSR framework. For example, the WRI (1995) constructs climate change as an environmental issue, GHG emissions as pressure, concentrations as states, and energy intensity/environmental measures as responses. Such a framework, being focused on environmental issues as the initial concern, is one of the reasons why environmental indicators are not sufficient for measuring empirically the achievement of sustainable development that consists of broader conceptual components as reviewed in the previous section.

Sustainable Development Indicators

While environmental indicators were being developed, there was some work on the development of SDIs in order to overcome the shortcomings inherent in indicators. Braat (1991) used sustainability indicators which were defined as indicators that provide information, directly or indirectly, about the future sustainability of specified levels of social objectives such as material welfare, environmental quality, and natural systems amenity. He distinguishes two types of SDIs: predictive and retrospective indicators.

> *The predictive indicators provide direct information about the future state and development of relevant socio-economic and environmental variables. This information constitutes the basis for anticipatory planning and management. The predictive power is based on mathematical models of the man-environment system. However, retrospective indicators include the traditional policy evaluation and historical trend indicators. They provide information about effectiveness of existing policies or about autonomous development, respectively. From these indicators decision-makers may learn and*

improve policy effectiveness. In this way, retrospective indicators may provide indirect information about future sustainability. They are usually quantified by a combination of measured data and reference values (e.g. historical situations, economic targets, health standards) (Braat 1991, p. 57-58).

The work on the development of SDIs has been promoted since the United Nations Committee on Sustainable Development (UNCSD) was established under the United Nations, taking the Rio Earth Summit Conference as an opportunity in 1992. UN Commission on Sustainable Development (UNCSD) requested the member countries to submit their practical report on the basis of Agenda 21, and to include SDIs with statistical data in the report. For this, most of the member countries began to establish National Committees on Sustainable Development, and to develop SDIs on the basis of a systematic framework.

In accordance with this, three levels of SDIs began to be developed. One was for their application to a local region in a country. The examples include Seattle in the United States (Sustainable Seattle 1995) and the British Local Agenda 21 (The Local Government Management Board, United Kingdom [LGMBUK] 1995). Another level was for their application to a whole country. The examples include United Kingdom (DEUK, 1996), USA (US Interagency Working Group on Sustainable Development Indicators [USIWGSDI], 1998), and Australia (Eckersley 1998). The other level for their application is to the global level. This was done mostly by international organisations (e.g. UNCSD 1996; Statistical Office of European Communities [SOEC] 1997; SCOPE 1997; UN Department for Policy Coordination and Sustainable Development [UNDPCSD] 1997; World Bank, 1997; OECD, 1998; European Environment Agency [EEA] 1999) or by academics (e.g. Bell & Mores 1999).

It is impossible here to consider all the relevant literature. The most important point is that they attempted to develop SDIs in a broad and integrative way, including the natural environment, the economy, socio-cultural factors, and even institutional factors. For example, The SOEC (1997) constructed four categories of SDIs, such as economic, social, natural environmental, and institutional. EEA (1999) constructed two categories of SDIs, with a perspective that sustainable development is basically a flow of material. Many other international organisations construct SDIs using a basic PSR framework of OECD environmental indicators as is shown in Figure 1. However, the concept of pressure is replaced by that of driving force in an attempt to accommodate more accurately the addition of social, economic and institutional indicators (e.g. UNCSD, 1996; SCOPE, 1997; World Bank, 1997; UNDPCSD, 1997). In this sense, their framework may be called driving force-state-response (DSR) framework.

D represents Driving Force, which is replaced by Pressure in the PSR framework. In other words, the PSR framework was used in the development of environmental indicators as shown in Table 1. Pressure is defined as human activities exerted on the environment such as the use of natural resources and omission of wastes, all of which are closely related to production and consumption. However, DSR (Driving Force, State, Response) framework has been adapted for the development of sustainable development indicators as shown in Table 2. In the DSR framework, the term Pressure has been replaced by that of Driving Force in order to accommodate the inclusion of economic, social, and institutional aspects of sustainable development. So, Driving Force is defined as human activities, processes and patterns that have an impact on sustainable development. So, the impact of Driving Force can be both positive and negative, which is not the case for Pressure in the PSR framework. This is particularly relevant for some Driving Forces, which have a positive impact on the developmental aspects of sustainable development, but a negative impact on the

Table 2: An Example of the DSR Framework Developed by International Organisations

Conceptual Components of Sustainable Development		Driving Force	State	Response
Social	Education	Rate of change of school-age population	Children reaching grade 5 of primary education	GDP spent on Education
	Human settlement	Rate of growth of urban population	Percent of population in urban areas	Infrastructure expenditure per capita
Economic	Per capita income	Growth of population	Inequality of property/income	Stable level of property/income
	Financial resources	Net resources transfer/GNP	Debt/GNP	Environmental protection expenditure as a percent of GDP
Institutional	Science for sustainable development	Not applicable	Potential scientists and engineers per million population	Expenditure on R&D as a percent of GDP
	Information for decision-making	Not applicable	Main telephone per 100 inhabitants	Programs for national environmental statistics
Environmental	Ozone	Consumption of CFC	Density of CFC	Application of Montreal Protocol
	Climate Change	Omissions of GHG	Density of GHG	Efficiency of energy use

environmental aspects. In this sense, Pressure in the PSR framework is not an accurate reflection of the impacts of human activities on sustainable development, which can be positive or negative.

The selected SDIs can be used as the descriptors for the empirical analysis of sustainable development. It is important to note some critical references we should keep in mind when we select SDIs (Jeong 2002). First, SDIs should be selected from those representing the conceptual components of sustainable development. This means that different SDIs can be selected according to how one defines the concept of sustainable development. Second, as international organisations have attempted, SDIs should be selected on the basis of a causal framework. This is because the conceptual and empirical components of sustainable development are not independent, rather they are interrelated. Third, SDIs should be those which can be expressed quantitatively. This is because qualitative descriptors cannot provide us with the information on how successfully sustainable development is being achieved. Fourth, SDIs should not be redundant. The problem of redundancy arises most often when indicators contain any sub-classes of other indicators, or when indicators with the same or almost the same denominators and numerators from different but actually closely related classifications are selected. Fifth, in case of comparative analysis, an identical set of SDIs, in which corresponding indicators have the same meaning and classifications over two points in time and between areal units, should be selected. Further, satisfactory SDIs should be comparable and applicable to the regions of different size and type. Six, although there is still no consensus on how many SDIs should be constructed and what they should cover, different SDIs would be appropriate for different purposes. For example, the issues of sustainable development will vary from country to country, and so the selection of SDIs can also be expected to vary.

Analysis of the Achievement of Sustainable Development

Analytic levels

Many individual SDIs can be selected from the conceptual components of sustainable development using the DSR framework as shown in Table 2. At the first level of analysis, we can capture the state of sustainable development by each SDI. This level may be termed the analysis by individual indicators. This will result in a very detailed analysis, but is not suitable for capturing the state of sustainable development by the category of its conceptual component

Because of this shortcoming, we need to cluster the individual SDIs into some categories as the second level of analysis. This may be termed the analysis by categoric indicators. There may be two possible operationalisations to categorise the individual indicators into the categoric indicators. The first one is to categorise the individual SDIs according to their conceptual components such as social, economic, institutional, and environmental dimensions as shown in Table 2. This is a theoretical categorisation in that they are reduced to their original place where they have been drawn from the conceptual components. Then, all of the individual SDIs can be reduced to one of the categories.

The second stage is to apply a factor analytic technique to the individual SDIs. This technique will produce some factors as the structural axes of sustainable development. The axes represent the empirical categories of sustainable development compared with the theoretical categories produced in the first operationalisation. The number of axes extracted from the factor analytic technique is the number of empirical categories of sustainable development. Then, we can identify the composite SDIs loaded on each axis on the basis of factor loading.

Before we apply the two approaches to empirical data, it is difficult to decide which one has more explanatory power as a technique to operationalise the analytic categories of sustainable development. One more important thing is how to estimate the total value of each category that is composed of the individual SDIs. The value of the individual SDIs is measured by different measurement units. For example, water pollution is measured in PPM, population growth as a percentage, and consumption of CFC in tons. This means that the value of each composite SDI cannot be summed up in order to estimate the total value of each category of sustainable development. To solve this problem, we need to standardise the values of all individual SDIs. The standard score, which is called *z*-score in statistical analysis, is the technique of readjusting the original value of each variable measured by different units of measurement. If we use the factors extracted from the factor analysis as the category of sustainable development, we may use the factor loading of each SDI instead of the standard score.

Even though the standard score of the individual SDIs is calculated, we have another important thing to consider in summing up the value of each composite indicator as a category of sustainable development. If we sum up their standard scores arithmetically, this has a premise that each SDI has the same impact on the determination of sustainable development. It is quite easy to assume that the SDIs have different degrees of impact on sustainable development. This requires consideration of the relative weighting of each SDI when the standard score of each composite indicator is summed up.

This level of analysis enables us to identify the state of sustainable development by its theoretical or empirical category, but does not tell us the state of sustainable development as a whole. This is why we need another level of analysis, which may be called the analysis by a multiple indicator. This can be developed by synthesising all of the categoric indicators whose weightings had already been included when their values were estimated on the basis of the standard score or factor loading. Even though the multiple indicator loses the detailed state of sustainable development by individual SDIs or by the categories of sustainable development, it tells us the state of sustainable development as a whole. This is why it would be desirable to analyse sustainable development in terms of the three analytic levels, respectively.

Assessment references

The final step is to measure empirically the sustainable development being achieved. It is quite easy to get the information on each indicator. For example, we can get data on how much the water and air are polluted. This information does not tell us anything about whether the current state is sustainable or not. For assessing this, we need to employ other references. Environmental impact and carrying capacity would be good references for this assessment. In regard to environmental impact, Ehrlich and Ehrlich (1992) created a way of conceptualising the joint impact of the human causes of environmental change as a concept of environmental impact. They argued that the impact (I) of any population or nation on environmental and ecosystems is a product of its population (P), its level of affluence (A), and the damage done by particular technologies (T) that support that affluence.

Ehrlich and Ehrlich's formula is a simple way of illustrating different but related dimensions of environmental impact: as functions of the number of people, the technologies employed to produce goods and services, and the amount of goods and services they consume, while relative weights of these are subject to debate (Harper 1996, pp.247-8). There is one important shortcoming found in the formula. That is, the formula cannot estimate the effect of P, A, T on the decrease in environmental impact, because the formula is based on the linearity as time goes by (Jeong 2002).

More recently, Sage (1995) has introduced another formula for overcoming the shortcomings inherent in Ehrlich and Ehrlich's formula. To determine the relative impact for each factor over a period of time, Sage uses "percentage change in population" and "percentage change in use of resource". This formula can distinguish between upward and downward pressure on environmental impact.

Overall, what the two formulae can do is to estimate environmental impact in total as functions of the number of people, the technology employed to produce goods, and the amount of goods they consume. In this sense, the concept of environmental impact is very useful. However, its usefulness is partial because it cannot capture the change in the volumes loaded on environmental pollution and destruction by the categories of human economic activities. In addition, the two formulae are not comprehensive in terms of the number of indicators, which should be included in the analysis of sustainable development. Also, the volumes estimated from the formulae cannot tell us about whether the environmental state is still within or beyond sustainability.

Carrying capacity was conceptualised originally in biology. It was defined as the maximal population size of a given species that an area could support without reducing its ability to support the same species in the future (Daily & Ehrlich 1992). This definition cannot be applied to human beings. The main reason for this is that for human beings, the amount of resources in a region cannot limit the size of population because the resources are transferred between regions in a country and/or between countries through trade. In other words, there is no region isolated from other ones. This would mean that the flow of trade is a way to overcome the constraints on regional carrying capacity imposed by local resource shortages (Wackernagel et al. 1993). With such an implication, a modified concept of carrying capacity applicable to human society has been developed. It is appropriated carrying capacity (ACC) which is also called an ecological footprint (Wackernagel et al. 1993).

ACC is defined as the aggregate land (and water) area in various categories required by the people in a region (1) to provide continuously all the resources they presently consume, and (2) to absorb continuously all the waste they presently discharge using current technology (Wackernagel et al. 1993). In other words, the ACC of a population is the land, which is needed exclusively to produce the natural resources it consumes and to assimilate the waste it generates indefinitely. It is the land that would be required now on this planet to support the current lifestyle forever. The basic question of estimating ACC is how much land is needed for a person. This question has been approached through three factors (e.g. Dasgupta, Folke & Maler 1994; Wackernagel et al. 1993). One is to identify the land use of consumption, another is consumption categories, and the other is land-use categories. The basic principles of the three factors are as follows (Wackernagel et al. 1993).

To determine the total land area needed to support a particular pattern of consumption we must understand the land-use implications of each significant category of consumption. Since it is not feasible to assess land requirements for the provision, maintenance, and disposal of every single consumption good, we confine our calculations to major categories. Hence, we can avoid the huge task of assessing the impact of the several hundred thousand consumption goods, which are available on the market on the over one hundred land categories that can be distinguished. Estimating ACC is an iterative process. Rather than starting with the analysis of each consumption item, it is simpler and more effective to assess first the ACC of total regional or national consumption. Data for preliminary assessments can be obtained from national statistics. Only later is it necessary to estimate the land-use associated with various consumption items. Adding up the land-use of these consumption items then permits us to revisit total consumption and its land-use. Going back and forth from the individual consumption category to total consumption helps eliminate data gaps, mistakes and apparent contradictions that are the inevitable hurdles of any ACC assessment.

Using such a technique, Wackernagel et al. (1993) and Bicknell et al. (1998) have calculated empirically the ACC of Canada and New Zealand, respectively. Chambers et al. (2000) have calculated ACC from 53 countries on the basis of some indicators such as fossil energy, CO_2 absorption, land, and forest, which can be included in the category of SDI. The ACC may be calculated by synthesising the individual SDIs. However, one important shortcoming inherent in the estimation of ACC is that the estimation is based on consumption items. This means that the SDIs, except those that cannot be estimated as land size, cannot be included in the calculation of the ACC. Because of this, it is not possible to assess the achievement of sustainable development as a whole, including all of the SDIs selected. In other words, the ACC can be a good reference for assessing the achievement of sustainable development empirically, but it is still a partial assessment.

Analysis of Change in Sustainable Development

In the 1970s, many human ecologists employed two different analytic frameworks in their empirical analyses of ecological structure and change in the spatial patterning of human activities resulting from their interaction with the environment. One was change in ecological structure, and the other was the structure of ecological change (e.g. Hunter 1971; Janson 1978; Latif 1974). These two dimensions of change can be applied to the analysis of change in sustainable development over time.

Compared to the analysis of the achievement of sustainable development, the analysis of change in sustainable development is a dynamic one because the analysis is for identifying what has been changed between at least two points in time. The analysis of the change may be examined in two ways as human ecologists did in the

1970s. One is a comparison between the two states of sustainable development after separate analyses have been undertaken at two different points in time. The other is to derive a pattern of change, using a new set of SDIs created from the value of change in each corresponding SDI between two points in time. The former is a cross-sectional analysis and is defined as ‘change in the structure of sustainable development’, while the latter is a longitudinal analysis and is defined as ‘the structure of change in sustainable development’.

Change in the Structure of Sustainable Development

Change in the structure of sustainable development may refer to the analysis of differences in the state of sustainable development, undertaken at different points in time. The differences can be compared in terms of some aspects for measuring the change in sustainable development between the two points in time. First, the comparison may be done in terms of the differences in the value of SDIs over time. As explained, SDIs are categorised into three dimensions - individual ones, categoric ones, and a multiple one. The difference can be examined by each dimension of SDIs. Then, the differences depict the change in sustainable development in terms of their values. Second, compositional change can be analysed. For doing this, we have three things to be clarified. They are: what is the structure of sustainable development? how to measure it? and how to analyse its difference over time?

The SDIs do not exist independently, rather they are in a mutual relationship as the components of sustainable development. The pattern of their mutual relationship can be termed the structure of sustainable development, and can be identified applying a factor analytic technique to the SDIs. Then, the structure can be depicted in terms of the number of factors extracted from the SDIs, factor loading of each SDI, the eigenvalue of each factor, and the communality of each SDI.

The number of factors represents the number of structural axes of sustainable development. The factor loading of SDIs on each factor enables us to identify the major composite SDIs of each factor, which finally enables us to capture the conceptual meaning of each factor. The eigenvalue represents the relative importance of factors as the structural axes of sustainable development. Meanwhile, the communality represents the relative importance of SDIs as the components of sustainable development.

Then, the differences in the structure of sustainable development over time can be compared in terms of the number of structural axes, their conceptual meaning, their relative importance as the structural axes, and relatively important SDIs as the individual components of sustainable development. These differences between different points in time depict the change in the structure of sustainable development.

The Structure of Change in Sustainable Development

Human ecologists (e.g. Hunter 1971; Janson 1978; Latif 1974) argued and evidenced empirically in the 1970s that the process of social change between points in time shows a patterned form. The patterned form is denoted as the structure of change. This conceptual framework can be applied to the structure of change in sustainable development. This analysis requires the creation of the value of change in corresponding SDI between, at least, two different points in time. The difference in the value is the value of change, and can be defined as the change coefficient. The change coefficients calculated from all SDIs can be factorially analysed. The resulting factor structure is defined as the structure of change in sustainable development between two points in time.

As can be applied to the change in sustainable development, the structure of change in sustainable development can be examined in terms of the number of factors extracted from change coefficients, factor loading of each change coefficient, the eigenvalue of each factor, and the communality of each change coefficient.

The number of factors represents the number of structural axes of change. The factor loading on each factor enables us to capture the conceptual meaning of each factor. The eigenvalue represents the relative importance of factors as the structural axes of change. The communality represents the relative importance of change coefficients as the structural component of change in sustainable development.

The Internal Mechanism of Sustainable Development Being Changed

The framework of socio-ecological structural change is generally based on at least a trichotomous causal model (Jeong 1997b). This framework can be applied to the analysis of change in sustainable development. That is, the structure of sustainable development of Time A is changed to that of Time B through the changing processes among the structural components in Time A. Thus, it is possible to hypothesise the structure of sustainable development of Time A as the independent variable, that of Time B as a dependent variable, and the structure of change in sustainable development resulting from the changing process between Time A and B as the intervening variable. A path analytic technique can be applied to this causal model. Then, we can identify the internal mechanism of sustainable development having been changed from Time A to Time B through changing process between Time A and B.

Summary and Discussion

Nowadays, sustainable development is a worldwide ideology of present and future social development. Many activities are carried out in order to achieve sustainable development, including environmental policy by government, green management by business corporations, the environmental movement of non-government organisations, and academic research by scholars. In addition, environmentalism is growing as a cultural goal in civic society.

A wide range of research on sustainable development has been done since the concept emerged in the 1980s. However, no empirical analysis of how successfully sustainable development is being achieved has been attempted either at a local or national level. Moreover, there is no empirical research on the change in sustainable development between time intervals. There is no doubt that all kinds of empirical research require a research framework applicable to the reality.

The paper aims to develop a comprehensive research framework for measuring empirically how successfully sustainable development is being achieved and changed at a local, national, and world-wide level. The first step for developing the research frame is to cluster the conceptual components of sustainable development. The economy and the natural environment have been the main conceptual components of sustainable development. However, it can be maintained that the economy and the natural environment cannot be sustainable without other social factors being sustainable. Therefore, it is desirable for the conceptual components to be multidimensional, including not only the economy and the natural environment, but also other social factors determining the sustainability of the economy and the natural environment.

The second step is to select the indicators representing the conceptual components. This is because the conceptual components are theoretical, while the indicators are empirical. It is desirable that the indicators should be constructed in a causal chain such as driving force-state-response. This is because all indicators exist interrelatedly as an integrated reality. Then, the indicators can be the empirical scales, which enable us to measure the state of sustainable development. The measurement can be done on three analytic levels. They are analysis by an individual indicator, by a categoric indicator, and by a multiple indicator.

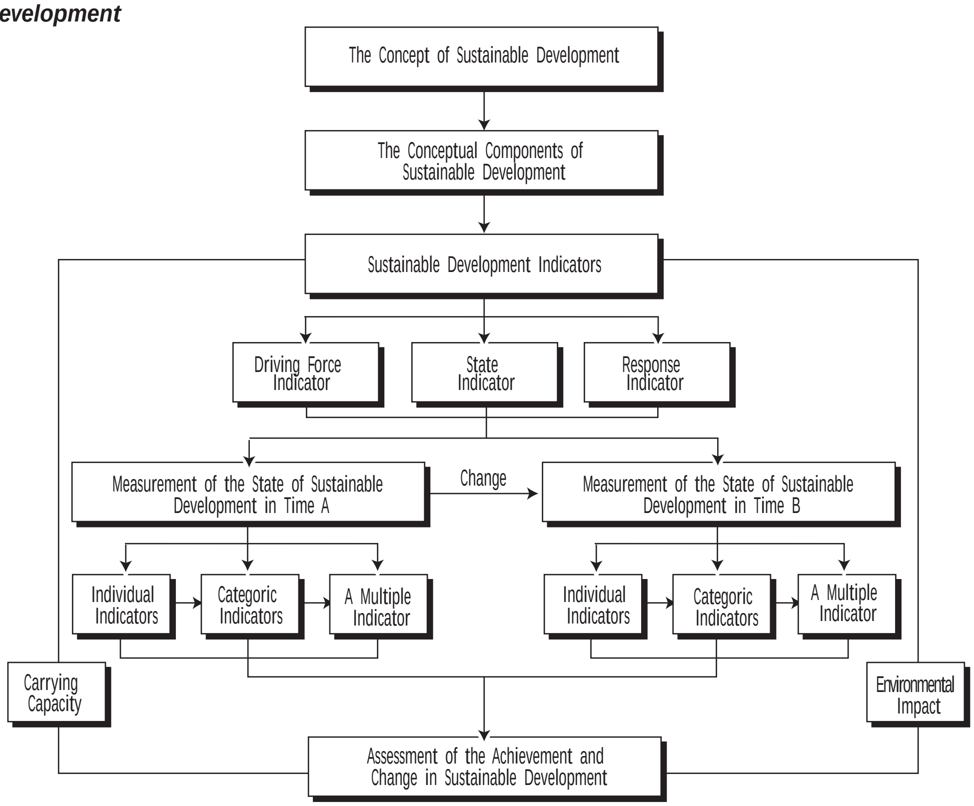
The third step is that we need references for assessing whether sustainable development is being achieved or not. This is because the indicators enable us to identify the state of sustainable development, but do not enable us to judge whether the state is sustainable or not. The environmental impact and carrying capacity are good scales for assessing the state of sustainable development being achieved.

The fourth step is to analyse the change in sustainable development between different points in time. The change can be analysed by two frameworks. One is change in the structure of sustainable development, and the other is the structure of change in sustainable development. The results drawn from these two frameworks are a useful set of data for analysing the internal mechanism of sustainable development being changed between different points in time.

The above steps are summarised in Figure 2 below.

Figure 2 is not a perfect framework, but a possible one. In addition, when we conduct empirical research, we are faced with, at least, the following problems. Theoretically, the concept of sustainable development and its components can be constructed in a comprehensive way. The indicators representing the conceptual components should be collected from the existing secondary data. However, the secondary data are limited in terms of two points. The first limitation is whether the secondary data representing all of the conceptual components are available or not. This is because the secondary data are mostly

Figure 2: Summary of the research framework for the empirical analysis of sustainable development



collected by the authorities according to their empirical concerns. Even though they are available, the second limitation is whether or not they exist in a way that meets the theoretical description of the conceptual components. These two points with which the existing secondary data are possibly faced make the selection of indicators not as comprehensive as the theoretical conceptual components demand. These two possible limitations bring about another problem in calculating the total amounts of carrying capacity. Therefore, this will result in a partial assessment of the achievement of sustainable development.

Endnote

1. An earlier version of this paper was presented at the Indopacific Ecosystem Health Conference in Perth, Western Australia in November 2002.

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Is Australia Progressing towards Ecologically Sustainable Development?[1]

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In December 1992, all Australian governments endorsed the National Strategy for Ecologically Sustainable Development. As no indicators were set in the National Strategy, Australia's progress towards Ecologically Sustainable Development has been difficult to measure. This paper addresses two questions: assessed against the quality standards set in the Bellagio Principles, are the National Headline Sustainability Indicators a good set of Sustainability Indicators? On the basis, primarily, of the National Headline Sustainability Indicators, is Australia progressing towards Ecologically Sustainable Development? Major weaknesses in the National Headline Sustainability Indicators versus quality standards for sustainability indicators are identified. The paper then assesses the indicators chosen against the objectives in the National Strategy for Ecologically Sustainable Development. It concludes that the version of Ecologically Sustainable Development reflected in the National Headline Sustainability Indicators is a weak version of sustainability. Based on the National Headline Sustainability Indicators, all of the economic indicators and some of the social indicators show some progress since 1992. Most of the key National Headline environmental indicators have no trend data. Those with trend data, however, show an adverse trend. The major conclusion is that Australia will require a new environmental paradigm to make significant progress towards Ecologically Sustainable Development.

Key Words: *Sustainability Indicators; Ecologically Sustainable Development; Australia*

In December 1992, following the World Summit for Sustainable Development (WSSD) in Rio, all Australian governments endorsed the National Strategy for Ecologically Sustainable Development (NSESD) (Commonwealth of Australia 1992a). The NSESD had three core objectives (detailed below) and 75 other objectives. One of the 75 objectives was to develop appropriate performance measures "as a means of indicating overall progress towards ESD" (Commonwealth of Australia 1992a, p. 110). Despite this, it was not until 2000 that a report on a proposed set of National Headline Sustainability Indicators (NHSI) was published (Australian Bureau of Statistics [ABS] 2000). In June 2002, just prior to the Johannesburg WSSD, Environment Australia published the inaugural NHSI report. This paper seeks to assess the quality of NHSI and the extent to which they provide an appropriate basis for assessing Australia's progress towards Ecologically Sustainable Development (ESD) over the last decade. It then uses the NHSI and some other relevant indicators to assess what progress Australia has made towards ESD.

Assessment of the National Headline Sustainability Indicators

Quality assessment of NHSI based on the Bellagio Principles

The Bellagio Principles (Hardi & Zdan 1997) are a set of 10 quality standards in relation to measuring and assessing progress toward sustainable development. An international meeting of sustainability indicator experts convened by the

International Institute for Sustainable Development in Bellagio, Italy in 1996, developed these principles. The Bellagio Principles are a highly regarded set of quality standards for sustainability indicators (Bell & Morse 1999; The Earth Council 1997). The principles provide an excellent framework to use for assessment of the Australian NHSI. The NHSI are assessed in relation to each of the 10 Bellagio Principles.

Principle 1: What is meant by sustainable development should be clearly defined

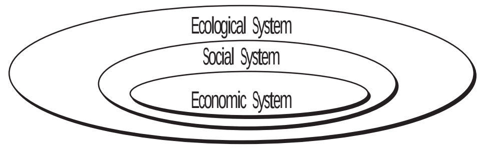
The NHSI were developed specifically to address the three core objectives of the NSESD and their component parts. Appendix A shows the three core objectives of the NSESD and the 22 Key Aspects that were developed to represent the component parts of these objectives as part of the development of the NHSI. As discussed below, there could be a range of definitions of ESD that are covered by the NSESD core objectives.

Principle 2: Sustainability should be viewed in a holistic sense, including ecological, social and economic components

The NHSI includes ecological, social and economic indicators, and Appendix A includes a classification of each of the NHSI as ecological, social or economic. The NHSI report does not make this classification.

The principle also states that in relation to holistic assessment that the assessment should include a review of the whole system as well as its parts. The NHSI have a focus on parts of the system and not the whole system. Without the planet's basic life support system there can be no society and no economy, so the social system therefore is contained within the ecological system. The economy only works to serve some of society's needs and therefore fits within society. Thus the appropriate system model to review the whole system should be based on a nested system model (Figure 1).

Figure 1: Nested System Model



The system model recognises the economy as only a model of part of society which fits within society and that human society is totally constrained by natural ecology. It is adapted from Lowe's work that was included in the 1996 *Australia: State of the Environment Report* (State of the Environment Advisory Council 1996).

Principle 3: Essential elements - notions of equity should be included in any perspective of sustainable development

The NHSI do not deal with over-consumption and poverty or human rights as specified in the full text of the principle. Six of the seven NHSI classified as Social NHSI shown in Appendix C do relate to notions of equity. These relate to educational, gender, health and locational (urban versus remote) equity, education, and drinking water quality.

Principle 4: Adequate scope in terms of time horizon and geographic scope

Australia is unusual in having no land borders with any other country. The only global issue addressed in the NHSI relates to greenhouse gas emissions and it does not address any issues of global poverty and related issues. It does, however, adhere to the part of the principle that relates to defining "the space of study large enough to include not only local but also long distance impacts on people and ecosystems" (Hardi & Zdan 1997, p. 2).

The time horizon should be long enough to capture both human and ecosystem time scales. The time scale used is mainly the 10 years since the 1992 NSESD, although for some NHSI the time series data provided include data from the period prior to 1992. This is probably sufficient to make some assessment even in relation to relatively slow moving ecosystem indicators.

Principle 5: Practical Focus - progress towards sustainable development should be based on the measurement of "a limited number" of indicators

There are 26 NHSI related to 22 aspects of the three core objectives of the NSESD, which represents an explicit organising framework that links vision and goals to indicators and assessment criteria. The aspects and related indicators chosen for each core objective reflect a set of assumptions and values about what ESD means in practice. What is not clear is whether the NHSI measure the particularly important, critical or salient aspects of ESD. Whether these are the most critical aspects depends on how ESD is defined. The aspects and NHSI chosen represent indicators and measures of progress towards one particular version of ESD. These are discussed below.

The interim NHSI for the Management of Agriculture (Indicator 5 in Appendix B) might not be a good indicator of what is an important aspect of ESD. This interim indicator for the Management of Agriculture represents the net value of rural land. The fact that the value of rural land is increasing in value does not seem to be a meaningful measure of ecologically sustainable management of agriculture in Australia.

The principle also states that the indicators chosen should be able to be compared with targets, reference values, ranges, thresholds, or direction of trends, as appropriate (Hardi & Zdan 1997). For each of the NHSI, there is a desired trend - either up or down. The problem is that the direction of change for some NHSI might be in the right direction but the trend might not be fast enough to avoid significant environmental problems. For some NHSI, it would be appropriate that more specific targets as well as desired trends were established. Trends only provide a relative frame of reference and for some indicators an absolute frame of reference (e.g. targets, thresholds) is also required. The Air Quality NHSI (Indicators 6 & 7 in Table 2) exemplify the problem of using only a relative framework; they may show an improving trend, but the trend may not be rapid enough to avoid significant health problems.

As a further example, the Management of Energy Headline Sustainability Indicator (Indicator 2 in Appendix B) is flawed as it only shows the renewable energy use as a percentage of total energy used. Even if it was moving in the right direction, the increase in total energy use could be large enough to make the total non-renewable energy use still increase. The desired trend should be downwards for total energy use or energy intensity (energy use/production). The latter is used in the Swedish Sustainable Development Indicators (Statistics Sweden & the Swedish Environmental Protection Agency 2001)

Despite the NHSI report claiming that the NHSI chosen are "reliant on data that are already available in other contexts", for 2 of the NHSI no data will be available for the foreseeable future (Environment Australia 2002, p. 2). For a further 2 NHSI no data is available so interim indicators have been used, and for a further 11 of the 26 NHSI no trend data are available. In other words, only 11 of the 26 NHSI meet the self-proclaimed criterion for inclusion. Many of the NHSI therefore do not conform to the part of this Bellagio Principle that states that the indicators should show trends or be able to be compared with a target, particularly over the last decade since 1992.

Principle 6: Openness - methods and data employed for assessment of progress should be open and accessible to all

Almost all of the NHSI meet these criteria as they are based on established statistical sources and methodologies, details of which are available from the various organisations which prepare and publish the indicators. One exception is related to the Management of Agriculture where the indicator “Net Value of Agricultural Land Use”, which is not yet available. The NHSI report also notes that the National Land & Water Resources Audit is currently developing the methodology and data for reporting against this indicator (Environment Australia 2002). When this is available, it might be easier to understand the method of assessment underlying this NHSI.

Principle 7: Effective Communication - progress should be effectively communicated to all decision-makers, users and audiences

The NHSI report uses reasonably clear language although for someone unfamiliar with ESD and indicators, there might be some problems in fully understanding the report due to its widespread use of technical terms. Environment Australia (EA) has made the report available on its internet site as well as making the published report available free of charge. The NHSI report received much less attention and media coverage than the State of the Environment Report that was also released by EA earlier in 2002.

Principle 8: Broad participation is required

This principle states that broad participation is required by key grass roots, professional, technical and social groups, including youth, women, and Indigenous people, to ensure recognition of diverse and changing values. The principle also requires participation of decision makers to secure a firm link to adopted policies and resulting action.

The NHSI report claims, “the indicator set has been developed in consultation with all Commonwealth agencies, other jurisdictions, key stakeholders and the general public” (Environment Australia 2002, p. 1). In response to an enquiry made by the author, EA commented that no documentation of the consultation process on the NHSI was available. The consultation process therefore seems to have been limited, particularly compared with the process by which the NSESD was developed and the process currently taking place in Canada to develop sustainable development indicators. Both of these processes are discussed in more detail below. The NSESD process, involved nine working groups each chaired by an independent academic or scientist, with 149 members from government, industry, trade unions, other NGOs, universities and Commonwealth Scientific and Industrial Research Organisation (CSIRO). Although the majority (78) of the working group members were federal or state government officials, there was still significant participation in the working parties by non-government members. The community participation in the NSESD process was limited but in the second half of the process, a newsletter was produced and public consultation meetings on ESD were held in several cities (Diesendorf & Hamilton 1997).

In February 2000, the Canadian federal government committed C$9 million (A$10m) to develop a national set of indicators. The Canadian Environment and Sustainable Development Indicators (ESDI) Initiative is a three-year multi-stakeholder program to develop and promote feasible and nationally accepted sustainable development indicators. Research, public consultations and analysis by subject experts are all part of the process, which will conclude in March 2003 when the Canadian government will be asked to respond to the ESDI Initiative recommendations (Smith & Choury 2002). The approach of the Canadian ESDI Initiative would appear to represent the broad participation required by this principle. The Australian NHSI process did not have a well-defined approach for ensuring broad participation.

Principle 9: Ongoing assessment through determining trends, with continuous improvement to measures, frameworks and goals based on new insights into complex systems

Most of the Australian NHSI can determine trends. Trend data, however, are not available for half of the NHSI for the decade since 1992 when the NSESD was endorsed. The part of the principle that relates to collective learning and continuous improvement of the indicators, goals and frameworks and decision making, based on new insights gained into the complex ecological and other systems, has not been addressed.

Principle 10: Institutional capacity in order to monitor progress towards sustainable development needs to be assured

Although Australia has the resources to monitor progress, it took 10 years from the endorsement of the NSESD to prepare the first NHSI report, and there is no clear indication how regularly Australia's progress towards ESD will be monitored using the NHSI. There is also no indication of how the outcomes of the first NHSI report are communicated to and acted upon by any of the levels of Australian government.

Are the NHSI a good set of Sustainability Indicators?

Reviewing the above assessment, there are clearly some major weaknesses in the NHSI versus the quality standards for sustainability indicators set out in the Bellagio Principles. The next section focuses on the assumptions made in relation to ESD that underlie the NHSI. This leads to an assessment of the implicit version of ESD to which the NHSI relate. It also compares the ESD version implicit in the NHSI with other possible versions and definitions of ESD. It also reviews some other indicators that could be used to measure progress towards the goal and core objectives included in the NSESD.

NHSI versus NSESD Core and Other Objectives

NSESD's goal and objectives

The NSESD had the following goal, "Development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends" (Commonwealth of Australia 1992a, p. 8). It had three core objectives (shown in Appendix A), which as noted previously were used as the framework for developing the NHSI. It also had 75 other objectives across a wide range of ESD issues (Commonwealth of Australia 1992a). These other objectives have not been a particular focus for headline or other indicators of progress over the decade since 1992. The framework of the three core objectives is used to examine the NHSI and to assess the assumptions in relation to ESD on which they have been based.

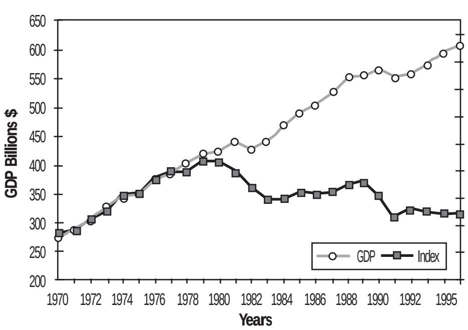
Core objective: To enhance individual and community wellbeing and welfare...

The most critical and questionable assumption made in the NHSI report is that economic growth (as measured by GDP-related indicators) represents a path of economic development that is likely to achieve this objective. There is ever increasing evidence that in developed countries, such as the UK, Canada, USA and Australia, Gross Domestic Product (GDP) growth is not a good measure of increased individual and community wellbeing. Much of the work in this area by the leaders in the field of ecological economics, such as Daly and Costanza, is well summarised in the two books, *The Growth Illusion* (Douthwaite 1999) and *Shovelling Coal for a Runaway Train* (Czech 2000). The next section of the paper critiques the NHSI related to the first part of this core objective from an ecological economics perspective.

Three of the five Economic NHSI (included in Appendix D - Economic

NHSI) relate to measures of economic GDP-based) growth. One of the most obvious problems with using GDP related indicators to measure progress is that GDP does not distinguish between costs and benefits, between productive and destructive activities, or between sustainable and unsustainable developments. GDP also includes a large component of activities that clearly do not enhance wellbeing and welfare. For example, costs from road accidents, divorces and repairing damage from storms and bushfires all add to GDP. In addition, GDP puts zero value on such things as family breakdown and crime, the destruction of farmland and entire species, unemployment, underemployment and the loss of free time. This problem has been recognised for at least 30 years, since Nordhaus and Tobin prepared their Measure of Economic Welfare (MEW) for the United States in 1972 (Nordhaus & Tobin 1972).

Figure 2: Index of Social Health and GDP



Source: Brink & Zeesman 1997

(1986 Prices), Canada 1970 - 1995

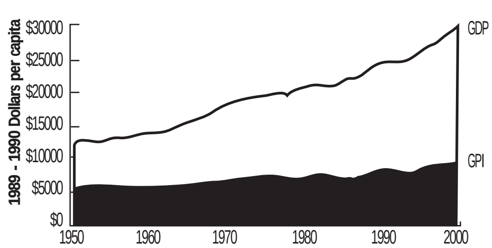
In a Canadian context, Figure 2 shows the Index of Social Health (a measure of individual and community wellbeing and welfare) not increasing with GDP since the 1970s. The indicators diverged in the 1970s and have followed opposite paths since with GDP continuing to increase and the Index of Social Health declining. Both the US and Canadian version of the Index of Social Health show a similar pattern of ceasing to follow the upward trend of GDP since the 1970s (Brink & Zeesman 1997). It is beyond the scope of this paper to assess how good and appropriate the Index of Social Health is as a national sustainability indicator related to individual and community well being.

The Index of Sustainable Economic Welfare (ISEW) was pioneered (for the US) by Daly, John and Clifford Cobb in an appendix to Daly and Cobb's book, *For the Common Good* (Daly & Cobb 1989). The key differences between ISEW, as a measure of sustainable economic welfare, and GDP are that in the ISEW:

- spending to offset social and environmental costs (defensive expenditure) is taken out;
- longer-term environmental damage and the depreciation of natural capital are accounted for;
- the net formation of man-made capital (i.e. investment) is included;
- changes in the distribution of income are included, reflecting the fact that an additional dollar in the pocket means more to the poor than to the rich;
- a value for household labour is included (Mayo, MacGillvray & McLaren 2002).

The initial US ISEW was revised by the Cobbs in 1994 (Cobb & Cobb 1994), and now forms the basis for the Genuine Progress Indicator (GPI). The Australian Institute has provided GPI data for Australia for all of the period since 1992 when the NSESD was endorsed.

Figure 3: Measuring wellbeing in Australia



Source: Australia Institute 2002

As Figure 3 shows, our wellbeing in Australia as measured by the GPI is increasing at a much slower rate than GDP. GDP per capita increased by over 20% from 1992 to 2000 whereas GPI has increased only marginally.

Why does the NHSI use GDP rather than GPI?

Given that GPI data are available for Australia for the period since 1992 and that it is widely regarded as a better indicator of individual and community welfare than GDP-based indicators; this raises the question of why it was not used as an indicator instead of, or in addition to, the three GDP based NHSI. Given the lack of broad-based participation and openness in the NHSI process, particularly in relation to selection of indicators, it is impossible to fully answer this question. The NHSI report uses Real Gross National Income (GNI) per capita as a measure of living standards and economic wellbeing. GNI is GDP with the minor adjustment of deducting the net income paid overseas. The NHSI report states the following rationale for inclusion of this indicator, "Economic well-being is a crucial element of human well-being because most aspects of well-being in modern human society have to be purchased, including food, water, shelter, health care and many forms of recreation" (Environment Australia 2002, p. 20). The problem is that GNI per capita is a very poor indicator of whether all Australians have adequate food, water, shelter and health care.

As well as the problems outlined above in relation to GDP (which relate equally to GNI), the growth on a per-capita basis does not provide any information on the distribution of income. The level of poverty in Australia is another indicator that is subject to much debate. It is, however, clear that adequate food, water, shelter and health care are not available to all Australians, particularly to many Indigenous Australians.

Core objective: By following a path of economic development that safeguards the welfare of future generations

The NHSI report recognises that progress against this part of this core objective is not clear based on the NHSI. It also notes that achieving this and other core objectives depends on protecting ecological processes on which life depends and sustainably managing the natural resources on which economic and community wellbeing depend. Appendix A shows the eight NHSI included under this part of the core objectives. This section focuses on which economic development path is likely to safeguard the welfare of future generations.

Daly (1991) is one of the leading ecological economists today to attack the idea that constant economic growth (GDP) is sustainable. He argues that a sustainable society has three characteristics:

- it does not use renewable resources faster than they regenerate;
- it does not use non-renewable resources faster than renewable substitutes are developed for them; and
- it does not release pollutants faster than natural systems can break them down.

These are largely consistent with the first three system conditions for a sustainable society in The Natural Step (TNS) Framework (Holmberg, Robert & Eriksson 1996). TNS adds a social condition that human needs are met worldwide of this and of future generations. The NHSI report largely avoids the issue of non-renewable resource use, apart from in relation to energy (as discussed earlier in the paper). The Swedish set of sustainable development indicators measures direct material consumption in tonnes per capita, split into renewable and non-renewable resources (Statistics Sweden & the Swedish Environmental Protection Agency 2001).

The NHSI report has some measures of pollutants (greenhouse gas emissions, SOx, NOx, particulates), but does not make any assessment as to whether they are being released faster than natural systems can break them down. This relates to the problem discussed above in relation to the need for targets as well as desired trends. The Swedish indicators are more comprehensive and show total waste (household, industrial and mining) and the disposal methods as well as usage of chemicals hazardous to health and/or the environment (Statistics Sweden & the Swedish Environmental Protection Agency 2001). They also do not address the issue of whether the pollutants are being released faster than natural systems can break them down.

The NHSI report includes National Net Worth as an indicator of Economic Security, which is one of the key aspects listed as contributing to this part of the first Core Objective (Appendix A). This NHSI report includes the value of all assets (farms, mines, factories, computer software, inventories) less all liabilities (borrowing from overseas, overseas ownership and so on). The problem with this financial measure is that, at best, it is only a partial measure of natural capital depletion. The physical measures of fossil fuel consumption, soil erosion, increased salinity, deforestation and loss of wetlands, thinning of stratospheric ozone, increased atmospheric greenhouse gases, groundwater pollution, and so on, strongly suggest that natural capital depletion is not fully reflected in this purely financial measure of economic security (England 2000). Almost none of these physical measures showing adverse trends would be included or reflected in the calculation of National Net Worth.

Other indicators (e.g. Land Clearance and Dryland Salinity) discussed below also reinforce Australia's lack of progress in providing for future generations over the decade since 1992. These indicators were not included in the NHSI, although they seem to meet all or most of the stated criteria for selection of NHSI (Environment Australia 2002). They were included as Headline Indicators in the ABS Report - *Measuring Australia's Progress* (ABS 2002), which was also published in 2002.

Land clearance continues to have a major adverse impact on Australia's biodiversity, soil and water. Land clearing has not only continued since 1992 but the rate of land clearance has increased from approximately 335,000 hectares in 1992 to 470,000 hectares in 1999(ABS 2002). Assuming that the 1999 rate has continued through to 2002, would mean that approximately 4.2 million ha (42,000 sq km) of land have been cleared since 1992. This represents an area approximately two-thirds the size of Tasmania.

The area of Australia at risk from dryland salinity also continues to increase. This has a major adverse impact on agricultural production, water resources, biodiversity, pipelines, houses and roads (ABS 2002). Data are not available on the area of Australia "at risk" of dryland salinity in 1992. It is clear that the area "at risk" increased since then to 4.8 million ha at risk in 2000 with this projected to increase by 2020 to 6.6 million ha (66,000 sq km - approximately the size of Tasmania) (National Land and Water Resources Audit 2002).

Core objective: To provide for equity within and between generations

The NHSI report recognises that the measures it provides do not allow progress to be measured on equity between generations. The gender, educational, health and locational equity measures all relate to equity within generations and are shown in Appendix C. Measures related to the distribution of income and wealth or levels of poverty are excluded from the NHSI.

Core objective: To protect biological diversity and maintain essential ecological processes and life-support systems

The NHSI report recognises that progress against this objective is not clear. This is mainly due to trend data not being available for most of NHSI included under this core objective. The only two NHSI, with trend data available, included in this objective, are moving in the wrong direction (Biodiversity and Climate Change) (Environment Australia 2002). Many of the problems raised in the previous section in relation to both parts of the first core objective are also problems in relation to how the NHSI measure progress towards this core objective.

Version of ESD reflected in the NHSI

The version of ESD that is reflected in the NHSI tends towards "weak sustainability" as defined by Bell and Morse (1999). Weak sustainability equates to a sort of economic sustainability where the emphasis is upon allocation of resources and levels of consumption, and financial value is a key element of system quality. The Bell and Morse definitions of weak and strong sustainability represent points towards either end of a continuum. At the weak sustainability end, economic factors tend to predominate and at the strong sustainability end, ecological factors predominate. Ecological factors are often not measurable in financial terms and include physical measures of soil erosion, biodiversity, and dryland salinity.

If trend data were available for all the NHSI and appropriate targets had been set, a stronger version of ESD would be reflected in the NHSI, as almost all of the Ecological NHSI have no trend data or targets. The NHSI also fail to recognise the holistic sense of ESD and the nested nature of the economic system within the social system, and in turn within the ecological system, as discussed above in relation to Bellagio Principle 2. The issue of the systems perspective of ESD is explored further below.

Assessment of Australia's Progress towards ESD

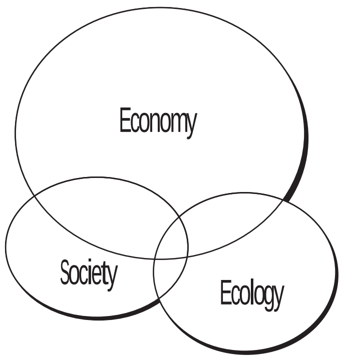
As noted above, the NHSI tend to represent a set of indicators based on measurement of progress towards a weak version of sustainability. The NSESD might have tended towards a stronger form or version of sustainability, including this precautionary principle as one of its seven guiding principles. "Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation". It does, however, also state that "no objective or principle should predominate over the others" and includes in one of the other principles "the need to develop a strong, diversified and growing economy" (Commonwealth of Australia 1992b, pp. 8-9).

The NSESD can also be seen as a political balancing act, endorsing a precautionary principle to keep the environmental lobby "onside" while endorsing a growing economy to keep the business lobby "onside". The current Australian federal government would give more weight to the business lobby and the weaker version of ESD based on the NHSI may reflect that change of priorities.

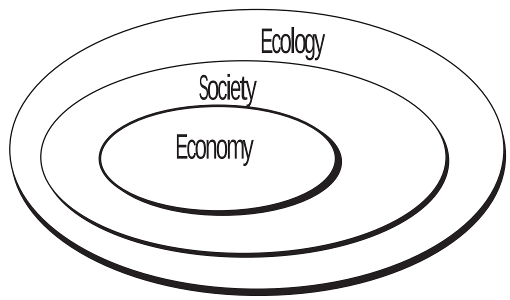
One of the major criticisms made of the original NSESD process (Diesendorf & Hamilton 1997) was that it failed to examine critically the role of economic growth within the context of ESD. The implementation of the NSESD has tended to apply more to an economic precautionary principle, where no policies will be implemented where they might adversely affect economic growth. One example is the "no regrets policy" on greenhouse gas emissions that will not implement response measures "that would have net adverse economic impacts nationally" (Commonwealth of Australia 1992b, p. 12). It is not clear whether the NSESD went as far as endorsing the Nested System Model of ESD. It is clear, however, that by 1996 it was recognised that the Nested System Model was required for Australia to progress towards ESD.

Figure 4:Two models of ESD

Overlapping System Model of ESD



Nested System Model of ESD



Source: State of the Environment Advisory Council 1996

The *1996 Australia: State of Environment Report* describes the left hand diagram as "the predominant model of decision making in Australia until the 1980s. It gives primacy to economic decisions and assumes that environmental problems can always be solved if the economy is sound" (State of the Environment Advisory Council 1996, ch. 10, p. 12). Using Milbrath's terminology (1994), it represents the Dominant Social Paradigm. The right hand diagram is described as "the decision making model needed for an ecologically sustainable future for Australia. It recognises that the economy is a sub-set of society, since many important aspects of society do not involve economic activity. Similarly, human society is totally constrained by the natural ecology of our planet. It requires integration of ecological thinking into all social and economic planning" (State of the Environment Advisory Council 1996, ch. 10, p. 12). Again using Milbrath's terminology, it represents the New Environmental Paradigm (Milbrath 1994).

Without the planet's basic life support system there can be no society or no economy. The economy is a social construct - it is not an end in itself. The economy only works to serve some of society's needs and therefore fits within society. The economy might have to be redefined to be sustainable in order to achieve ESD. In order for Australia to be progressing towards ESD, we need to be sure that the Australian society and economy are remaining within the limits imposed by natural ecology.

Trend data are not available for most of the Ecological NHSI. This could be viewed as a concern in itself as societies tend to measure what they value. This might indicate that Australian society is not giving sufficient focus to the ecological aspects of ESD. As shown in Appendix B, trend data are only available for four of the 14 ecological indicators, three of which are moving in the wrong direction. The validity of the only Ecological NHSI (Management of Agriculture), moving in the right direction is also questionable (as discussed above). Other environmental indicators for which trend data are available, such as Land Clearance and Salinity (discussed above) also reinforce Australia's lack of progress towards ESD, particularly in relation to the critical ecological issues over the previous decade.

Conclusion

When assessed using the quality standards for sustainability indicators set out in the Bellagio Principles, the Australian NHSI fail to meet many of these quality standards. The aspects and NHSI chosen to measure progress against the three core objectives of the NSESD tend to represent a weak version of ESD. The NHSI report is based on the dominant social paradigm represented in the overlapping system model, which suggests that social, environmental and ecological problems can be solved while continuing economic growth. Australia will require a new environmental paradigm to make significant progress towards ESD. This new environmental societal paradigm will help generate a better set of indicators that will show whether Australia is maintaining the natural ecology on which our life-support systems and society depends.

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Endnote

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Appendix A: Core objectives with key aspects classified as ecological, social or economic

Core Objective: To enhance individual and community wellbeing and welfare ....

Key Aspect	National Headline Sustainability Indicator	Ecological, Social or Economic
Living standards and economic well-being	Gross National Income (GNI) per capita (GNI = GDP less net income paid overseas) Gross per capita disposable income	Economic Economic
Education and skills	Percentage of people aged 25-64 who have attained upper secondary and/or attained post secondary qualifications including vocational training	Social
Healthy living	Disability adjusted years life expectancy (DALE)	Social
Air quality	Number of occasions where concentrations of pollutants exceeded NEPM standards for ambient air quality in major urban areas	Ecological
	Total SOx, NOx and particulate emissions	Ecological
Drinking water quality	The proportion of the Australian population with access to drinking water systems by settlement type and quality	Social
Core Objective: (continued)... by following a path of economic development that safeguards the welfare of future generations		
Economic capacity	Multi-factor productivity (Gross product per combined unit of labour and capital)	Economic
Industry performance	Real GDP per capita	Economic
Economic security	(i) National Net Worth (ii) National Net Worth per capita	Economic
Management of water	(i) Surface water units within 70% of sustainable yield (ii) Ground water management units within 70% of sustainable yield	Ecological
Management of forests	Total area of all forest type	Ecological
Management of fish	Percentage of major Commonwealth harvested wild fish species classified as fully or under fished.	Ecological
Management of energy	(i) Renewable energy use as a proportion of total (ii) Total renewable and non-renewable energy use	Ecological
Management of agriculture	Net value of rural land (Interim indicator - Agreed indicator: 'net value of agricultural land use' not yet available)	Ecological
Core Objective: To provide for equity within and between generations		
Economic and gender equity	Adult female full time (OT) average weekly earnings as a proportion of adult male full time (OT) average weekly earnings	Social
Economic and educational equity	Percentage difference in the year 12 completion rate between bottom and top socio-economic decile	Social
Economic and health equity	(i) Percentage difference in burden of life years lost due to disability between bottom and top socio-economic quintile. (ii) Percentage difference in burden of life years lost due to mortality between bottom and top socio-economic quintile	Social
Locational equity	Percentage difference in the year 12 completion rate between urban and remote locations	Social
Core Objective: To protect biological diversity and maintain essential ecological processes and life-support		
Biodiversity and ecological integrity	Extent and condition of native vegetation, freshwater habitats, coastal habitats, estuarine habitats and marine habitats including extent to which represented in reserves and non-reserve systems.	Ecological
	Actual indicators used: (i) Proportion of (354) bio-geographic sub-regions with greater than 30 per cent of original vegetative cover (ii) Proportion of (354) biogeographical sub-regions with greater than 10 per cent of the sub-region's area in protected areas	
	Number of extinct, endangered and vulnerable species and ecological communities. Actual indicators used:	Ecological
	(i) Number of extinct, endangered and vulnerable species (ii) Number of endangered ecological communities	
Climate change	Total net greenhouse gas emissions	Ecological

Appendix A continued…

Core Objective: To protect biological diversity and maintain essential ecological processes and life-support (continued…)

Key Aspect	National Headline Sustainability Indicator	Ecological, Social or Economic
Coastal and marine health	Estuarine condition index - proportion of estuaries in near pristine or slightly modified condition	Ecological
Freshwater health	Proportion of assessed sites which are with high in-stream biodiversity, based on macro-invertebrate community structure (Interim indicator - Agreed indicator: 'river condition index' not yet available)	Ecological
Land health	Catchment Condition Index - proportion of assessed catchments that are in moderate or good condition	Ecological
	Area of land affected by land degradation	Ecological

Appendix B: Ecological - National Headline Sustainability Indicators

Key Aspect (1)	Ecological (1) - National Headline Sustainability Indicator	Data	Desired trend	Actual trend over last decade (if known)
Climate change	1. Total net greenhouse gas emissions	458.2 Mt	Down	Up
Management of energy	2. (i) Renewable energy use as a proportion of total (ii) Total renewable and non-renewable energy use	5.8% 4858 PJ	Up Not Specified (1)	Down Up (1)
Biodiversity and ecological integrity	3. Extent and condition of native vegetation, freshwater habitats, coastal habitats, estuarine habitats and marine habitats including extent to which represented in reserves and non-reserve systems.			
	Actual indicators used: (i) Proportion of (354) bio-geographic sub-regions with greater than 30 per cent of original vegetative cover	84%	Up	
	(ii) Proportion of (354) bio-geographical sub-regions with greater than 10 per cent of the sub-region's area in protected areas	26%	Up	
	4. Number of extinct, endangered and vulnerable species and ecological communities. Actual indicators used: (i) Number of extinct, endangered and vulnerable species (ii) Number of endangered ecological communities	1560 23	Down Down	Up
Management of agriculture	5. Net value of rural land (Interim indicator - Agreed indicator: 'net value of agricultural land use' not yet available)	$111.7bn	Up	Up
Air quality	6. Number of occasions where concentrations of pollutants exceeded NEPM standards for ambient air quality in major urban areas	98	Down	
	7. Total SOx, NOx and particulate emissions	3.6b kg	Down	
Coastal and marine health	8. Estuarine condition index - proportion of estuaries in near pristine or slightly modified condition	72%	Up	
Freshwater health	9. Proportion of assessed sites which are with high in-stream biodiversity, based on macro-invertebrate community structure (Interim indicator - Agreed indicator: 'river condition index' not yet available)	60%	Up	
Land health	10. Catchment Condition Index - proportion of assessed catchments that are in moderate or good condition	83%	Up	
	11. Area of land affected by land degradation	No data (1)	Down (1)	
Management of water	12 (i) Surface water units within 70% of sustainable yield (ii) Ground water management units within 70% of sustainable yield	74% 60%	Up Up	
Management of forests	13. Total area of all forest type	157 m hectares	Up	
Management of fish	14. Percentage of major Commonwealth harvested wild fish species classified as fully or under fished.	37%	Up	

(1) Notes that relate to material covered in the paper added to original table in NHSI report by author.

Source: Environment Australia 2002

Appendix C: Social - National Headline Sustainability Indicators

Key Aspect (1)	Social (1) - National Headline Sustainability Indicator	Data	Desired trend	Actual trend over last decade (if known)
Education and skills	1. Percentage of people aged 25-64 who have attained upper secondary and/or attained post secondary qualifications including vocational training	64.3%	Up	Up
Healthy living	2. Disability adjusted years life expectancy (DALE)	71.16	Up	
Economic and gender equity	3. Adult female full time (OT) average weekly earnings as a proportion of adult male full time (OT) average weekly earnings	84.85%	Up	Unchanged
Economic and educational equity	4. Percentage difference in the year 12 completion rate between bottom and top socio-economic decile	16%	Down	Down
Economic and health equity	5. (i) Percentage difference in burden of life years lost due to disability between bottom and top socio-economic quintile.	41-45%	Down	
	(ii) Percentage difference in burden of life years lost due to mortality between bottom and top socio-economic quintile	26-41%	Down	
Locational equity	6. Percentage difference in the year 12 completion rate between urban and remote locations.	12%	Down	Down
Drinking water quality	7. The proportion of the Australian population with access to drinking water systems by settlement type and quality.	Not available (1)	Up (1)	

(1) Notes that relate to material covered in the paper added to original table in NHSI report by author.

Source: Environment Australia 2002

Appendix D: Economic - National Headline Sustainability Indicators

Key Aspect (1)	Economic(1) - National Headline Sustainability Indicator	Data	Desired trend	Actual trend over last decade (if known)
Living standards and economic well-being	1. Gross National Income (GNI) per capita (GNI = GDP less net income paid overseas)	$31 847	Up	Up
	2. Gross per capita disposable income	$31 851	Up	Up
Economic capacity	3. Multi-factor productivity (Gross product per combined unit of labour and capital)	1.1%	Up	Up
Industry performance	4.Real GDP per capita	$32 636	Up	Up
5. Economic security	(i) National Net Worth	$2431.40bn	Up	Up
	(ii) National Net Worth per capita	$127 666	Up	Up

(1) Notes that relate to material covered in the paper added to original table in NHSI report by author.

Source: Environment Australia 2002

The Relationship between De-industrialisation, Community and Ecological Sustainability[1]

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According to Harold Innis, Canada's economic history has been based on the discovery of natural resources, consequent community formation to facilitate their extraction, resource depletion, and finally community disappearance. This model links industrial change and development in the resource sector, with community and ecological outcomes but neglects detailed exploration of the industry/ecosystem linkage. The purpose of this paper is to adapt the ecological footprint concept in order to make the ecological impact of economic and technological change in a Canadian resource industry (sawmilling) explicit. This investigation utilises a large cohort of sawmill workers gathered in British Columbia (BC) sawmills, a study which measured the ecological footprint (Rees 2000; Wackernagel & Rees 1996) in several of these mills, and, a labour adjustment study conducted by Statistics Canada to explore the links between technological change and downsizing in this resource industry and both community and ecological sustainability. The recession of the early 1980s eliminated 40% of the sawmill workforce and stimulated increased replacement of labour by capital in remaining sawmills. The new technical infrastructure now in place in most sawmills has accelerated forest ecosystem draw-down while at the same time producing less economic benefit for the local community. Adaptation of the ecological footprint for use at the site of the transformation of natural capital makes these trade-offs more specific.

Keywords: *Deindustrialisation; Sawmills; Community; Ecological Footprint; Sustainability*

Canada, among western industrialised countries, is unusual in having many communities economically involved in the direct exploitation of nature. According to Harold Innes, much of Canada's economic history has been based on the discovery of natural resources, consequent community formation to facilitate their extraction, resource depletion, and finally community disappearance (Hayter & Barnes 1990). This Innesian "cycle of destruction" which began with Canada's fur trade economy is less publicly acceptable today because natural resource depletion is increasingly equated with ecosystem compromise and ultimately with reduced livability for human beings.

The forest ecosystems that sustain British Columbia's (BC) forest products industry and communities are under increasing pressure. In BC, "fifty percent of all the public timber cut has been felled in the last 13 years. The most rapid acceleration has primarily been in the BC interior, with 50 percent of the total cut being done since 1977- the northern regions of Prince George and Prince Rupert have an even faster acceleration rate" (Travers 1993, p. 189). In addition, "much of this acceleration has been above the Ministry of Forests' own estimates of the sustainable yield" (Travers 1993, p. 190).

This increased rate of natural capital depletion has been made possible because of the dramatic technological changes and associated drastic reduction in the size of the workforce that began in the forest products manufacturing sector in the late 1970s and early 1980s. Large segments of the industry had, by the early 1980s, moved from "Fordist" assembly line mass production methods to "flexible" methods of production and work organisation. This was made possible largely by a combination of new markets and new computerised production technology (Barnes & Hayter 1995).

The increasing rate of tree consumption combined with a diminishing labour force poses a twin sustainability challenge. On the one hand, forestry-based communities receive less revenue in the form of direct wages and municipal taxes from local mills (Regional Data Corporation 1994). If there is no diversification within the affected community, or if the public sector does not intervene, the economic base is reduced and the structure of the local labour market altered. On the other hand, the ecosystems from which logs are extracted to feed the mill are placed under greater pressure (Marchark 1995).

In order to understand better the impact of the recent industrial revolution in BC forests on both communities and ecosystems, I examine the changing ecological footprint of several of the major sawmills in the province between 1950 and 1985. This is done using a database of approximately 26,000 BC sawmill workers, gathered to investigate the occupational effects of anti-sapstain chemicals, in combination with sawmill production data gathered during this time (Hertzman et al. 1996) The job history information in the database is used to determine changing employment patterns in these mills. For mills located in forestry-dependent communities, changing employment opportunities will have direct effects on the economic sustainability of the community. Thus, employment change can be linked with community sustainability. In addition, using a survey of employed and laid off forest industry workers during the period 1978 to 1985, an estimate of the economic impact within the community of technological restructuring in sawmills is obtained (Cohen, Couture & Allen 1988). By linking these studies, a discussion of recent changes in BC's sawmill industry in terms of both community and ecosystem sustainability is undertaken.

The Empirical Base

1. Sawmill workers' cohort

The cohort was gathered between 1987 and 1992 in order to investigate the effects of an anti-sapstain chemical, chlorophenol, on worker health. It consists of 26,487 men who worked for at least one year between 1950 and 1985, in at least one of 14 large sawmills located in four regions of the province: the Lower Mainland, the Interior, Vancouver Island, and the Southern BC Mainland Coast. Because complete information on job history is available in 11 of the study mills for the time period 1950 to 1985, temporal and regional changes in employment can be tracked. Because three of the mills were not built until the 1960s, data for early time periods are missing.

2. Forestry Sector Labour Adjustment Study

Produced in 1988 for Employment and Immigration Canada, this longitudinal study linked Statistics Canada and Revenue Canada files for the years 1978 and 1985 in order to study income changes among Canadian forestry workers (Cohen, Couture & Allen 1988). Data were individually linked but are presented in grouped form for confidentiality reasons. Income data for workers and their spouses and unemployment data for workers in the BC sawmill work force are available for the period 1978 to 1985. This is convenient as this time frame straddles the major restructuring period in the industry and overlaps with the last few years of the sawmill workers' cohort study. By linking the cohort study data with the economic study, demographic changes occurring between 1978 and 1985 can be translated into likely economic impacts for sawmill workers and their families at the community level.

Labour Demography for the Cohort

For the initial analysis, three mills built in the 1960s were excluded from the analysis; the remaining 11 study mills reflect the demographic reality of the larger, established sawmills for the entire time period of 1950 to 1985. It should also be noted that because the minimum eligibility for entrance into the cohort was one year of employment between 1951 and 1985, this study does not capture the experience of the most transient segment of the work force.

Figure 1 shows that in all 11 mills employment was stable until 1979 after which employment dropped by approximately 40%. Of the 3,561 workers who lost their jobs between 1979 and 1985, 2,232 were actively terminated and 1,329 retired or were retired. In a labour market where layoffs usually proceed in terms of strict seniority, one would expect younger workers to bear the brunt of employment layoffs. The extent to which older workers were affected by employment downturns depended on the degree to which mills adopted policies of encouraged or forced early retirement. These data indicate that, during the recession of the early 1980s, about one-third of workers were let go through both normal and possibly early retirements.

In fact, however, most job losses were active terminations, meaning that the downturn affected mainly the younger segment of the work force. Because community viability is directly related to the ability of younger workers to obtain local employment, the age-specific changes in termination profile across time periods and regions are informative. Figure 2 shows the change in the rate of active terminations for the sawmill cohort from 1955 to 1985. Layoffs are considered active terminations, while terminations due to illness, disability, or retirement are not. Active terminations are emphasised because these are more likely to reflect the size of the real "bite" of economic change in the work force.

Using a life-table approach, age-specific person-years of employment were

Figure 1: Total number of workers in 11 study mills by year

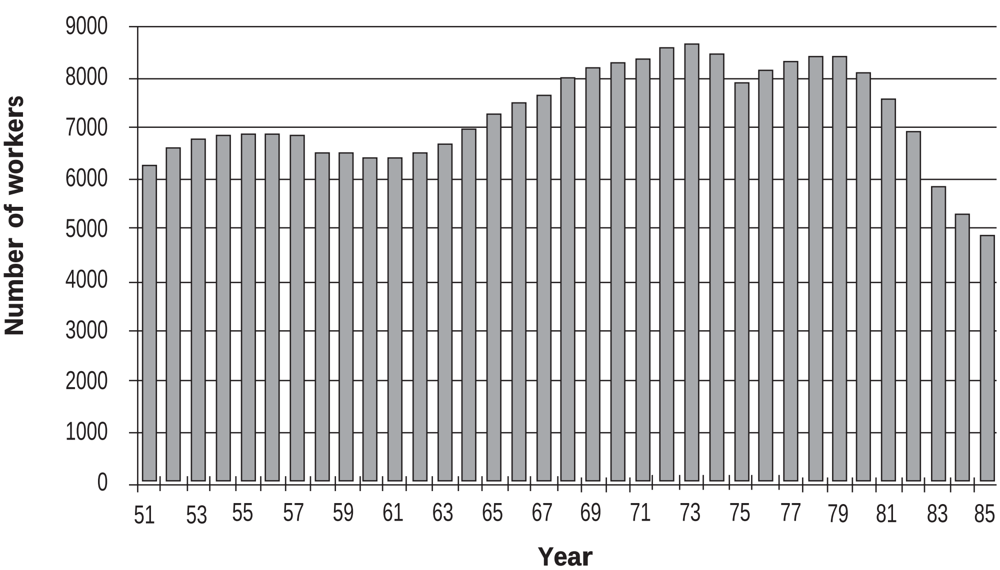
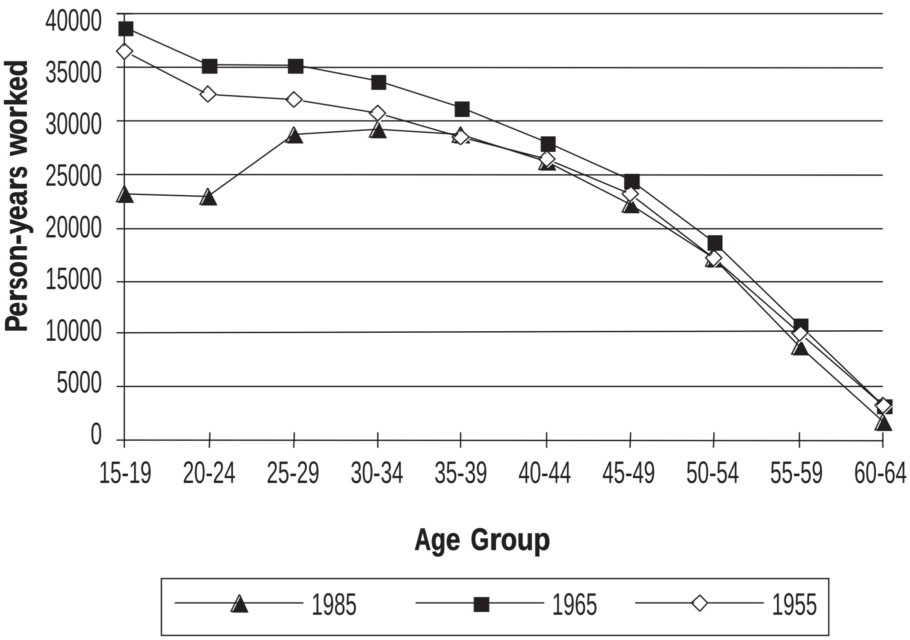


Figure 2: Comparison of person-years worked by age group for three time periods standardised to 1981-1985 mortality rates



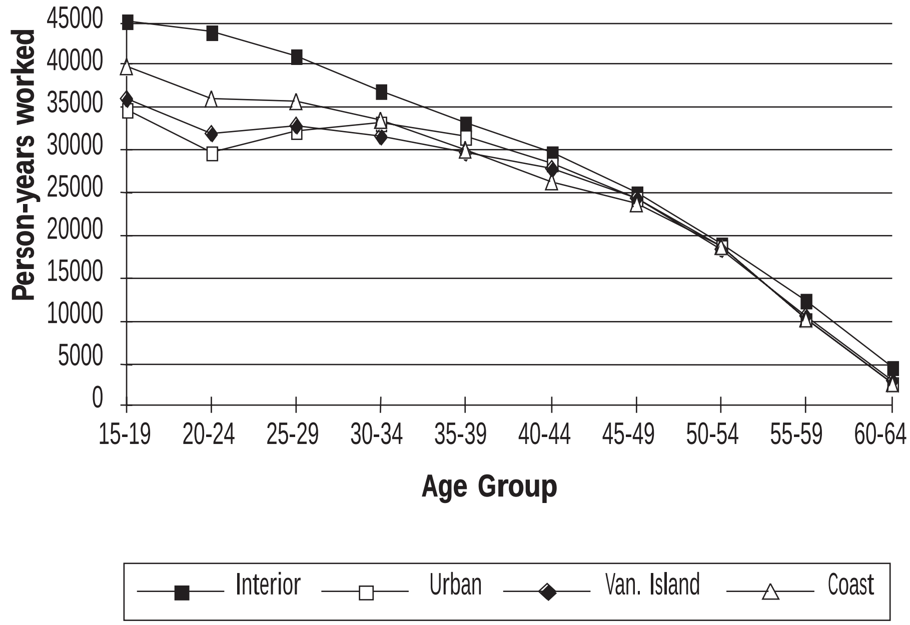
constructed with active termination rates for three time periods between 1950 and 1985. These were standardised for mortality using 1981-85 cohort mortality rates. The standardisation was performed because the number of deaths in the cohort in the 1980s was much higher than in the 1950s. By standardising for mortality across time periods in this way, comparison of active termination rates across time is more accurate.

In Figure 2, active termination rates are modelled over time by showing the decline in the number of person-years worked for 10 age groups in three different time periods. Active terminations reduced the person-years worked in 1981-85 by 20% compared to 1961-1965. Seventy-eight percent of these lost person-years were within the age groups 15 to 35, with particularly hard losses for those under the age of 25. Again, this is not surprising given that the order of layoffs is strictly seniority-based and the absolute number of jobs lost was very high.

It is interesting to look at the regional differences in these age-specific termination patterns, both because labour markets tend to be regionally organised and because different regions often depend on different forest ecosystems for their log supply. In order to accomplish this task, we need to move to an analysis of all 14 study mills so that the BC Interior can be included in the regional comparison. By using data from all mills we can compare and contrast the time periods 1966-1970, the earliest time period for which we have data from the cohort encompassing the widest possible regional variation, with 1981-1985.

Figures 3 and 4 show standardised person years of employment for four regions during 1966 to 1970 and 1981 to 1985, respectively. (As in Figure 2 these have been standardised to 1981-1985 cohort mortality rates.) The person-years of employment for those under 35 years of age are dramatically different in the two time periods. Also, in both eras, those under 35 bear the largest employment

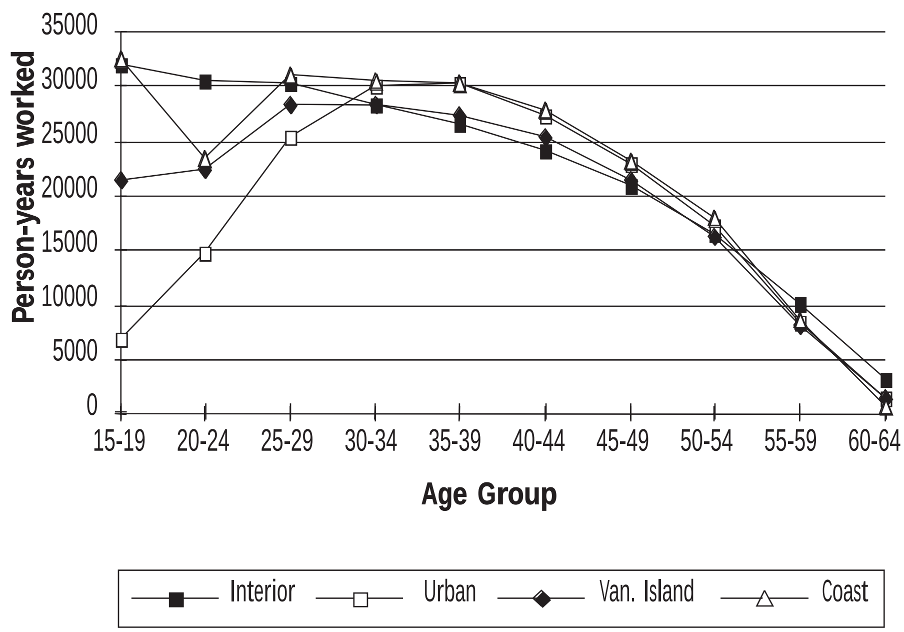
Figure 3: Person-years worked by age group in four regions during 1966-1970



loss, particularly in the Vancouver and Vancouver Island regions, and particularly during the recession of the early 1980s.

These data indicate that employment losses following the recession of 1981 were more drastic than for any other recessionary era after 1950. Workers under the age of 35 appear to have been most affected. Across

Figure 4: Person-years worked by age group in four regions during 1981-1985



regions, it appears that younger workers in Vancouver Island and Vancouver mills suffered the greatest job losses.

Community Sustainability

The cohort survey indicates that about 60% of the sawmill work force employed during the peak years in the 1970s remained employed in the mills after the recession of the early 1980s. These results are similar to those found in the Forestry Sector Labour Adjustment Study, which indicates that 56% of BC sawmill workers employed in 1978 were still employed in a sawmill in 1985 (Cohen, Couture & Allen 1988). The latter study found that, of the 100 workers who had a sawmill job in 1978, 44 had lost their sawmill jobs by 1985 (Table 1). They found that 62% of these workers managed to find another job by 1985. However, of these, only 16% found employment somewhere in the forestry industry other than a sawmill. Eighty-four percent of those who managed to find another job found one outside the industry. By linking this information to income tax files, they were able to ascertain that workers who found jobs elsewhere within the forestry industry kept their incomes stable. However, those who obtained jobs outside the industry were earning 33% less in 1985 than their sawmill jobs had paid in 1978, $31,435 compared to $21,147. In addition, a total of 17% of the workers employed in a sawmill in 1978 were unemployed by 1985.

When one combines the information from both the cohort study and the Labour Adjustment study, it is clear that there has been a large loss of jobs from the sawmill and forestry sector, and that this job loss has the most severe impact on young workers and those near retirement. And, even for those who obtained re-employment, income levels earned in 1985 were drastically reduced from 1978 levels (Table 2).

If one assumes that no migration took place in the affected communities between 1978 and 1985, there is a net income loss of $83,991,816 just in terms of personal income. This does not include lost municipal tax revenue and any associated downturn in local economic activity.

Employment losses in small sawmill towns are more directly translatable to reduced community sustainability than in urban regions and more economically diversified mid-size towns. Given this fact, and combining the cohort study with the Forestry Sector Labour Force Study, it is clear that the approximately 40% employment losses in the sawmill cohort probably translated to a minimum 25% income loss for the community, assuming that the unemployed workers did not out-migrate. If one assumes out-migration took place, and this is a much more likely scenario in single-mill towns, then overall economic loss to the community was greater than 25%. In addition, as the termination-by-age-group data indicate, the brunt of employment loss has been borne by younger workers, who in turn were more likely to

Table 1: 1985 Status of 100 sawmill workers who were employed in BC sawmills in 1978

No. of Workers in 1978	No. of Workers in 1985		Income of Workers in 1985
100	56	still in mills	$35,906
	6	in other forest industry	$33,761
	21	jobs outside forest industry	$21,147
	2	UIC	$6,306
	15	no job/no UIC	0

1. *Core workforce in 1985 is 56% of its size in 1978 and in 1985 had an average income of 35,906.*
2. *Only 6% of workers in sawmills in 1978 were able to move "sideways" into another high-income sector of the Forest industry.*
3. *If we assume the people on UIC and with jobs outside the forest industry are available potentially as a "peripheral" workforce for the sawmills, this peripheral labour market operates at an average wage level 45% less than the core ($19,850 vs $35,906).*

Table 2: Estimated income in 1978 and 1985 for sawmill workers in the cohort assuming rates of layoff and subsequent income levels from the Forest Sector Labour Adjustment Study

	1978	1985
Estimated wages from 12 Mills•	332,238,218	186,053,042
Income from workers who obtained other forest industry jobs		19,934,293
Income from workers who obtained non-forest industry jobs		41,091,370
UIC income		1,166,988
TOTALS	332,238,218	248,246,402
NET LOSS		83,991,816

•All Incomes in 1985 Canadian dollars

Source: Travers 1993, p. 190

choose out-migration. Future community growth may therefore be compromised, as younger workers leave these largely hinterland communities and their demographic patterns are skewed toward an older age group; leading to their premature senescence.

Besides these direct losses, there are a number of less direct fiscal and health-related losses. There are costs to the municipality in lost forest company taxes, as well as losses to municipal, provincial, and federal governments in other tax shortfalls resulting from the employment downturn. For example, according to a survey by the Regional Data Corporation, municipal tax revenue in the small mill town of Powell River dropped by 15% between 1990 and 1993. The same study indicates an increase in the economic dependency ratio, which is a measure of the extent to which transfer income from other levels of government enters the community in order to replace the income lost from industry layoffs (Regional Data Corporation 1993).

Unemployment creates indirect costs for all levels of government. Both the anticipation of unemployment in employed groups of workers and unemployment itself have been linked to a range of disease outcomes including heart disease and psychiatric disorders (D'Arcy & Siddique 1985; Jin, Shah & Svoboda 1995; Mattiasson et al. 1990; Westin, Schlesselman & Korper 1989). In 1995, the suicide rate among the unemployed in BC was 11 times that of the total labour force (BC Division of Vital Statistics 1995, p. 24). The suicide rate for young males is usually high, but the impact of unemployment may render this group even more vulnerable. The health consequences of unemployment are enormous. They are paid for by tax dollars but the cost is not usually included in the accounting process when the cost of technological change in industry is measured.

Direct and indirect health and other welfare-related costs of labour force reduction can be viewed as a public subsidy to labour force structural change carried out within the private sector. If total company income remains stable or even increases after these structural changes in the labour force, and if the taxpayer covers the health and welfare costs incurred by these changes, then a massive public subsidy of the private sector will have occurred. Further, it will have occurred within an ideological and political atmosphere in which the federal government has been withdrawing massive funds from health, welfare, unemployment insurance, and labour force retraining, placing the burden of this hidden public subsidy increasingly on the provincial government.

Clearly, changes in mill technology affect labour force demography and community sustainability. Because long-term sustainability of the forest-based community ultimately depends on the long-term sustainability of the forest ecosystems which supply its mills with logs, it is important to ground changes in technology, labour demography, and community sustainability within an ecosystem health framework. The first step is to attempt to gauge the changing ecological footprint of these mills over time.

Ecosystem Sustainability

In BC the pressure on forest ecosystems has increased dramatically. The Annual Allowable Cut, the volume of trees the

Ministry allowed to be cut on forest tenures in the province, amounted to 60.8 million cubic metres in 1975. By 1980 this had increased to 66.7 million cubic metres. By the middle of the decade it was up to 67.3 million cubic metres, and by the end of the decade it was 74.3 million cubic metres. This amounts to an increase of volume allocated in forest tenures of about 1 million cubic metres per year since 1976.12. By the 1980s "the capacity of current operating mills exceeded the AAC by about a third" (Travers 1993, p. 18).

After the mid-1970s there was a significant increase in the rate at which the carrying capacity of the BC forests had been appropriated. This increase has for the entire decade hovered above the Ministry's own estimates of ecosystem sustainability. Ecological appropriations above an ecologically sustainable limit have helped fuel the shift towards a more technology intensive industrial system.

One way of measuring the impact of such a change is to determine the ecological footprint of each mill, or the quantity of logs each mill consumes over time. Ideally one would want to know the exact quantity of logs consumed per unit time. This information is not available, but estimates of annual mill production are available for eight of the 14 study mills for selected years from 1949 to 1985 (Miller Freeman Directory 1986). These data can be used to examine the mills' changing impact on the ecosystems, which supply them with logs.

The ecological footprint, expressed as millions of board feet, is therefore proportional to the volume of lumber produced per mill during each of the five time periods for which data are available (Figure 5). The eight large coastal mills show a greater than 60% increase in their production volume from 1949 to 1965, and, therefore a 60% increase in ecological footprint. Thereafter, the rate of increase slows, but the footprint per mill in 1985 is still nearly twice its 1949 size. An increased rate of production of wood means increased logging, which, in turn, means more road building and encroachment into wilderness areas, with consequent impacts on forest sustainability.

During this time period, 1949 to 1985, the number of workers in these mills first increased, reaching a peak in the late 1970s, and then decreased drastically in the early 1980s. It is therefore instructive to consider the changing ecological footprint of a sawmill worker, expressed as millions of board feet per worker, for this time period (Figure 6). Clearly, by 1985 technology had increased the ecological footprint of each sawmill worker from 154 Million board feet (Mbf) to 330 Mbf.

Figure 5: Lumber production per mill for eight large coastal sawmills from 1949 - 1985

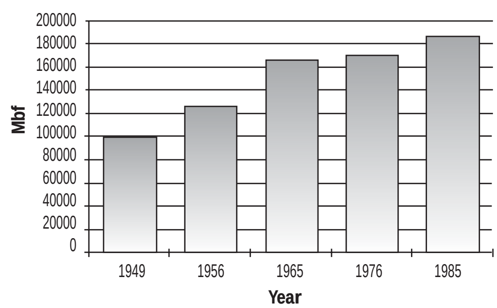
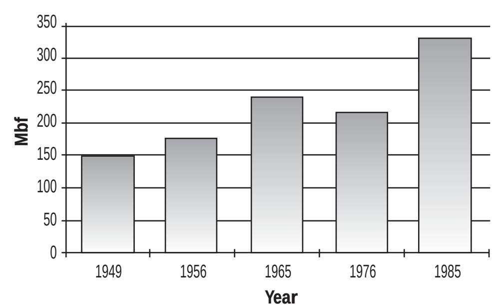


Figure 6: Lumber production per worker for eight large coastal sawmills from 1949 - 1985



Limitations and Advantages of the Methods Used in this Case Study

The ecological footprint is an estimate of a specific population's consumption of major resources measured in terms of the amount of land in continuous production that is necessary to sustain the group's rate of consumption. In this study, an attempt has been made to adapt the concept to a resource-extracting industry. Accordingly, the sawmill, rather than a population group, is the unit of consumption and, because turning trees into lumber is a relatively crude primary manufacturing process, most of the footprint can be assessed fairly directly by measuring lumber production.

It should be emphasised that this approach results in a considerable under-estimation of the ecological footprint because per annum sawmill lumber production is a crude proxy for the number of trees consumed each year. Also, the size of the land base required for a constant flow of trees to a sawmill depends on logging intensity and general forestry and silvicultural policies and must always expand as accessible stands of this largely non-renewable resource are logged off. An under-estimation of the size of the footprint also results because not included are measures of wastage involved in milling trees to lumber, the energy required for logging the trees, building logging roads, and other extractive infrastructure, and the energy expenditure required to operate the sawmills.

In reality, the sawmill is a site where raw natural capital is transformed rather than consumed. Further, the ecological footprint is usually assigned to the population that is the site of consumption of the mill's lumber. Assigning an ecological footprint to the site of transformation rather than consumption, de-couples the linkage between the consumption of specific population groups and its impact on the ecosystem.

The inherent danger in using the ecological footprint in this way is that its utility as an educational and analytical tool may be blunted. During the 1980s and 1990s, for example, Japan has become the final destination for an increasing number of trees processed in BC coastal mills. These changes in the BC lumber market result in an increased ecological footprint for Japan in general and for various Japanese cities and regions in particular. By focusing on transformation rather than final consumption, the specific links between consumption in Japan and ecosystem draw-down in BC are not made explicit.

There are advantages, however, in assigning ecological footprints to the site of the extraction and transformation of natural capital. First, for a nation like Canada which engages heavily in direct natural resource extraction with minimal value-added manufacturing and export, the trade-off between ecosystem depletion and community benefit needs to be explicit in order to determine the sustainability of the transformation process both for communities engaged in the process and ecosystems supplying the natural resource.

Second, the ecological footprint as it is generally used, is calculated from a range of essential items and expressed in land area needed to produce them. The power of the concept lies in its ability to make explicit the impact on ecosystems of the general consumption patterns of a defined population. While the ecological footprint links consumption patterns to nature, and expresses the impact of consumption in terms of land area needed to support it, there is no identification of the location or type of land-bases or ecosystems which are being exploited. Because it is primarily a planning and educational tool, the ecological footprint focuses on the final consuming population rather than the specific ecosystem being consumed or the population groups engaged in transforming natural products on their way to the final site of consumption.

Canadian industries such as sawmilling, fishing, and mining, which are heavily reliant on the direct harvesting and minimal processing of products of natural ecosystems and which have communities that are highly dependent on these industries, lend themselves to a particular adaptation of the ecological footprint. The approach is centred on the specific ecosystems and associated communities engaged in their extraction and transformation, rather than on the population consuming the products. The focus on minimally transformed natural products like the number of fish caught or the quantity of lumber produced, produces a rough indication, albeit an under-estimation, of the direct draw-down of natural capital as well as locating the site of this draw-down. This approach links the costs and benefits of transformation with site or region-specific ecosystem exploitation.

The measure of community sustainability used in this study was also somewhat crude, being based on the number of hourly pay jobs in sawmills. The measure excluded salaried and contracted workers, and any mechanisms by which reductions in the number of hourly pay jobs within sawmills may have been offset or transferred by increases in related employment within the sawmill communities. In spite of the crudeness of the measure of community sustainability used in this investigation, it is clear from other studies of sawmills during the recession of the early 1980s, that the loss of hourly pay jobs in mills were largely mirrored by reductions in salaried positions, contracted work, and office staff, indicating that fluctuations in hourly pay mill jobs are a fairly valid indicator of changes in community benefit from mill employment.

Conclusion

The discussion has until now focused on underlying methods and their limitations. But what are the main findings of this investigation? The case study, involving about 20% of workers in the coastal sawmill industry, showed that the downturn of the early 1980s was particularly hard on younger workers. In part, this was because of the seniority-based system in the mills which ensured that those with less seniority, who are generally the younger workers, are most likely to be laid off. When this finding is analysed in relation to between-mill migration patterns and the Forest Labour Adjustment Survey, it is clear that younger workers in older sawmill communities with increasingly less viable nearby forest ecosystems have either moved away from these communities and the entire industry, or, if they have remained in the industry have tended to move to the interior of the province with its newer mills and, most importantly, its less exploited forest ecosystems.

The increased personal ecological footprint of those workers who remained in the industry is a function of a new industrial strategy, which replaces labour investment with capital. New technologies enable workers to be more productive. While each worker can transform more trees into lumber than ever before, as a group there were about 40% fewer of them after the recession. Even with this drastically reduced and more aged work force, the ecological footprint of the eight coastal mills for which we have data increased between 1976 and 1985 principally because of increased productivity per worker.

A classical or neoclassical economist might be pleased with such productivity increases, but an ecological economist might see these in a less positive light. The new technical infrastructure now in place in most sawmills is more capable than ever of accelerating the pace of forest ecosystem draw-down. This enhanced production capacity was established at a time when BC’s coastal forest ecosystems, which have historically been over-harvested, are under increasing pressure from other forest sector uses such as tourism.

As the coastal forest ecosystems are depleted, the mills and the jobs move to the BC Interior. The infrastructure left in place in the coastal mills is the most efficient the industry has ever seen. The irony of this situation is that the coastal forest ecosystems are moving into their least productive phase at a time when a more efficient industry is creating intense production pressure. The efficiency of production methods ensures that more can now be taken from the forest ecosystems.

The changes are felt at the community level. The direct impact is job loss, reduced incomes, and a smaller tax base. The indirect losses range from increased migration of younger workers, increased community instability and senescence, and increased health and welfare costs associated with community instability and employment losses. These losses are likely to be particularly strong in small, highly dependent mill communities. Indirect costs such as these are not usually part of the accounting procedure. The extent to which the government must step in to deal with health and social costs incurred in industrial re-structuring amounts to a public subsidy, which is usually unrecognised by the private sector.

Calculation of the ecological footprint used in conjunction with measures of community sustainability can usefully illuminate the linkages and tradeoffs, which occur in some industries at the level of ecosystem and community health. While the results of this particular case study may not be encouraging, the development and application of new planning and conceptual tools like these may at least begin the process of making these tradeoffs explicit.

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Using Environmental Interventions to Create Sustainable Solutions to Problems of Health and Wellbeing[1]

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Recent research by Deakin University, in collaboration with Parks Victoria and its Strategic Partners, indicates that contact with nature may promote human health and wellbeing. International research indicates that simply viewing a natural scene or watching wildlife reduces stress and tension, improves concentration, remedies mental fatigue, boosts immunity, and enhances psychological health. This is aside from any physical health benefits flowing from reduced stress, increased exercise and improved air quality when contact with nature involves activities in natural environments. The literature suggests that interacting with nature through gardening or having a companion animal is also beneficial for health, and where these activities involve contact with other humans, might extend benefits beyond the individual to the community, through enhanced social capital. This paper sets out the potential scope of work flowing from the initial research, in terms of target groups, research foci, intervention strategies, and likely benefits, and reports on progress in establishing a program of Australian-based empirical research. It proposes the establishment of alliances between researchers and practitioners in a range of disciplines (including environmental health) to ensure that the links between contact with nature and human health and wellbeing are explored and expressed in ways that are both beneficial and sustainable.

Key Words: *Nature; Natural Environments; Health and Wellbeing; Biophilia*

The notion that humans are dependent on nature, not only for material needs (food, water, shelter, and so on) but perhaps more importantly for psychological, emotional and spiritual needs, has gained growing support recently (Friedmann & Thomas 1995; Frumkin 2001; Katcher & Beck 1987; Roszak, Gomes & Kanner 1995; Wilson 1984, 2001). But the basis and extent of that dependency and the exact character of the benefits to be gained from interacting with nature are issues that require much more investigation.

Research and publications in such diverse disciplines as psychology, environmental health, psychiatry, biology, ecology, landuse planning, horticulture, leisure and recreation, wilderness, public health policy and medicine support the idea that contact with nature is good for human health and wellbeing. For example, the 'biophilia' hypothesis developed by the biologist Wilson (1984, 1993) and debated and expanded by others (e.g. Kahn 1999; Kellert 1997; Kellert & Wilson 1993; Takacs 1996) suggests that the evolution of humans in the company of other living organisms predisposes human beings to rely intellectually, emotionally, physically and spiritually on affiliations with nature. This view is supported by ecopsychologists, who assert that many psychological and physical afflictions are due to withdrawal from contact with nature, and that exposure to nature can have positive benefits (Burns 1998; Cohen 2000; Durning 1995; Hillman

1995; Levinson 1969; Roszak et al. 1995; Scull 2001).

A broad range of health benefits appears to flow from contact with nature. For example, international research indicates that simply viewing a natural scene or watching wildlife has been shown to reduce stress and tension, improve concentration, remedy mental fatigue, boost immunity, speed recovery, and enhance psychological health. That is aside from any physical health benefits (for example, in terms of cardiovascular health) that may flow from reduced stress, increased exercise and improved air quality experienced by those whose contact with nature involves activities in natural environments. The literature suggests that interacting with nature through gardening or having a companion animal is also beneficial for health, and where these activities involve contact with other humans, might extend benefits beyond the individual to the community, through enhanced social capital.

Separation from nature (a relatively recent trend in human history) related to the shift of people away from rural areas into cities (Axelrod & Suedfeld 1995; Beck & Katcher 1996; Katcher & Beck 1987) is seen, therefore, as undermining human health and wellbeing. Moreover, the insulation of people from outdoor environmental stimuli (Stilgoe 2001) and their exposure to excessive artificial stimulation - both features which characterise modern societies - are believed to cause exhaustion and produce a loss of vitality and health (Katcher & Beck 1987; Stilgoe 2001). Frumkin (2001) suggests that satisfying human beings' innate affinity with the natural world might be the key to enhancing human health. Table 1 provides an overview of the evidence supporting this view.

Yet, there remains a lack of understanding and acceptance among the majority within the general populace, governments, institutions and health care providers about the significance of human connectedness with nature, and its relevance to current problems of health and wellbeing. A number of possible explanations exist for this lack of broad support for the "nature-health" connection. They can be classified under four broad foci: philosophical issues; theoretical issues; methodological issues; and empirical issues.

At the most basic philosophical level, the issue of what constitutes "nature" remains a matter of debate. Harper (1996) points out that, though pre-industrial societies were dependent on "nature" (i.e. the environment in which they existed), the concept of "nature" as a way of thinking about the environment emerged largely in the 18th century, through the works of the romantic artists, poets and writers of the time. According to Harper (1996 p. 35), "nature" (which was conceptualised as "good" – the "pristine natural state") was contrasted with the world of science and industry, which was characterised as evil, artificial and corrupt. This conceptualisation of "nature" emerged largely in response to the dominant paradigm of industrial societies, which featured a low valuation of nature for its own sake and a belief that nature/the environment was primarily a resource for exploitation by humans for their own ends (Birch 1993; Harper 1996; Townsend 1998). Such has been the dominance of that paradigm, that one might be tempted at times to question whether or not, in the increasingly synthetic and "mass-mediated" environment of most modern Western societies, there is much about nature that is (in fact) natural. In a society where "good nature" is perceived to have passed out of existence, and/or where "nature" is seen as merely an economic resource, it is not hard to see why the relevance of nature to human health and wellbeing is overlooked. Moreover, while the link between place (including natural elements of place) and health has always been a key focus within the practice of environmental health, the emphasis has been on protecting the public

Table 1: Evidence for the health-enhancing role of contact with nature

Evidence Key A = Anecdotal, T = Theoretical, E = Empirical

What the Research Demonstrates With Certainty

Assertion	Evidence			Key Reference/s
	A	T	E	
Beneficial physiological effects occur when humans encounter, observe or otherwise positively interact with animals, plants, landscapes or wilderness	✔	✔	✔	(Friedmann, Katcher et al. 1983; Friedmann, Katcher et al. 1983; Parsons 1991; Ulrich, Simons et al. 1991; Rohde and Kendle 1994; Beck and Katcher 1996; Frumkin 2001)
Natural environments, such as parks, foster recovery from mental fatigue and are restorative	✔	✔	✔	(Kaplan, 1995; Hartig et al. 1991; Kaplan & Kaplan, 1990; Kaplan & Kaplan, 1989; Furnass, 1979)
There are established methods of nature-based therapy (including wilderness, horticultural, and animal-assisted therapy among others) that have success healing patients who previously had not responded to treatment	✔	✔	✔	(Fawcett & Gullone, 2001; Crisp & O'Donnell, 1998; Lewis, 1996; Russell et al 1996; Beck et al, 1986; Katcher & Beck, 1983; Levinson, 1969)
People prefer natural environments to urban ones, regardless of nationality or culture		✔	✔	(Herzog et al. 2000; Newell, 1997; Parsons, 1991)
The majority of places that people consider favourite or restorative are natural places, and being in these places is recuperative	✔	✔	✔	(Herzog et al, 2000; Herzog et al, 1997; Newell, 1997; Korpela & Hartig, 1996; Rohde & Kendle, 1994; Kaplan & Kaplan, 1989)
People have a more positive outlook on life and higher life satisfaction when in proximity to nature (particularly in urban areas)	✔	✔	✔	(Kuo, 2001; Kuo & Sullivan, 2001; Kaplan, 1990a; Leather et al , 1998; Lewis, 1996; Kaplan & Kaplan, 1989)
The majority of health problems society will face, now and in the future, are likely to be stress-related illnesses, mental health problems, and cardiovascular health problems	✔	✔	✔	(Commonwealth Dept of Health & Aged Care & Australian Institute of Health & Welfare, 1999; Australian Institute of Health & Welfare, 1998)
Social capital is decreasing and is likely to continue to decline	✔	✔	✔	(Putnam, 1995)
Exposure to natural environments, such as parks, enhances the ability to cope with and recover from stress, cope with subsequent stress, and recover from illness and injury	✔	✔	✔	(Parsons 1991; Ulrich et al 1991; Ulrich et al, 1984)
Observing nature can restore concentration and improve productivity	✔	✔	✔	(Taylor, et al. 2001; Leather et al. 1998; Tennessen & Cimprich, 1995)
Having nature in close proximity or just knowing it exists, is important to people regardless of whether they are regular "users" of it	✔	✔	✔	(Cordell et al. 1998; Kaplan & Kaplan, 1989)

(Adapted from Maller, Townsend, Brown & St Leger, 2002 – see original document for detailed reference list relevant to this Table)

from environmentally-induced harm rather than facilitating beneficial contact with nature. However, recent trends in the practice of environmental health reported in previous issues of this journal (e.g. the emerging emphasis on sustainability highlighted by Harris & Chu 2001; the development of Municipal Public Health Planning discussed by Hay, Frew & Butterworth, 2001; and the increasing role of environmental health officers in integrating community-based environmental health activities, noted by Nicholson 2001) suggest a shift in emphasis within environmental health which may help to overcome this philosophical disjunction.

The diversity of disciplines encompassed by the issue of the human health impacts of contact with nature also poses problems for the development and application of cogent theories and explanations. This issue of disciplinary bias lies at the heart of the debate about the relationship between "nature" and "culture" (the so-called "nature/culture dualism"), and while some attempts have been made to overcome the dichotomies and dualisms evident within the debate (e.g. Dickens 1992; Wolfe 1990), the lack of integration undermines the capacity to use theories to encourage adoption of nature-based approaches to human health.

Methodologically, too, problems confront those who wish to research the human health impacts of contact with nature. In part these methodological difficulties arise from the conceptualisation of "health" in different ways. For example, research into "health" defined in physical health terms (such as blood pressure, heart rate, or lung capacity), requires a different approach from research into "health" defined in the terms of the World Health Organization (1948) as "a complete state of physical, mental and social wellbeing, and not merely the absence of disease or infirmity". This differentiation is further compounded by the fact that, in many situations, it may be difficult (if not impossible) to implement properly "controlled" studies, since controlling for contact with "nature" might be difficult, if not impossible. At the very least, it is fair to say that research into the human health benefits of contact with nature will require triangulation - defined as the "use of multiple and different sources, methods, investigators, and theories to provide corroborating evidence" (Creswell 1998, p. 202) as a means of verification of outcomes.

Empirical evidence for the human health benefits of contact with nature is limited, as Tables 1 and 2 demonstrate. Much of the research that has been undertaken is US-based, with very little Australian research in this area. However, the existing literature indicates the potential for promoting health and wellbeing in a cost effective, accessible and equitable way through contact with nature. This paper outlines a program of research being developed in Australia to address this shortfall.

Healthy Parks, Healthy People

Parks Victoria (the body responsible for management of parks in the State of Victoria) uses the slogan "Healthy Parks, Healthy People" to promote its activities. Interested to explore the extent to which the slogan's claims could be verified, in June 2001 Parks Victoria provided funding to Deakin University to undertake an independent review of literature on the links between human health and contact with nature in a park context.

In the process, it became apparent that little or no empirical research into the human health benefits of contact with nature has been undertaken in Australia, and that research elsewhere has been limited. Table 2 based on the findings of the initial research, indicates some of the major gaps in existing research (Maller et al. 2002) and some of the areas where research/data is needed.

In response to this void, the Deakin University research team has established collaborative relationships with a range of researchers, practitioners, institutions and policy makers to develop projects that will provide empirical data necessary to evaluate the claims made or implied for health benefits flowing from human-nature interaction.

The remaining sections of this paper outline the program of research being established by the Deakin-based team to address the need for empirical data. Details are provided of the rationale, scope, methodology and progress on a range of projects, either currently being undertaken or for which funding has been sought. Additional potential foci for research and partnerships/collaborations are also outlined.

Current or proposed projects

Living high but healthy

Despite evidence that urban environments are detrimental to human health (Parsons 1991; Rohde & Kendle 1994), and that isolation from nature produces a loss of vitality and health (Gullone 2000; Katcher & Beck 1987; Stilgoe 2001), inner city highrise apartment living in Australia's major cities is increasing rapidly. The impacts of this trend on individual and population health, wellbeing and daily life functioning are unknown. While some

***Table 2:* Gaps in the research/evidence for the health-enhancing role of contact with nature**

Evidence Key A = Anecdotal, T = Theoretical, E = Empirical

What the Research Demonstrates With Promise but for which Empirical Data is Lacking

Assertion	Evidence			Key Reference/s
	A	T	E	
People have an innate affiliation with nature that enhances health, and humans rely on nature intellectually, emotionally, physically and spiritually	✔	✔		(Fawcett & Gullone, 2001; Frumkin, 2001; Roszak et al, 1995; Kellert & Wilson, 1993; Katcher & Beck, 1987; Wilson, 1984)
There may be a genetic basis to human affiliation with, and attraction for, nature	✔	✔		(Kellert, 1997; Newell, 1997; Kellert & Wilson, 1993)
Separation from nature via modern living is detrimental to human development, health, and well-being	✔	✔		(Frumkin, 2001; Scull, 2001; Stilgoe, 2001; Kellert, 1997; Katcher & Beck, 1987)
Regular contact with nature, such as provided by parks, is required for mental health		✔		(Roszak, 1995; Levinson, 1983; Levinson, 1969)
There are psychological and physiological benefits to health from the act of nurturing living things (including plants, animals, and humans)	✔	✔		(Kellert, 1997; Bustad, 1996; Wilson, 1993; Lewis, 1990a; Katcher & Beck, 1987)
Nurturing is an essential part of human development, and lack of opportunities to nurture may be detrimental to health and well-being	✔	✔		(Kellert, 1997; Bustad, 1996; Wilson, 1993; Lewis, 1990a; Katcher & Beck, 1987)
Too much artificial stimulation and lack of exposure to natural environments, such as parks, can cause exhaustion and reduce vitality		✔		(Stilgoe, 2001; Parsons, 1991; Katcher & Beck, 1987; Furnass, 1979; Stainbrook, 1973, in Lewis, 1996)

What the Research Suggests but for which Limited Evidence exists

Assertion	Evidence			Key Reference/s
	A	T	E	
Human health is affected by lack of opportunities to experience nature	✔			(Frumkin, 2001; Stilgoe, 2001; Kellert, 1997; Katcher & Beck, 1987)
The destruction of the natural environment directly affects human health and well-being and is linked to the prevalence of mental disorders in modern society	✔			(Roszak et al, 1995)
Parks are important to the community in terms of health and people derive actual health benefits from parks		✔		(Kickbusch, 1989)
Natural environments (natural capital) play a key role in facilitating social and human capital, and this has outcome/s in terms of health	✔			(Frumkin, 2001; Putnam, 1995)
Contact with nature plays an important role in wilderness and adventure therapy	✔	✔		(Crisp, 1998; Crisp & O'Donnell, 1998)
Health and life satisfaction of some population groups (e.g. Friends of Parks groups, park volunteers, wildlife feeders and carers, or birdwatchers) is greater than others, where those groups have regular contact with nature/wilderness via parks				No information discovered at this time
Nature and parks play an important role in maintaining psychological health (but the extent, nature and process of this influence is unclear)				No information discovered at this time
Nature and parks play an important role in fostering a sense of quality of life and happiness (but the extent, nature and process of this influence is unclear)				No information discovered at this time
Exercise carried out in natural settings may have greater health benefits than indoor exercise				No information discovered at this time

(Adapted from Maller, Townsend, Brown & St Leger, 2002 – see original document for detailed reference list relevant to this Table)

contact with nature for highrise residents is provided through urban parks, the requirement by planning authorities that developers contribute to funds for the establishment and maintenance of parks is being challenged on the basis of a lack of evidence of the need for, and/or benefits of, urban parks. However, recent research in the US by Kuo (2001) found that access to “green environments” for people living in highrise urban settings predicted more effective management of the demands of everyday life. This project will provide comparable data for Australia.

The "Living high but healthy" project will identify, describe and measure associations between differing levels of access to natural environments, and the health, wellbeing and effective functioning of residents in inner urban highrise developments. The project will be based on the administration of a questionnaire including psychometrically validated self-report measures, with a sample of 600 residents in a selection of high-rise housing developments in inner Melbourne and inner Sydney. Qualitative data will be collected through face-to-face semi-structured interviews with a sub-sample of 300 residents. The interview schedule will explore meanings, understandings and experiences of participants about their health, wellbeing and effective functioning.

NATYR - Nature-based Therapy for Youth at Risk

Anecdotal evidence indicates that sustained contact with nature could be used as a strategy to address social and mental health problems, including addiction and anti-social behaviour (e.g. Bennett, Cardone & Jarczyk 1997; Beringer 1999; Cohen 2000; Crisp & O'Donnell 1998; Lewis 1996; Scull 2001; Taylor, Kuo & Sullivan 2001). Recent publicity surrounding the issue of "chroming" (the inhalation of toxic but licit substances) by young people in the care of welfare and support agencies in Victoria prompted an investigation into the possibility of undertaking a nature-based intervention study, working with young people who either are involved in chroming or are at risk of involvement in chroming.

Preliminary research drew together information on more than 70 different intervention programs thought to have potential for adaptation to meet the needs of the target group. This research reinforced the belief that there has been a lack of empirical research in this area, and that many of the programs adopted, especially in Australia, have not been well documented or evaluated. Moreover, while most programs reviewed reported a high degree of success, the long-term sustainability of the benefits to health and wellbeing is largely unknown. It became apparent, therefore, that both empirical research and longitudinal program evaluation are needed if the claims about the benefits of nature-based interventions for "at risk" youth are to be verified. In response to this need the NATYR project has been developed.

This collaborative project, based at Deakin University, will involve the development, implementation and evaluation of a nature-based intervention program with vulnerable young people with multiple risk factors for licit substance abuse. The intervention will involve several components, including a nature-based expedition in a Parks Victoria location in rural Victoria, and participation in a 5-month long activity program involving contact with nature (including companion animal and horticultural elements). Approximately 90-100 young people identified by a major child, youth and family welfare agency as being at high risk of licit substance abuse will be recruited over a period of three years to participate in the intervention program. A repeated measures pre-post follow-up design, using a wait-list control group, will be used to evaluate the intervention outcomes. Repeated assessments will include standardised measures of psychological and behavioural functioning, and risk and resilience factors.

Influence of "hands-on" nature-based activities on the mental health of children

Empirical studies indicate that nature can have significant and lasting psychological and physiological effects on health and wellbeing in children (Fawcett & Gullone 2001; Taylor et al. 1998; Wells 2000). Other work using companion animals and/or wilderness experiences to treat children and adolescents suffering from behavioural and/or psychological disorders has also indicated positive outcomes (Beck & Katcher 1996; Crisp & Aunger 1998; Fawcett & Gullone 2001; Levinson 1969; Ross 1999). Yet the mental health benefits of contact with nature for "normal" children have not been investigated as a potential tool for health promotion. Recently, Kellert (2002) asserted that direct experience of nature plays a significant, vital, and perhaps irreplaceable role in affective, cognitive, and evaluative development, but further study is needed to verify this.

This study will investigate the effect of contact with nature on children's mental health and wellbeing as a result of participating in "hands-on" nature-based activities encountered at school. The potential mental health benefits arising from contact with nature gain greater significance in the context of the rise in mental illnesses, both in Australia and worldwide, and the high social and financial costs these disorders entail (Herrman 2001).

The study will involve a survey of Victorian primary schools to identify the type and extent of any "hands-on" nature-based activities experienced by school pupils over the last 3-5 years. From the initial survey, a sub-sample of schools that have included a substantial "hands-on" nature-based program within the life of the school will be selected. A detailed questionnaire will be distributed to key contact staff within this sub-sample to determine the perceived outcomes and benefits of the activities, including the mental health benefits for the student participants.

A sample of schools from the initial survey that have not introduced any "hands-on" nature-based activities will be selected and invited to participate in the study by agreeing to introduce a "hands-on" nature-based activity at the school. Parents/guardians of children participating in the program will be asked to complete periodic questionnaires focusing on their child's development/progress, and teachers of children participating in the program will be asked to rate children's performance on a range of indicators of mental health. After the program has been running for six months, focus groups will be conducted with a selection of staff and a selection of parents whose children participated in the programs. The purpose of the focus groups will be to explore the perceptions of parents and teachers about the outcomes of the programs, particularly in terms of mental health benefits for the participants.

Exploring the health and wellbeing benefits of friends group membership

The role of social capital (defined in terms of networks, trust and norms which facilitate co-operation and cohesion in communities) as a key determinant of health has been highlighted by recent research (Kawachi & Kennedy 1997; Leeder & Dominello 1999; Runyan et al. 1998). Despite this recognition of the importance of social capital for health, Putnam (1995) observes that social connectedness and civic engagement – key aspects of social capital – are in decline. Other research has demonstrated the importance of contact with natural environments for human health and wellbeing (Frumkin 2001; Wilson 2001). These two strands of research into health determinants appear to merge in anecdotal evidence that suggests engagement in civic environmentalism (through groups such as "Friends of Parks") has spin-off health benefits, relating to a combination of exposure to natural environments and increased social capital (Maller et al. 2002). This link is supported by Furnass (1996) who defines the components of wellbeing as including satisfactory human relationships, meaningful occupation, opportunities for contact with nature, creative expression, and making a positive contribution to human society.

This pilot project, undertaken in collaboration with Parks Victoria and the Damper Creek Friends Group, has as its aims:

- to identify the range of motivations of Damper Creek Friends Group members for joining the group;
- to document members' perceptions of the benefits they gain either directly or indirectly from membership of the group (including health and wellbeing benefits);
- to explore members' perceptions of the factors contributing to the benefits they gain through group membership;
- to assess the potential for Friends groups to be used as an "upstream" measure to generate improvements in public health and wellbeing.

The program involves several components. The first element (recently completed) involved face-to-face interviews with members of the Damper Creek Friends Group. The second stage of the program will involve the conduct of a focus group with a sample of members of the Damper Creek Friends Group, representatives of Parks Victoria, representatives of VicHealth, and representatives of several Divisions of General Practice, to explore barriers to and potential for the intentional use of Friends groups as a way of promoting health and wellbeing.

Exploring the potential for nature-based therapies within the Children's Protection Society

Recent discussions with staff of the Children's Protection Society (CPS) have identified the need for a feasibility study to be undertaken to identify the potential benefits of and barriers to the adoption of nature-based therapy programs (such as animal-assisted therapy and/or horticultural therapy) within CPS. This project involves the use of qualitative interviews with staff and management of the Children's Protection Society, West Heidelberg, to assess perceptions of the potential benefits arising from nature-based interventions, and to explore issues such as: liabilities; occupational health and safety; hygiene; staff preparedness; client consent; the nature of potential interventions; and a Framework for Evaluation.

The aims of the project are as follows:

- to assess respondents' perceptions of the potential benefits arising from nature-based interventions;
- to identify any problems perceived by staff in relation to animal assisted therapy and/or horticultural therapy;
- to explore issues relating to the implementation of nature-based interventions by CPS (as listed above);
- to gauge the potential for formal adoption of nature-based therapies within CPS.

Face-to-face interviews will be conducted with CPS staff and management. During these interviews, the researchers will explore the issues outlined above.

Linking PAWS (Linking People & Animals for Wellbeing in Strathdon)

Strathdon Community is a Uniting Church aged care facility in Forest Hill, Victoria which is home to approximately 250 residents. Staff of Strathdon have expressed interest in nature-based therapies as a mechanism for improving the wellbeing of Strathdon residents, especially those who because of frailty are unable to "get out and about". Currently, there is a limited gardening program in which residents can participate, and the Community has a resident cat. However, the Activities Officer has noted that the cat spends most of its time in the administration area, and residents of the nursing home section of Strathdon do not really have any significant contact with the cat.

Given the ageing of Australia's population, and the burgeoning health costs associated with that, the issue of strategies to optimise health and wellbeing among older people is a matter of increasing significance. This study will involve an analysis of the health and wellbeing of a sample of Strathdon residents before and after an intervention involving the introduction of a visiting companion animal program (organised through the Lort Smith Animal Hospital), and will have as its aims:

- to develop a theoretical understanding of the benefits of contact with nature for human health and wellbeing, with a particular emphasis on benefits for older people in residential accommodation;

- to assess the health and wellbeing of a sample of residents within the Strathdon Community, both before and after the introduction of a visiting companion program;

- to evaluate the visiting companion animal program and identify the factors that might facilitate and/or inhibit its continuation and/or expansion within Strathdon and other similar agencies/facilities

This study will be undertaken by Deakin University, in partnership with the Strathdon Community. A mixture of quantitative and qualitative methods will be used, including questionnaires and face-to-face interviews with a sample of staff and residents.

Discussion

The findings of the preliminary studies undertaken by the Deakin University team indicate that the potential scope of research into the benefits of contact with nature for human health and wellbeing is virtually limitless. As Table 1 shows, existing data indicate that contact with nature is important for human health and wellbeing. However, Table 2 highlights the fact that empirical data need to be collected to verify this link and to explore its implications in terms of a range of health foci and a variety of target groups.

The projects outlined above form part of a program of research developed by the Deakin University-based collaboration, to be implemented over the next five years, as funding becomes available. The health-related foci of these and other future studies will include: mental health (including stress and depression); social wellbeing; cardiovascular disease; ageing; abusive behaviour; recidivism. A wide range of target groups will be included in the studies, including groups of varying age, socio-economic status, geographic location, and life situation.

In light of the ageing populations in the developed world, the burgeoning rates of mental illness, and the increasing pressures these will place upon government health care budgets, efficient and cost effective options for prevention of potential health problems and for the solution of existing health problems must be explored as a matter of urgency. Moreover, growing threats to the environment associated with climate change, resource depletion and environmental degradation are increasingly being recognised as threats also to human health, implying that "ecosystem health issues" relate not only to access to nature but also to quality of nature. This highlights the fact that management of changing environmental conditions and management of health go together. The Deakin-based collaboration is attempting to address these issues by linking academics, practitioners (particularly in the area of community-based services for children and older people), and urban planning/open space managers/policy-makers. However, if the potential benefits of contact with nature for human health and wellbeing are to be maximised, then many other stakeholders need to be brought in to the decision making. These include: policy-makers within federal, state and local governments (across a range of policy areas, including health, environment, education, welfare, employment, and industrial relations); mainstream health care providers; architects, designers, planners and developers; community representatives; media; and educators. This paper highlights an agenda for future research, and in doing so, places a challenge before health researchers, research funding bodies, and the broad range of stakeholders outlined above, to ensure that human connectedness with nature is not ignored as a potential determinant of health and wellbeing.

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Endnote

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Watershed Torbay: Restoring Torbay Catchment[1]

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Watershed Torbay is a new project to restore the waterways of the Torbay Catchment. It is an Australian first, with the project aiming to restore a whole catchment, not simply a river reach. This national demonstration catchment project runs for four years and is jointly funded by the National Rivers Consortium and the Water and Rivers Commission, Western Australia. The State of Western Australia's Department of Agriculture, Water Corporation and the Torbay Catchment Group Inc. are the other major partnership organisations. The project aims to achieve whole catchment outcomes through a combination of good science and knowledge, strong community partnerships, planning, community visioning and change processes, action learning, and adaptive management. Issues being addressed through the project include managing toxic algal blooms in receiving water bodies, protecting a future public drinking water supply, managing a deep drainage area including stakeholder conflicts over flooding and environmental impacts, changing land use, and environmental flows for river, wetlands and estuaries. Torbay Catchment also provides ecosystem services, including potable water supplies and wastewater disposal, which benefit communities far beyond the catchment. The project aims to integrate river management with positive social and economic benefits for the entire catchment community. This paper reports on all aspects of project progress to date, including the principles and philosophy of approach, the project process, outcomes, research and community linkages.

Key Words: *River Restoration; Whole of Catchment; Partnerships; Community Change; Ecological Condition; Ecological Services*

The Watershed Torbay whole of catchment river restoration project is an Australian first, aiming to achieve whole catchment river restoration outcomes through a combination of good science and knowledge, strong community partnerships, prioritised planning, community visioning and change processes, and adaptive management. The four-year project aims to show the benefits of stream restoration at the catchment scale rather than for discrete river reaches, with a research component included in project activities. It aims to demonstrate community participation as an essential project component; to incorporate monitoring and evaluation to allow ongoing adaptive management; and to achieve an action oriented learning environment through the collective work of researchers, agencies and community groups (Land and Water Resources Research and Development Corporation 2000).

Torbay Catchment Issues

The Torbay catchment has complex management issues and at times, conflicting land uses. It is widely accepted that farming (including beef cattle production, intensive horticulture and dairying) will remain a major land use, vital for the local economy.

However, farming practices will need to change to meet community expectations regarding the protection of environmental values. To date there has been a very low adoption of on-ground Natural Resource Management activities in the catchment, with historical and current land uses leading to nutrient hot spots. A deep drainage system throughout the lower catchment floodplain, constructed in the 1950s for flood control has many significant management problems. The drainage system links Torbay Inlet, Lake Powell and Manarup Lagoon, which are some of the most severely degraded water bodies in the state, with the exception of the Vasse-Wonnerup system in the South West of Western Australia. Toxic blue green algal blooms in Lake Powell and Torbay Inlet impact on biodiversity, community health and recreational activities. The catchment provides ecosystem services for the Albany urban community in the form of wastewater disposal and a future drinking water source area. The growth of Albany is putting further pressure on the demands of all suitable potable water sources within the catchment, the Marbelup Brook Water Reserve and Albany Groundwater Area. Very careful planning and education of all stakeholders, government agencies, landholders and residents, is essential for the long-term prosperity of the district and environment.

Principles and Philosophy of Approach

This project provides the project managers with the challenge of achieving whole of landscape and sectoral change, when a "single issue" program funds the project. The Water and Rivers Commission (WRC) is the project manager of Watershed Torbay, with the core business of this organisation being water resources management. However, WRC's intention is to broaden the scope to ensure the project integrates river management with positive social and economic benefits for the entire catchment community, beyond the scope of river restoration. This starts with the collective visioning carried out with all stakeholders and is followed through with planning and activities in the catchment. Within the program, WRC provides an issue-raising forum and acts as an information recipient, however, non-core issues are referred to the relevant group or organisation. The project team has identified the links this catchment project could have with all stakeholders including individuals, local community groups and organisations, state organisations and federal programs, and ensures that local representatives are present at catchment and project events. Barriers that exist across some agencies need to be overcome. Integration across different management issues is therefore a key feature of the plan.

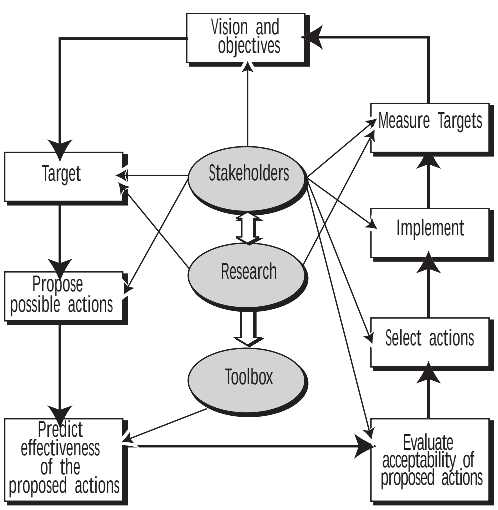
Project Management

Three committees have been set up to further the project. The Project Support Team is the core project management team that ensures that project milestones, research, planning, communications, and coordination are on track. The Technical Advisory Group brings together all researchers involved with the project, meeting six times per year to collaborate and report on the progress of Watershed Torbay's five principal research components. The Community Steering Committee has nine community members with industry and community expertise who provide strong support and commitment from within the catchment community to the Watershed Torbay project. The Steering Committee meets eight times per year, and provides valuable local knowledge and advice on the practical applicability of research to achieving outcomes and on-ground work in the catchment. Specific project committees made up of community and technical members are formed at critical points, for example the Drainage Committee which will provide local knowledge and technical expertise to develop the drainage district water balance model.

The Planning Approach

The Watershed Torbay project framework, shown below, is an adaptation of the model provided in Land and Water Australia's *River Restoration Framework* (2001). This model emphasises two main roles in selecting actions – whether they will work technically, and how practical they are to adopt. The Technical Advisory Group and the Community Steering Committee both have a key role in helping to develop the actions. The Watershed Torbay River Restoration Plan will be produced in a number of versions, with each version better informed from the research outcomes, and more challenging for the community in terms of adoption.

Figure 1: Watershed Torbay Project Framework



Issues, Vision and Objectives

The community and agencies have worked together to establish a common vision for the catchment. Community workshops, the Torbay Catchment Group, and landholder surveys have identified the critical issues now being addressed by the project. These are algal blooms, the function of the lower drainage system, catchment nutrient sources, environmental water requirements, and catchment social and economic issues.

Project objectives developed to address these issues include: minimising conditions which encourage algal blooms; ensuring that water quality, flows, and the ecological and recreational values of waterways are maintained; managing the drainage district to best meet the needs of current and future land uses and the environment; encouraging biodiversity through the management of remnant vegetation, in-stream habitat, weeds and pests; assisting in ways that aid the viability of farming and result in better environmental outcomes; increasing the awareness of appropriate land use planning; and education and communication objectives.

The collective visioning carried out means that those issues not covered within the river restoration project can be referred to other agencies, providing seamless support across all sectors. A key objective of the project will be to engage the community to negotiate and agree on management objectives for the catchment waterways that best meet environmental, social and economic outcomes. The communication and participation activities have involved a process that engages the whole community, and aims to achieve community consensus on setting project objectives.

Selecting Targets, Actions and Implementing the River Restoration Plan

The Community Steering Group and Project Support Team are working on target setting and action planning. Research projects have been identified which will fill the knowledge gaps in those issues targeted by the project. Restoration activities are now being implemented based on current "best bet" practices, as prioritised by the research and targets set by the community in the river restoration plan, and based on the effectiveness and practicality of the proposed actions. The effectiveness of various actions has been predicted using aids provided by researchers, for example, mathematical models and flow dynamics, or assessment based on previous studies or experience. The extent to which the proposed actions are acceptable will be gauged by which actions are practical in terms of acceptability to the community and how much they will cost to implement.

The Torbay Catchment Group (TCG) has received Federal Government Envirofund grants to commence on-ground works in the catchment in 2003, valued at $31,000. This is in addition to total grants of $21,000 provided by the Water and Rivers Commission from 1999-2002 for on-ground waterways rehabilitation works following Best Management Practices, on those properties in Torbay Catchment targeted for restoration works by waterways foreshore condition surveys. The TCG has also been successful in applying for the allocation of a federally funded Green Corp team to work in Torbay Catchment for six months during 2003, carrying out the work funded by the Envirofund Grants. This work will include 30 km of waterways fencing, 15 hectares of riparian revegetation; installation of five stock crossings, weed control (arum lily, taylorina, sydney golden wattle, watsonia), bird hide construction at the nationally significant wetland Lake Powell, and maintenance work on three community halls in the catchment.

Channel stabilisation and revegetation implementation will be according to current best practices as in Land and Water Australia's Riparian Land Management Technical Guidelines (1999) and the National River Consortium's Rehabilitation Manual for Australian Streams (2000). Funds will be sought from other federal, state and local government programs where outcomes match, for example for salt management, development of potable water supplies, or biodiversity conservation. It is unlikely that one source of funds will be available to implement all aspects of the River Restoration Management Plan immediately, but the catchment community believes that by developing the Plan, they will be in a much stronger position to bid for any funds that are available.

The implementation of restoration activities will take into account the social and economic constraints (and opportunities) in the catchment.

Research Program

At the same time that the restoration plan is being developed (Vision, Issues, Objectives, Targets and Action), scientific and technical work has begun on issues already identified over many years by the community as critical to the health of Torbay's waterways. In this way, the community can be assured that the project is not just another planning exercise, but will lead to tangible outcomes. This is essential for active community involvement in the project.

The research projects that are now in progress will assist with assessment of the characteristics and driving processes of the Torbay system, and will define management issues and potential solutions. It is essential that good science underpins the river restoration action plan and that the research can define management issues and practical solutions for the community. One of the challenges this project faces is the integration of science across disciplines. All researchers are required to do a communications plan for the project, and to involve the community wherever possible in the research. Watershed Torbay provides many opportunities for linkages across disciplines, for example, water quality, environmental flows, in-stream habitat, and nutrient and pesticide levels. These links have been identified, and partnership projects and funding are now being co-ordinated. This approach also avoids duplication across agencies. For example, two West Australian organisations, the Department of Agriculture and the Water Corporation are now working on a project looking at the sub-surface flow of nutrients and pesticides to Marbelup Brook, sharing project infrastructure costs and sampling equipment. The Water Corporation is funding a postgraduate student to carry out the pesticide research. The results will be used by the Watershed Torbay project, and in Water Corp's feasibility study of Marbelup Brook as a public drinking water source.

This example is part of a detailed research and investigation plan developed by the Technical Advisory Group, with many projects well underway. The five research themes are as follows:

- Environmental water requirements

  What water quality and quantity do the rivers, wetlands and estuary require to maintain their environmental values and prevent issues such as algal blooms? This includes a postgraduate developing environmental water requirement methodologies for south coast estuaries using Torbay Inlet as a case study.

- Wetland and estuarine algal blooms

  What are the key drivers of the algal blooms that occur in the catchment's receiving waterbodies? What roles do a range of environmental parameters play, including nutrient availability and salt water input through bar openings?

- Catchment nutrient sources

  What are the main sources of nutrients in the catchment and the pathways through which they reach the receiving water bodies? Where can we most cost-effectively implement on-ground works to limit nutrient discharges? How much does groundwater account for the input of nutrients to the receiving lakes and estuary?

- Drainage management

  How can we better manage the lower drainage district to meet stakeholder and environmental requirements? A complicated drainage system operates on three levels with a complex system of weirs, floodgates and stop boards. Research includes development of a water balance model through which drain management scenarios can be developed and evaluated.

- Barriers to change

  This suite of projects will look at the social issues involved in managing the catchment waterways. What economic or social issues are preventing the implementation of on-ground works in the catchment? What economic incentives do we need to encourage uptake? How do we encourage recognition of, and foster a "user pay" ethos for the important ecosystem services that Torbay Catchment provides for the nearby City of Albany (potable water source and liquid waste management sites)?

Community Involvement

Watershed Torbay is involving the community in some traditional as well as new and exciting ways.

Local ownership

It is essential that Watershed Torbay has strong community participation and ownership. Local community people are involved in all aspects of the project. Local halls are used for meetings, with local businesses and Progress Associations catering for project events. The Watershed Torbay project launch was held at Woodbury Boston Environmental School with sweeping views of the Torbay Coastline.

Guidance

The Community Steering Committee meets monthly to guide the project and a small support team which includes the community chairman and project staff meets fortnightly to progress issues.

Links to science

A number of initiatives are underway to link scientists represented on the Technical Advisory Group with the broader community. Joint meetings and briefings are held regularly, and all scientists have been asked to develop a community involvement plan as part of their research proposal. Opportunities for community involvement include using community members to support fieldwork and monitoring.

Web Page and newsletters

The Watershed Torbay web page (www.torbay.scric.org) and quarterly newsletter of the same name are produced for all catchment residents and stakeholders.

Celebrations and activities

Community celebrations are an important project component. The project launch in April 2002 was attended by over 150 community members, with local produce displays and project information a feature. A photographic exhibition in July 2002 attracted many entries depicting the many different features of the catchment landscape, celebrated with a prize giving and afternoon tea. Woodbury Boston Environmental School, located within the catchment, is using the project to guide a range of curriculum activities over the next few years, including photography, building a catchment water model and capturing the oral histories of older people living in the catchment.

Community catchment health indicators

The development of community catchment health indicators underpins the community involvement for this project. While we will have a range of scientifically based indicators and targets, the community's perceptions of what will make this project a success are important. Community visioning workshops have been held to identify the future vision for the catchment and the issues that need to be resolved. Information from the workshops will form the basis for the development of community indicators, to be reported back to the community on an annual basis. These indicators will be the true measures of success of the project.

Capturing local knowledge

People living in the catchment have an enormous wealth of catchment knowledge. The project teams are currently investigating ways of using Geographic Information Systems (GIS) and web-based technology to capture community information on a range of matters, in particular on historical and current land uses.

Best practice community change

Adoption is always a challenge with any planning and implementation project and is an issue in this catchment for a range of reasons. To support the community initiatives, the project's Communications Coordinator is undertaking a post graduate degree in Best Practice Community Change. From a worldwide review of literature and case studies, the project will provide a best practice community process for this project.

Community skills audit

A skills audit carried out at one of the first Community Steering Group meetings identified a broad range of expertise within the community. The project now has access to a resource base of people with a wide range of skills including graphic design, web site production, accountancy, primary production, tourism, amateur biologists, historians, photographers, teachers and project managers.

Project Communications

A communications strategy has been initiated early on in the project to identify the appropriate ways of communicating the results of the project within and beyond the catchment. The strategy has also been developed to ensure that the best practice approaches are demonstrated and incorporated as criteria into funding schemes for the implementation of on-ground works.

Effective communication is a critical element of the project, ensuring that the restoration plan is developed in partnership with the community and reflects stakeholder issues and priorities. With extensive community participation factored into the project's communication plan, community motivation to implement the restoration plan is ensured. The communications plan also ensures that knowledge from the project process is communicated to other catchments, and that an action learning approach is used. A high communications profile is being maintained for the project, not only within the region, but also across the southwest, as a "living" example of what a whole of catchment approach can deliver for improved waterways management.

Project Monitoring and Evaluation

Annual evaluation of project progress, research and on-ground activities will be carried out to ensure that community objectives are being met, and to support a longer-term, adaptive management approach to continued improvement in waterway condition. Documentation of the critical success and failure points is obviously another focus so that the knowledge developed from this project can be transferred to other catchments and communities throughout Australia and beyond.

The communication and monitoring and evaluation strategies being developed as part of the project will include indicators and targets for the project. These will be measured and reported on an annual basis. Techniques being used to measure the success or otherwise of the communication and adoption outcomes from this project include: questionnaires for forum attendees; a periodic survey of landholder attitudes, and the number of landholders actively involved in on-ground activities including areas fenced and replanted; expenditure on on-ground projects; the extent of achievement of on-ground targets; and measurable improvement in waterway condition.

Project Outcomes

Community ownership and participation are essential ingredients to the success of Watershed Torbay. The project will help the community identify a future vision for the catchment and will facilitate the development of management objectives for the catchment and receiving water bodies that are agreed on by all stakeholders. Project research will result in an improved understanding about the state of the catchment, the sources of nutrients, and how to manage the wetlands that are receiving water from the catchment. At the end of the second year of the project, an improved drainage management plan for the floodplain Drainage District will be completed. Iterative development of a restoration plan for all waterways in the catchment will take place throughout the life of the four-year project as new research and best management practice becomes available. Cost benefit analysis and implementation of restoration activities across the catchment to improve the waterways will show the benefits of stream restoration at the catchment scale backed by research.

Incorporation of monitoring and evaluation of restoration activities will allow changes to implementation as the project progresses.

Conclusion

The chief outcome of the program will be a major improvement in the water quality and ecosystem health of the Torbay catchment stream system and associated wetlands and estuary. However, the project will lead to environmental improvement only, as the catchment is highly modified and degraded by land use and drainage. The impacts of any specific works will be assessed for potential environmental degradation on a case-by-case basis. There are six major areas of benefit from the project: improved drinking water quality; reduction in algal blooms; improved property values; improved environmental values; improved social values; and improved primary production and income. Many of these are hard to value, but a conservative estimate for the first three areas is in excess of AU$7 million dollars.

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Endnote

1. An earlier version of this paper was presented at the Indopacific Ecosystem Health Conference in Perth, Western Australia in November 2002.

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AUSTRALIA

A Risk Management Approach to Sustainable Water Reuse[1]

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The Hawkesbury Water Reuse Scheme being developed by the ICEM research group at the University of Western Sydney involves the construction of a wetland system on degraded agricultural land to receive and polish low quality stormwater from the town of Richmond with the aim of augmenting existing aquatic habitats, buffering large variations in tributary flow due to urban runoff, and providing an additional source of water for Campus irrigation to replace the chlorinated town water presently in use at certain times of the year. The Scheme will incorporate a long-established sewage effluent irrigation system for University agricultural, horticultural, and recreational land using effluent from the Richmond sewage treatment plant. To ensure sustainability of future stormwater effluent reuse in terms of health, ecological and agricultural considerations, a comprehensive risk management system is being developed as part of a total environmental management system. The health component of this is described in the paper. The initiative integrates a range of research interests and expertise, with the aim of securing improved water use locally and assisting in the development of guidelines, standards and protocols for sustainable water reuse elsewhere.

Key Words: *Risk Management; Risk Assessment; Effluent; Water Reuse; Sustainable*

The desirability for land-based application of effluent or degraded-stormwater runoff to enable nutrient removal and pathogen reduction prior to entry into natural receiving bodies is widely recognised (Anderson 1996; Asano & Levine 1996; Mills & Asano 1996). Where effluent or poor quality stormwater is discharged directly into rivers or lakes it not only increases pathogenic load but also introduces nutrients such as nitrates and phosphates which lead to algal bloom, the associated proliferation of aerobic bacteria, and the resultant removal of oxygen. Such "eutrophication" ultimately leads to a reduction in biodiversity including loss of commercially useful species of fish and crustacea, and causes problems at drinking-water treatment works where final quality relies primarily on the action of aerobic organisms for the conversion of unstable or harmful substances to stable safe ones. Excessive algal biomass and bacterial capsular slime aggravate the problem by choking trickling filters at water works (Morgan, Moran & Wiersma 1993; Ryding & Rast 1989).

Under natural conditions organic matter high in nutrients such as dead plants, animals or faeces, when deposited on land may take a long time to reach a natural water body resulting in the stabilisation of nutrients through prolonged contact with terrestrial organisms and soil compounds. Following this process uptake of nutrients by terrestrial plants occurs and animals subsequently use the plant material as food. Engineered waste treatment systems tend to short-circuit these natural events by passing nutrients directly to fresh water bodies or the ocean through a system of pipes where the they are taken up by water weeds and algae.

Managed land application of effluent reintroduces the terrestrial phase of the water cycle allowing for much nutrient matter to be taken up by terrestrial plants instead of by aquatic or marine weeds and algae. On exposure of pathogenic microorganisms deposited on land to ultraviolet light, and with drying and ecological competition, many are likely to be destroyed before entering town water supplies. While problems relating to effluent irrigation have been identified, including water-logging, increased salinity and weed growth, these can be effectively controlled when a sound environmental management system (EMS) is in place (Ashford & Caldart 1999). Despite the advantages of terrestrial application, a construction-centred engineering approach has led to the predominance of the unitary "plug and play" STP in Australia, where treated effluent is typically conducted through pipes and channels directly to fresh or marine water, effectively bypassing the terrestrial stabilisation phase (vide: STPs along South Creek and the Hawkesbury-Nepean River System in the Sydney area) (Derry, Booth & Attwater 2002).

The problem of poor downstream water quality has been exacerbated in some instances by successive abstractions, usage and return of water into one stream by a series of STPs, sometimes operated by different authorities. As a result of such nutrient loading in Sydney's main source of potable water, the Hawkesbury-Nepean River, toxic blue-green algal (cyanobacterial) blooms were occurring in the early 1990s necessitating the establishment of a special trust to manage the problem (Aplin 1999). For the time being the blue green algae have disappeared, the Hawkesbury Nepean Catchment Trust has been dissolved, but the spectre of potentially hazardous cyanobacterial growth through direct STP discharge to the Hawkesbury Nepean River and its tributaries remains.

A universal engineering response to the deterioration of water quality in rivers and dams following burgeoning human settlement has been the continued sourcing of additional pristine upland water. This practice has, however, been criticised in Australia by conservationists and certain agriculturalists because of a variety of problems including failure to secure sustainable flows to some areas (Blackmore 1995; Tyson 1995). An additional problem has been seen to result from the practice of offsetting high construction costs for upland dams against an assumed long-term saving in pumping costs, filtration and effluent disposal. This assumption in many cases has proved spurious because of the need subsequently to pump water to settlements in hilly areas opened up by innovative road construction; the need to filter and otherwise treat water from upland catchments which have become settled, farmed and industrialised; and the need for costly retrofitting of STPs as public consciousness becomes aware of the undesirability of direct marine discharge. The policy of dam construction with cost offsetting in regard to filtration practice has been hypothesised as being partially responsible for the finding of unacceptable levels of potentially hazardous forms of *Cryptosporidium* and *Giardia* in Sydney's water supply in 1998, following proliferation of urban, industrial and agricultural activity in the Warragamba Dam catchment (Derry, Booth & Attwater 2002).

In part as a result of perceived non-sustainability of expanded upland water exploitation, government is encouraging those vested with the management of Australia's scarce water resources to direct their focus towards more effective use of existing water supplies. In this regard, stormwater and effluent harvesting and use is likely to be an important strategy, in keeping with overseas acceptance of the concept that not all water supply with potential for human contact must be of potable quality (Angelakis & Bontoux 2001). To this end Australian guidelines have been revised and expanded to include a range of water quality indicator values relevant to a range of uses, and protocols for safe use, and related risk assessment and management, are currently being developed (Australia and New Zealand Environment and Conservation Council & Agriculture and Research Management Council of Australia and New Zealand [ANZECC & ARMCANZ] 2000).

Agencies involved in this revisionary process are those relevant to environmental health, environmental protection, catchment management, water supply, local government and others, and the fact-finding and developmental aspect of the process is often supported by University-based research groups, such as the Integrated Catchment and Environmental Management (ICEM) group based at the Hawkesbury Campus of the University of Western Sydney (UWS). This group is presently engaged in developing the Hawkesbury Water Reuse Scheme (HWRS), a project aimed not only at contributing to sustainable reuse of effluent and stormwater locally, but also to the development of health, ecological and agricultural guidelines for the sustainable reuse of water regionally and nationally.

The Hawkesbury Water Reuse Scheme (HWRS)

The central component of the scheme is the harvesting of degraded stormwater runoff from the town of Richmond, situated in the North Western sector of the Sydney Metropolitan Area, with subsequent polishing in wetlands being developed on previously agricultural land attached to UWS's Hawkesbury Campus. The wetlands will augment local aquatic habitats, buffer excessive flow variations resulting from urban runoff and provide an additional source of polished water for agricultural, horticultural and sportsfield irrigation at the University, to replace the chlorinated town water presently in use at certain times of the year.

The initiative will include an existing infrastructure of dams, distribution mains, pumps and irrigators for present on-campus effluent irrigation practiced in terms of an agreement with Sydney Water which spans almost 20 years, as regulated by the University's EPA licence. Advantages are reciprocal, the University obtaining a ready source of low-cost, high-nutrient water for irrigation and Sydney Water reducing high-nutrient flows into the adjacent Rickaby's Creek as part of the Hawkesbury Nepean River system, thereby reducing cost in terms of potential EPA disincentives.

It should be added that while the introduction of effluent reuse schemes is typically met with some level of community mistrust or opposition, effluent reuse on the once predominantly agricultural Hawkesbury Campus has been the norm for so many years that a level of complacency has crept in to usage patterns in some areas. Irrigation close to certain populated areas and the deterioration of precautionary signage are examples.

In this reuse system, secondary treated and chlorinated effluent from Sydney Water is held in a series of on-site storage dams and is then used for pasture irrigation for dairy cattle, horses and deer; playing field irrigation; and the overhead irrigation of horticultural and agricultural crops. The study has shown that considerable stabilisation of effluent takes place in the dams indicating that they should be managed not as mere impoundments but as working ecosystems. The proposed harvesting of stormwater from the Town of Richmond and potentially from North Richmond, with subsequent polishing in wetlands, will free the University from having to supplement the effluent supply with precious town water in dry months, and will increase the diversity and number of users through the offering of a broader range of irrigation water quality types.

Increasing the complexity and scope of the existing system, however, emphasises the need for a comprehensive EMS in which health risk monitoring is a vital component. The following discussion primarily concerns the health component of the Scheme, but it should be kept in mind that for an effective total EMS, simultaneous attention to health, environmental and agricultural components needs to occur.

Risk Management

As a component of the EMS a risk management strategy has been developed which incorporates risk assessment. Risk assessment could be regarded as a process for measuring, assessing, evaluating and predicting the likelihood and outcome of hazard potentiation at specific locations, while risk management is the process in which this information is contextualised in terms of social, political, economic, institutional, community and ethical considerations. Risk Management is needed in order to design, implement and monitor strategies for risk intervention and amelioration.

At UWS a Risk Management Committee has been established under the leadership of the Campus Provost consisting of representations from the range of stakeholders, while a Risk Assessment Team consisting of specialists from the ICEM research group has been appointed to report to the Risk Management Committee. Specialist servicing such as laboratory analysis is outsourced by the Risk Management Committee to University and other agencies as necessary.

The risk management model was presented at the International Water Association's 3rd World Congress in Melbourne in April 2002 to attract comment by the scientific community (Derry et al. 2002). While negative outcomes of health such as morbidity, mortality and risk are generally more easily measured than positive ones, it needs to be kept in mind that benefit and risk are inexorably linked, and the model is designed to take cognisance of the risk-benefit relationship.

Figure 1 shows a schematic for the model, based on a generic plan originally relating to chemical risk management suggested by Eduljee (1998).

To enable decision making by the Risk Management Committee a set of action triggers is being established for each hazard based on threshold values. In this "decision-tree" model as shown in Figure 2, when sub-threshold values are recorded, a "no-action" approach will be applied, but where the threshold is approached or exceeded then best practice intervention will be put into effect, or more advanced risk assessment carried out in response to increasing uncertainty. This tiered and branched approach conforms to the relevant guidelines (ANZECC/ARMCANZ 2000)

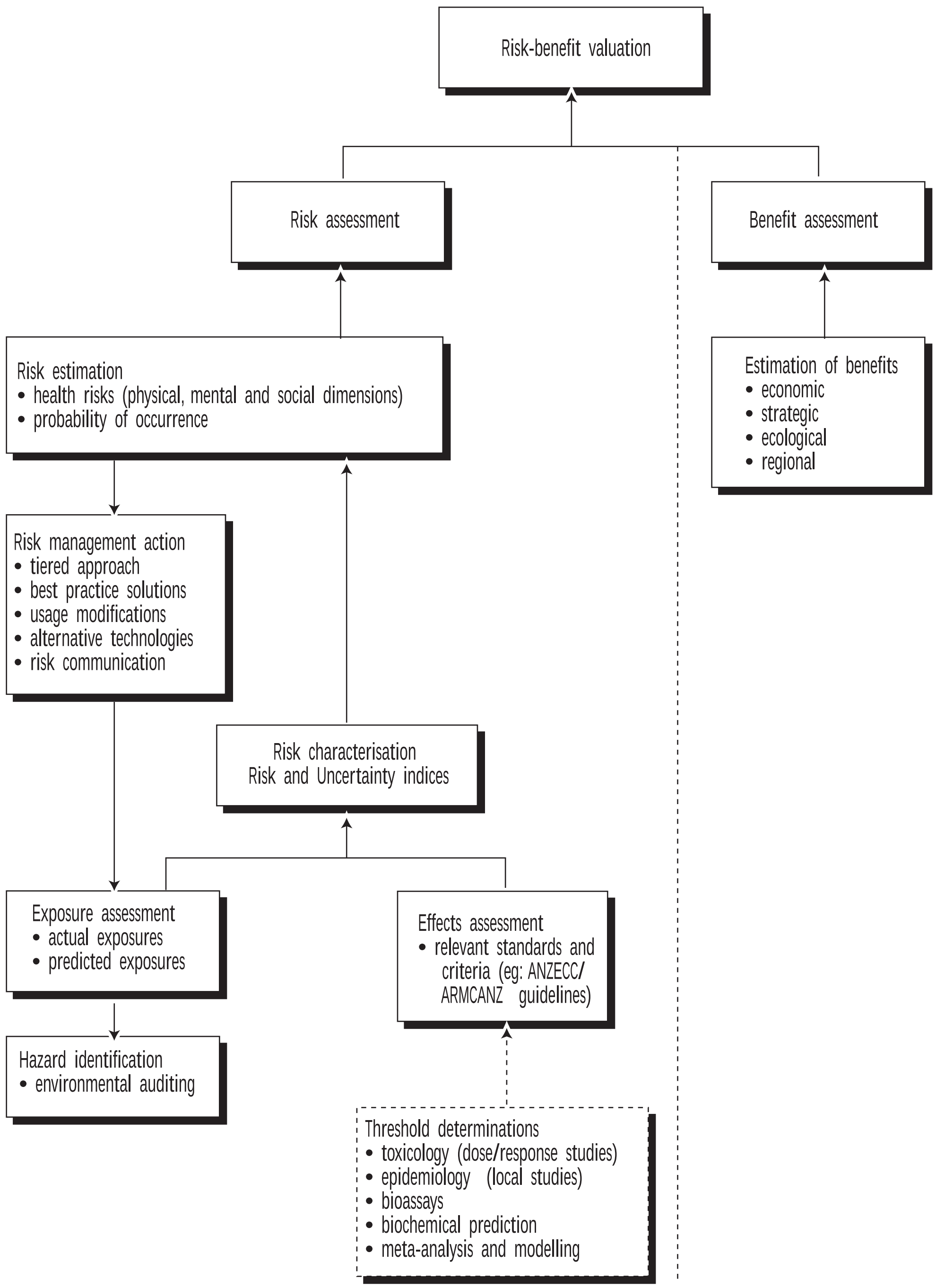
Groups to be considered in exposure evaluation include University staff and students, those potentially exposed to spray irrigation drift, users of playing fields irrigated with effluent and contract workers entering the University precinct. Extended groups will include consumers of milk, meat and horticultural products that are part of the human food chain, and the broader population potentially affected by disease or nuisance from vectors breeding on site, spray drift from irrigators, noise from pumps or odour problems.

Central to the process of risk management is effective risk communication involving relevant groups and committees, stakeholders and members of the community. Researching relationships and methods of ensuring communication within a framework of accountability to the University and regional communities forms an important component of the research being carried out in terms of the HWRS (Cromar 2000).

Preliminary Health Risk Assessment

During 2002 the Risk Assessment Team carried out a preliminary health risk audit of on-Campus effluent reuse practice and infrastructure, key aspects of which are discussed. Details of methodology, indicator

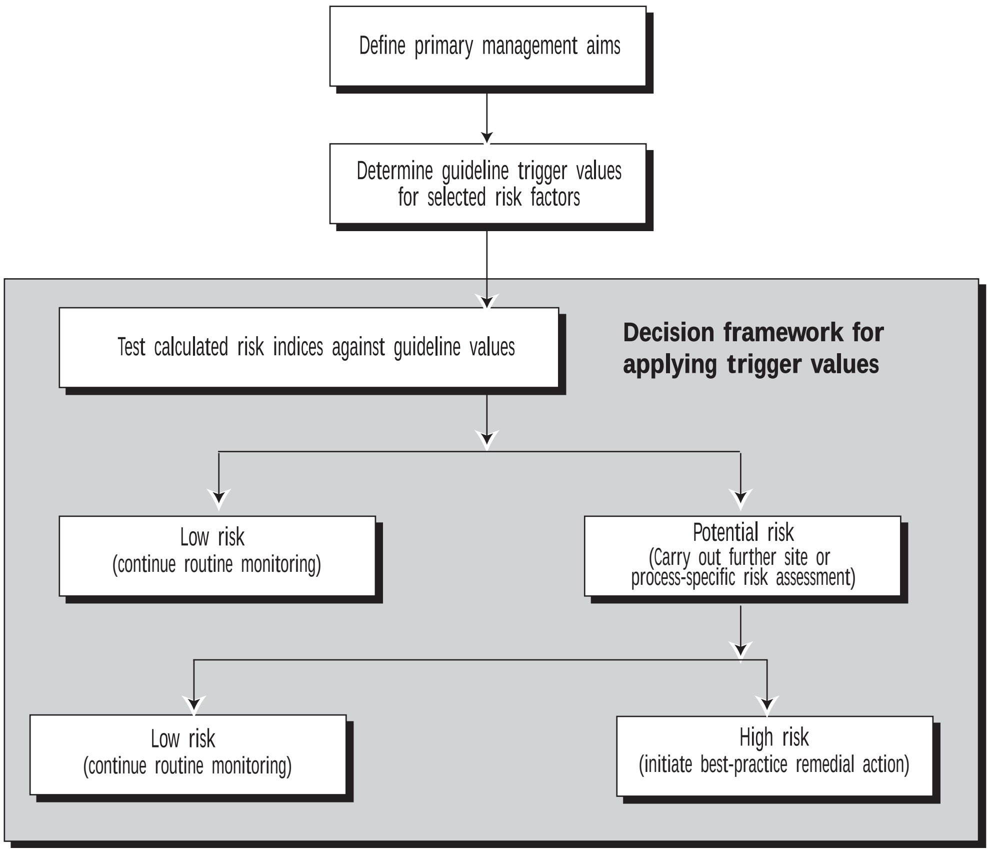
Figure 1: Risk management model for the Hawkesbury Water Reuse Scheme



selection, risk monitoring and the results of data analysis will be presented in a subsequent paper.

Preliminary site inspections ("scoping") were carried out during which a number of potential hazards was recorded. An early recommendation was that improved detail of mapping of underground pipework should be carried out to enable all existing and abandoned linkages between the

Figure 2: The Risk Management Decision-Tree



impoundments to be plotted to minimise the risk of future cross-connection between the effluent and potable water supplies. The need for additional metering in the system to improve management of volume flows and distribution to users was also noted.

While soil penetration of microorganisms and many chemical substances is limited in sandy loams of the type found on the Campus, it was recommended that some basic geological surveying be carried out to detect sites of potential fissuring where direct flow to the aquifer might occur. The need for a study of disease endemicity and of potential epidemiological "spikes" in the effluent and stormwater catchments was noted, as was the need to assess the likelihood and potential impact of hazardous chemical releases or spills.

The ICEM group includes specialists in GIS, geohydrology, water science, epidemiology, systems management and social ecology. The assessment will bring together a diverse range of knowledge and research skills needed to make recommendations for the establishment of meaningful guidelines by agencies vested with national, state and local water interests.

Following the scoping exercise, preliminary effluent sampling at a number of distribution points across the campus was carried out in terms of existing guidelines for the monitoring of effluent irrigation in order to assess the relevance of indicators and level of detection required under local conditions (ANZECC/ARMCANZ 2000). It was concluded that the following indicators should be used in ongoing monitoring using standard procedures

(American Public Health Association [APHA] 1999):

- Thermotolerant or "faecal" coliform as the main indicator of potential pathogenicity (APHA 1999). The use of other indicators not presently referred to in the guidelines will be researched as high nutrient environments may present ecological challenges to thermotolerant coliforms reducing their effectiveness as indicator organisms (Anderson, Turner & Lewis 1997; Derry 2002).

- Five-day biochemical oxygen demand (BOD_5) and suspended solids (SS) as process performance indicators. In this regard it should be noted that the effluent is stored on Campus in a series of dams for distribution to users and that this storage can impact on final water quality.

- Conductivity and total dissolved solids (TDS), pH, dissolved oxygen (DO) and temperature as contextualisation indicators, for interpretation of results.

In addition, exploration of the relevance of the following indicators for pathogen, vector and toxicant presence will be carried out for the development of protocols flexible enough to be used in other locations:

- parasitic worm presence such as the ova of *Ascaris*, *Trichuris* and hookworm spp.

- *Giardia lamblia* and *Cryptosporidium* spp.

- *Entamoeba histolitica* as pathogen and other amoeboid opportunists, such as *Naegleria* and *Acanthamoeba* spp.

- selective tests for chemicals such as heavy metals based on observations of hazardous catchment processes or potential spills

- a mosquito index for nuisance mosquitoes and arboviral disease vectors

In the preliminary risk assessment it was noted that Sydney Water will probably be upgrading the existing activated sludge process through the addition of an intermittently decanted aerobic lagoon (IDAL) unit and that shifts in nitrification/denitrification potential of the effluent might impact on the spectrum of micro-organisms necessitating modification of the set of indicators (Rajanayagam et al. 1999).

An important part of preliminary risk assessment was the identification of potential exposures of individuals and groups to known hazards and the consequence of such exposures. In this regard "most sensitive individuals" (MSIs) are being identified and taken into account.

By assessing environmental hazards and potential exposure it is possible to calculate a preliminary risk index (r) for each environmental situation using the formula:

$$r = p \times c$$

where:

p is the probability or likelihood of that risk occurring or potentiating, and

c is the consequence or impact of the risk, were it to occur or potentiate

As many population exposure situations show a non-linear response, more complex risk models will be explored as the study proceeds. Ranking of risk indices derived in the preliminary phase has already enabled important risk factors to be identified and some preliminary recommendations to be made to the Committee regarding specific environments and practices.

These recommendations included:

- the need for closer liaison with the effluent supplying agency, Sydney Water, to ensure a more consistent quality

- increased duty of care at certain University sites where it was believed effluent had potential to enter the human food-supply chain

- the development of better communication of risk and precautions to students, staff and to visiting contractors with special attention to safety induction

- the prevention of contact with effluent through the development of multiple physical and procedural barriers.

Attention of the Management Committee was also drawn to the apparent amplification of organisms through the existence of loops in some Campus aquatic systems where terrestrial runoff from irrigation was being returned to original storage impoundments.

Some early precautions were outlined with the aim of preventing the exposure of most sensitive individuals (MSIs) to irrigation water and to reduce the exposure of the public using roads adjacent to the campus to spray drift. In this regard multiple barrier techniques, such as separation by distance or irrigation at times when students are not on campus, are being explored. The improvement of more explanatory cautionary signage was also recommended. While this preliminary investigation focused on the health component, data were collected and recorded in such a way as to facilitate later integration with ecological and agricultural data.

Conclusion

The future sourcing, use and disposal of water in Australia to secure sustainability of supply, both at a local and national level, is a complex issue which will require considerable investigation and reappraisal of approach. The return of water high in nutrients to natural aquatic environments is no longer acceptable, and intervention which extends the managed component of the water cycle through a land application phase, permitting nutrient uptake by terrestrial plants and then by animals can offer a viable option if correctly managed. All reuse, however, requires the coordinated assessment of risk relating to human health, ecosystems and agriculture in terms of an overall EMP.

The risk management methodology adopted in the HWRS as part of an integrated EMS will bring together a range of research interests to promote sustainable water reuse in the Richmond area and to contribute to the development of guidelines, standards and protocols for sustainable water reuse elsewhere.

Endnote

1. An earlier version of this paper was presented to the National Conference of the Australian Institute of Environmental Health, Sydney, 20-25 October 2002.

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Creating a Living Environment

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Hornsby is a green and beautiful Shire located approximately 25 kilometres north east of Sydney, with vast areas of outstanding bushland that make up almost 70% of the Shire. However, Hornsby Shire is not without its environmental problems. Environmental issues, which Hornsby Shire Council has identified, that relate to rural activities in the Shire include illegal land modifications, land clearing, erosion and sedimentation, stormwater and wastewater disposal, nutrient run-off, weed proliferation, chemical storage and applications, liquid and solid waste disposal, and air and noise emissions. Stormwater management on private properties on the urban rural fringe can have a significant impact on catchments. The ways in which properties are managed are important in determining the quantity and quality of stormwater runoff leaving the site either as surface water or as percolation to groundwater. To address these environmental issues the Council has undertaken a large number of programs involving the community to enhance environmental health and pursue sustainability. These include an Environmental Education and Review Program for Rural Businesses, an Urban Fringe Stormwater Project, and the Community Sustainability Indicators Project (CSIP). The Council has a strong partnership with its Local Agenda 21 Committee. This partnership supports the Council's commitment to the pursuit of sustainability in all its dimensions - social, economic and ecological. A Committee initiative, the CSIP is a process involving the community that aims to identify what the community treasures about the Shire and what its visions and ideals are for the future of the area. It also aims to develop a set of community sustainability indicators based on these values and to incorporate them into key Council documents to achieve the effective integration of community values, as well as social, environmental and economic considerations, into Council's decision making processes.

Key Words: *Sustainability Indicators; Community; Environmental Education and Review; Rural Business; Environmental Management; Stormwater Management*

The Hornsby Shire Council realises that a sustainable future is a challenge to us all, but it is this challenge which drives the Council to achieve its vision of "creating a living environment". The Council recognises that without a partnership with the community it will not be able to achieve its vision. It has developed the following objectives to achieve this:

- to create a partnership between the community and Council in achieving a sustainable Hornsby Shire;
- to enhance key performance indicators through the inclusion of sustainability indicators developed by the community;
- to provide a management tool which aligns Council's strategic intent with its operational activities; and
- to develop a sustainable outcomes focused holistic management tool.

The Council has a strong partnership with its Local Agenda 21 Committee. This partnership supports the Council's commitment to the pursuit of sustainability in all its dimensions - social, economic and ecological. In 1999 the Local Agenda 21 Committee initiated the Community Sustainability Indicators Project (CSIP), a process involving the community that aims to identify what the community treasures about the Shire, and what its visions and ideals are for the future of the area.

One of CSIP's aims was the development of a set of community sustainability indicators based on these values to measure progress towards a sustainable future in the Shire.The indicators developed through CSIP encompass social, environmental and economic issues. They are designed to measure not only physical or material things, like air and water quality, but also things like quality of life and sense of community in our Shire. To date seven of these indicators are reported in the Council's latest 2001-2002 State of the Environment Report, and six indicators are already included in Council's Management Plan. Incorporating the indicators into key Council documents achieves the effective integration of community values, as well as social, environmental and economic considerations into decision making processes. It is the incorporation of the significant contribution the community has made through the CSIP and the "whole of Council" management focus on sustainability, which makes Council's Management Plan and approach to sustainability unique.

The Bushland Shire

Hornsby is a green and beautiful Shire located approximately 25 kilometres north east of Sydney, with vast areas of outstanding bushland - which account for almost 70% of the Shire. It is the second largest Local Government Area in the Sydney Metropolitan Area, covering approximately 510km2. Major land uses include developed and developing urban, light industrial and commercial, and rural lands. It is home for more than 1000 vascular plant species and many frog, mammal, reptile, and bird species. Moreover, many of its waterways are gradually stabilising and even improving in quality and the occurrence of algal blooms has drastically reduced in recent years.

However, Hornsby is not without its environmental problems such that it faces rising levels of household waste, energy consumption is increasing at an alarming rate and the car continues to dominate our lives. As a result, the Council has undertaken a large number of programs aimed at enhancing environmental health and pursuing sustainability, including the historical Statement of Joint Intent (SOJI) and moratorium on development for Berowra Creek, the ESD Landcom Study, the Energy Efficient Housing Policy, the Sustainable Water DCP, Hornsby CBD Stormwater Project, the environmental education and review program for rural industries, the Urban Fringe Stormwater Project, and the community sustainability indicators project.

Holistic Management Tool

The Council's 2001/2002 - 2003/2004 Management Plan provides a clear direction from its strategic intent, "Creating a living environment...", through to its operational activities. The Management Plan is not structured or driven by organisational structure, its focus is the pursuit of sustainability. This "whole of council" approach ensures that the Council's drive towards sustainability is the focus of strategic and day-to-day operational activities.

The Council has determined a set of eight elements and aligned them with eight themes, called Community Visions, developed through the CSIP in order to integrate further the outcomes of the CSIP with the Management Plan, and to ensure its intent becomes a reality:

1. Engaging the community in the future of the Shire

Community vision: Informed community action on sustainability

2. Protecting the natural environment

   Community vision:

   - Preserve and enhance bushland and biodiversity
   - A clean environment without pollution

3. Conserving and renewing resources

   Community vision:

   - Reduce, reuse, recycle and renew resources

4. Facilitating increased social wellbeing

   Community vision:

   - Healthy and interactive community relationships

5. Aligning services to meet changing needs

6. Integrating land use and transport planning

   Community vision:

   - Environmentally friendly and integrated transport modes and networks
   - Planning and development decisions based on sustainable values

7. Facilitating a healthy and diverse local economy

   Community Vision:

   - Vibrant and self-sufficient regional economy

8. Achieving financial stability

Sustainability indicators

For each of these elements Council has developed outcomes and indicators. The community sustainability indicators are intended to raise awareness of what progress is being achieved, highlight issues to be addressed, and focus future action toward sustainability.

Nine of the twenty-three indicators developed by the community through the Community Sustainability Indicators Project (CSIP) have been included in the Plan. Consultation with the community is still continuing as the numerous proposed indicators are refined and distilled. It is envisaged that further indicators will be incorporated in Council's Management Plan over time.

Indicators developed by the community are aligned with strategic responses in Council's Management Plan to ensure indicator-related issues are addressed in Council activities. The Council's environmental education and review program for rural industries and Urban Fringe Stormwater Project are two examples of the strategic response. They will contribute towards achieving a positive outcome for the following environmental health-related indicators developed by the community:

- proportion of businesses participating in environmental management programs and the proportion achieving improvement in environmental management practice.
- percentage of monitored healthy streams/waterways within the Shire.
- percentage of land in the Shire under the active care of the community and the Council (Bushcare, Landcare, Friends of…, other community groups, and Council contracts.
- areas of bushland and agricultural land lost to development (where loss of agricultural land is defined by conversion of agricultural land to unproductive use).

Hornsby earthwise

Hornsby earthwise is being established as an overarching brand for the Council's sustainability initiatives. It is currently being used to identify and link initiatives that utilise a sustainable approach. This brand or logo outlines the integration of community values into Council policy and highlights the actions it is taking towards achieving the shared community and Council vision of "creating a living environment". Currently, the Environment Division is using the logo to brand its sustainability initiatives such as the Local Agenda 21 Committee and Urban Fringe Stormwater Project – Rural Lands Incentive Scheme.

Environmental Education and Review Program for Rural Businesses

The Hornsby Council has been active in undertaking environmental education and review projects of industry since it was successful in obtaining a grant from the NSW Environment Protection Authority under the 'Solutions to Pollution' program during 1996. The Council carried out an environmental education and review project of marinas, slipways and boatsheds under this program. Council built on the success of this project and carried out further environmental education and review projects of nurseries and landscape suppliers and the Hornsby and Mount Kuring-gai industrial areas.

Council had identified a number of environmental issues relating to farm activities in the Shire. These issues related to illegal land modifications, land clearing, erosion and sedimentation, stormwater and wastewater disposal, nutrient run-off, weed proliferation, chemical storage and applications, liquid and solid waste disposal, and air and noise emissions. The major farm activities in the Shire consist of nurseries, market gardens, orchards and cut flowers.

The Council was successful in obtaining a $40,000 grant from the National Heritage Trust to assist in funding an environmental education and review project of rural businesses. The focus of the project was on market gardens, orchards and cut flowers as an environmental education and review project of nurseries had already been undertaken.

Project preparation

Some preparation was required before undertaking the environmental reviews. This work included undertaking extensive research in developing a knowledge base in agricultural land use practices and identifying stakeholders. In this project stakeholders consisted of rural business operators, industry associations, NSW Agriculture, NSW Environment Protection Authority and Council. A working party was convened from the stakeholders, which formed the consultative and partnership component of the project. A data base of rural business operators was obtained form the Council's Finance Branch by reference to properties qualifying for rate reductions as a primary producer under section 515 of the Local Government Act 1993.

Undertaking the project

Council's database indicated that there were potentially 372 rural business properties to be reviewed. Conditions of the Heritage Trust grant required the Council to undertake a pilot environmental review of 40 properties. The pilot reviews gave the Council the opportunity to test the environmental review protocol and to prepare environmental fact and information sheets relative to environmental protection issues.

The remainder of rural properties was reviewed following completion and evaluation of the pilot reviews. In the major program the Council approached each property on a door-to-door basis to undertake the reviews. The door-to-door approach was undertaken following a poor response to letter mail-outs during the pilot program. The personal door-to-door approach was complemented by providing the business operator with an introductory/explanatory letter, a five-minute self audit check sheet and a farm best practice environmental protection fact sheet. This approach proved successful as it provided a face-to-face personal introduction with the result being that the majority of reviews were conducted on the spot. Council officers handed out spill clean-up equipment at the conclusion of the review, which was readily and favourably accepted by the business operators.

Following completion of the reviews the business operators were provided by mail-out a letter advising of the environmental review rating, recommendations to improve performance ratings, a schedule of required works where applicable and environmental information sheets. The environmental sheets contained information concerning land modification, chemical storage, fill importation, sediment and erosion control, bushland clearing, environmental responsibilities, water quality management, weed control, bushland clearing, hazardous substance storage, control of burning, pesticide management and spill clean-up. Inspections of rural properties are continuing by Council officers in providing further assistance and to ensure compliance with required works. Workshops for rural business operators were proposed as part of the project however have been postponed and combined with the Rural Land Incentives Program.

Environmental review protocol manual

An environmental review protocol manual was considered an important component of the project. The manual was prepared by an environmental consultant for the Council for application to all business within the Hornsby Shire. The manual contains an environmental rating system ranging from 1 being poor environmental performance to 10 being best environmental performance. Standard and site specific conditions where developed by the Council, which formed recommendations to improve environmental performance ratings and to undertake required works.

Required works were applied in situations where the council officer detected an adverse environmental impact occurring or likely to occur. Required works usually applied to situations such as erosion and sedimentation and wastewater discharging to drains leading to natural waters or to bushland. The Council issued Prevention or Clean-up Notices under the Protection of the Environment Operations Act 1997 where rural business operators failed to undertake required works.

Points for a successful project

In evaluating the project the Council considered that a number of matters were important in order to complete successfully a project such as this:

- Establishing a partnership with all stakeholders. Working with and getting all stakeholders involved in the project was considered valuable in establishing a sense of ownership and understanding of the purposes and reasons for undertaking such a project. This partnership approach was particularly important for the rural business operators.

- Knowing the industry. Undertaking extensive research and background investigation into the particular rural industries by Council officers undertaking the environmental reviews was valuable in establishing trust and confidence with the rural business operators.

- Developing a sound database. With over 370 rural business properties the Council considered it important to have a readily accessible and flexible data base of all rural business operators involved in the project. The data base was important in maintaining accurate records for property file references, review dates, follow-up details and dates, business operator details, future contacts, business activity types and appointment times.

- Being prepared to assist rural business operators in undertaking works for environmental protection. Trust and confidence was afforded to Council officers by business operators through the officer's knowledge and expertise, which resulted in a partnership approach to environmental protection. Again it was considered important and valuable for Council officers involved in the project to have extensive knowledge and to offer solutions for environmental protection. Council also organised collections for unwanted chemicals through the NSW Waste Services ChemCollect program and unwanted chemical containers through the Federal Governments drumMuster program.

Urban Fringe Stormwater Management Program

The Hornsby Shire Council in partnership with the Environment Protection Authority, rural landholders, and other local councils is currently working towards improving the environmental and stormwater management of private holdings on the urban rural fringe. The Urban Fringe Stormwater Management Program has been funded under the NSW Government Urban Stormwater Education Program and is targeting local councils that have private holdings of about 1 to 10 hectares. The program focuses not only on commercial activities such as nurseries, poultry, and horticultural pursuits, but also is incorporating larger residential holdings.

Stormwater management on private properties on the urban rural fringe can have a significant impact on catchments. The ways in which properties are managed is important in determining the quantity and quality of stormwater runoff leaving the site either as surface water or as percolation to ground water. In order to assist local councils and private landholders deal with stormwater management the Urban Fringe Stormwater Management Program has been broken down into seven projects as follows:

1. Regulatory and Non-Regulatory Planning
2. Economic Incentives
3. Environmental Assessment
4. Sustainability Resources
5. On-site Sewage Management
6. Land Modification
7. Leisure Horse Industry.

Hornsby Shire Council is coordinating four of the projects and a brief description of each can be found below.

Non-regulatory planning

Property planning is fundamental to achieving long-term environmental outcomes. While many property owners might have informal plans for their properties (e.g. planning to build a second shed, or extra paddock) few have formal plans or plans which incorporate environmental objectives. There are several triggers that might prompt a property owner to develop a property plan that includes an environmental objective:

- strong personal interest
- a local council officer has required a Property Environmental Management Plan (or similar) to be prepared in response to a pollution concern, or
- a development application has been submitted to the local council and the local council requires a Property

Management Plan to support the application.

To assist with property planning a model Property Environmental Management Plan is being developed for the use of rural landholders and will include a whole of property assessment.

Economic incentives

Councils primarily use regulatory and education approaches to address stormwater pollution. However, it is increasingly being recognised that economic incentives are a powerful tool for achieving environmental outcomes. This project was developed to explore the options available to NSW councils in using economic incentives to influence stormwater management and Hornsby Shire Council is currently undertaking a trial of a “Rural Lands Incentive Program”. The output of the project will be a report for local government on the options available for using economic incentives to improve stormwater management and encourage other sustainable land management practices on private properties.

Environmental assessment

Local councils tend to visit properties in relation to complaints (often about noise or odour) and some councils have proactive programs in place for the systematic evaluation of commercial properties. While an officer is at a property there is an opportunity to look at broader issues such as stormwater management. A need has been identified for a guide for environment officers in local councils to encourage consideration of a broad range of environmental issues on a variety of property types.

The project output will be an environmental assessment guide for use by local council officers when carrying out environmental assessments of properties on the urban rural fringe. It will cover issues such as water quality, drainage and nutrient management, chemical control, farm dams, sediment and erosion control, site sewage management, air and noise. It will provide council officers with information to create their own assessment protocol and will include guide notes, questions and a checklist.

Sustainability resources

The Sustainability Resources project will take information on stormwater management from other projects within the Urban Fringe Stormwater Management Program and target it more directly to property owners in the form of an information package Living Sustainably on the Urban Fringe: Information for Property Owners. It will provide practical advice to local residents and will be easy to read and understand. Local councils also intend the package for use as an education resource for property owners.

The Urban Fringe Stormwater Management Program is anticipated to be completed in June 2003 with a variety of education resources for both council officers and private landholders being developed. The information will be disseminated in a Council resource kit and information workshops are to be held in late 2003[1].

Looking Forward to a Sustainable Future

The Council hopes to continue to be an advocate for the community, to convey the wider community’s vision for a sustainable future for the Shire, and to help find ways to foster this future, both internally and in partnership with the community. Community partnership has been assisted by the CSIP consultation process and other Local Agenda 21 work. The Council also envisages that in this way it will develop a wider network in the community of businesses, agencies, groups and individuals committed to a sustainable future.

It is important to be a place where innovative ideas can be discussed and where the community can find links to other groups working on specialist areas of sustainability. The Council is always improving the way it interacts with the community to ensure that all members believe they can contribute positively to a sustainable future. The ultimate aim is to spread the message further and further that we need to "think globally and continue to act locally" each person playing his or her part in creating a living environment and a sustainable future.

Endnote

1. Copies of the information kit for the Urban Fringe Stormwater Management Program will be distributed to all NSW Councils in mid-2003. To obtain a copy of the *Environmental Review Protocol Manual* or for further information about these programs, contact Hornsby Shire Council's Environmental Health & Protection Team on (02) 9847 6666.

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CUMULATIVE INDEX
Volume 2, Numbers 1 - 4, 2001 by Author

Cumulative Index, Volume 2, Numbers 1 - 4, 2001 ***by Author***

Volume 1, Numbers 1 - 4, 2001 by Subject

Cumulative Index, Volume 1, Numbers 1 - 4, 2001 ***by Subject***

Cumulative Index, Volume 1, Numbers 1 - 4, 2001 ***by Subject***

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