Southern Alberta Landscapes

MEETING THE CHALLENGES AHEAD

Sustainable Development: A Review of Current Literature

Prepared for
Alberta Environment by
The Miistakis Institute for the Rockies and
The University of Calgary
February 2004

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As we begin to appreciate the intimate fashion in which humans depend on the ecological systems of the planet, it is becoming increasingly obvious that numerous issues that we have previously thought of as independent of the environment are intimately connected to it. Human health, the economy, social justice, and national security all have important environmental aspects whose magnitude is not generally appreciated.

Jane Lubchenco (1998, p. 491).

[T]he global population is precariously large, will grow another third by 2020, and climb still more before peaking sometime after 2050. Humanity is improving per capita production, health, and longevity. But it is doing so by eating up the planet's capital, including irreplaceable natural resources. Humankind is approaching the limit of its food and water supply. As many as a billion people, moreover, remain in absolute poverty, with inadequate food from one day to the next and little or no medical care. Unlike any species that lived before, Homo sapiens *is also changing the world's atmosphere and climate, lowering and polluting water tables, shrinking forests, and spreading deserts. It is extinguishing a large fraction of plant and animal species, an irreplaceable loss that well be viewed as catastrophic by future generations. Most of the stress originates directly from a handful of industrialized countries. Their proven formulas are being eagerly adopted by the rest of the world. The emulation cannot be sustained, not with the same levels of consumption and waste. Even if the industrialization of developing countries is only partly successful, the environmental after shock will dwarf the population explosion that preceded it.*

Edward O. Wilson (1998, p. 280).

Today, [hu]*mankind has the capacity to produce far more information than anyone can absorb, to foster far greater interdependency than anyone can manage, and to accelerate change far faster than anyone's ability to keep pace. Parallel to (or as a result of) this unprecedented labyrinth of complexity, we have a myriad of systemic dysfunction, each with its own ecological, economic, and social dimensions without simple cause or solution. This has led to the evolution of new concepts, including that of sustainable development as a basis for overcoming the environmental challenges.*

Desta Mebratu (1998, p. 493)

Sustainable development is about how we meet the needs of people today, without compromising the ability of future generations to meet their needs. It is not an end point, but rather an approach to decision making. It recognizes that social, economic and environmental issues are interconnected, and that decisions must incorporate each of these aspects if they are to be good decisions in the longer term. It is an approach that will help us to achieve a healthy environment, a prosperous economy, and a vibrant and just society for current and future generations.

Environment Canada (2001, p. 1)

Foreword

The Miistakis Institute for the Rockies prepared the following report under contract to Alberta Environment, Integrated Resource Management. Peggy Desserud and Meredith Hamstead provided the initial research and writing under the supervision and project management and general editing of Michael Quinn at the Faculty of Environmental Design, University of Calgary. The project was managed by Jan Simonson at Alberta Environment and benefited from the comments and input of a number of Alberta Environment personnel and area experts from other relevant ministries. Ian Dyson (Alberta Environment) provided the initial background papers and idea for the project.

The writers are grateful to all those who provided thoughtful comments and suggestions.

Disclaimer – *The proliferation and diversity of sustainable development literature over the past two decades make a comprehensive review all but impossible. In addition, the report was prepared on a modest budget and timeframe. The resultant manuscript is representative of the dominant issues in the sustainable development literature, but is necessarily cursory.*

The report may be cited as:

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Contents

Preface

Alberta Environment, in cooperation with other government departments, is developing a sustainable development program called the *Southern Alberta Landscapes: Meeting the Challenges Ahead* (SAL). The first phase of the SAL -- *Defining the Agenda* -- will appraise the current state of the region, identify a vision, goals, and principles for sustainable development, make policy recommendations and identify the key issues that need to be addressed and in what order of priority. In the initial step of Phase 1, the province will compile air, water, land use and socio-economic data, build landscape modeling and simulation tools, gather information about important resource sectors and identify key issues and opportunities relating to sustainability in Southern Alberta based on plausible projected trends over a 50-year period.

One of the required background information products is an overview of literature on the theory and practice of sustainable development. An overview of the key global and continental issues and trends that have shaped sustainable development theory and practice is also required in order to put the findings in the appropriate context. The potential value of this is twofold:

- It may guide the evaluation of current or future sustainability under various scenarios,
- It may offer options for addressing sustainability issues in SAL.

There is also educational value for parties and publics involved in the SAL exercise by relating SAL findings to a broader context.

More information about the *Southern Alberta Landscapes: Meeting the Challenges Ahead* is available at: http://www3.gov.ab.ca/env/regions/southern/strategy.html. Although issues and trends related to southern Alberta are the focus of the current report, the intent is to examine global issues and trends, not specific issues within southern Alberta.

Introduction

The focal area for the *Southern Alberta Landscapes: Meeting the Challenges Ahead* is a diverse landscape comprised of grassland, parkland, foothills, and mountains covering approximately 130,000 km^2 or about 17% of the province. The region experiences a transitional Plains-Cordilleran climate with cold winters and short, warm summers. The landscape includes the Alberta portions of the South Saskatchewan and Milk River Basins with the former accounting for the majority of land area.

An elaborate irrigation infrastructure and the presence of favourable soil and climatic conditions, has promoted agriculture to be a dominant force in the regional economy. Agricultural production is diverse, including market gardens, greenhouses, livestock operations (dairy, cattle, swine, poultry, exotics), dry land and irrigated farmland (on which a wide variety of cultivated crops are grown), and ranching.

The discovery and development of hydrocarbon resources in the mid-1900s dramatically transformed the economy of southern Alberta. The petroleum industry continues to be a significant economic driver with many head offices and associated services located in Calgary. Other industries in the region include agricultural processing, timber harvesting, hydroelectricity, mining, service industry, recreation and tourism and many others.

The region is home to approximately 50 per cent of Alberta's population with the majority residing in the larger urban centres of Calgary, Lethbridge and Medicine Hat. The continuously expanding economy has resulted in net in-migration and rapid population growth. The City of Calgary's emergence as a centre for information technology is expected to further diversify the regional economy. Regionally based industries such as food processing and tourism are expected to double their economic output over the next few decades. The human population of southern Alberta is forecast to grow to over two million by 2025, an increase of 140%.

In response to the pressures created by strong economic growth, the Alberta Government affirmed and renewed a commitment to the wise management of Alberta's natural resources and environment in a policy document entitled *Alberta's Commitment to Sustainable Resource and Environmental Management* (Government of Alberta, 1999). A key element of implementing the policy is the development of *regional strategies.* One such strategy, the *Southern Alberta Landscapes: Meeting the Challenges Ahead,* will involve Albertans in developing a vision of the future of Southern Alberta and the desired environmental, social and economic benefits for the region, and then address the issues and follow a plan to achieve the vision. The goal is to ensure a continuing high quality of life for southern Alberta.

The following report summarizes the findings from a variety of leading sources, including peer-reviewed literature wherever possible, and a number of recent international reports on sustainable development by organizations including the United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), World Bank, World Resources Institute, WorldWatch Institute, and the Organisation for Economic Co-operation and Development (OECD). The purpose of the report is to identify the primary issues and trends in sustainable development at a global and continental scale, especially those having contextual relevance to southern Alberta.

Chapter I Definitions and Concepts

1.0 A Brief History of Sustainable Development

The North American roots of environmental awareness and conservation extend well back to the early eighteenth and nineteenth centuries (Grove 1992, Pepper 1994). The rise of a social and political *environmental movement,* however, is generally attributed to activities surfacing in the 1960s and marked by such events as the publication of Rachel Carson's *Silent Spring* (1962) and the first Earth Day in 1970 (Guha 1999, Sale 1993, Shabecoff 1993). Unlike their predecessors, what Carson and other environmental writers of the 1960s accomplished was the arousal of a receptive public to grass roots activism.

> While the conservation movement at the turn of the century was initiated by a wealthy intelligentsia concerned about the future well-being of the nation, the new environmental movement was led and supported by ordinary people, together with segments of the scientific community, who recognized pollution as a source of immediate danger to their own health and well-being (Neimark & Mott 1999, p. 180).

Consequently, issues of environmental concern quickly took centre stage in the realm of international politics. The 1972 *United Nations Conference on the Human Environment*[1] marks the commencement of international efforts to address environmental problems. The conference, attended by 113 nations, advanced the connection between quality of life and quality of the environment and provided the conceptual foundation for sustainable development. In the same year, the neo-Malthusian *Club of Rome* released a prominent review of human population growth and consumption called *Limits to Growth* (Meadows *et al.* 1972) warning that industrial society would exceed ecological limits within a matter of decades if contemporary growth rates were not abated.

[1] Often cited as the Stockholm Conference because it was held in Stockholm, Sweden.

One of the earliest documented uses of the term *sustainable development* was in the subtitle of the 1980 World Conservation Strategy (IUCN/WWF/UNEP 1980) – "Living Resource Conservation for Sustainable Development." Interestingly, the term did not appear in the text of the document. An influential text by Brown (1981) then elevated the concept of *sustainability* within the international environmental discourse. The term *sustainable development,* however, did not enter the international lexicon until the 1987 report of *The World Commission on Environment and Development* (WCED) [2] defined it as *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* This definition marks the concept's political coming of age and establishes the content and structure of the present debate (Kirkby *et al.* 1995).

Since the Brundtland Commission, the term *sustainable development* has become ubiquitous in discussions of environment and development around the globe. Two major international sustainable development meetings followed the World Commission on Environment and Development. The 1992 *United Nations Conference on Environment and Development* (UNCED, or the Earth Summit), held in Rio de Janeiro, resulted in a set of fundamental principles (*Rio Declaration*) and a program of action (*Agenda 21*) to achieve global sustainable development (UN 1992; see also Moffatt 1996, O'Keefe *et al.* 1993, O'Riordan and Voisey 1998). The *Commission on Sustainable Development,* an international organization, formed to ensure effective follow-up to UNCED. Most recently, the *World Summit on Sustainable Development* (WSSD or the Johannesburg Summit) in 2002 reaffirmed a commitment to global implementation of sustainable development with particular emphasis on the need to address poverty (UN 2002)[3].

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[2] The report is also known as *The Brundtland Commission Report* because Dr. Gro Harlem Brundtland, the then Prime Minister of Norway, chaired it. The report is recognized as more a political document than a scientific one.

[3] See for example Resolution 1, Annex 19: "We reaffirm our pledge to place particular focus on, and give priority attention to, the fight against the worldwide conditions that pose severe threats to the sustainable development of our people, which include: chronic hunger; malnutrition; foreign occupation; armed conflict; illicit drug problems; organized crime; corruption; natural disasters; illicit arms trafficking; trafficking in persons; terrorism; intolerance and incitement to racial, ethnic, religious and other hatreds; xenophobia; and endemic, communicable and chronic diseases, in particular HIV/AIDS, malaria and tuberculosis." (United Nations 2002).

1.2 Sustainable Development: An Evolving and Contested Concept

> *... the concept of sustainable development as presently defined ... is a chimera, quite divorced from the reality of our occupation of this planet* (Glasby 2002).
>
> *"Sustainable development" is a zone of creative ambiguity in environmental policy discourse that enables participants to agree to live together while continuing to pursue incompatible agendas* (Rayner 2001).
>
> *Sustainable development is an intuitively powerful concept that, as commonly understood, provides a useful guide for development practitioners. It involves trade-offs between biological, economic, and social systems and is found in the interactive zone between these systems* (Holmberg 1992).

The concept of sustainable development is multi-constructed (as a social construct), contested (Eder 1996) and highly political (Jacobs 1999). The concepts of sustainable development are shaped by the worldviews of institutions and individuals. "These underlying worldviews influence what are considered the main priorities and choices about what polices should be implemented and actions taken" (Giddings *et al.* 2002). Defining sustainable development is ultimately a political act of power.

Perhaps the most astonishing (and impressive) feature of the term *sustainable development* is its rise "to the prominence of mantra - or shibboleth" (Daly 1996) by a broad spectrum of interests. Furthermore, the penetration of *sustainable development* into the global lexicon has transpired with remarkable speed. In less than two decades, the term has become ubiquitous in the agendas of politicians, grassroots environmentalists, corporate interests, educators and almost every modern enterprise from local to global scales. That *sustainable development* has been so widely embraced is testament to the appeal of the seemingly simple phrase. In part, the attraction might be explained by: 1) the ambiguity of the phrase (there seems to be something in sustainable development for everybody) and, 2) the 'motherhood and apple pie' spirit it encapsulates (how could one be opposed to such a notion?).

The ambiguity of *sustainable development* is a result of the juxtaposition of two concepts that many view as antithetical; *sustainable* implies a notion of equilibrium while *development* implies change and growth[4]. When social or environmental activists hear the phrase, they hear *sustainable* while business interests hear *development*. For the former, *sustainable development* represents a radical paradigm shift in development discourse and practice; while for the latter "sustainable development ... emerges from the business discourse as 'green' business as usual that fails to focus on the exploitation of people and resources" (Springett 2003, see also Adams 1995, Escobar 1995, Willers 1994). Therefore, it is not surprising that in most debates over sustainable development either the environment or the economy is given priority.

Those who focus more on (neoclassical) economics generally subscribe to a wordview that is characterized as *expansionist* or *cornocopian*. Adherents to this worldview are generally optimistic about human ingenuity and capacity to compensate for depleted natural resources. The other end of the spectrum (*environmentalist* or *ecologist*) is characterized by a worldview that is more pessimistic with respect to human capacity and sees the economy and ecological systems as inextricable linked. The latter perspective "recognizes that the so-called environmental crisis is really a human ecological crisis" (Rees 2001) rather than externalizing the problem and viewing the economic system as separate from the ecological system.

The ambiguity of *sustainable development* has lead some to question its value. "Many analysts have come to regard it as an insubstantial and clichéd platitude unworthy of further interests or research, and perhaps even more significantly, theorizing of the idea seems to have reached something of an impasse" (Agyeman, Bullard and Evans 2002). Middleton *et al.* (1993) suggest that the term is the result of a political fudge that occurred at the World Commission on Environment and Development with the intent to gain widespread acceptance. Although, as Daly (1996) pointed out, having a consensus on a vague concept, rather than disagreement over a sharply defined one, was a "good

[4] For discussions on how the term "development" has evolved in the past half century, see Sachs (1990 and 1992) and Livingston (1996).

political strategy." O'Riordan (1987) deemed *sustainable development* an "inoperable concept," while others have stated that the phrase is clearly an oxymoron (see for example: Choi and Patten 2001, Daly and Townsend 1993, Khan 1992, Livingstone 1996, Mourchid 2001, Tryzna 1995). "Business has made sustainable development synonymous with sustainable growth - an oxymoron which reflects the conflict between a trade vision of the world and an environmental and social vision" (Kahn 1992). Livingston (1996) posits that sustainable development is simply the most recent in a string of ideological slogans that seem to say "How to plunder nature and get away with it."[5] Daly and Townsend (1993) suggest that *sustainable development* can only escape oxymoronic perdition if it is understood as development without growth "- i.e. qualitative improvement of a physical economic base that is maintained in a steady state by a throughput of matter-energy that is within the regenerative and assimilative capacities of the ecosystem."

The second feature that explains the widespread adoption of *sustainable development* is that the alternative is intuitively unacceptable (Drummond and Marsden 1999). To dismiss *sustainable development* implies tacit acceptance of *un*sustainable development - a proposition that is untenable to most (Fernando 2003). The phrase fits nicely into media "sound bites" and has a motherhood and apple pie appeal. On the surface, it simply seems imprudent and impractical to be against sustainable development.

In spite of the many critiques of sustainable development, it has become the core element of contemporary environmental discourse (Mebratu 1998). Although there is no shortage of definitions, (Holmberg (1992) documented at least eighty), there are some common points of agreement in scoping the purview of sustainable development.[6] At the root of all descriptions of sustainable development is the acceptance that we face a global environmental crisis and that we must undertake fundamental changes to

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[5] The full range of critical analyses is beyond the scope of this paper, but the reader is directed to representatives reviews by Nieto *et al.* (1995) and Mebratu (1998).
[6] For other lists of sustainable development definitions see: Pearce *et al.* (1990), Pezzey (1989) and Rees (1989). Mebratu (1992) provides a critical analysis of definitions and presents a typology that categorizes sustainable development definitions as one of three types: institutional, ideological or academic.

address the crisis. Most descriptions build from the foundation of an intersection of the three E's (or three pillars) of sustainable development (World Development Report 2003): environment, economy and equity. Models of sustainable development are often depicted as the intersection of three separate circles (fig. 1). More recently, it has been proposed that a better integrated model might be represented by a set of concentric circles with the economy nested in society, which is in turn nested within the environment (Giddings *et al.* 2002, fig. 2).

Figure 1. Simple Venn Diagram of Sustainable Development Theory

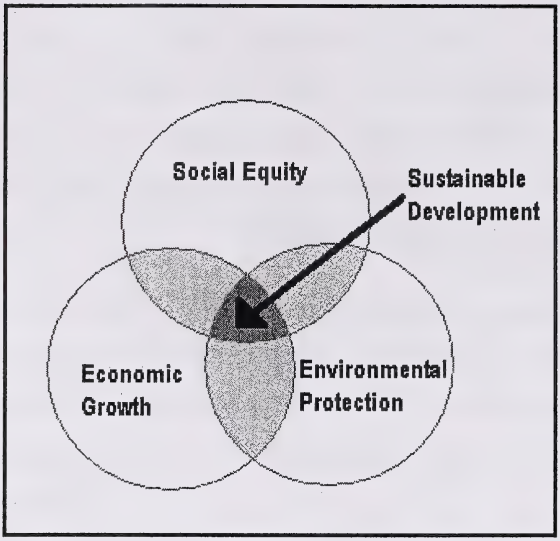
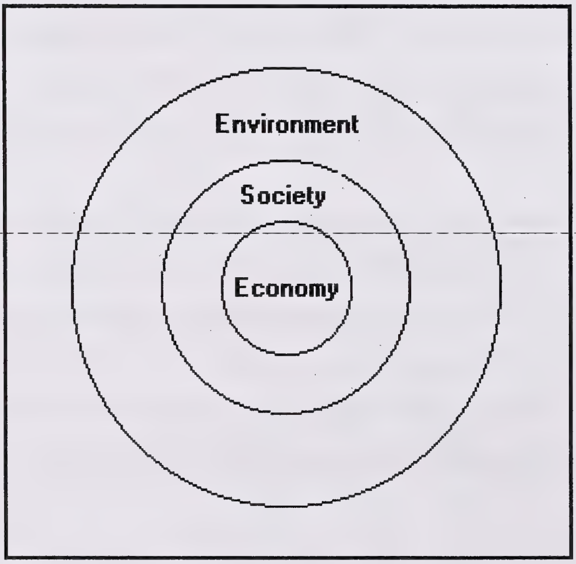


Figure 2 Modified Venn Diagram of Sustainable Development Theory



There is a growing consensus that sustainable development means achieving a quality of life that can be maintained for many generations because it is:

- socially desirable, fulfilling people's cultural, material and spiritual needs in equitable ways,
- economically viable, paying for itself, with costs not exceeding income, and
- ecologically sustainable, maintaining the long-term viability of supporting ecosystems.

Sustainable development entails integration of these three objectives where possible, and making hard choices and negotiating trade-offs between objectives where integration is not possible (see Box 1 for some representative definitions of sustainable development).

Where the definitions and praxis of sustainable development differ are in considerations of exactly what is being sustained and what is meant by development. Sadler (1996) defines sustainability as "passing an equivalent or greater resource endowment or capital bequest to the next generation, so that it has the same or better opportunity to meet its needs as the present generation." However, this does not necessarily mean that we have to guarantee exactly the same level of income or wealth to every generation, but that we should try to guarantee the same set of initial options (Borghesi and Vercelli 2003). The measurement of what is to be sustained (capital) and how trade-offs are to be made (substitution) are the nexus of sustainable development debates.

Box 1 Selection of Sustainable Development Definitions

- *For development to be sustainable, it must take account of social and ecological factors, as well as economic ones; of the living and non-living resource base; and of the long-term as well as the short-term advantages and disadvantages of alternative action* (World Conservation Strategy, IUCN/WWF/UNEP 1980)
- *development that meets the needs of the present without compromising the ability of further generations to meet their own needs* (World Commission on Environment and Development 1987)
- *a better quality of life for all, now, and into the future, in a just and equitable manner, while living within the limits of supporting ecosystems* (Agyeman, Bullard and Evans 2002)
- *the kind of human activity that nourishes and perpetuates the historical fulfillment of the whole community of life on earth* (Engel 1990)
- *development without growth in throughput of matter and energy beyond regenerative and absorptive capacities* (Goodland and Daly 1996)
- *a dynamic process which enables all people to realise their potential, and to improve their quality of life, in ways which simultaneously protect and enhance the Earth's life support systems* (Forum for the Future 2000)
- *positive socio economic change that does not undermine the ecological and social systems upon which communities and society are dependent* (Rees 1989)
- *a development path that meets the major needs of the present without endangering subsequent needs and aspirations of future generations, allowing for the conservation of nature to be part of this path* (Mirovitskaya and Ascher 2001)
- *A sustainable society implicitly connotes one that is based on a long-term vision in that it must foresee the consequences of its diverse activities to ensure that they do not break the cycles of renewal; it has to be a society of conservation and generational concern. It must avoid the adoption of mutually irreconcilable objectives. Equally, it must be a society of social justice because great disparities of wealth or privilege will breed destructive disharmony* (Hossain 1995).
- *the development and management of natural resources to ensure or enhance the long-term productive capacity of the resource base and improve the long-term wealth and well-being derived from alternative resource use systems, with acceptable environmental impacts* (Schultink 1992).

1.3 *Capital*

One way to assess the sustainability of resources is through the economic notion of capital. The classic economic definition of capital includes physical assets produced by the economy, and financial assets, available as inputs for further production. Combined with land and labour, capital forms the input to the production process. Modern economics identifies three types of capital: *anthropogenic or manmade technological capital* (machines, factories, buildings and infrastructure), *land* or *natural capital*[7] (environmentally provided assets such as soil, water, wetlands, forests and atmosphere) and *human capital* (investments in education, health and nutrition of individuals). In essence, economists have treated all inputs available for economic activity (production) as capital. Environmental concerns and the concept of sustainable development have added a fourth: *social capital* (the institutional and cultural bases of society - the way people view the world) (Ekins *et al*. 2003, Serageldin and Steer 1994).

Theoretically, if one could enumerate the quantity of each type of capital for a given area, then it would be possible to measure the degree to which each is maintained or changed. Such quantification opens the door for discussions of substitution between types of capital stock. In the simplest sense, substitution of capital can be understood through an example of tractors and hectares of agricultural land. If the elasticity of substitution is 1.0 (perfect elasticity) between the natural capital (hectares of land) and the technological capital (tractors), then a farmer with two tractors and 100 ha of land should be able to produce as much agricultural output as a farmer with one tractor and 200 ha of land. The elasticity of substitution is one of the main points of divergence in debates over sustainable development and degrees of sustainability (Gerlah and van der Zwaan 2002).

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[7] For a discussion of the natural capital concept applied to western Canada, see Wobets and Berdahl (2003).

1.4 Degrees of Sustainability

The degree to which capital, especially natural capital, may be substituted for a different form of capital, characterizes different levels of sustainability, from weak to moderate (or sensible), to strong (Turner 1993). The basic characteristic defining each degree of sustainability is the level of substitutability of resources and energy between the different forms of capital (Neumayer 1999). It is important to recognize that between the views of perfect substitutability and non-substitutability a spectrum of possible levels of substitution abound (Gerlagh and van der Zwaan 2002).

1.4.2 Weak Sustainability

Sustainable development is a state of dynamic equilibrium between societal demand for a preferred development path and the supply of environmental and economic goods and services to meet this demand (Briassoulis 2001). Maintaining a balance requires trade-offs or substitutions. Weak sustainability looks at maintaining the total capital intact, implying that different forms of capital are substitutes, at least within the boundaries of current levels of economic activity and resource endowments (Serageldin and Steer 1994). The most strident proponents of weak sustainability argue perfect substitutability of technological and natural capital such that resources (e.g. fossil fuels) may be exhausted as long as they are usefully replaced by man-made capital. (Hartwick 1977; Solow 1974, 1993). This model maintains that welfare is not normally dependant on a specific form of capital and is maintained by substituting manufactured capital for natural capital (with some significant exceptions) (Ekins *et al.* 2003). Furthermore, technoscientific ingenuity will serve to replace diminishing resources or identify suitable substitutes (Simon and Kahn 1984).

Of course, all life depends upon natural capital and the services it provides, so there is a limit to substitutability (Aghion and Howitt 1998). The weak sustainability approach would allow for incremental changes to existing policies so long as they assure continuing economic expansion and jobs, along with acceptance by local businesses and the public. These policies would tolerate some environmental degradation if the overall balance of natural and human made capital continues, through economic and social gains (Baker *et al.* 1997).

1.4.3 Moderate Sustainability

Moderate sustainability requires that in addition to maintaining the total level of capital intact, some concern be given to the composition of that capital. This definition of sustainability still assumes that human-made and natural capital are, to a large extent, substitutable, but recognizes they are also complementary (Serageldin and Steer 1994). Trade-offs and compromises appear to conflict with the principles of immediate and long-term integration of positive steps toward sustainability. However, in some cases, integrating the social, economic, and environmental impacts and devising the least impact to all, could result in trade-offs.

Gibson (2001) describes several types of potentially acceptable substitutions in kind, place, and time:

- Introduction of aggregate mining operations on somewhat degraded agricultural lands and rehabilitation of those lands to superior standards at the end of mining operations in 20 years (substitution in time);
- Elimination of a relatively natural wetland and substitution of a constructed wetland elsewhere (substitution in place);
- Provision of new community recreational facilities in a remote village facing risk of ecological damage to traditional hunting and trapping areas (substitution in kind).

1.4.4 Strong Sustainability

Strong sustainability requires maintaining individual types of capital intact. For example, the loss of a forest in one area, depleting natural capital, would require replacement by a new forest of similar type elsewhere. Extra strong sustainability would never deplete non-renewable resources and is generally recognized as unrealistic (Serageldin and Steer 1994). In extra strong model, substitutability between types of capital is not acceptable (Bridger and Luloff 1999). Strong sustainability derives from the perception that substitutability of manufactured capital for natural capital is seriously limited by such environmental characteristics as irreversibility, uncertainty, and by the existence of critical components of natural capital, which make a unique contribution to welfare (Daly and Costanza 1992, Ekins *et al.* 2003).

The strong sustainability model argues for greater resource protection, particularly of key types of natural capital, even if this means foregoing some development opportunities (Baker *et al.* 1997). Its focus is the preservation of natural capital or ecosystems at almost any cost to other types of capital (Goodland and Daly 1996). This is especially true of "critical natural capital" which is defined as a type of natural (ecological) capital that provides critical functions (i.e. life support) for which no known substitutes exist (Ekins *et al.* 2003)[8]. "The strong sustainability principle holds that [critical natural capital] should be absolutely protected" (Ekins 2003).

1.4.5 Conclusion

In practice, sustainability may exist in varying degrees, from weak to moderate to strong, depending on the degree of substitution of capital. To balance economic, environmental, and social factors, different types of sustainability may be appropriate. For example, development might not be allowed at all in an endangered species habitat (strong sustainability), while the need to provide housing might require re-locating a

[8] A typology of functions associated with critical natural capital includes four primary functions: 1) Source functions - those which provide resources for human activities; 2) Sink functions - those which absorb, neutralise and recycle wastes from human activities; 3) Life Support functions - those which act to maintain ecosystems; 4) Human Health and Welfare functions - those, which contribute directly to human health and welfare (Ekins 2003).

wetland (moderate sustainability).

1.5 Intra and Inter-generational Equity

The World Commission on the Environment and Development (1987) defined sustainable development as "ensuring the needs of the present generation without compromising the ability of future generations to meet their own needs". Two key words are the present generation – intra-generational equity, and future generations – inter-generational equity. The concepts of equity are also associated with the literature on environmental justice (Agyeman, Bullard and Evans 2003).

1.5.1 Intra-generational equity

Intra-generational equity, the needs of the present, is important to sustainable development because of the links between income inequality, economic growth, human capital, and the environment. Levels of inequality in the economy may have considerable impact not only on present levels of well-being, but also on the well-being of future generations (Stymne and Jackson 2000).

Intra-generational equity also extends beyond regional or national borders because of international trade. International trade and the increasing integration of world markets in recent decades has led to controversial concept called globalization. Critics claim globalization may influence inequality and environmental degradation (Borghesi and Vercelli 2003). Proponents of globalization suggest global trade may benefit a country, both the receiving and sending countries, depending on its history (Liddle 2002).

Much discussion on intra-generational equity focuses on the distribution of wealth. Daly (1992) says, "good distribution is one that is just or fair, or at least one in which the degree of inequality is limited within some acceptable range". Le Grand and Robinson (1976) identify several approaches to the question of "fair" distribution:

- the minimum standard approach – which is concerned only with the poor in the society and argues that nobody's income should fall below a certain minimum level,

- the total equality approach — which argues that everyone should have the same income, i.e. the bottom 10% of the population should receive 10% of the income,
- the need or desert approach — which accepts inequalities either on the grounds that some people need more income or because people deserve more due to own effort, sacrifice, intelligence, etc,
- equality of opportunity or procedural approach — inequality accepted if everyone has had the same opportunity, or if the distribution is a result of a fair process.

1.5.2 Inter-generational Equity

The principle of inter-generational equity is a principle of preservation of capital. The capital that future generations will inherit will be a combination of the various forms of capital, either preserved intact (strong sustainability) or preserved in total through some level of substitution (moderate or weak sustainability) (George 2001).

One keyword in the definition of sustainable development is "needs" - how do we equate the needs of the current generation with the needs of future generations? Vollenbroek (2002) provides a discussion on defining inter-generational needs. First, we do not know the needs of future generations. Obviously, they need food, shelter, clothing and transportation. However, what resources do they need to meet these functions? Should we save some of our natural gas reserves and other resources? Assuming that future economies will acquire new emerging (energy) technologies, fossil fuels might even be superfluous in the future. Second, needs have the tendency to grow and new technologies may give rise to new needs. For example, a decade ago, the current generation would not have predicted the proliferation of cellular phones. However, once the new technology took hold, cellular phones became a requirement for many people, who revealed an unrestrained need to communicate at any time and at all places (Vollenbroek 2002). In this case, the previous generation had no need for cellular phones, while the current one has that need.

Most discussion of the needs of a generation includes analyses of the economic welfare of populations or individuals. An economic definition of inter-generational sustainability is "an economy is sustainable if and only if it is dynamically efficient and the resulting stream of total welfare functions is non-declining over time" (Stavins *et al.* 2003). This implies that whatever economy exists today has an equivalent value in the future. However, future generations have no say in the decisions and policies, which made today, may have irreversible effects in the future. Conventional economic analysis implicitly assumes that the Earth and all its resources belong exclusively to present individuals, who also have the power of deciding how to use these resources. As a result, the endowment that will reach future generations is just a residual of present decisions (Padilla 2002).

Another issue in determining the value of an economy for future generations is the concept of discounting, i.e. determining the value of a future dollar in today's dollar. Conventional cost-benefit analysis discounts future impacts by applying a time preference as if they happened to present-day individuals. This does not take into account the difference between considering the efficient allocation of consumption during one's own life span and considering the potential consumption of future generations (Padilla 2002).

While there is no single unified theory of sustainable development, all theories share a common theme in recognizing that future well-being is determined by what happens to capital stock over time (Atkinson 2000).

1.6 The Environmental Kuznets Curve

The Brundland Commission report asserts that economic growth (measured in GDP per capita) is ultimately beneficial, in fact necessary, for global improvement in environmental quality. The imperative for growth, as seen in the above discussion of degrees of sustainability, is among the most controversial in the sustainable development discourse. The development of empirical models to explore the relationship between economic growth and environmental quality has recently focused on tests of the *Environmental Kuznets Curve* hypothesis (EKC; after the work of Nobel Prize winning economist Simon Kuznets (1955)). The relationship was first made explicit in the early 1990s with specific reference to comparisons between national income levels and industrial pollutants. Princeton economists Grossman and Krueger (1995) reported that economic growth brings an initial phase of environmental deterioration followed by a subsequent phase of improvement. They found, for instance, that light particulates, a pervasive form of air pollution, tend to increase until a country reaches annual per capita income levels of around $8,000. After that, air pollution declines as countries become wealthier. The inverted-U pattern (the Kuznets Curve) is graphically represented in Fig. 3 (see also Andreoni and Levinson 2001).

This postulated relationship is at the heart of the Brundtland Commission's assertion that in order to achieve sustainable development, a renewed period of economic growth is necessary, particularly in developing countries. However, recent economic research is challenging the details and mechanisms of this assertion (Roca 2003, Freidl *et al.* 2003, Pasche 2002, Lindmark 2002, Coondoo *et al.* 2002, Ansuategi *et al* 2002, Dietz *et al.* 2003, Borghesi *et al.* 2003, Dinda *et al.* 2000). This body of research suggests that economic growth cannot be taken as the sole driving factor of improvements to social and ecological sustainability. Instead, if economic growth is to be a factor in such improvements, it must be accompanied by a reduction in the scale of consumption associated with growth - either by reducing total consumption or by also reducing the total population.

This notion is demonstrated in further considering the relationship between air quality and economic growth. Dinda *et al.* (2000) demonstrate that up to a certain level of average per capita income, air pollution levels (as measured by suspended particulate matter) will tend to decrease as the capital intensity of an economy rises. However, beyond a very high level of average per capita income, a "U-turn" is observed in the Environmental Kuznets Curve. This seems to indicate that, beyond a threshold level of per capita income, further increases in income cannot be achieved without increasing the intensity of environmental degradation (Dinda *et al.* 2000; Fig. 4). In Figure 4, point "A" represents a period when the primary cause of environmental degradation is over-consumption. Point "B" represents the time when new pollution abatement technologies offset to some degree ecological degradation by a rise in an "environmental ethic", and the growth of an affluent population with time and money available to concern themselves with issues of quality of life and ecosystem health. Finally, at point "C", as economic expansion continues, it starts exceeding reductions in degradation intensity. This N-shaped Kuznets curve calls into question the belief that economic growth necessarily is the solution to ecological degradation (Timoney & Lee 2001).

There is an additional factor to be considered in the shape of the Environmental Kuznets Curve. It is suggested that environmental problems that have a direct and strong impact on an immediate population (access to urban sanitation, smoke, drinking water quality/supply) will more likely tend to improve steadily with economic expansion, following something approximating the traditional Environmental Kuznets Curve (Fig 3). However, environmental problems that can be transferred elsewhere or that do not have immediate implications for a localized population, (municipal solid wastes, biodiversity loss, global warming, consumption deficiencies etc.) do not exhibit any clear tendency to diminish with increasing economic expansion.

Thus, for "transferable or distant" environmental issues, the Modified Environmental Kuznets Curve depicted in Fig. 4 would better represent the graphic depiction. This suggests that while economic expansion may, under certain conditions, be integral to achieving sustainable development (as suggested by the WCED in 1987), in North America, the capacity for economic expansion to assist in the resolution of environmental problems is diminishing and it may now be counter-productive (Unruh & Moomaw 1998 and Galleoti & Lanza 1998). Nevertheless, it must be clearly stated that it is reasonable to conclude that a very low average per capita income is conducive to neither ecological or social sustainability, and that higher average per capita incomes offer the prospect of but do not guarantee the outcome of sustainability (Czech, 2001). The empirical relationships being explored through the EKC remain controversial and will continue to be an active area of sustainable development research.

Figure 3: Environmental Kuznets Curve (EKC)

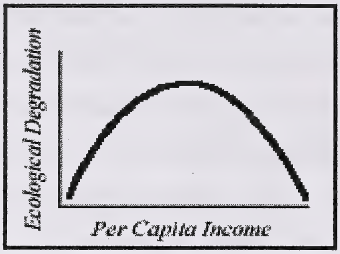
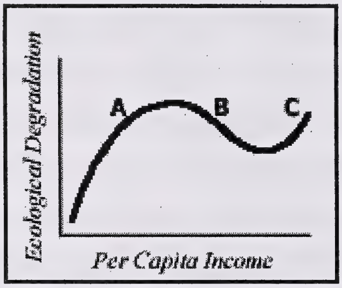


Figure 4: Modified (N-Shaped) Environmental Kuznets Curve



1.7 The Precautionary Principle

Anticipating future needs, both intragenerationally and intergenerationally, without knowing for sure what those needs are and preserving capital stock for them has given rise to the *Precautionary Principle*. The Precautionary Principle attempts to account for the level of risk, whether known or perceived, and provides guidance for managing in the face of uncertainty. The *Rio Declaration on the Environment and Development;* Principle 15 states,

> In order to protect the environment, the precautionary approach shall be widely applied by states according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific uncertainty shall not be used as a reason for postponing cost-affective measures to prevent environmental degradation (UN 1992).

The onus is on a proponent of change to justify actions that pose potentially significant risks, even if poorly understood. For example, the developer of a new herbicide should have to prove beyond a reasonable doubt that the chemical constituents and their metabolites will not cause unacceptable or irreversible environmental damage. There is clearly a normative element in determining levels of acceptability, which makes application of the precautionary principle highly contentious.

Another way of looking at the Precautionary Principle is as a preventative measure. For example, the World Bank (1999) "favours preventive measures over mitigatory or compensatory measures, whenever feasible". This implies developers must have a forward-looking, predictive focus and should "design for surprise and manage for adaptation" (Sadler 1996, Noble 2002). However, O'Riordan (2000) cautions that *precaution* should be distinguished from *prevention* because the former introduces a duty of care on all actions while the latter is more a regulatory matter aimed at an established threat (e.g. a known toxic or noxious substance).

The Precautionary Principle implies a concept of strong sustainability: avoid potential environmental degradation, i.e. the reduction of natural capital. If a position of weak sustainability is assumed, and it is shown in the future to have been incorrect, it may not possible to revert to a strong sustainability position as the resource or capital in question may have already been irreversibly damaged or lost (Ekins *et al.* 2003). The basic concepts enshrined in the Precautionary Principle are summarized in Box 2.

Box 2 Basic Concepts of the Precautionary Principle (O'Riordan and Cameron 1994)

Preventative anticipation: a willingness to take action in advance of scientific proof of evidence of the need for the proposed action on the grounds that further delay will prove ultimately most costly to society and nature, and, in the longer term, selfish and unfair to future generations.

Safeguarding of ecological space or environmental room for manoeuvre as a recognition that margins of tolerance should not even be approached, let alone breached. This is sometimes known as widening the assimilative capacity of natural systems by deliberately holding back from possible but undesirable resource use.

Proportionality of response or cost-effectiveness of margins of error to show that the selected degree of restraint is not unduly costly. This introduces a bias to conventional cost benefit analysis to include a weighting function of ignorance, and for the likely greater dangers for future generations if life support capacities are undermined when such risks could consciously be avoided.

Duty of care, or onus of proof on those who propose change: this raises profound questions over the degree of freedom to take calculated risks, thereby to innovate, and to compensate for possible losses by building in ameliorative measures. Formal duties of environmental care, coupled to an extension of strict liability for any damage, no matter how unanticipated, could throttle invention, imagination and growth. Alternatively, when creatively deployed such strictures could encourage imagination and creativity in technology, economic valuation, technological advance and unusual forms of ameliorative compensation. Hence the concept of proportionality can be regarded either as a deadweight or a touchstone for the visionary.

Promoting the cause of intrinsic natural rights: the legal notion of ecological harm is being widened to include the need to allow natural processes to function in such a manner as to maintain the essential support for all life on earth. The application of ecological buffers in future management gives a practical emphasis to the thorny ethical concept of intrinsic natural rights.

Paying for past ecological debt: precaution is essentially forward looking but there are those who recognize that in the application of care, burden sharing, ecologically buffered cost effectiveness and shifting the burden of proof, there ought to be a penalty for not being cautious or caring in the past. This suggests that those who have created a large ecological burden already should be more "precautious" than those whose ecological footprints have to date been lighter. In a sense this is precaution put into reverse: compensating for past errors of judgment based on ignorance or an unwillingness to shoulder an unclearly stated sense of responsibility for the future. This element of the principle is still embryonic in law and practice, but the notion of "common but differentiated responsibility" enshrined in the UN Framework Convention on Climate Change, and the concept of conducting precaution "according to capabilities" as laid down in principle 15 of the Rio Declaration reflect to some extent these ideas.

The techniques of implementing the precautionary principle include such mechanisms as: risk assessment, minimal regret criteria, safe minimum standards and environmental bonds (flexible assurance bonds). Practical application of the precautionary principle requires an analysis of the costs and benefits associated with carrying out or foregoing any given activity. As with many other areas of sustainable development, implementation mechanisms and criteria have given rise to a suite of nested acronyms including: ALARA – as low as reasonably achievable, ALARP – as low as reasonably practical, BATNEEC – best available technique not entailing excessive cost, BPEO – best practical environmental option, and BPM – best possible means. The essence of all these procedures is quantifying the relationship between potential present gain and potential future loss (O'Riordan and Cameron 1994).

1.8 Measuring and Accounting for Sustainable Development

1.8.1 The Ecological Footprint

A fundamental concept of sustainability is maintaining the integrity of biophysical systems and building human-ecological relations to allow natural systems to maintain their structure and functions in the face of natural fluctuations, imposed stress and irregular events (Sadler 1996). One way to measure the impact of human activity on natural systems is by measuring the E*cological Footprint (EF)* of that activity. The ecological footprint is a simple operational indicator to aid in monitoring progress towards (un)sustainability, i.e. the maintenance or loss of natural capital (Bergh and Verbruggen 1999). It is a concept based on the *carrying capacity* of an environment, "the maximum population of a given species that can be supported indefinitely in a defined habitat without permanently impairing the productivity of that habitat" (Wackernagel and Rees 1996). Carrying capacity in the EF context is the amount of "land in various categories required to support a region's population indefinitely at a given material standard" (Rees 1992).

An ecological footprint measures the pressure of human load on the earth resulting from humanity's natural resource consumption and waste generation (Wackernagel and Rees 1996). The EF of any defined population is defined as the total "area of productive land and water ecosystems required to produce the resources that the population consumes and assimilate the wastes that the population produces, wherever on Earth that land and water may be located" (Rees 2000). Originally, the EF concept measured the impact of large geographical areas such as countries, regions and cities. More recently, EF measures functions, products and packaging systems (Lenzen *et al.* 2003).

Rees (1992) first developed the ecological footprint concept as a simple way to compare the sustainability of resource use among populations. By converting the resource use of these populations to a single index, it is possible to compare the sustainability of different populations, which use the same resources. Ecological footprint is also easy to understand and is a good communication and educational tool (Lenzen *et al.* 2003, Costanza 2000).

Bergh and Verbruggen (1999) give a description of how to calculate ecological footprint. An ecological footprint accounts for the flows of energy and matter to and from a specific economy or activity, converted into corresponding land and water area needed to support these flows.

- Six land categories are included in the procedure: consumed/degraded land (built environment), gardens, cropland, pastureland and grasslands, productive forest, and energy producing land,
- First, consumption is determined in each category, including food, housing, transportation, consumer goods and services,
- Next, the land area appropriated by each consumption category is estimated for different land categories. This includes land appropriated by fossil energy use, built environment, gardens, cropland, and pasture: grassland and

managed forest,

- Using both resource and waste flow leads to a consumption and land-use matrix. Summing all the area figures in this matrix gives an estimate of the ecological footprint of the region considered.

An example of an ecological footprint is one calculated for a large metropolitan water supplier – the Sydney, Australia, Water Corporation (SWC) (Lenzen *et al.* 2003). Included in the calculation are the area of land occupied by the premises (water and sewage pumping stations and treatment plants, drainpipes, stormwater channels, sewers, reservoirs, operations centres, etc.) and carbon dioxide emissions (from fuel use). The assessment comprises each item contributing to land and atmospheric disturbance within each premise. These include very detailed items, such as vehicles, gas, oil, sanitation services, books, stationary, paint, electrical fixtures and even clothing and footwear. Not only are the actual operations measured, but also, the land use of suppliers, i.e. how much land was used to produce all the items used by the SWC. The results are usually expressed as the total number of hectares (ha) considered disturbed, in the case of the SWC, about 73,100 ha per year (Lenzen *et al.* 2003).

Ecological footprints can also be calculated for units as small as an individual, incorporating the land use equivalent of all items consumed by the individual. For example, the ecological footprint of a typical Albertan has been calculated to equal 10.7 ha, compared with the world average of 1.8, Belgium and the Netherlands of up to 20 and London with 120 (Wilson 2001).

It is possible to over-simplify an ecological footprint calculation, thereby missing complex factors, which are the real indicators of consumption and sustainability in an area (Costanza 2000). For example, are the people of London and Belgium actually consuming more than Albertans? The reported difference could instead be indicative of a failure of ecological footprint to include the comparative advantages of countries or regions related to the endowment of ecological resources or factors such as space and population density (Bergh and Verbruggen 1999).

This illustrates one problem of ecological footprint, that each unit measured, e.g. a chemical pollutant, should have the same effect on bio-productivity wherever it occurs. However, many pollutants have thresholds, are non-polluting below those, and may have a large effect above them. Alternatively, some "pollutants" are beneficial in some circumstances, e.g. traces of some heavy metals are beneficial to plants, as are human and animal waste if properly managed (Levett 1998).

Other possible problems with EF are that it does not account for 'downstream' impacts or social factors. An example of this is an increase in energy consumption to provide safe and reliable drinking water, which would increase the EF of that area while actually improving its social sustainability (Lenzen 2003). EF also does not account for trade between countries or regions, which could have positive or negative impacts on the EF of either region (Bergh and Verbruggen 1999). In the end, the EF principles and procedures

> seem to concretize the *human* ecological crisis in a way other energy and material flows studies do not. Knowing our ecological footprint not only makes us conscious of our personal contribution to global climate change, but also makes us responsible for doing something about it. Pluralistic democracies can work only if the public are well informed about key policy issues and have a keen sense of their capacity to make a difference in improving the human prospect and those of other species. To the extent that ecological footprint analysis helps to generate a more ecologically literate populace, it will have achieved its most important objective (Rees 2001).

1.8.2 The Genuine Progress Indicator and the Gross Domestic Product

The *Ecological Footprint* is a cumulative measure of various environmental effects. Nevertheless, discussions about sustainability should consider the economic functions of the environment because of the interdependence between economic and ecological systems (Padilla 2002).

One of the most commonly quoted economic indicators for countries is the Gross Domestic Product (GDP) and the Gross National Product (GNP). GDP is the monetary value of all the goods and services produced in a country in a given year, while GNP is the value of all goods and services produced by residents of a country, either in that country or abroad (Hird 2002).

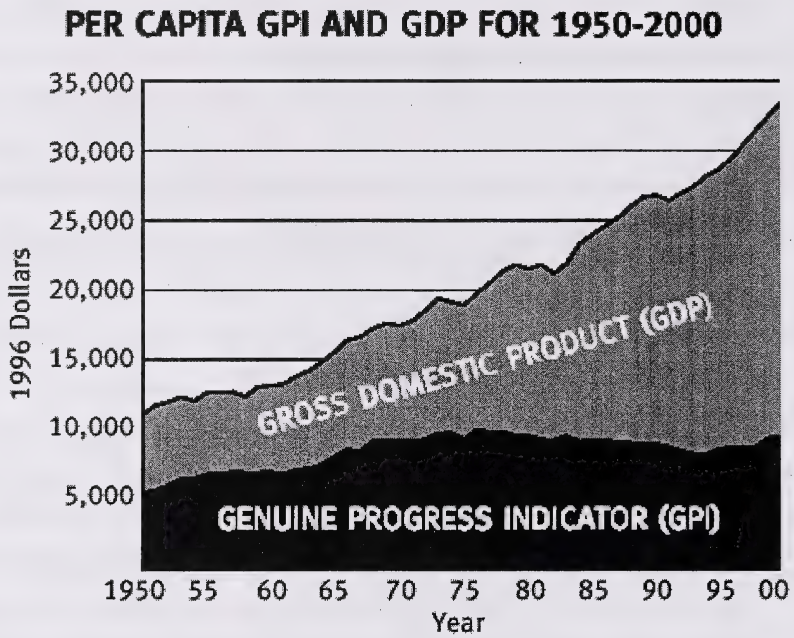
Box 3. Elements of Gross National Product

GDP
Consumption spending by households on goods and services (+)
Gross investment by businesses and government, which includes the purchase of machines and equipment, new housing constructed, and changes in inventory (+)
Government purchases of goods and services (+)
Exports (+)
Imports (-)
Total = Sum of all positive and negative elements = GDP
Source: Hird, 2002

Many ecological economists believe the GDP and GNP are inadequate measures of sustainability because they fail to include environmental and social factors (Lawn 2003, Neumayer 2000). Natural resources, in effect, are valued at zero and considered externalities (Munda 1997). England (1998) criticizes the GDP by saying it does not measure social well-being. Further, the GDP excludes those elements of an economy that are outside of the market, but contribute, nevertheless to total economic wealth. GDP also excludes depreciation of manufactured and natural capital. (In)equity is not factored into the GDP at all (Hamstead 2001).

In response to the failures of the GDP to include the major aspects of sustainability, many researchers have proposed alternative measures, such as the Index of Sustainable Economic Welfare – ISEW and the Genuine Progress Indicator – GPI. The ISEW and GPI are very similar, so this discussion will focus on GPI (Cobb, Halstead and Rowe 1995, Daly and Cobb 1989). Fig. 5 illustrates a comparison between GDP and GPI for the United States – 1950-2000; note that GDP has continued to increase while GPI has remained relatively flat.

Figure 5 **Comparison of United States Per Capita Gross Domestic Product and Genuine Progess Indicator for 1950-2000 (Cobb, Glickman and Cheslog 2001)**



Computation of a GPI usually starts from personal consumption expenditures, weighted with an index of income inequality (see Box 4). Certain welfare-relevant contributions are added, such as the services of household labour and the services of streets and highways. Certain welfare losses are subtracted, such as defense spending, costs of environmental pollution, depletion of natural resources and long-term environmental damage (Neumayer 2000). The report, *Alberta Sustainability Trends 2000: The Genuine Progress Indicators Report 1961 to 1999*, presents the sustainability trends that emerged from a detailed examination of fifty-one indicators in three main areas: economic, personal-social and environmental (Aneilski *et al.* 2001).

Many ecological economists believe GPI is inadequate because of a lack of a theoretical foundation to support the GPI. Ecological economic literature considers GPI a sustainability measure, but its definition rarely includes economic theory (Lawn 2003). Another criticism is the weighting measures used to account for income inequalities introduce a bias. Studies employ different methods of indexing inequality of income, with different results (Neumayer 2000).

Box 4. Elements included in the calculation of GPI

Items used to calculate the GPI for USA from 1950 to 1995
Personal consumption expenditure (+)
Index of distributional inequality (+/−)
Weighted personal consumption expenditure
Cost of consumer durables (−)
Services yielded by consumer durables (+)
Services yielded by roads and highways (+)
Services provided by volunteer work (+)
Services provided by non-paid household work (+)
Cost of noise pollution (−)
Cost of commuting (−)
Cost of crime (−)
Cost of underemployment (−)
Cost of lost leisure time (−)
The cost of household pollution abatement (−)
The cost of vehicle accidents (−)
The cost of family breakdown (−)
Net capital investment (+/−)
Net foreign lending/borrowing (+/−)
Loss of farmland (−)
Cost of resource depletion (−)
Cost of ozone depletion (−)
Cost of air pollution (−)
Cost of water pollution (−)
Cost of long-term environmental damage (−)
Loss of wetlands (−)
Loss of old-growth forests (−)
TOTAL = sum of all positive and negative items = GPI (valued in dollars)
(+) = positive item
(−) = negative item
(+/−) = item that may be either positive or negative
Source: Redefining Progress, 1995.

1.8.3 Polluter Pays Principle (PPP)

The OECD defines the *Polluter Pays Principle (PPP)* as a cost-allocation principle between private and public sectors for efficiency purposes, meaning that the costs of pollution abatement activities undertaken in the private sector should be borne by the private sector and not by government grants and subsidies. Sometimes referred to as "take-back" policies, it implies that a corporation is responsible for the environmental impacts of its business. If implemented it would ensure product prices reflect the full social cost of production, and allow producers to pass forward environmental control costs in product price to consumers (Pearson and Repetto 1994). The PPP is a type of moderate or weak sustainability, since monetary payment is a substitution for environmental damage, e.g. loss of natural capital. Alternatively, it could represent a move towards strong sustainability in order to avoid future take-back costs.

A recent example of the PPP is a March 2003 European Economic Union decree called "Waste Electrical and Electronic Equipment" (WEEE). Under WEEE, which member states must implement by 2004, producers must pay the cost of taking back and recycling old equipment (Hume *et al.* 2002).

Costanza and others (Costanza and Perrings 1990, Costanza and Cornwell 1992) have combined the elements of the Precautionary Principle and the Polluter Pays Principle into the notion of "assurance bonds" which they have dubbed *the 4P approach to scientific uncertainty*. The approach proposes that before any new technology or development can be introduced, an economic estimate of the worst-case damage must be calculated. The proponent would then have to post a bond of that amount (in full) before commencement. If the development or process is deemed benign, the proponent has the bond returned; if not, the bond is used for clean up, remediation, compensation, etc. There are many details that remain in question about such a system, but it clearly operationalizes two key principles of sustainable development

1.8.4 Corporate Environmental Responsibility: The Triple Bottom Line

Corporate entities are increasingly under pressure to demonstrate how they contribute to sustainability goals outlined by the government (Atkinson 2000, Willard 2002). Hawken (1993) argues that a firm is behaving sustainably if it does not reduce the capacity of the environment to provide for future generations. At a minimum, the sustainable business is one that leaves the environment no worse off at the end of each accounting period than it was at the beginning. For full sustainability, a business would also rectify some of the excess affecting current un-sustainability and consider the intra-generational inequalities (Bebbington and Gray 1997). Both these definitions reflect the concept of strong sustainability.

Several terms have come into common use in describing business sustainable development. *Corporate Social Responsibility* focuses on community investment, employee relations and human rights, as well as environmental responsibility (Choquette and Khoury 2000). *Environmental Stewardship* deals with the way a company handles the environment, e.g. the amount of energy, water, and material consumed in the manufacture of products, reducing waste, and remediation of contaminated sites. The term *eco-efficiency* marries the economic and environmental aspects of sustainable development. It means doing more with less over the full life cycle of a product (Willard 2002).

For a business, sustainable development means sustaining nature's resources as well as sustaining the company (Thompson 2002). In business terms, sustainable development has three components: economic prosperity, environmental stewardship and social responsibility (Lamming *et al.* 1999). Measuring the degree to which a company follows these has been termed the *Triple Bottom Line* (Elkington 1998). Several mnemonics are used to describe triple bottom line: 3 Es – economics, environment and equity; 3 Ps – profits, planet and people; SEE – society, environment and economics (Willard 2002).

Industry has well-developed techniques, practices and regulations for measuring and reporting the economic or financial bottom line. However, measuring environmental and social bottom lines are not well defined, nor commonly practiced (Elkington 1998). One way to measure environmental impacts and their financial bottom line is through the technique of full-cost accounting.

Full cost accounting is a way for a corporation to measure all their environmental impacts in monetary terms (Atkinson 2000). From an environmental perspective, full cost accounting is the integration of an entity's internal costs (including all internal environmental costs) with the external costs relating to the impacts of the entity's activities, operations, products, and/or services on the environment. Full cost accounting is a relatively new accounting concept and not all practices have been defined by accounting governance policies, e.g. GAPP (Canadian Institute of Chartered Accountants 1997).

Accounting for environmental costs has some similarities to financial accounting, and some differences. Although addressed in financial accounting, *direct or conventional* costs, such as materials, labour, supplies, utilities, etc. may also be environmental costs. For example, they may relate to a decreased use of raw materials, less environmental degradation or less consumption of non-renewable resources. Other environmental costs are not so obvious and are termed *hidden, contingent or less tangible* costs. These include costs related to project siting, design of environmentally preferred products, future costs of decommissioning or cleanup, etc. (Bennet and James 1998). A significant challenge of full cost accounting is the economic valuation of non-market goods and services.

Accounting for the social bottom line aims to assess the impact of an organization on people, both within the company and outside it. Issues often covered are community relations, product safety, training and education, sponsorship, charitable donations of money and time, and employment of disadvantaged groups (Elkington 1998).

Another significant global trend on the corporate and institutional management side of sustainable development is the implementation of *environmental management systems* (EMS). Over 40,000 organizations around the world have now been registered under formal international standards for EMS. The two primary international standards organizations are the European Eco-Management and Audit Scheme (EMAS) and the International Standards Association (ISO 14001). The ISO defines an EMS as: "the part of the overall management system which includes organizational structure, planning, activities, responsibilities, procedures, processes, and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy" (Canadian Standards Association 1996). An EMS must be highly integrated into the management of an organization and is designed to improve environmental performance by:

- setting goals and objectives (policy);
- identifying, obtaining, and organizing the people, skills, and knowledge, technology, finances, ad other resources necessary to achieve the goals and objectives;
- identifying and assessing options for reaching the goals;
- assessing risks and priorities;
- implementing the selected set of options;
- auditing performance for necessary adjustments by providing feedback to the system; and
- applying environmental management tools as required (Kirkland and Thompson 2002).

1.8.5 The Natural Step

The *Natural Step* is a framework for integrating environmental issues into the frame of business to move the company towards sustainable development through backcasting principles of sustainability and a strategic step-by-step process (Nattrass and Altomare 1999, Robert 2000). Dr. Karl-Henrick Robèrt founded the Natural Step in Sweden in

1989. Using the laws of thermodynamics (that matter can neither be created nor destroyed, only changed), he developed four systems conditions for sustainability:

1. Substances from the Earth must not systematically increase in the ecosphere,
2. Substances produced by society must not systematically increase in the ecosphere,
3. The physical basis for productivity and diversity of nature must not systematically be diminished,
4. There must be fair and efficient use of resources with respect to meeting human needs.

Municipalities and corporations throughout Sweden, and increasingly around the world, are using the framework to modify business practices, including IKEA, Electrolux, Sweden McDonalds, Scandic Hotels, Nike, and Dupont (Sian and Thompson 2002).

1.8.6 Corporate Responses to Measuring Sustainability

The previous sections outlined various tools or techniques for measuring sustainability; however, the degree of implementation of these in corporations varies widely. Few are legislated or mandated in codes of practices like financial accounting (Canadian Institute of Chartered Accountants 1997). In fact, the practice and measurement of sustainability is more of an art than a science, especially given the difficulty of measuring the "soft" aspects of social and environmental impacts (Nattrass and Altomare 2002).

Winsemius and Guntram (2002) describe four types of corporate response to environmental developments:

1. Reactive – reluctant, often regulation compliance driven,
2. Functional – a more positive attitude, involving implementing standardized practices like an environmental management system (EMS), though changes are still not fundamental,
3. Integrated – industry leaders start to look beyond the boundaries of their

business to more fundamental answers to environmental questions,

4. Proactive – still a rare occurrence that requires the deep transformation of the business culture to an environmental vision.

Nattrass and Altomare (2002) define companies who embrace sustainability as those that:

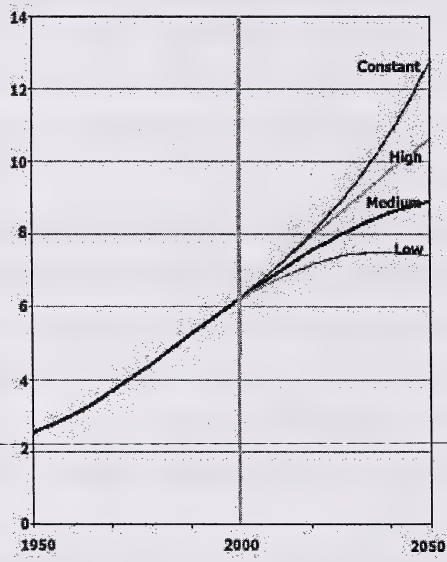
- Are aware that the health of global economic, ecological, and social systems is integrally interconnected and interdependent;
- Realize that sound business, strategy, and management decisions - whether implemented for financial profit, social profit – ignore the realities of these interconnections and interdependence at their peril;
- Operate with an expanded sense of social responsibility that is based on the belief that "doing the right thing" needs to be a deep seated core value of any citizen, community or organization, if we are to create a vibrant and prosperous future, and that integrating more sustainable practices is the right thing to do;
- Have leaders who take personal responsibility for the conscious evolution of their organization and communities in a more enduring and sustainable direction.

Chapter II: Global Issues and Trends

2.1 Population Growth

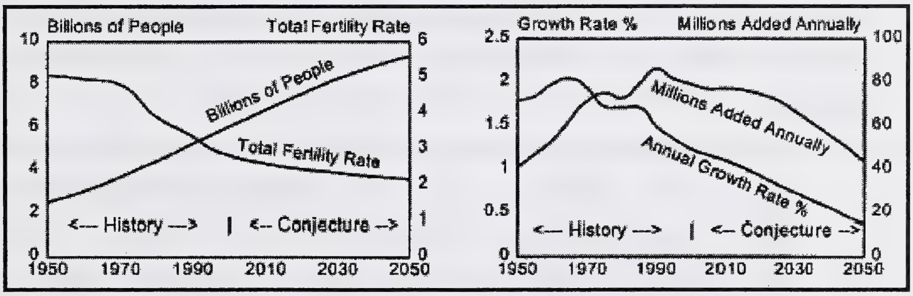
Population growth is a critical factor in any discussion of sustainable development because resource consumption is a factor of both population size and *per capita* consumption rates. The United Nations Population Division predicts that the world population will swell to between 7.4 and 10.6 billion people within two generations (United Nations Population Division 2003; Fig. 6).

Figure 6 World Population – Historical and Predicted 1950- 2050 (United Nations Population Division 2003)



However, the United Nations Population Division expects the global *rate* of human population growth will continue to slow over the course of the next century. Figure 7 shows that although population numbers are increasing, the fertility rate is dropping, which results in a decrease in the rate of population growth.

Figure 7 **World Population Growth Rates – Historical and Predicted, 1950- 2050 (United Nations Population Division 2001)**



The most recent revision (2002) of the official United Nations population estimates and projections make new assumptions on future human fertility and the impact of the HIV/AIDS epidemic. The United Nations Population Division now projects that future fertility levels in the majority of developing countries will likely fall below 2.1 children per woman, the level needed to ensure the long-term replacement of the population, at some point in the twenty-first century. A second important change in the 2002 revision is that it anticipates a more serious and prolonged impact of the HIV/AIDS epidemic in the most affected countries than previous revisions. Because of these changes, the 2002 revision projects a lower population in 2050 than the 2000 Revision did - 8.9 billion instead of 9.3 billion according to the medium variant (United Nations Population Division 2003).

2.2 Consumption

Given that the effect of humans on the environment is partly a function of *per capita* consumption times the number of people consuming those resources, levels of consumption are critical factors of sustainability[9]. The United Nations Human Development Report 2003 (United Nations Development Programme 2003) reports the following:

> *Many environmental problems arise from the production and consumption patterns of non-poor people, particularly in rich countries. Rich countries consume many fossil fuels and deplete much of the world's fisheries, damaging the global environment. They also use a lot of tropical hardwoods and products from endangered species. To ensure the sustainability of Earth and its resources, including the development prospects of poor countries, these harmful production and consumption patterns must change. Energy systems will have to generate much lower greenhouse gas emissions. Fisheries will have to be managed based on ecological limits rather than heavily subsidized free-for-alls. And international rules of the game will have to mitigate the over consumption that endangers ecosystems and certain plants and animals. But with smart policies and new technologies, the costs of these changes can be quite low.*
>
> *At the same time, many environmental problems stem from poverty – often contributing to a downward spiral in which poverty exacerbates environmental degradation and environmental degradation exacerbates poverty. In poor rural areas, for example, there are close links among high infant mortality, high fertility, high population growth and extensive deforestation, as peasants fell tropical forests for firewood and new farmland.*

The following sections focus on two major areas of human consumption: energy and land, and the various impacts that occur within these types of consumption.

[9] For a graphic real-time representation of population and global consumption, see: http://www.osearth.com/resources/worldometers/

2.2 *Energy*

2.2.1 Oil, Gas and Coal - The fossil fuels

The world's energy needs are met primarily by the fossil fuels, which lead to issues centering on the availability/reserves, consumption/production, and the sustainability of these resources for the future.

Proven world oil reserves for 2002 stand at 1047.7 billion barrels; an increase of 3.4 % since 1992. Proven world gas reserves for 2002 stand at 5501.5 Tcf (trillion cubic feet) which is an increase of 11.2 % since 1992. Proven world coal reserves for 2002 stand at 984.5 billion tonnes; no available 1992 data (British Petroleum 2003).

World oil production for 2002 is 73.9 million barrels per day; an 11 % increase from 1992. World gas production for 2002 is 247.4 Bcf/d (billion cubic feet per day or 90.3 Tcf for the year); a 19 % increase from 1992. World coal production for 2002 is 2379.4 million tonnes oil equivalent; a 7.3 % increase from 1992 (British Petroleum 2003).

Current forecasts predict world primary oil consumption to rise 1.6 % per year reaching 120 million barrels per day by 2030 (International Energy Agency 2002). The largest gains in consumption will come from China and India. North American consumption (currently at 25 % of world energy consumption) will drop but will still account for a large proportion of oil use when compared to the relative population sizes (International Energy Agency 2002).

Transport, followed by commercial and residential energy uses are the most rapidly growing areas of demand for global energy use (Zacharias-Farah & Geyer-Allely 2003a).

Forecasts for world primary gas production indicate 2.4 % growth per year until 2030. Much of the demand is for power generation, which is growing by more than 3.5 % per year (International Energy Agency 2002). The share of gas in the global primary energy mix will increase from 23 % to 28 % in 2030. The demand for gas is a result of increasing supplies and the impetus to switch to a cleaner burning fuel (Stark 2003).

Coal's share of world primary energy demand declines from 26% in 2000 to 24 % in 2010 and then stable to 2030. Electrical energy generation is the primary use for coal and the largest consumers of coal for power are China and India (International Energy Agency 2002).

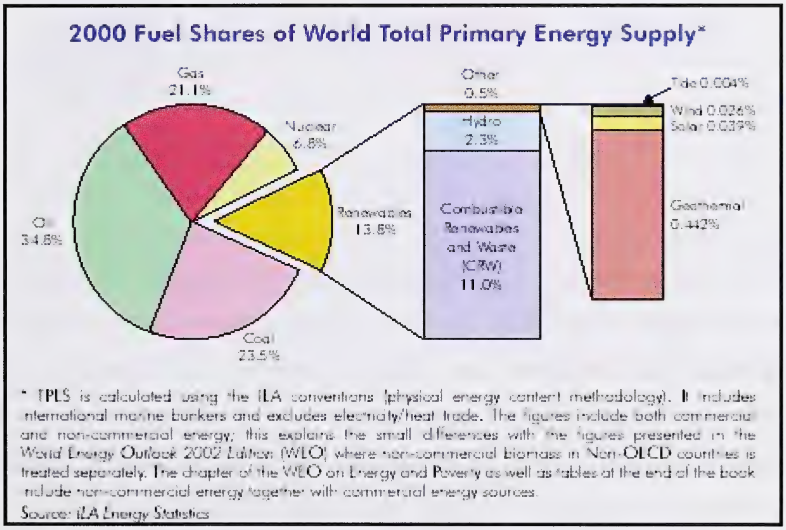
The International Energy Agency predicts that primary world demand for energy will increase by 1.7 % per year between 2000 and 2030. The fossil fuel share of total demand will increase from 87 % in 2000 to 89 % in 2030. More than 60 % of this increase will come from developing countries especially the Asian countries. OECD (Organization for Economic Co-operation and Development) countries share of demand (including Canada) will experience a decline from 58 % in 2000 to 47 % in 2030 (International Energy Agency 2002).

There are more than enough reserves of oil, gas and coal to meet projected growth in energy demands through 2020, but exploiting these reserves is becoming more and more costly in terms of production and transportation infrastructure (International Energy Agency 2001). As well there will be a geographical shift to the Middle East and Russia for oil and gas supplies. Canada and Venezuela will also play a larger role with their significant reserves of oil sands and heavy oil due to their proximity to the United States. Forecasts are based on the current political, economic, and societal conditions that can change almost immediately. Of note is the advancement of technology in the energy equation.

2.2.2 Renewable Energy Sources

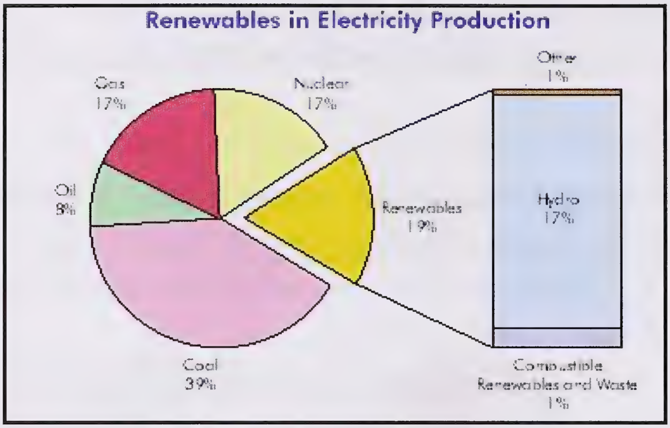
Alternatives to fossil fuel are so-called "renewable" energy sources. These include hydro-electricity, wind, solar and hydrogen. The International Energy Agency in 1999 noted, "The world is in the early stages of an inevitable transition to a sustainable energy system that will be largely dependent on renewable resources" (International Energy Agency 1999). Figure 8 shows the world total supply of energy, where energy includes all forms, transportation, heating, cooking, industrial production, and electricity.

Figure 8 World Renewable Energy Supply (International Energy Agency 2000)



Renewables are the second largest contributor to global electricity production (Fig. 9). They accounted for 19% of production in 2000, after coal (39%) but ahead of nuclear (17%), natural gas (17%) and oil (8%). Most of the electricity generated globally from renewables comes from hydro power plants (92%) followed by combustible renewables, such as wood, and waste (5%). Geothermal, solar and wind accounted for less than 3% of electricity generation in 2000, although these renewables are growing quickly (International Energy Agency 2000).

Figure 9 World Electricity Production (International Energy Agency 2000)



Hydroelectric generation is a renewable resource, but there are concerns about the environmental impact of hydro dams. Damming disrupts biologically significant flood regimes, blocks fish spawns, and halts the transfer of fresh water to marine ecosystems. However, changes in management practices and public awareness are improving running water ecosystems in developed countries and could underpin conservation strategies in developing countries (Malmqvist & Rundle 2002). Thus, if managed properly, this renewable resource could reduce the side effects associated with the combustion of oil, gas, and coal.

The world now uses 10 times as much wind energy as it did only a decade ago and solar power has increased sevenfold (Sawin 2003). Europe has over 70% of the world's wind capacity, with Germany, Spain, and Denmark leading the way. India is increasing its wind energy production and Brazil may become the world's fourth largest producer of wind energy by 2005 (Flavin 2002).

Rees (1994) predicted that continuing growth in material consumption, energy included, would eventually overwhelm gains from efficiency causing total resource use (and corresponding environmental damage) to rise. For example, significant progress in improving fuel efficiency has been fully offset by increases in the total number of vehicles and the total number of kilometres traveled, and by a trend towards heavier and less fuel efficient vehicles (United Nations Environment Programme 2002a). In the last 25 years, Canada's population increased by 50%, but the number of cars on the road doubled (Secretariat of the Commission for Environmental Cooperation 2001). In many instances, gains made recently in arresting environmental pollution and degradation have been eroded by choices related to consumption increases and population growth (United Nations Environment Programme 2002a; Zacharias-Farah & Geyer-Allely 2003a). Additionally, it is predicted that global economic growth will return to the high rates experienced in the 1960s and 1970s and that the "global economy is well positioned to achieve a sustained period of dynamism", or increased rates of consumption (National Intelligence Council 2002). Energy consumption has led to an examination of global climate and the evidence of possible climate change caused by the chemical emissions produced during energy production with fossil fuels.

2.3 Land use

The term land use denotes human employment of the land, including settlement, cultivation, pasture, rangeland, recreation, etc. (Turner and Meyer 1994). Use of the land, in addition to energy is another major consumption activity of humankind.

2.3.1 Agriculture

The main driving force leading to pressure on land resources, since 1972, has been increased food production (United Nations Environment Programme 2002c). In 2002, 2,220 million more people required food than in 1972 (United Nations Population Division 2001). The trend during the decade 1985–95 showed population growth racing ahead of food production in many parts of the world, particularly Africa. In 64 of 105 developing countries studied in this period, food production lagged behind population growth (United Nations Population Fund 2001). In particular, although world grain production was down during 2000 and 2001, consumption continued to rise (Hsin-Hui *et al.* 2001). If this trend continues, producing countries will receive pressure to increase agricultural production (Brown 2002). Increased consumption could cause prices for grain to increase resulting in intensification of agricultural land use and possible conversion of low-yield land to cropland, both contributing to depletion of land resources.

Globally, policy failure and poor agricultural practices contribute to increased land pressure. For example, the excessive use of fertilizers and other chemicals contributes to soil degradation and water pollution (United Nations Population Division 2001). Irrigation has also made, and continues to make, an important contribution to agricultural production but the potential for future growth has changed. Poorly designed and implemented irrigation schemes can cause water logging, salinization and alkalization of soils (United Nations Population Division 2001, Brown 2002).

Over-utilization of natural resources and inappropriate management of grassland environments can cause desertification, especially in the arid and semi-arid zones of the world. Overgrazing causes soil compaction and erosion may follow with a decrease in soil fertility, organic matter, and water-holding capacity (Delgado *et al.* 1999). As an example, the Horqin Steppe, located at the northeastern China, has been suffering from desertification over the past two decades primarily because of overgrazing practice. In addition to depletion of ground cover, grazing reduces surface roughness substantially so that wind can act directly on sandy grassland surface initiating desertification (Gong Li *et al.* 2000).

On the other hand, many of the world's most productive lands have unusually long histories of continuous settlement and increased output. Alteration is nearly inseparable from human use, but alteration may lead to improvement, not necessarily degradation (Turner and Meyer 1994). For example, some herbaceous communities in the Mediterranean, despite being grazed for thousands of years, continue to thrive (Osem *et* *al.* 2002). Well-managed livestock practices can help maintain soil fertility, increase nutrient retention and water-holding capacity, and create a better climate for micro-flora and fauna (Delgado *et al.* 1999). Knapp *et al.* (1999) identified the key components for conserving and restoring the biotic integrity of tall-grass prairie: fire and ungulate grazing activities that shift across the landscape. Bison and other ungulate grazing were integral to the health of the tall-grass prairie. They argue that bison and cattle are functionally similar large herbivores, and that management strategies that mimic herbivores past activity, such as stocking densities, are important to grassland condition (Knapp *et al.* 1999). Eneboe *et al.* (2002) found that even during drought conditions, moderate stocking rates of cattle did not adversely affect the long-term growth of native grasses in Montana.

2.3.2 Forestry and Forest Conversion

Deforestation over the past 30 years has been the continuation of a process with a long history. The historic loss of forests is closely related to demographic expansion and the conversion of forest land to other uses. Major direct causes of forest degradation brought on by humans include over-harvesting of industrial wood, fuel wood and other forest products, and overgrazing. Underlying causes include poverty, population growth, markets and trade in forest products, and macroeconomic policies. Forests are also susceptible to natural factors such as insect pests, diseases, fire, and extreme climatic events (United Nations Environment Programme 2002b).

Past harvesting practices, the introduction of exotic species, and suppression of natural disturbances have created large forested landscapes in some parts of the world, with an unnatural tree distribution and age structure, which have increased the forest's vulnerability to drought, wind, insects, disease, and fire (UN 1997, US Department of Agriculture 1997). In addition, decades of aggressive fire suppression contributed to major ecological change in some of North America's forest ecosystems so that the structural homogeneity of many stands render them less diverse and they are only adequately renewed after a major catastrophic event such as fire (Stuart 1998).

In their pursuit of sustainable forest management, forest managers today consider forests as functioning ecosystems. It is generally accepted that a functioning ecosystem supports biodiversity and is resilient; as such it provides wildlife habitat, supports internal ecosystems, has aesthetic appeal, and maintains a sustainable supply of timber and non-timber resources (Natural Resources Canada 1999). Today it is accepted that some level of fire, insects, and disease is a natural component of healthy forests.

2.3.3 Land Use Effects on Land and Soil

Human activities including deforestation and removal of natural vegetation on steep slopes and erodable soils, improper use of heavy machinery, overgrazing, improper crop rotation, and poor irrigation practices can all contribute to land degradation. Natural disasters, including droughts, floods and landslides, also contribute (United Nations Population Division 2001). Nearly two million hectares of land worldwide (23% of all cropland, pasture, forest, and woodland) have degraded since the 1950s (Table 1). About 39% of these lands are lightly degraded, 46 moderately degraded, and 16 so severely degraded that the change is too costly to reverse. Some areas face sharp losses in productivity. Grasslands do not fare much better: close to 54% show degradation, and 5 are strongly degraded (World Bank 2002).

Despite these compelling statistics on land degradation, some studies argue that degradation estimates are overstated (United Nations Population Division 2001). A major reason suggested for the overestimation of land degradation has been underestimation of the abilities of local farmers (Mazzucato and Niemeijer 2001).

Table 1 Extent and causes of land degradation

Extent and causes of land degradation	
Degradation extent	Cause
580 million ha	**Deforestation** - vast reserves of forests have been degraded by large-scale logging and clearance for farm and urban use. More than 220 million ha of tropical forests were destroyed during 1975–90, mainly for food production.
680 million ha	**Overgrazing** - about 20% of the world's pasture and rangelands have been damaged. Recent losses have been most severe in Africa and Asia.
137 million ha	**Fuelwood consumption** - about 1 730 million m3 of fuelwood are harvested annually from forests and plantations. Woodfuel is the primary source of energy in many developing regions.
550 million ha	**Agricultural mismanagement** - water erosion causes soil losses estimated at 25 000 million tonnes annually. Soil salinization and waterlogging affect about 40 million ha of land globally.
19.5 million ha	**Industry and urbanization** - urban growth, road construction, mining and industry are major factors in land degradation in different regions. Valuable agricultural land is often lost.
Source: FAO 1996	

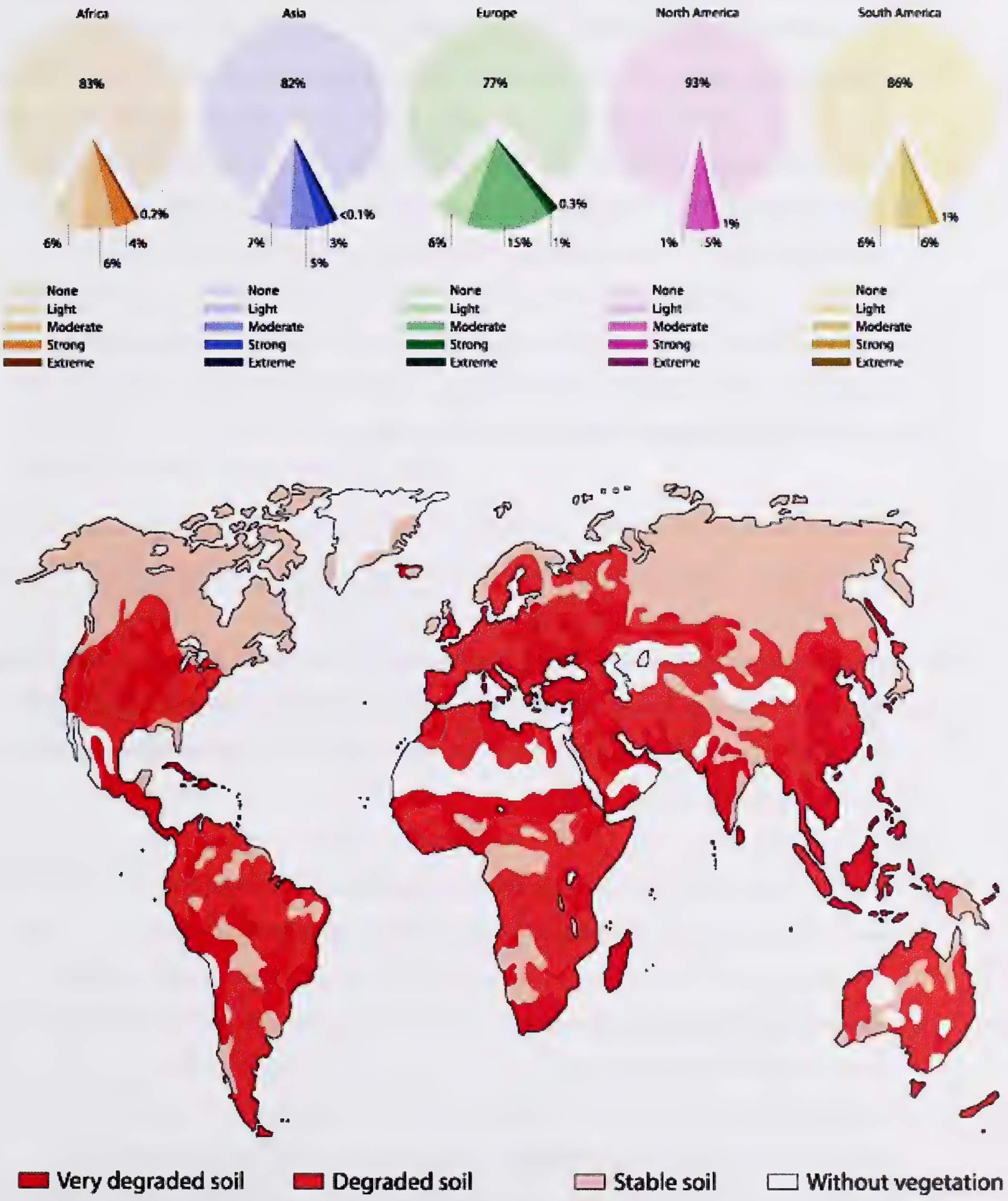
Soil erosion is a major factor in land degradation and has severe effects on soil functions – such as the soil's ability to act as a buffer and filter for pollutants, its role in the hydrological and nitrogen cycle, and its ability to provide habitat and support biodiversity. About 2 000 million ha of soil, equivalent to 15%of the Earth's land area (an area larger than the United States and Mexico combined), have been degraded through human activities (German Advisory Council on Global Change 1994).

Irrigation is essential to agricultural production; however, the inefficiency of many irrigation schemes may be limiting potential agricultural growth. Poorly designed and implemented irrigation systems can cause waterlogging, salinization, and alkalization of soils (United Nations Environment Programme 2002c). Some 25–30 million ha of the world's 255 million ha of irrigated land were severely degraded due to the accumulation of salts, according to 1995 FAO (Food and Agriculture Organization of the United Nations) estimates. An additional 80 million ha were reported to be affected by salinization and waterlogging (FAO 1995).

Salinization results when deep-rooted perennial native vegetation is replaced with shallow rooted annual species, with a consequent rise in water tables that brings salt stored deep in the ground to the soil surface (Prairie Farm Rehabilitation Administration 1983). One solution to landscape salinity lies in the reintegration of trees and other perennial species back into agricultural systems with the aim of returning hydrological function to a condition that mimics that of the original landscape (Hatton and Nulsen 1999). Another approach is the partial restoration of productivity of salinized land through revegetation with salt tolerant plants (halophytes). Data are available to show that stands of halophytes can transpire sufficient water to lower water tables, thereby reducing the salinity of the surface soils (Barrett-Lennard 2001).

Other strategies to preserve soil are gaining acceptance around the world. Studies estimate that conservation agriculture is practiced on about 58 million hectares of farmland, mainly in North and South America, but also in Southern Africa and South Asia. Under one approach, termed zero-tillage, farmers leave crop residues in the soil, and rather than tilling the soil at the start of the next cropping season, seed directly into the soil. The surface cover reduces salinization, erosion and water loss (Global Environment Facility 2002). The pie charts and map below (Fig. 10) show the extent of areas of degraded land in the world and the location of degraded soils.

Fig. 10 Global extent of degraded soils (UNEP 1992)



2.3.4 Urban Expansion

Urban areas occupy about 1% of the Earth's land area (United Nations Environment Programme 2000a). However, urban expansion, including land requirements for industry, transport and for leisure activities in all regions, continues to grow rapidly in many areas. In the United States, for example, about 400,000 ha of farmland are lost to urbanization annually and China lost about 5 million ha of farmland to towns and cities during 1987–92 (United Nations Population Fund 2001). Land degradation, river siltation and soil pollution, from acid rain and industrial wastes, are some of the environmental issues associated with urbanization and industrialization. Nevertheless, well-planned, densely populated urban areas can reduce the need for land conversion, provide opportunities for energy savings and make recycling more cost-effective (United Nations Environment Programme 2002c).

Urban development frequently results in the elimination of many native species from the local area. The loss of native biodiversity resulting from urbanization is typically more lasting than other types of habitat loss due to the intense process of scarification, permanent resurfacing (i.e. paving) and revegetation with non-native species. Urban and other built up areas cover over 5% of the total surface area of the USA – and the rate of growth in urbanization is growing faster than the rate of habitat protection and land preservation (McKinney 2002).

Low to medium density residential areas (commonly termed *urban sprawl*) around urban centres is common in the developed world. Well-developed infrastructure and the increasing use of the car have facilitated this trend. Furthermore, low-density development occupies proportionally larger areas of land per capita (United Nations Environment Programme 2002c).

Planners are under increasing pressure to conserve and enhance the natural environment and protect it from development where appropriate. New strategies are being used to evaluate biodiversity in attempts to encourage urban development to allow for the maintenance of local ecosystems (Lofvenhaft 2002, Freeman 1999). One example is preserving any natural habitat that remains after development and restoring modified habitats in urban areas to promote native species preservation (McKinney 2002).

A benefit of urbanization is the large concentration of people in urban areas, e.g. 80% of the American public lives in or near an urban area. This creates opportunities for a well-informed public as a means for promoting effective conservation policies (Kendle and Forbes 1997). Indeed, residents of suburban and urban areas tend to place a higher value on species preservation than those living in rural areas (Kellert 1996). An analysis of U.S. voting behaviour bears this out, showing that legislators from highly urbanized states and districts tend to be supportive of environmental acts, such as the Endangered Species Act (Mehmood and Zhang 2001).

2.3.5 Effects on Wildlife Habitat

Over the past few decades, research has shown that the loss and alteration of habitat has come to pose the most significant threat to biodiversity. Czech *et al.* (2000) in a study of species endangerment in the U.S. list several causes of habitat loss:

- Urbanization – discussed above,
- Agriculture – second to urbanization in terms of habitat loss, including soil erosion and siltation of nearby water bodies,
- Outdoor recreation – disturbances caused by hikers, hunters, dirt bikers, 4-wheel drivers and tourist facilities,
- Livestock and ranching activities – the strongest impact is the introduction of non-native species,
- Reservoirs and other surface water diversions – species destruction, species movement blockage, introduction of predatory species,
- Oil and gas exploration – surface disturbances,
- Road construction and maintenance – create habitat fragmentation and edge

habitat along the roadsides resulting in non-native species introduction (Reed *et al.* 1996),

- Aquifer depletion and wetland drainage or filling – agriculture and urban expansion both contribute to efforts to make wetlands tillable or habitable.

Landscape fragmentation, which occurs with agriculture, urbanization, roads, oil and gas exploration and reservoirs, may often lead to habitat loss. For example, one study showed that habitat fragmentation results in a reduction of the local survival and the colonization capacity of remnant populations of wind-dispersed grassland forbs, which increases regional extinction risks of the species (Soons and Heil 2002). Activities that fragment landscapes may have a reduced impact if an understanding of their effect on ecosystems is first studied (Reed *et al.* 1996).

One activity that may enhance habitat is grazing. In several studies grazing increased, reduced, or lacked consistent effect on plant diversity (Osem *et al.* 2002). Characteristics of the ecosystem subjected to grazing, such as primary productivity, evolutionary history and resulting vegetation physiognomy and plant life forms, can interact with grazing in determining plant community structure and diversity. In nutrient-rich ecosystems, grazing may increase plant diversity (Proulx and Mazumder 1998, Osem *et al.* 2002).

Wetlands are a particularly important habitat, being vital nesting grounds for birds as well as stopovers sites for transcontinental migrants, as well as supporting many aquatic and plant species. In many parts of the world, flat lowland areas were the first exploited for timber or farming destroying wetlands in the process (Stark 2003). Another activity that changes wetlands is river damming for reservoirs or hydroelectricity. Dynesius and Nilsson (1994) estimated 77% of the 139 largest river systems in Canada, the United States, Europe and the former Soviet Union, are moderately to strongly altered by dams, reservoirs, diversions and irrigation projects. Until recently, water management practices have virtually ignored the importance of natural streamflow variability in maintaining healthy ecosystems (Poff *et al.* 1997). The result has been the loss of many types of ecosystems and their associated species populations (Postel 2002).

Flow regulation of dammed rivers may destroy or may restore natural ecosystem balances. An example is the Glen Canyon dam, built in 1963, on the Colorado River. Prior to damming, an annual cycle of scour and silting maintained large sandbars along the riverbanks and prevented vegetation encroachment. When the dam reduced flow, vegetation, made up mainly of exotic woody species, encroached along the banks. In 1996, as an adaptive management process, controlled floods were released through the dam, with the immediate result of sandbar building (Poff *et al.* 1997).

2.3.6 Effects on Biodiversity and Species

Many plant and animal species are close to extinction because of habitat loss through over-consumption of land and associated resources (Annan 2000). While species extinction is a part of the natural evolution of life on the planet, the current rate of extinction far exceeds the natural "background rate" (United Nations Environment Programme 2002c). Globally, 1 in 8 plant species is at risk of extinction, as are 25% of the world's mammals and 11% of birds (Annan 2000, United Nations Environment Programme 2002c). Through a series of local extinctions, the ranges of many plants and animals are less than at the beginning of the century. In addition, many plants and animals are unique to certain areas. One-third of terrestrial biodiversity, accounting for 1.4% of the Earth's surface, is in vulnerable "hot spots", threatened with complete loss in the event of natural disasters or further human encroachment. Some statistics suggest that species, introduced by human activity and alien to the locality, threaten 20% of all endangered species (United Nations Environment Programme 2002c).

International action has helped some species and habitats, but the pace of species loss and resource degradation continues to accelerate. This may be in part because the issue is typically understood simply as species extirpation and extinction, when, in fact, the issue is far more complex, encompassing all facets of habitat loss and bio-invasion, as well as resource over-consumption (Reid 2001).

One conservation challenge of urban growth is the introduction of non-native or exotic species, which often replace native species such as plants, birds and butterflies. Urban-gradient studies show that of these species, the number of non-native species increases towards centres of urbanization, while the number of native species declines (McKinney 2002, Blair and Launer 1997). On the other hand, rare and endangered species sometimes occur in urban habitats and appropriate urban policies could conserve them (Godefroid 2001).

2.4 Air Quality

Over the past three decades, anthropogenic emissions of chemical compounds into the atmosphere have caused many environmental and health problems (United Nations Environment Program 2002c). Some chemicals such as chlorofluorocarbons end up in the atmosphere by accident from equipment or goods. Others, such as sulfur dioxide and carbon monoxide, are unavoidable by-products of burning fossil fuels. Urban air pollution, acid rain, contamination by toxic chemicals (some of them persistent and transported over long distances), and changes in the global climatic system are all important environmental threats to ecosystems and human wellbeing.

Many nations have adopted ambient air quality standards to safeguard the public against the most common and damaging pollutants (World Resources Institute 1998). Although substantial investments in pollution control in some industrialized countries have lowered the levels of these pollutants in many cities, poor air quality is still a major concern throughout the industrialized world. A recent assessment by the European Environment Agency found that 70 to 80 percent of 105 European cities surveyed exceeded World Health Organization (WHO) air quality standards for at least one pollutant. In the United States, an estimated 80 million people live in areas that do not meet U.S. air quality standards, which are roughly similar to WHO standards.

Over the past 30 years, there have been notable air quality improvements at both regional and local levels in North America. Levels of many air pollutants have been gradually reduced. These include sulfur dioxide, suspended particulate matter, ground-level ozone, nitrogen dioxide, and carbon monoxide. Since 1995, acid rain control programs contributed to the dramatic decline in sulfur emissions with reductions of 10–25 per cent in some parts of the north-eastern United States (US EPA 2000). Recent evidence, however, suggests that many sensitive areas are still receiving acid deposition that exceeds their assimilation capacity, and damage caused by acid deposition may be more fundamental than was previously believed (Munton 1998). New concerns have arisen over ground level ozone and fine particulate matter, which have not decreased as much as other common pollutants.

The health consequences of exposure to dirty air are considerable (World Resources Institute 1998). On a global basis, estimates of mortality due to outdoor air pollution vary between 200,000 and 570,000, representing about 0.4 to 1.1%of total annual deaths. As the range of these estimates indicates, it is difficult to quantify the toll of outdoor air pollution. The health impacts of urban air pollution seem likely to be greater in some of the rapidly developing countries where pollution levels are higher. The World Bank has estimated that exposure to particulate levels exceeding the WHO health standard accounts for roughly 2 to 5% of all deaths in urban areas in the developing world.

As dangerous as polluted outdoor air can be to health, indoor air pollution actually poses a greater health risk on a global level (World Resources Institute 1998). Indoor air pollution is a concern in developed countries, where, for example, energy efficiency improvements sometimes make houses relatively airtight, reducing ventilation and raising indoor pollutant levels. In such circumstances, even small pollution sources emanating from a furnace, a new carpet, or from naturally occurring radon gas can lead to significant human exposures.

2.5 Water

2.5.1 Water Quality

The issues of groundwater use and quality have until recently received far less attention than surface water, and data on groundwater stocks and flows are even less reliable. However, in most parts of the world, people depend on groundwater for water supply, including drinking water. In general, water quantity and quality research needs to be conducted and the information base expanded for understanding the relationship between surface and groundwater systems, and determining the sustainable yield of major aquifers (Minister of Agriculture and Agri-Food 2003).

The intensification of agriculture to meet growing world food demands has led to environmental problems associated with water in many countries (Aldwell 1997). Additional emphasis may need to be placed on addressing the risks posed by agriculture to groundwater because it is a hidden resource and its degradation and rehabilitation often take place slowly. Such an approach demands cross-sectoral collaboration involving multidisciplinary research and action within an integrated policy framework.

Generally, groundwater resources are vulnerable to a variety of threats, including overuse and contamination (United Nations Environment Programme 2002b). Common issues include inadequate protection of aquifers from urban and industrial activities, and intensification of agriculture. Contaminants may include pathogens, nitrates, ammonium salts, chlorine, sulphates, boron, heavy metals, aromatic and halogenated hydrocarbons nitrates, and pesticides (United Nations Environment Programme 2002b).

The interactions between groundwater and surface water are complex (Sophocleous 2002). Groundwater interacts with surface water in nearly all landscapes, ranging from small streams, lakes, and wetlands in headwater areas to major river valleys and seacoasts (Winter 1999). Although it generally is assumed that topographically, high areas are groundwater recharge areas and topographically low areas are groundwater discharge areas, this is true primarily for regional flow systems. The superposition of local flow systems associated with surface-water bodies on this regional framework results in complex interactions between groundwater and surface water in all landscapes, regardless of regional topographic position. Research is needed to understand these interactions in relation to climate, landform, geology, and biotic factors. Suggested approaches include multidimensional analyses, interface hydraulic characterization and spatial variability, site-to-region regionalization approaches, as well as cross-disciplinary collaborations (Sophocleous 2002).

One significantly positive trend pertaining to water quality concerns Canada's provision of wastewater treatment facilities in municipalities. In 1989, one in five municipalities were not served by wastewater treatment facilities. Today that number has fallen to 1 in 30 (Federal Commissioner of the Environment and Sustainable Development 2002). This clearly represents a positive move toward addressing the health and ecosystem concerns associated with wastewater emissions.

Another trend is the use of wetlands for wastewater treatment, currently several hundred systems are in place in the U.S. and Canada (Knight *et al.* 1993). Wetlands are invaluable as habitat for fish and wildlife, furnishing nutrients, food and cover. Wetland ecosystems have the capacity to trap and filter a spectrum of contaminants, and are often constructed expressly to clean wastewater. Wetland treatment systems include natural wetlands, constructed surface-flow wetlands, and constructed subsurface flow wetlands (Zimmerman 2003). Degraded lands such as surface mines or damaged wetlands provide several ecological benefits if they are converted into a constructed wetland (Ewel 1997).

Several examples of using watersheds to manage water quality and supply are occurring today. In New York, rather than spend US $6 billion on a new water filtration plant, the city of New York set up a watershed conservation program to protect the 2,000 square mile upstate watershed in the Catskills. At a cost of some US $1.5 billion, the city is buying land in and around the watershed, improving local sewage treatment, and paying farmers to forego planting crops or grazing animals next to streams. As a result, the city is not only avoiding the large capital cost of a filtration plat, but the $300 million a year to operate it, and also is helping to add income to rural parts of the state and improving the quality of life in many watershed communities (Heal 2000). An intensive information campaign in New York has resulted in city residents being aware of the importance of maintaining a healthy watershed – habitats for fish and birds, carbon sequestration, and landscape preservation (Daily and Ellison 2002).

2.5.2 Water Supply

Water is the most abundant environmental resource, covering more than 70% of the earth's surface. Nevertheless, because of salt water and polar ice caps, only 0.6% of the total volume is available as accessible fresh water (Mather and Chapman 1995). Internationally, global freshwater consumption increased six fold between 1900 and 1995, more than twice the rate of population growth, and North Americans consume more water than any other people in the world (Annan 2000, De Villiers 2000). In Canada, water withdrawal rose by 50% between 1972 and 1991 (Environment Canada 2001).

The benefits provided by freshwater fall into three broad categories: 1) the supply of water for drinking, irrigation and other industrial uses, 2) the supply of goods provided by water, such as fish and waterfowl, and 3) the supply of in-stream benefits such as recreation, transportation and flood control (Postel and Carpenter 1997). The volume of water removed from rivers, lakes, and aquifers worldwide is more than 4,430 km^3 per year. Globally, agriculture uses the most water, followed by industrial use, especially in developed countries, with municipal use being the least consumptive. In developed countries, industrial use replaces agricultural use as the greatest consumer of water (Postel *et al.* 1996).

If water consumption continues to increase, coupled with climatic variability such as drought, it will strain water supplies in many areas. Globally, the greatest potential for reducing water losses and using water more efficiently lies in agriculture, which accounted for almost 70% of global water use. Water is "lost" to agriculture in two main ways: first in form of surface runoff which finds its way into rivers and streams and second as evaporation from water and land surfaces (Mather and Chapman 1995). North America has an abundant supply of freshwater resources though unequally distributed across the continent. Surface and groundwater sources together provide an annual 5 308 cubic kilometres of renewable and fossil water to the two countries, which is about 13% of the global total. On a per capita basis, Canada has 10 times more water resources than the United States, although much of Canada's water resources occur away from population centres. However, water scarcities occur in many parts of North America, including some parts of the Canadian prairie provinces and the U.S. southwest (United Nations Environment Programme 2000b).

2.5.3 Glacial Retreat

Glaciers are important sources of fresh water. For example the Bow River in Alberta, arises in a valley covered with glaciers and with high annual precipitation relative to the more arid prairies, which it feeds. The hydrological process that dominates its annual runoff is snow and glacial melt. The Bow River is regionally important as a water resource, particularly during the summer months for water supply and prairie irrigation (Hopkinson and Young 1998). Several studies and empirical evidence show that glaciers have been retreating over the past several decades, with potential impacts on the rivers and fresh water they supply (Schindler 2001).

The Mendenhall Glacier in Alaska experienced dramatic thinning during the 20th century, up to 200 m at lower elevations since 1909, and up to 50 m at higher elevations since 1948. The glacier and the meltwaters that flow from it are integral components of the Mendenhall Valley ecosystem. The glacier contributes significantly to Mendenhall River discharge, up to 50% or more during summer months. Excess glacier ice melt from glacier thinning accounts for approximately 13% of the current annual discharge of the Mendenhall River. Qualitative comparison of glacier thinning to Juneau climate statistics indicates that shrinkage of Mendenhall Glacier is mainly due to local warming: the average annual temperature at Juneau has increased 1.6 C since 1943. Based on recent mass balance measurements, glacier response appears to depend strongly on summer conditions. Juneau temperatures generally decreased between 1947 and 1976 and have been steadily rising since. These trends are reflected in the rate of thinning on the lower glacier, which doubled between 1948 and 1982 (Motyka *et al.* 2003).

Hodge and Trabant (2001) found similar shrinkages in three western North American glaciers, although one showed less shrinkage, probably due to local micro-climate variability. They attribute the changes to atmospheric and oceanic conditions in the tropical and North Pacific, caused by a combination of El-Niño and climate change. These changes correlate qualitatively with a regime shift in Pacific Ocean temperatures (Minobe 1997)

2.6 Climate Change

Climate change refers to any change in climate over time, whether due to natural variability or because of human activity. While there remains uncertainty as to what portion of current climate changes are caused by natural events and what is attributable to human activity, there is evidence that our climate is changing. The following sections describe the possible contributing factors to climate change.

2.6.1 Climate Change: The science

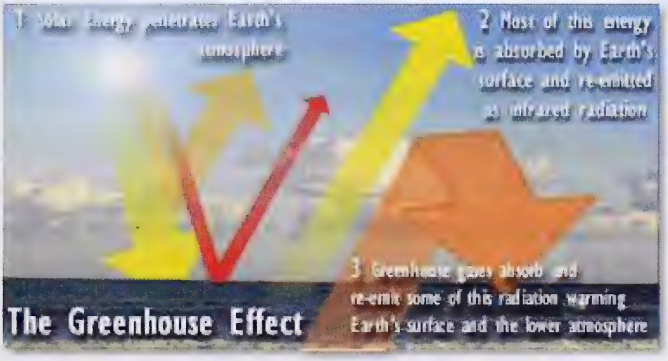
Weather is described as the daily fluctuation in temperature, precipitation, winds, etc. Climate is the long-term average (30-year intervals) of weather. Climate change is a change in the average weather and its variability.

Many natural factors influence the climate system, including incoming solar radiation, volcanic activity, and ocean and atmospheric circulation. The concentration of greenhouse gases in the atmosphere also affects the climate. There is concern that the concentration of these greenhouse gases has been increasing over time and that these increases are linked to human activity. It is possible that anthropogenic (human related) emissions are at least partially responsible for current, observed climate changes.

2.6.2 Greenhouse Effect

Earth's greenhouse effect is a natural phenomenon that helps warm the surface of our planet. Incoming solar radiation heats Earth's surface. Some of this heat is absorbed while the remainder is reflected back into space. Gases in Earth's atmosphere (water vapour (clouds), carbon dioxide, and methane for example) trap heat, keeping Earth some 30°C warmer than it would otherwise be. This is known as the greenhouse effect (Alberta Environment 2003; Fig. 11).

Figure 11 Schematic of the Greenhouse Effect



Source: Alberta Environment, Edmonton

The important greenhouse gas emissions for the climate change discussion are:

- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous oxide (N_2O)

Other greenhouse gases include: water vapour (H_20), chlorofluorocarbons (CFCs), hydrofluocarbons (HFCs), perfluorocarbons (PFCs), ozone (O_3) and sulphur hexafluoride (SF_6). Water vapour is an important greenhouse gas; however, because most water vapour comes from natural sources and cannot be controlled, it is not considered a cause of the enhanced greenhouse effect. The other gases are from industrial processes and are related to human activities. Increased greenhouse gas concentrations will increase the amount of heat trapped by the atmosphere and could increase global temperatures. Since the industrial revolution, the concentration of various greenhouse gases in Earth's atmosphere has increased. The amount of carbon dioxide, for example, has increased by more than 30% since pre-industrial times and is still increasing at an average rate of 0.4% per year. Methane has increased more than 150% since 1750 while nitrous oxide has increased by 16% (Intergovernmental Panel on Climate Change 2001).

2.6.3 Trends

Earth's average temperature has fluctuated over a wide range over time. Average global temperatures were approximately 4.5°C colder during the last glacial maximum. Reliable, recorded temperatures since the mid-1800s indicate that a global warming of nearly 0.5°C has taken place over the past century (Ismail 1993). A similar trend is seen in Alberta where average temperature has warmed by 0.5°C over the past 40 years. A greater degree of warming has occurred more recently and minimum temperatures have warmed more than maximum temperatures (Chaikowsky 2000).

Other observations show a 10% increase in precipitation in the Canadian prairies over the past 40 years, mainly occurring as light to medium rainfall events (Khandekar 2000). Studies from around the world are starting to show patterns that may be linked to climate change. For example, studies show vegetative range shifts of 6.1 km poleward per decade and 6.1 m upward in elevation per decade. Studies also suggest an advancement of spring events by 2.3 days per decade (Parmesan and Yohe 2003). Hall and Fagre (2003) suggest that global warming is causing the retreat of the glaciers in Glacier National Park (by 25 to 50%). In their opinion, glaciers are excellent barometers of climate change, because they respond directly to trends in temperature, precipitation and cloud cover (see section 2.5.1 Glacier Retreat).

The results of research by the Intergovernmental Panel on Climate Change (2001) show a 0.6°C increase in the temperature of the atmosphere since the late 19th century. They also suggest that there have been real differences between the rate of warming in the troposphere[10] and the surface over the last twenty years, and that the magnitude of twentieth century warming is likely to have been the largest of any 100-year time interval during the last 1,000 years. In addition, the 1990s are the warmest decade of the millennium (Intergovernmental Panel on Climate Change 2001).

2.6.4 Climate Change Conclusion

Our climate is changing. Both mitigation and adaptation are needed to address these changes. Mitigation works to control greenhouse gas emissions associated with human activity. Adaptation is required regardless of the causes of climate change. Adaptation addresses impacts where they are felt and seek to reduce our vulnerability to those changes. Taking action on climate change is risk management because of the uncertainties involved.

2.7 Further Reading

Recognized international organizations, such as the United Nations and the World Bank perform substantial analysis of global ecological and sustainability issues. The reader may pursue further reading from these organizations through the following publications.

[10] Troposphere: the layer of atmosphere extending from about 6-10 km upwards from the earth's surface (The Concise Oxford Dictionary, 1990).

United Nations Development Program.	**Human Development Report.** Contains two sections. Section one is topic specific with substantial analysis and tables. The topic for 1997's report is 'Poverty from a people-centered perspective.' It offers a new poverty measure and a six-point plan for poverty eradication. Section two is the 'Human Development Index' with extensive economic, developmental, demographic and health data sets. Surveys over 170 countries. www.undp.org
United Nations Environment Program.	**GEO Report.** Presents information on the state of the global environment. Gives a global analysis of the environmental concerns in each of the earth's seven major geographical regions, along with their major underlying causes. Concerns are dealt with by sector as follows: Land, Forests, Biodiversity, Water, Marine and Coastal Environments, Atmosphere and Urban and Industrial Environments. A region-based participatory process was used to produce the report. It also includes policy responses and directions. **http://www.grida.no/geo/**
World Bank.	**World Development Report.** Comprised of two sections. Section one gives a detailed overview of a particular topic (e.g. 1995 – 'Workers in an Integrated World', 1996 –'From Plan to Market'.). Section II contains the 'World Development Indicators', which mainly focus on economic dimensions. They include: Production, Domestic Absorption, Fiscal and Monetary Accounts, Core International Transactions, External Finance, Human Resources Development and Environmentally Sustainable Development. Surveys over 200 countries. http://econ.worldbank.org/wdr/
World Resources Institute.	**World Resources: A Guide to the Global Environment.** Comprised of two sections. Section one gives a detailed overview of a specific topic. e.g. The Urban Environment in 1996/97 and 'People and the Environment' in 1994/95. The second section contains data on 'Global Conditions and Trends' which is consistently presented in each edition.

These include a mixture of economic, developmental and environmental data as follows: Basic Economic Indicators, Population and Human Development,Forests and Land Cover, Food and Agriculture, Biodiversity, Energy and Materials, Water and Fisheries and Atmosphere and Climate.
www.wri.org/wr-96-97

Worldwatch Institute. **State of the World: A Worldwatch Institute Report on Progress toward a Sustainable Society.**
Identifies and analyses key sustainable development trends from around the world. The analysis is issues-based with a strong environmental component. Ten issues are included each year. A companion book – 'Vital Signs' – provides 'Key Indicators' of current trends.

Chapter III: Strategies for Sustainable Development

> *...a sustainable development strategy should not be seen as just another plan but rather as a new approach to planning that places the emphasis on strategy development as a process. A strategy process should be regarded as an effective, iterative process of consensus-seeking whereby an underlying vision is conceived, targets are formulated, instruments to accomplish those targets are identified and the progress achieved is monitored, with findings fed back to signal the way forward for continuous improvement* (Gesner, Shulz and Kreeb 2001).

Signatories to the *Agenda 21 Programme of Action* (178 countries) agreed to a number of concrete sustainable development actions including the adoption of national strategies for sustainable development (UN 1993: Ch. 8.7). The Development Assistance Committee of the Organisation for Economic Co-operation and Development (OECD DAC 2001) defines national sustainable development strategies as

> A co-ordinated set of participatory and continuously improving processes of analysis, debate, capacity-strengthening, planning and investment, which integrates the economic, social and environmental objectives of society, seeking trade-offs where this is not possible.

In other words, a sustainable development strategy should not be seen as just another plan but rather as a new approach to planning that places the emphasis on strategy development as a process(Gesner, Shulz and Kreeb 2001). Strategic approaches to sustainable development require new ways of thinking and working so as to:

- Move from developing and implementing fixed plans, ideas and solutions towards operating an adaptive system that can continuously improve governance to promote coherence between responses to different challenges.

- Move from a view that it is the state alone which is responsible for development towards one that sees responsibility with society as a whole.

- Move from centralised and controlled decision-making towards sharing results and opportunities, transparent negotiation, co-operation and concerted action.

- Move from a focus on outputs (e.g. projects and laws) towards a focus on outcomes (e.g. impacts of projects and legal changes).

- Move from sectoral towards integrated planning.

- Move from a dependence on external assistance towards domestically-driven and financed development.

- Move towards a process which can accommodate monitoring, learning and improvement (OECD DAC 2001).

A commitment to continuous learning and improvement is central to the notion of sustainable development strategies. Defining, measuring and communicating progress in sustainable development is a critical part of the process. A set of principles (The Bellagio Principles) for assessing sustainable development progress are presented in Box 5).

Canada tabled its first national sustainable development strategy in 1997 and developed an updated version in 2001 (Environment Canada 2001). The strategy is central to meeting Environment Canada's mission, which is: *to make sustainable development a reality in Canada by helping Canadians live and prosper in an environment that needs to be respected, protected and conserved* (Environment Canada 2001). While national strategies provide overall guidance and vision for sustainable development there is a requirement for more regional and local strategies, programmes and activities to advance the agenda of sustainable development. The remainder of the chapter provides a selected list of approaches, ideas and programs for sustainable development strategies.

Box 5 The Bellagio Principles (Hardi and Zdan 1997)

Vision and goals

1 Guiding vision and goals. Assessment of progress toward sustainable development should be guided by a clear vision of sustainable development and goals that define that vision (Criterion 1).

Content

2 Holistic perspective. Assessment of progress toward sustainable development should

- Include review of the whole system as well as of its parts (Criterion 2.1)
- Consider the wellbeing of social, ecological and economic subsystems, their state as well as the direction and rate of change of that state, of their component parts and the interaction between parts (Criterion 2.2)
- Consider positive and negative consequences of human activity, in a way that reflects the costs and benefits for human and ecological systems, in monetary and non-monetary terms (Criterion 2.3)

3 Essential elements. Assessment of progress toward sustainable development should

- Consider equity and disparity within the current population and between present and future generations, dealing with such concerns as resource use, overconsumption and poverty, human rights and access to services, as appropriate (Criterion 3.1)
- Consider the ecological conditions on which life depends (Criterion 3.2)
- Consider economic development and other, non-market, activities that contribute to human and social wellbeing (Criterion 3.3)

4 Adequate scope. Assessment of progress toward sustainable development should

- Adopt a time-horizon long enough to capture human and ecosystem time-scales, thus responding to needs of future generations as well as to those current to short-term decision-making (Criterion 4.1)
- Define the space of study large enough to include not only local but also long-distance impacts on people and ecosystems (Criterion 4.2)
- Build on historic and current conditions to anticipate future conditions—where we want to go, where we could go (Criterion 4.3)

5 Practical focus. Assessment of progress toward sustainable development should be based on

- An explicit set of categories or an organising framework that links vision and goals to indicators and assessment (Criterion 5.3)
- A limited number of key issues for analysis (Criterion 5.3)
- A limited number of indicators or indicator combinations to provide a clearer signal of progress (Criterion 5.3)
- Standardised measurement wherever possible, to permit comparison (Criteria 9 and 10.3)

Box 5 continued The Bellagio Principles (Hardi and Zdan 1997)

- The comparison of indicator values with targets, reference values, ranges, thresholds or direction of trends, as appropriate (Criterion 5.4; Criterion 4.3)

Analysis

6 Openness. Assessment of progress toward sustainable development should

- Make the methods and data that are used accessible to all (Criterion 6.1)
- Make explicit all judgements, assumptions and uncertainties in data and interpretations (Criterion 6.2)

7 Effective communication. Assessment of progress toward sustainable development should

- Be designed to address the needs of the audience and set of users (Criterion 7.1)
- Draw from indicators and other tools that are stimulating and serve to engage decision-makers (Criterion 7.1)
- Aim, from the outset, for simplicity in structure and use of clear and plain language (Criterion 7.2)

8 Broad participation. Assessment of progress toward sustainable development should

- Obtain broad representation of key grass-roots, professional, technical and social groups—including the young, women and indigenous people—to ensure recognition of diverse and changing values (Criterion 8.1)
- Ensure the participation of decision-makers to secure a firm link to adopted policies and resulting action (Criterion 8.2)

Institution

9 Ongoing assessment: assessment of progress toward sustainable development should

- Develop a capacity for repeated measurement to determine trends (Criterion 9.1)
- Be iterative, adaptive and responsive to change and uncertainty, because systems are complex and change frequently (Criterion 9.2)
- Adjust goals, the framework and indicators as new insights are gained (Criterion 9.2)
- Promote development of collective learning and feedback to decision-making (Criterion 9.1)

10 Institutional capacity. Continuity of assessing progress towards sustainable development should be assured by

- Clearly assigning responsibility and providing ongoing support in the decision-making process (Criteria 5.1 and 10.1)
- Providing institutional capacity for data collection, maintenance and documentation (Criterion 10.2)
- Supporting development of local assessment capacity (Criterion 10.3)

3.1 *Integrating the Environment into Policy Making*

The previous chapters discussed a variety of critical issue areas in sustainable development. Climate change, consumption, land use, water quality and supply, biodiversity, and species and habitat loss are among the most critical ecological issue areas. Although policy makers may recognize these as issues, the traditional approach is to formulate economic policy then "add-on" environmental policy. A new approach would assess the environmental and social costs of all development at the outset of the decision-making process (Dixon and Margulis 1994).

Put somewhat differently, Corson (1994) identifies an extensive list of "transitions" required to meet the challenges of sustainable development:

- economic transitions – to economies that increase product quality rather then quantity, and include social and ecological "harm" or costs in the price,

- resource and energy transitions – to greater reliance on renewable resources specifically by decreasing reliance on fossil fuels and other petroleum products,

- technology transitions - from resource depleting, polluting, and chemical dependant technologies to efficient, environmentally regenerative and benign technologies,

- transportation transitions – from fossil fuelled, individual transport, to more efficient options such as light rail systems and low emission vehicles,

- lifestyle transitions – to sustainable patterns of consumption that emphasize quality rather than quantity.

Sustainable development requires coherent and integrated policy-making that transcends the customary silos of disciplinary and sectoral responsibilities. The development and implementation of effective policy for sustainable development will require a kind of transition not mention on the list above – institutional transition. At the national and local level, it will require cross-sectoral and participatory approaches and integrating mechanisms which can engage governments, civil society and the private sector in developing shared visions, planning and decision-making. Policy-makers can also expect a greater level of public scrutiny and demand for accountability (OECD DAC 2001).

3.2 *Set priorities*

Jurisdictions cannot address all sustainable development problems at once. Given that that resources are limited, policy makers must set priorities for environmental interventions (Dixon and Margulis 1994). Environmental priorities should include economic analysis, incorporating full-cost accounting principles by placing value on environmental and social values, e.g. leisure, recreation, and enjoyment of the ecosystems (Padilla 2002). The costs of not considering the environment in national policies are often very high. A World Bank study found the annual costs in Mexico City of health-related air pollution might total US $1 billion (Dixon and Margulis 1994).

3.3 *Revision of the system of national accounts and full-cost accounting*

An important step in shifting to an eco-economy is revising the internationally standardized system of national accounts. As discussed above, the GDP is not a measure of sustainability (Munda 1997, Neumayer 2000, Hamstead 2001,Lawn 2003). A move to the Genuine Progress Indicator – GPI, would be one approach in accounting for national economic, social, and ecological appreciation and depreciation. See Section 1.6.2 for a more detailed explanation.

3.4 *Public Education*

Environmental education for the public is critical for environmentally and socially concerned decision makers because they cannot succeed if they are too far ahead of their citizenry in their thinking and planning (Farley and Costanza 2002). While the application of innovative policy, planning, and economic mechanisms is vital, their success ultimately depends on acceptance by the public. Thus, investment in environmental and social outreach and education must be part of the use of other implementation tools (Krapf 2001). Effective social change and education programs employ a clear and convincing message, authoritatively delivered, that explain:

- the need for change, the benefits to be gained, and specific steps to be taken,
- employ a variety of techniques targeted at a variety of audiences,
- develop links with a wide range of partners,
- enhance the credibility and status of participants (Corson 1994).

Community planning and education tools include public meetings, visioning, popular education, and media, among others (Roseland 2000). Universities also have a role to play in educating decision makers and the community, especially through their research findings and facilities.

3.5 *Scenarios and Modeling*

A specific tool that meets the criteria of flexible policy platforms, backcasting, ecosystem based planning, and the precautionary principle is Scenario Planning (Peterson, Cumming, & Carpenter, 2003). The central idea of scenario planning is to consider a variety of possible futures that include many of the important uncertainties in the system, rather than to focus on the accurate prediction of a single outcome. Ecological and social problems have three fundamental, interacting problems: uncertainty, contingency, and reflexivity. These problems are only rarely resolved in single, predetermined approaches.

Scenario planning embraces uncertainty by viewing it as an opportunity, and is, therefore, most effective where levels of uncertainty are high and system manipulations are difficult or impossible.

Scenario planning follows a six stage process, each stage interacting iteratively with the others.

1. Identification of a focal issue – SP must be focused to be effective.
2. Assessment of the issue – focus on uncertainties is essential.
3. Identification of alternatives – alternatives should be both plausible and relevant.
4. Building the scenarios.
5. Testing scenarios – for example, whereas a scenario may describe people moving away in response to an ecological change, discussion with local residents may reveal such emigration to be quite unlikely.
6. Policy screening – develop scenarios can then be used to test and create policies based on the preferred outcome.

It is apparent that many current sustainable development problems and issues are too complex and involve too may interest groups to be solved through narrowly focused predictive studies. The long term success or failure of sustainable development is heavily dependant on co-operative, long term, and broad scale human efforts. Scenario planning is one means of addressing these challenges. For recent examples of scenario planning with relevance to southern Alberta, see Steinitz *et al.* (2003) and Alberta Environment and Olson & Olson 2000).

3.6 *Modify government policies*

Ecological integrity and sustainability must become part of mainstream economic policy, which means modifying the national system of accounts so they begin to reflect true environmental and social costs of production and consumption. Additionally, policies must assure funding for environmental conservation, restoration and protection (United Nations Environment Programme 2002c). Applying strong policy and a strong example, policy makers can lead the push toward integration of economy, environment, and equity in all aspects of life. Public policy makers must be able to create conditions that are attractive enough for private parties to cooperate, but private parties must also be prepared to commit to public goals (Vollenbroek 2002).

3.7 *Environmental regulations and incentives*

While the matter of consumption is one of private concern, government regulations and incentives must reward desired behaviours more conducive to sustainable development (United Nations Environment Programme 2002c). Some areas to examine are subsidies, taxes and regulation.

3.7.1 Elimination of perverse subsidies

Van Beers and van den Bergh (2002) describe the following reasons for implementing subsidies:

- as an instrument of environmental policy, e.g. to stimulate the production of less polluting goods and services,
- to provide for cheap production factors, notably energy resources,
- to stimulate investments and technological development (R&D),
- as an instrument of labour market policy, notably for creating or maintaining employment,
- as an instrument of trade policy, for instance, to stimulate the export of goods that are domestically produced at prices above world market price levels,
- to protect vulnerable social or income groups.

However, financial incentives offered by governments, especially those promoting development, may result in unintended harm to the environment (Hill and Thompson 2002). These are known as *perverse subsidies.* An example of potentially damaging subsidies is politically decided subsidies that divert farmers away from sustainable practices (Robert *et al.* 2002). In a study of wetland conversion to farmland in Lake St. Clair, Ont., van Vuuren and Roy (1993) found the agricultural benefits were greater than the private and social benefits of preserving the wetland, the difference lying in drainage subsidies and property taxes for the wetland conversions.

The usefulness of subsidies depends on their contribution to the intended goal, weighed against their potentially unintended and undesirable impact on the environment, known as environmentally damaging subsidies or perverse subsidies (Van Beers and van den Bergh 2002). Such subsidies may result in environmental damage because the private or corporate benefits from receiving the subsidy or tax incentives outweigh the cost to the environment (Balmford *et al.* 2002). For example in the United States, estimates of subsidies for the automobile range as high as $730 billion per year (in the form of road building grants, failure to account for ecological and health degradation resulting from the extraction and combustion of fossil fuels etc.). Levied as a tax on gasoline, this would amount to U.S. $7/gallon of gasoline (Orr 2001).

3.7.2 Tax based tools

The Organisation for Economic Co-operation and Development (OECD) adopted the Polluter Pays Principle (see Section 3.7.3) as a guideline for domestic environmental policy in 1972, and further clarified it in 1974 (Hyung-Jin 2000). Initially, the PPP meant that the polluter had to bear the cost of measures to prevent and control pollution to the level established by the government. The goal was to keep governments from financing new environmental protection measures in the form of subsidies and to prevent differences in subsidies between countries from causing significant distortions in international trade and investment. Later, it came to include compensation payments, taxes and charges, and is now evolving in certain instruments towards encompassing all pollution-related expenditure (OECD 2002).

Polluter-pays taxes, green taxes (also known as Pigouvian taxes[11]), and other such tools are often set as sources of revenue generation rather than for some specific concern for

[11] Named for Prof. A. C. Pigou (1887-1959), credited for the analysis of taxation as an economically efficient instrument that discourages harmful behaviour (Ciocirlan and Yandou 2003).

the environment (Ciocirlan and Yandle 2003). They have mostly been viewed as adding costs to industry and thus have been seen as a restriction on economic prosperity. They may not discourage pollution, but rather collect compensation from those who harm the natural environment and human health (Cerin and Karlson 2002).

3.7.3 Environmental Regulation

On the other hand, environmental awareness may influence the competitiveness of companies. Innovative solutions from regulatory pressure not only decrease environmental problems, but also result in more eco-friendly products and better competitiveness (Cerin and Karlson 2002).

Porter and van der Linde (1995) cite five purposes that properly written environmental regulation can fulfill.

1. Regulation signals companies about likely resource inefficiencies and potential technological improvements. It helps companies still inexperienced in measuring their discharges, understanding the full costs of incomplete utilization of resources and toxicity, and conceiving new approaches to minimize discharges or eliminate hazardous substances,
2. Regulation focused on information gathering can achieve major benefits by raising corporate awareness. For example, Toxics Release Inventories, published annually as part of the 1986 Superfund reauthorization, require more than 20,000 manufacturing plants to report their releases of some 320 toxic chemicals. Such information gathering often leads to environmental improvement without mandating pollution reductions, sometimes even at lower costs,
3. Regulation reduces the uncertainty that investments to address the environment will be valuable. Greater certainty encourages investment in any area,
4. Regulation creates pressure that motivates innovation and progress. Economists are used to the argument that pressure for innovation can come from strong competitors, demanding customers or rising prices of raw materials. Properly constructed regulation can also provide such pressure,

5. Regulation levels the transitional playing field. During the transition period to innovation-based solutions, regulation ensures that one company cannot opportunistically gain position by avoiding environmental investments. Regulations provide a buffer until new technologies become proven and learning effects reduce their costs.

A survey of a variety of companies in 14 countries in Europe, Africa and Asia confirmed some of these observations. It revealed that the biggest influences on companies moving towards sustainability were the law or regulation and market opportunities or competitiveness (Bebbington and Gray 1997).

On the other hand, a company's actions may reduce the likelihood of regulation. In one instance, Cargill instituted a program that allowed farmers to apply less plant nutrients and agrochemicals through techniques such as soil testing and satellite-linked technology. Farmers save money by buying less and the environment benefited through less run-off. Cargill loses money in the short term, but gains in the longer term through more satisfied customers and less likelihood of regulatory intervention (DeSimone and Popoff 1997).

3.8 Ecosystem Based Management

Ecosystem based management seeks to transcend the restrictions of political and administrative boundaries to achieve more effective integrated management of resources and ecosystems at regional and landscape scales. Ecosystem based management typically deals with large landscape units and focuses on coordination and integration of planning and management systems with the goals of maintaining or restoring a balance of social and ecological objectives (Slocombe 1998). Application of this approach means evaluating every decision made on land or resource use in terms of how it affects the essential functioning of ecosystems – and thus their productivity (World Resources Institute 2000). Some authors go so far as to suggest that economic activity necessarily leads to ecological degradation unless ecosystem-based management is integrated into all facets of decision-making (Timoney and Lee 2001). Nevertheless, regardless of the degree of sustainability applied in crafting an ecosystem based management approach to sustainable development, this approach is ultimately concerned with shifting management focus from resource extraction to ecosystem management (Quinn 2002).

The fundamentals of an ecosystem based approach to management are outlined in the Guide to World Resources 2000-2001 (World Resources Institute 2000).

An ecosystem approach:

- Is an integrated approach. It considers the entire range of possible goods and services in an ecosystem unit and attempts to optimize the mix of benefits within and across ecosystems. Its purpose is to make trade-offs efficient, transparent, and sustainable,
- Reorients boundaries that traditionally have defined the management of ecosystems. It looks beyond traditional jurisdictional boundaries, and is more concerned with ecosystem boundaries than political ones,
- Takes the long view. This approach works across a variety of scales and time dimensions, seeking to ensure social and ecosystem stability into the future,
- Includes people. It explicitly links human needs to the biological capacity of ecosystems to fulfill those needs. Although it is attentive to ecosystem processes and biological thresholds, it acknowledges an appropriate place for human modification of ecosystems.

3.9 *Understanding International Drivers*

3.9.1 The World Bank

The World Bank (the Bank) uses environmental assessment is to examine the potential environmental risks and benefits associated with Bank lending operations. The Bank's environmental assessment policy and procedures are described in OP/BP (Operational

Policy/Bank Procedures) 4.01. Under OP/BP 4.01, Bank lending operations include investment lending, sector lending, and rehabilitation lending through financial intermediaries, and investment components of hybrid lending. Prototype Carbon Fund and Global Environmental Facility co-financed projects are also subject to the provisions of OP/BP 4.01 (World Bank 1999).

Not only does the Bank require an environmental assessment prior to lending money, any Bank funded project may be required to undergo a "Request for Inspection" if stakeholders feel a project should be investigated for environmental guideline compliance. An example is a pipeline built by ExonMobil in Chad and Cameroon. The Center for the Environment and Development, a Yaounde-based NGO, and various individuals, submitted a Request for Inspection to the World Bank. The request raised questions about insufficient information during project preparation, consultation, occupational health and safety, compensation, HIV/AIDS and the adequacy of environmental and social impact studies. An independent panel completed its evaluation in July of 2003, and submitted an Action Plan outlining 15 specific actions aimed at enhancing project quality, including:

a. Additional Data Collection - monitoring data will continue to be collected to facilitate ongoing assessment of impacts.
b. Analysis of Cumulative Impacts - the Long-Term Vision Study of the Environmental and Social Management of the Petroleum Sector, under the CAPECE project, will address the cumulative impact of the Pipeline Project on the overall economic and social development of Cameroon.
c. Health and HIV/AIDS - agreement has been reached with the Ministry of Health to develop an action plan for health care facilities along the pipeline route and to contract NGOs and consultants on HIV/AIDS issues. CAPECE will finance part of the activities, while the IDA-supported national HIV/AIDS project will fund others.
d. Institutional Capacity - an action plan was agreed upon, during the CAPECE Mid-Term Review, to speed up implementation of capacity

development activities, including acceleration of the procurement process and strengthening of field-based activities. (World Bank 2003)

3.9.2 The Equator Group

An interesting development in the environmental management arena came about at an IFC (International Finance Corporation) meeting of major banks in 2003 to discuss environmental and social issues in project finance (IFC 2003). At that meeting, the banks present developed a banking industry framework for addressing environmental and social risks in project financing. This led to the drafting of the Equator Principles - "an industry approach for financial institutions in determining, assessing and managing environmental & social risk in project financing". The Equator Principles use the World Bank environmental guidelines as a basis, with augmented requirements where the World Bank has gaps. The environmental assessment is comprised of the following:

b) assessment of the baseline environmental and social conditions
c) requirements under host country laws and regulations, applicable international treaties and agreements
d) sustainable development and use of renewable natural resources
e) protection of human health, cultural properties, and biodiversity, including endangered species and sensitive ecosystems
f) use of dangerous substances
g) major hazards
h) occupational health and safety
i) fire prevention and life safety
j) socioeconomic impacts
k) land acquisition and land use
l) involuntary resettlement
m) impacts on indigenous peoples and communities
n) cumulative impacts of existing projects, the proposed project, and anticipated future projects
o) participation of affected parties in the design, review and implementation of the project
p) consideration of feasible environmentally and socially preferable alternatives
q) efficient production, delivery and use of energy
r) pollution prevention and waste minimization, pollution controls (liquid effluents and air emissions) and solid and chemical waste management

Projects requiring lending fall into those requiring an environmental assessment (EA) and those that do not. Projects failing to meet the environmental standards set by the IFC will not receive funding. Currently sixteen banks are signatories to the principles, including ABN Amro, Barclays, Credit Suisse, Citigroup, the Royal Bank of Canada and the Royal Bank of Scotland.

3.9.3 Environmental Standards - ISO 14000

ISO stands for the International Organization for Standardization, located in Geneva, Switzerland. ISO promotes the development and implementation of voluntary international standards, both for particular products and for environmental management issues. ISO 14000 refers to a series of voluntary standards in the environmental field under development by ISO. Included in the ISO 14000 series are the ISO 14001 EMS Standard and other standards in fields such as environmental auditing, environmental performance evaluation, environmental labeling, and life-cycle assessment (International Organization for Standardization 2003).

Communities and companies may subscribe to ISO 14000 and ASO 140001 standards. ISO assesses their implementation of the standards and if in compliance, they receive ISO 14000 or 140001 registration. Because it is a standard, having registration indicates the level of environmental management that a company employs. It also provides a framework for companies to implement environmental management. Registrations have been increasing rapidly in Europe and Japan, and in the United States (Thompson 2002).

Summary

Sustainable development is an evolving theme for business and governments and the literature identifies many trends for defining and measuring it including: 1) forms of capital and strong and weak sustainability, 2) inter- and intra-generational equity and social justice, 3) ecological footprint, 4) indicators, triple bottom line, GPI, and 5) the Natural Step. The literature includes proponents and opponents of these trends and measures, and shows governments and industry are making use of them to varying degrees.

The literature also contains analyses of global issues in sustainable development, including environmental, social, and economic issues. This report focused on those with applicability to Southern Alberta. Population growth is a worldwide phenomenon, and is evident in Alberta. It drives consumption of resources; energy, especially fossil fuels; land, including agriculture, forestry, and urban expansion; and, water. Land use effects soil, wildlife habitat, and species biodiversity. Human use also affects water quantity and quality. Fossil fuel use has been cited as a cause for global warming, however the literature contains much discussion about other potential causes, including; solar radiation, volcanic activity, ocean warming.

The literature review presented here is part of the Phase 1 of *the Southern Alberta Landscapes: Meeting the Challenges Ahead* and should serve to identify issues, risks, and opportunities relating to sustainability in Southern Alberta over the next 50 years.

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