PART 1

1

The Concept of Sustainable Development and its Practical Implications

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Sustainable development is an approach to development which focuses on integrating economic activity with environmental protection and social concerns. This chapter describes the emergence of the concept of sustainable development as a response to destructive social and environmental effects of the prevailing approach to economic growth and discusses its practical implications. The chapter argues that the transition to a more sustainable society requires new ways of meeting our needs which can reduce the level of material consumption and reduce environmental damage without affecting quality of life. This will require, above all, limiting the throughput of materials and energy in the economy and finding less wasteful ways of meeting needs through increasing efficiency, reusing materials and using sustainable technologies. However, as the chapter points out, meeting the objective of sustainable development requires not only reducing the scale of polluting activities and excessive levels of consumption, but also calls for well-planned actions to alleviate poverty and achieve greater equity and distribution of opportunities both within and between countries.

1.1 Introduction

Around the world we see signs of severe stress on our interdependent economic, environmental and social systems. Population is growing – it topped 6 billion in 2000, up from

Sustainable Development in Practice: Case Studies for Engineers and Scientists, Second Edition
Edited by Adisa Azapagic and Slobodan Perdan

4.4 billion in 1980, and it is expected to reach 8 billion by 2025 (UNCSD, 2002). Excessive consumption and poverty continue to put enormous pressure on the environment. In many areas, the state of the environment is much more fragile and degraded than it was a few decades ago. Despite notable improvements in areas such as river and air quality in places like Europe and North America, generally there has been a steady decline in the environment, especially across large parts of the developing world (UNEP, 2002, 2007).

There are some alarming trends underway. Most recent global environmental assessments (UNEP, 2002, 2007, 2009; MA, 2005; Solomon *et al*., 2007) put them into stark figures, characteristic examples of which include:

- Twenty per cent of Earth's land cover has been significantly degraded by human activity and 60% of the planet's ecosystems are now damaged or threatened (UNEP, 2009).
- Species are becoming extinct at rates which are a 100 times faster than the rate shown in the fossil record, because of land-use changes, habitat loss, overexploitation of resources, pollution and the spread of invasive alien species (MA, 2005; UNEP, 2007). Of the major vertebrate groups that have been comprehensively assessed, over 30% of amphibians, 23% of mammals and 12% of birds are threatened (UNEP, 2007).
- Concentrations of carbon dioxide, the main gas linked with global warming, currently stand at 386 parts per million, or more than 25% higher than in 150 years ago. Concentrations of other greenhouse gases, such as methane and halocarbons, have also risen (Solomon *et al*., 2007).
- Global average temperatures have risen by about 0.74 °C since 1906, and the rise this century is projected to be between 1.8 and 4 °C; some scientists believe a 2 °C increase would be a threshold beyond which the threat of major and irreversible damage becomes more plausible (Solomon *et al*., 2007; UNEP, 2007).
- Available freshwater resources are declining: some 80 countries, amounting to 40% of the world's population, are suffering serious water shortages; by 2025, 1.8 billion people will live in countries with absolute water scarcity (UNEP, 2007).
- Around half of the world's rivers are seriously depleted and polluted (UNEP, 2002).
- More than 2 million people worldwide are estimated to die prematurely every year from indoor and outdoor air pollution (UNEP, 2007).

Other noteworthy trends include:

- Around 1.4 billion people are living in extreme poverty (measured as $1.25 a day) (UN, 2009);
- The number of hungry people worldwide grew to 963 million, or about 14.6% of the world population of 6.6 billion, representing an increase of 142 million over the figure for 1990–1992 (FAO, 2009);
- More than 100 million primary school age children remain out of school (UN, 2009);
- Around 1.1 billion people still lack access to safe drinking water and an estimated 2.6 billion people today lack improved sanitation facilities (UNEP, 2007);
- Poverty claims the lives of 25 000 children each day (UNICEF, 2000).

These and a host of other trends suggest that our current development course is unsustainable. The high and increasing consumption of scarce resources, the resulting pollution compounded by population growth and the growing imbalance in development between

different countries pose unacceptable risks to communities, nations and humanity as a whole. It has become clear that economic development that disregards environmental and social impacts can bring unintended and unwanted consequences, as evidenced by the threat of climate change, overuse of freshwater resources, loss of biological diversity and raising inequalities.

The concept of sustainable development has grown out of concerns about these adverse trends. In essence, it is an approach to development which focuses on integrating economic activity with environmental protection and social concerns.

1.2 Development of the Concept

The concept of sustainable development as we know it today emerged in the 1980s as a response to the destructive social and environmental effects of the prevailing approach to 'economic growth'.

The idea originated within the environmental movement. One of the earliest formulations of the concept of sustainable development can be found in the 1980's World Conservation Strategy jointly presented by the UN Environment Programme, the World Wildlife Fund and the International Union for Conservation of Nature and Natural Resources (IUCN/UNEP/WWF, 1980). This early formulation emphasized that:

> 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 actions.

It called for three priorities to be built into development policies: the maintenance of ecological processes; the sustainable use of resources; and the maintenance of genetic diversity.

However, the concept of sustainable development gained a wider recognition only after the World Commission on Environment and Development (WCED) published its report 'Our common future' (also known as 'the Brundtland Report') in 1987. It was this report that gave the concept the prominence it has today.

The WCED report set the benchmark for all future discussions on sustainable development. The starting point for the commission's work was their acknowledgement that the future of humanity is threatened. 'Our common future' (WCED, 1987) opened by declaring:

> The Earth is one but the world is not. We all depend on one biosphere for sustaining our lives. Yet each community, each country, strives for survival and prosperity with little regard for its impacts on others. Some consume the Earth's resources at a rate that would leave little for future generations. Others, many more in number, consume far too little and live with the prospects of hunger, squalor, disease, and early death.

To confront the challenges of overconsumption on the one hand and grinding poverty on the other hand, the commission called for sustainable development, defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.

In order to reverse unsustainable trends the WCED recommended the following seven critical actions aimed at ensuring a good quality of life for people around the world (WCED, 1987):

- revive growth;
- change the quality of growth;
- meet essential needs and aspirations for jobs, food, energy, water and sanitation;
- ensure a sustainable level of population;
- conserve and enhance the resource base;
- reorient technology and manage risk; and
- include and combine environment and economics considerations in decision-making.

Since the Brundtland Report, a whole series of events and initiatives have brought us to the wide-ranging interpretation of sustainable development that we see today. One of the key events was, undoubtedly, the United Nations Conference on Environment and Development, more informally known as the Earth Summit, held in Rio de Janeiro in 1992. At the Earth Summit, representatives of nearly 180 countries endorsed the Rio Declaration on Environment and Development which set out 27 principles supporting sustainable development. The assembled leaders also signed the Framework Convention on Climate Change, the Convention on Biological Diversity, and the Forest Principles. They also agreed a global plan of action, Agenda 21, designed to deliver a more sustainable pattern of development, and recommended that all countries should produce national sustainable development strategies.

Ten years later, in September 2002, at the World Summit on Sustainable Development (WSSD) in Johannesburg, leaders and representatives of 183 countries reaffirmed sustainable development as a central element of the international agenda. The present governments agreed to a wide range of concrete commitments and targets for action to achieve sustainable development objectives, including (WSSD, 2002a):

- halve, by the year 2015, the proportion of people in poverty;
- encourage and promote the development of a 10-year framework of programmes to accelerate the shift towards sustainable consumption and production;
- diversify energy supply and substantially increase the global share of renewable energy sources in order to increase its contribution to total energy supply;
- improve access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services and resources;
- accelerate the development and dissemination of energy efficiency and energy conservation technologies, including the promotion of research and development;
- develop integrated water resources management and water efficiency plans by 2005; and
- achieve by 2010 a significant reduction in the current rate of loss of biological diversity.

The Johannesburg Summit moved the sustainability agenda further, and consolidated and broadened the understanding of sustainable development, particularly the important linkages between poverty, the environment and the use of natural resources.

These political events brought sustainable development firmly into the public arena and established it as a widely accepted goal for policy makers. As a result, we have seen a proliferation of sustainable development strategies and policies, innovative technological,

scientific and educational initiatives, and new legislative regimes and institutions. The concept of sustainable development now influences governance, business and economic activity at different levels, and affects individual and society lifestyle choices.

In the last three decades, a continuing debate about what sustainability truly means has produced a plethora of definitions. A wide variety of groups – ranging from businesses to national governments to international organizations – have adopted the concept and given it their own particular interpretations.

The UK Government, for example, in its sustainable development strategy, defines sustainable development as 'the simple idea of ensuring a better quality of life for everyone, now and for generations to come' (DETR, 1999; DEFRA, 2005). The UK Government's sustainable development strategy aims to deliver a 'strong, healthy and just society within global limits' (DEFRA, 2005).

The strategy emphasizes that sustainable development means meeting the following four objectives at the same time, in the UK and the world as a whole:

- social progress which recognizes the needs of everyone;
- effective protection of the environment;
- prudent use of natural resources; and
- maintenance of high and stable levels of economic growth and employment.

Most countries in the developed world, and many developing countries, have now incorporated sustainability into their national planning, and defined sustainable development in their national contexts. According to national reports received from governments before the World Summit on Sustainable Development in 2002, about 85 countries have developed some kind of national sustainability strategy, although the nature and effectiveness of those strategies vary considerably from country to country (UNCSD, 2002).

The concept of sustainable development has also made inroads into the business community. In the last three decades, the understanding and acceptance of sustainable development within the business community have grown significantly. Most forward-looking companies and businesses are beginning to integrate sustainability into corporate strategies and practice. They recognize that the challenge of sustainable development for the business enterprise means adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future (IISD, 1992). This way of thinking is, for instance, behind the World Business Council for Sustainable Development (WBCSD), a wide coalition of more than 200 international companies (including some of the world's largest corporations) united by 'a shared commitment to sustainable development via the three pillars of economic growth, ecological balance and social progress' (WBCSD, 2010). Although not all of the WBCSD component corporations have exemplary environmental records, this coalition has been involved actively in the activities aimed at identifying and defining sustainable pathways for businesses.

Many professional organizations, including engineering and scientific associations, have incorporated sustainable development into their mission statements, statutes and codes. As an example, in their 'Melbourne communiqué' representatives of 20 chemical engineering organizations from around the world committed themselves to using their 'skills to strive to improve the quality of life, foster employment, advance economic and social development and protect the environment through sustainable development' (WCEC, 2001).

Finally, environmental organizations contributed significantly to the development of the concept of sustainable development. After all, sustainable development began life as one of their concepts. One of the most prominent and influential definitions comes from a 'Strategy for Sustainable Living' (UNEP/WWF/IUCN, 1991), another joint publication by the United Nations Environmental Programme (UNEP), International Union for the Conservation of Nature (IUCN), and World Wildlife Fund (WWF), in which sustainable development is defined as 'improving the quality of life while living within the carrying capacity of supporting ecosystems'. In a similar vein, in its 'Action for Global Sustainability', the Union of Concerned Scientists advocates that 'humanity must learn to live within the limits of natural systems while ensuring an adequate living standard for all people' (UCS, 2001).

These are just some of the many formulations which have over the years increased our understanding of what sustainable development means within many different contexts. The principle of sustainable development and many of its objectives have now been widely adopted, and the agenda has moved from the question of 'What does sustainable development mean?' on to the questions of 'How do we achieve sustainable development?' and 'How do we measure our progress towards achieving it?' (for more on measuring sustainability, see Chapter 2). Yet, in contrast to rapid progress on *developing* the *concepts* of sustainable development, progress on its *implementation* has been slow. Sustainable development, it is fair to say, remains largely theoretical for the majority of the world's population.

1.3 Sustainable Development: Implementation

Sustainable development presents a framework for change rather than a list of prescriptions to achieve it. There is, however, a growing consensus that the transition to a more sustainable society requires new ways of meeting our needs which can reduce the level of material consumption and reduce environmental damage without affecting quality of life. This will require, above all, limiting the throughput of materials and energy in the economy and finding less wasteful ways of meeting needs through increasing efficiency, reusing materials and using sustainable technologies.

Moving to a more sustainable path, however, does not only require a better management of the environment. Certain minimal socio-economic conditions must also be met to ensure the necessary consensus for short-term actions and long-term stability. 'Greening' industrial economies whilst ignoring the need for poverty alleviation and the redistribution of opportunity would not ensure long-term sustainability. True sustainability means ensuring a satisfying quality of life for everyone. Meeting this objective therefore, requires not only reducing the scale of polluting activities and reducing excessive levels of consumption, but also calls for well-planned actions to alleviate poverty and achieve greater equity and distribution of opportunities both within and between countries.

1.3.1 Sustainable Production and Consumption

According to the Johannesburg Plan of Implementation, adopted at the 2002 World Summit on Sustainable Development, 'fundamental changes in the way societies produce and consume are indispensable for achieving global sustainable development' (WSSD, 2002a).

There are some encouraging signs of a more sustainable production, such as energy efficiency improvements and lower consumption of raw materials per unit of production in industrialized societies. The European Union, for example, achieved significant economic growth in the 1990s without notable increases in its consumption of fossil fuels. This was mainly due to a shift in production and consumption from material- and energy-intensive sectors to services. However, these gains in efficiency have been offset by an increase in the volume of goods and services consumed and discarded. For instance, according to the Organization for Economic Cooperation and Development (OECD), the amount of waste generated in Europe between 1990 and 1995, increased by 10% and has continued to grow since. It is estimated that by 2020 Europe could be generating 45% more waste than it generated in 1995 (for more details on the issue of waste, see Chapter 10).

As more natural resources are being consumed and more pollution is generated, it is becoming clear that decoupling economic growth from adverse environmental impacts, such as emissions of greenhouse gases, waste production and use of hazardous materials, holds one of the keys to sustainable development.

While governments have an important role to play in this process by stimulating companies to act more sustainably through incentives, rewards and the threat of penalties, it is ultimately businesses that will deliver a supply of goods and services that are less damaging and more resource efficient (DEFRA, 2010).

Some producers have already responded to this challenge by using eco-design tools to rethink products and services: creating goods that perform as well or better than conventional products, using resources more productively, reducing pollution and improving profitability.

One of the prominent initiatives in this respect is the eco-efficiency approach, developed by the World Business Council for Sustainable Development (WBCSD).

Eco-efficiency calls for business to achieve more value from lower inputs of materials and energy and with reduced emissions. It applies throughout a business, to marketing and product development just as much as to manufacturing or distribution. The WBCSD has identified seven elements that business can use to improve their eco- efficiency and should be considered at each stage in the production process of all goods and services (WBCSD, 1996, 2000, 2001; de Simone and Popoff, 1997):

- reducing the material requirements (total mass consumed);
- reducing the energy intensity (energy consumed during every phase of production);
- reducing toxic dispersion (release of toxic substances to all media);
- enhancing material recyclability (reuse of materials or energy);
- maximizing sustainable use of renewable resources (avoiding depletion of finite resources);
- extending product durability (optimizing product life);
- increasing the service intensity (creating value added while reducing environmental impacts).

A central tenet of eco-efficiency is that it requires improvement in most, if not all, of the above elements over the medium to long term, while maintaining performance with respect to the others. These seven elements may be thought of as being concerned with three broad objectives (WBCSD, 2000).

- **Reducing the consumption of resources**: this includes minimizing the use of energy, materials, water and land, enhancing recyclability and product durability, and closing material loops.
- **Reducing the impact on nature**: this includes minimizing air emissions, water discharges, waste disposal and the dispersion of toxic substances, as well as fostering the sustainable use of renewable resources.
- **Increasing product or service value**: this means providing more benefits to customers through product functionality, flexibility and modularity, providing additional services and focusing on selling the functional needs that customers actually want. This raises the possibility of the customer receiving the same functional need with fewer materials and less resources. It also improves the prospects of closing material loops, because responsibility and ownership and, therefore, concern for efficient use remain with the service provider.

In short, eco-efficient companies and industries must deliver competitively priced goods and services that improve peoples' quality of life, while reducing ecological impacts and resource-use intensity to a level within the Earth's carrying capacity.

Increasing the resource productivity is an important measure in the move towards more sustainable economic activities. Yet, how much more efficient do companies and industries need to be to become more sustainable?

There have been some estimates that, globally, the goal should be to quadruple resource productivity throughout the economy so that wealth is doubled, and resource use is halved. This has been described as the need to achieve a 'Factor 4' increase in resource efficiency (von Weizsäcker *et al.*, 1997).

Often associated with 'Factor 4' is 'Factor 10', whose proponents argue that, in the long term, a 10-fold reduction in resource consumption in the industrialized countries is necessary if we are to approach sustainability (International Factor 10 Club, 1997; UNEP, 2000). The reasoning behind this is that, globally, consumption needs to be halved, but that the greatest reduction should be borne by those countries that are currently the most profligate in their use of resources. Thus, UNEP (2000) stated that 'a 10-fold reduction in resource consumption in the industrialized countries is a necessary long-term target if adequate resources are to be released for the needs of developing countries'.

Implementing sustainability strategies, such as Factor 4 and Factor 10, and increasing resource efficiency will require step changes in processes and products. This is unlikely to be achieved with incremental improvements. Shifting economic activity towards a more sustainable pattern will certainly require new ideas to encourage us to meet our needs in different, less harmful ways, and innovative approaches to the development and use of technologies, products and services.

Here, we turn our attention to the role of technology in this process.

1.3.2 Sustainable Technologies

Sustainable technologies enable humans to meet their needs with minimum impact on the environment. Many kinds of sustainable technologies already exist, ranging from direct solar and wind power to recycling. Some, such as wind and water power, were invented centuries ago. The others are much 'younger'; for example, the solar cell was invented in the

1950s. These technologies, however, have failed to become widespread largely for social and economic reasons, not technical ones. Many other technologies and practices that could reduce the environmental impacts of economic activities are also already available. For example, numerous technical means of improving the scope and rates of recycling of waste materials exist but are poorly used in many countries.

The latest technological advances offer even greater opportunities for a more sustainable production. Just as technological progress has been a major source of economic growth over the past two centuries, so today's technological transformations could play a pivotal role in achieving sustainable development. They offer the prospect of reconciling economic development and prosperity with environmental improvement, and create new possibilities for reducing environmental impacts, improving health, expanding knowledge, stimulating economic growth and ensuring a better quality of life. Leading these transformations are the accelerated developments in information and communications technology, biotechnology and just-emerging nanotechnology.

Innovations in information and communications technology nowadays enable us to process, store and rapidly distribute enormous amounts of information. By dramatically increasing access to information and communications, these new technologies are breaking barriers to knowledge and participation, offering tremendous possibilities for improving education and political participation. They also create new economic opportunities, thereby contributing to economic growth and employment creation.

Modern biotechnology – recombinant DNA technology – is transforming life sciences. Genetics is now the basis of life sciences, and much research in pharmaceuticals and plant breeding is now based on biotechnology. The power of genetics can now be used to engineer the attributes of plants and other organisms, creating the potential for huge advances, particularly in agriculture and medicine. Biotechnology can speed up plant breeding and drive the development of new crop varieties with greater drought and disease resistance, more nutritional value and less environmental stress. Pest-resistant genetically modified (GM) crops, for instance, could reduce the need to use pesticides that can harm soil quality and human health.

Designing new drugs and treatments based on genomics and related technologies offers potential for tackling the major health challenges facing poor countries and people. The cloning of Dolly the sheep has pushed scientific frontiers even further and will transform technology development for years to come. The mapping of the genes that comprise the human genome, together with the development of genetic screening, makes possible even the alteration of the human species itself!

To these two new technologies may soon be added a third, the just-emerging nanotechnology, which promises to revolutionize medicine, electronics and chemistry. Nanotechnology is evolving from scientific breakthroughs enabling engineering and science at the molecular level, and it is promising to create smaller and cheaper devices, using less material and consuming less energy. Although research into nanotechnology is still in its infancy, it has already created single-molecule transistors, an enzyme-powered biomolecular motor with nickel propellers, and a minute carrier able to cross from the blood to the brain to deliver chemicals to fight tumours. Future (still hypothetical) applications suggested include cheap, light materials strong enough to make space transport economical, nano-scale robots which will heal injured human tissue and remove obstructions in the circulatory system, and solar nanotechnologies which may in the future be able to provide energy to an ever-growing population.

These accelerated technological developments will undoubtedly further transform the way we live, work, communicate, produce and consume. Many products – vaccines for infectious diseases, drought-tolerant plant varieties for farmers in uncertain climates, clean energy sources for cooking and heating, Internet access for information and communications – contribute directly to sustainable development through improving people's health, nutrition, knowledge and living standards, reducing environmental pollution, and increasing people's ability to participate more actively in the social, economic and political life of their communities. They also deliver the necessary improvement in resource efficiency and contribute to economic growth through the productivity gains they generate.

However, just as technological advance in these instances opens new avenues for sustainable development, it also creates new risks. Every technological advance brings potential risks, some of which are not easy to predict. Nuclear power, once believed to be a limitless source of energy, came to be seen as a dangerous threat to health and the environment after the accidents at Three Mile Island in the United States and Chernobyl in Ukraine. Chlorofluorocarbons (CFCs), until recently widely used in refrigerators, aerosol cans and air conditioners, caused the depletion of the ozone layer and increased danger of skin cancer for people in the countries exposed to increased ultraviolet radiation. Reliance on fossil fuels as *the* energy source has led to increased atmospheric carbon dioxide levels and the prospect of global warming.

As in previous developments, today's technological advances raise concerns about their possible environmental, health and socio-economic impacts. There is, for instance, a growing public unease about some aspects of information and communications technology, such as the health risks associated with the use of mobile phones or the role of the Internet in facilitating drug trade and terrorist networks and the dissemination of child pornography. Some concerns are also raised about potential contribution of information technology to raising inequalities and widening the gap between the rich and the poor, both at national and global levels.

Cutting-edge biotechnological research has raised ethical concerns about the possibility of human cloning and the easy manufacture of devastating biological weapons. Serious questions have been asked about the potential risks posed by genetically modified organisms (GMOs) with some concerns that they could adversely affect other species, disrupt entire eco-systems and cause risks to human health. With genetically modified foods, the two main health concerns are that the introduction of novel genes could make a food toxic and that they could introduce new allergens into foods, causing reactions in some people. As to possible harms to the environment, the concern is that genetically modified organisms could reproduce and interbreed with natural organisms, thereby spreading to new environments and future generations in an unforeseeable and uncontrollable way. Doubt is also cast on the role of GM technology in providing the answer to food security, with the claim that technological solutions like GM crops overshadow the real social and environmental problems that cause hunger and malnutrition.

Most recently, some concerns about nanotechnology have been expressed as well. Echoing in some way the concerns about biotechnology, the problem areas include the environment ('What will the new nano-materials do when they are released?') and equity ('Who will benefit – just the rich, or the poor as well?').

It has been suggested that most effective response to technological risk is the adoption of a precautionary principle. The precautionary principle states that when an activity

raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically (see Box 1.1 for more detail on the precautionary principle). Sometimes it seems to imply a generalized hostility to science and technology as such, but, more rationally, it means taking action before risks are conclusively established. It is, basically, a 'better-safe-than-sorry' principle.

Box 1.1 The precautionary principle

Although applied more broadly, the precautionary principle has been developed primarily in the context of environmental policy. It emerged in European environmental policies in the late 1970s and has since become enshrined in numerous international treaties and declarations. It was explicitly recognized during the UN Conference on Environment and Development (UNCED) in Rio de Janeiro 1992 and included in the so-called Rio Declaration. Since then, the precautionary principle has been implemented in various environmental instruments, and in particular in those related to global climate change, ozone-depleting substances and biodiversity conservation. It is, by the Treaty on European Union (1992), the basis for European environmental law and plays an increasing role in developing environmental health policies as well (Foster *et al.*, 2000).

Essentially, the precautionary principle specifies that scientific uncertainty is no excuse for inaction on an environmental or health problem.

Despite its seemingly widespread political support, the precautionary principle has engendered endless controversy and has been interpreted in different ways. In its strongest formulations, the principle can be interpreted as calling for absolute proof of safety before allowing new technologies to be adopted. For example, the World Charter for Nature (UN, 1982) states: 'where potential adverse effects are not fully understood, the activities should not proceed'. If interpreted literally, no new technology could meet this requirement (Foster *et al.*, 2000). Another strong formulation is set out in the Third Ministerial Declaration on the North Sea (1990), which requires governments to 'apply the precautionary principle, that is to take action to avoid potentially damaging impacts of [toxic] substances . . . even where there is no scientific evidence to prove a causal link between emissions and effects'. This formulation requires governments to take action without considering offsetting factors and without scientific evidence of harm.

A relatively soft formulation appears in the 1992 Rio Declaration on Environment and Development which opens the door to cost–benefit analysis and discretionary judgement. The Rio Declaration (UN, 1992) says that lack of 'full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation'.

Between these soft and strong formulations lie a wide range of other positions, which should not be surprising. The precautionary principle is still evolving, and its final character will be shaped by scientific and political processes. A range of formulations – from soft to strong – will continue to be used in different circumstances because different technologies and situations require different degrees of precaution.

However, development of science and technology is bound up with risks and, as the progress of science and technology accelerates, we have to get used to dealing with risk situations. These risks deserve our full attention, but cannot be the only consideration in shaping our choices of sustainable technologies. An approach to technology assessment that looked only at potential harms of technologies would be flawed. We need a full assessment to weigh the expected harms of a new technology against its expected benefits and compare these with the harms and benefits of existing and alternative technologies. To obtain a full picture of the risks and benefits, these assessments must be done on a life cycle basis, or from 'cradle to grave' (Azapagic, 2002). (The life cycle approach is discussed in more detail in Chapter 3.)

Furthermore, the full technology assessment must also take into consideration the context in which specific technological risks occur. The trade-offs of technological change vary from use to use, and from country to country. Different societies expect different benefits, face different risks and have widely varying capacities to handle those risks safely.

Take, for example, the controversy over GM foods. Opponents of the GM technology often ignore the harms of the status quo. European consumers who do not face food shortages or nutritional deficiencies see few benefits of genetically modified foods; they are more concerned about possible health effects. Undernourished farming communities in developing countries, however, are more likely to focus on the potential benefits of higher yields with greater nutritional value (UNDP, 2001). As Sakiko Fukuda-Parr, the lead author of a UN report that looked into potential benefits of new technologies for developing countries, put it:

> You and I don't really need the tomato with longer shelf life. On the other hand, a farmer in Mali facing crop failure every three years really needs better drought-resistant crops that biotechnology can offer.

So, the potential benefits that biotechnology has for the agriculture of developing countries is enormously different from the potential benefits for the agriculture in Europe or the OECD countries. Many developing countries might reap great benefits from genetically-modified foods, crops and other organisms (GMOs). For developing countries facing malnutrition, the unique potential of GM techniques for creating virus resistant, drought-tolerant and nutrient-enhanced crops, poses different choices. In their case, the risks of no change may outweigh any concerns over the potential health effects of GMOs.

Similarly, proponents of new technologies often fail to consider alternatives. Nuclear power, for example, should be weighed not just against fossil fuels but also against other – possibly preferable – alternatives such as solar power and hydrogen fuel cells. And many people argue that the use of genetically modified organisms should be weighed against alternatives such as organic farming, which in some situations could be a more suitable choice. 'The golden rice' controversy is an appropriate case to consider in this context.

The GM industry claims that a rice variety that is genetically modified to contain vitamin A ('the golden rice') could save thousands of children from blindness and millions of malnourished people from vitamin A deficiency (VAD). Yet, the golden rice could, if introduced on a large scale, exacerbate malnutrition and ultimately undermine food security because it encourages a diet based on one staple. For the short term, measures such as supplementation (i.e. pills) and food fortification are effective and cheaper. Promoting locally appropriate and ecologically sustainable agriculture and diet diversification programmes would address a wide variety of micronutrient deficiencies, not just VAD, and lead to a long-term solution.

The golden rice case highlights an important point when considering sustainable technologies: we must not fall into the trap of thinking that technological innovation is a universal remedy for our problems. To create a sustainable society, we must focus on strategies that address the root causes of our problems.

Treating the symptoms, regardless of how technologically advanced the treatment is, results only in short-term gains that may be offset by other factors. Consider, for example, the catalytic converter, a device used on cars to reduce the emissions on certain pollutants, notably carbon monoxide and hydrocarbons. Catalytic converters work well and are responsible for a dramatic decline in the pollution our cars produce. They are even responsible for a general 'cleansing' of the air in many urban centres. However, the number of motor vehicles in the world has increased from 630 million in 1990 to over 1 billion in 2000. Continuing expansion of the population and the ever-increasing number of vehicle-miles travelled per year (increasing in the USA alone by about 51 billion miles per year) could overwhelm the gains resulting from the use of catalytic converters (Chiras, 2003).

Certainly, there are many examples of how technologies can help us to move to a sustainable path (such as those considered in this book!). The authors of the Factor 4 concept, for instance, give 50 examples of technologies that could be called upon to deliver the necessary improvement in resource efficiency, including ultra fuel-efficient cars and low-energy homes (von Weizsäcker *et al.*, 1997).

Technological innovations can indeed offer new, less wasteful ways of meeting our needs through efficiency improvements, reuse, recycling and substitution of natural resources. Ultimately, however, sustainability will require social and institutional innovation just as much as technological innovation. It is a simple fact that, as we become more efficient at producing things, we will get wealthier. And as we get wealthier we are able to produce and consume more goods and services.

1.4 Economic Growth, Environmental Constraints and Social Concerns

World consumption has expanded at an unprecedented rate in the last century, with private and public consumption expenditures reaching $24 trillion in 1998, twice the level of 1975 and six times that of 1950 (WSSD, 2002b). Consumption in and of itself is not bad, of course – all living things must consume to maintain their biological existence. The real sustainability issue, however, is the extent of consumption and its environmental and social impacts. And, worryingly, global current consumption and production levels appear to be much higher than the Earth's sustainable carrying capacity (UNEP, 2009).

Carrying capacity is defined as the maximum number of individuals of a defined species that a given environment can support over the long term. The notion of limits is fundamental to the concept of carrying capacity.

Researchers and environmental organizations have promoted a range of new approaches to define these ecological limits and demonstrate the extent of our consumption. The ecological footprint is one of the most prominent of these approaches.

1.4.1 Ecological Footprint

The ecological footprint shows how much productive land and water is required to support a defined economy or population at a specified standard of living. Industrialized economies

are considered to require far more land than they have, thus, through trade, impacting on resources in other countries. Also known as 'appropriated carrying capacity', this concept, too, incorporates the distributional aspects of sustainable production and consumption.

According to the latest ecological footprint studies (Venetoulis and Talberth, 2005; UNEP, 2009), humanity's footprint is 21.9 ha/person, while the Earth's biological capacity is, on average, only 15.7 ha/person, which means that humanity is currently exceeding the biosphere's ecological capacity by 39%. In other words, at present rates of consumption, we would need 1.39 Earths to ensure that future generations are at least as well off as we are now (Venetoulis and Talberth, 2005).

Owing to population increase, the biologically productive space available per person has decreased considerably in recent years. Leaving space untouched for other species – the authors of the Brundtland Report (WCED, 1987), for instance, invited the world community to set aside 12% of the biologically productive space for other species – makes the ecological deficit even larger.

National ecological footprints show that many countries are running ecological deficits, with their footprints larger than their own biological capacity. Others depend heavily on resources from elsewhere, which are under increasing pressure (Global Footprint Network, 2010).

Amongst the world's countries, rich nations such as United Arab Emirates, Kuwait and the USA exceed their biological capacities the most. On the other hand, some poor nations have the largest per capita ecological surpluses (positive ecological balances); for example, Mongolia, Nambia, Gabon, Mauritania and Papua New Guinea. On a continental basis, western Europe and North America had the greatest ecological footprints and ran negative ecological balances, while Africa, Latin America and other less consumptive regions had relatively smaller footprints and ran positive ecological balances (Venetoulis and Talberth, 2005).

In general, wealthier nations tend to run negative ecological balances, largely because of the high degree of correlation between affluence (expenditures) and fossil fuel consumption. As a rule, wealthier countries (despite technological advantages), were found to have larger footprints on a per capita basis as compared to their fellow global citizens that consume less. The ecological footprint of an average US citizen, for instance, is over five times more than is available per person world-wide and is 16 times more than the ecological footprint of an average person in Bangladesh (Redefining Progress, 2003).

Large 'ecological deficits' are common for industrialized regions and countries, and if everyone in the world were to live like an average person in high income countries, we would need some additional planets to support us all. The UK footprint, for instance, shows that, if everyone in the world consumed at the average UK rate, we would need three planets' worth of resources (WWF/SEI/CURE, 2006).

The ecological footprint is by no means a perfect measure. However, it is useful in many ways. First, by measuring a population's demands on the Earth's available biological capacity the ecological footprint enables us to understand better the environmental limits to human activity at the global scale. The ecological footprint studies cast light on rather worrying facts – we are overusing the Earth and depleting ecological assets at an increasing rate. They send us, therefore, a clear message: we have to be less profligate in our use of nonrenewable resources and thermodynamically irreversible processes if the planet is to be fit for us and for future generations to live on.

Second, the ecological footprints of nations reveal a huge disparity in access to environmental resources and an increasing gap between the developed and developing worlds. The patterns of consumption highlighted by the ecological footprint studies point to global inequality characterized by a growing 'lifestyle divide'. One side of the lifestyle divide is characterized by excesses of consumption by the minority one-fifth of the world population, which is responsible for close to 90% of total personal consumption; the other side is characterized by extreme poverty, where 1.4 billion live on less than US$1.25 per day (UN, 2009). This gap – partly a result of growing poverty and of affluence – is a serious threat to sustainable development.

Global inequality is evident in many aspects of consumption. Disparity in energy consumption, for instance, highlights global inequality clearly – people in developed countries use almost 10 times more energy per person than people in developing regions. It is not, of course, only energy consumption that is highly disproportional in global terms. It is estimated that the 15% of the world's population living in high-income countries account for 56% of the world's total consumption, while the poorest 40%, in low-income countries, account for only 11% of consumption (WSSD, 2002b).

Finally, by demonstrating disparity in the way global resources are used, the ecological footprint reminds us that sustainable consumption is inextricably linked with the question of *equity* with respect to access to available resources and opportunities.

1.5 Equity and Sustainable Development

The question of equity is at the heart of sustainable development. It focuses attention on redressing the enormous imbalances in political and economic power – between rich and poor countries and peoples, and amongst corporations, states, communities and generations.

The Brundtland Report strongly underlined that benefits and burdens from development and environmental policies should be distributed fairly among the members of society and between generations in order to promote social and economic equity. The report has repeatedly emphasized that a primary goal of sustainable development is greater equity, both within the current generation (intra-generational equity) and between generations (inter-generational equity).

1.5.1 Intragenerational Equity

One of the core principles of sustainable development is to achieve basic standards of material equity and social justice both within and between countries. Combating poverty and extending to all the opportunity to fulfil their aspirations for a better life are indispensable for achieving this aim.

The Brundtland Report pointed out that meeting essential needs requires not only economic growth for nations in which the majority are poor, but an assurance that those poor get their fair share of the resources required to sustain that growth (WCED, 1987). It also stated that 'the world in which poverty is endemic would always be prone to ecological catastrophes', pointing to significant links between poverty and the environment. Indeed, much environmental degradation in the developing world today arises from poor people

seeking the basic essentials for human life: food, water, fuel and so on. Environmental degradation, on the other hand, has serious social and economic repercussions for the poor, including unsafe water and poor sanitation causing diseases and death of millions of people and children in developing countries, and health-threatening levels of pollution in the urban environment.

In addition, the poor tend to be the most vulnerable to the effects of environmental degradation. They tend to have much lower coping capacities and, therefore, they are particularly susceptible to the impact of disasters, drought, desertification and pollution. As the UN Intergovernmental Panel on Climate Change (IPCC) reports on the impacts of increased global temperatures point out, the poorest parts of the world will suffer most from climate change in the future. The impacts are expected to fall 'disproportionately on the poor' the reports claim, because most less-developed regions are vulnerable due to a 'larger share of their economies being in climate-sensitive areas', such as agriculture, and their low capacity to adapt to change (McCarthy *et al.*, 2001; Solomon *et al.*, 2007).

Unfortunately, the link between poverty and environment is often uncritically characterized as a 'vicious circle'. Population growth and inadequate resources are presumed to lead to the migration of the poor to ever more fragile lands or more hazardous living sites, forcing them to overuse environmental resources. In turn, the degradation of these resources further impoverishes them. Although this does sometimes happen, as a general model it is highly simplistic. Moreover, it often leads to policies that either protect the environment at the expense of the poor or reduce poverty at the expense of the environment.

The linkages between poverty and the environment are complex and require locally specific analysis to be understood – there is no simple causal link. In many areas, the non-poor, commercial companies and state agencies actually cause the majority of environmental damage through land clearing, agro-chemical use, water appropriation and pollution. Sometimes privileged groups force the poor onto marginal lands, where, unable to afford conservation and regeneration measures, their land-use practices further damage an already degraded environment. Indeed, unsustainable practices by the poor, such as slash-and-burn farming by displaced peasants, seriously damage tropical forests; but, as Norman Myers put it, 'blaming them for deforestation is like blaming soldiers for starting a war' (Myers, 2002).

There are also many examples in which very poor people take care of the environment and invest in improving it. Based on experience from around the world, 'win–win' options exist that can build better institutions and partnerships with poor people to create more robust livelihoods and healthier environments. These options simultaneously pursue two goals: reduced poverty and enhanced environmental protection.

Take, for example, the case of indoor pollution from cooking and heating. Around 1 billion people are affected by problems caused by the use of traditional biomass fuels for cooking and heating. They prepare food and heat their homes with fires that burn dung, wood, crop residues, charcoal or other combustible materials. While seemingly rather harmless, these cookstoves are major causes of massive environmental destruction. Many thousands of acres of forests and other ecosystems are degraded as people seek firewood and other biomass fuels. Besides the obvious harm to the ecosystem, deforestation and plant denudation are a major cause of soil erosion. Human health suffers too, as people are exposed to high levels of indoor pollution in poorly ventilated areas. Estimates suggest that indoor air pollution contributes to acute respiratory infections that kill some 4 million

infants and children a year and decreases the overall health and life expectancy of millions more women and children (UNEP, 2007).

In the case of indoor pollution from cooking and heating, even a simple but well-thought change could create a win–win situation. Improving efficiency of traditional cookstoves to just 20%, for instance, can reduce the amount of firewood (ecological damage) and smoke (health impact) by half (McKinney and Schoch, 2003). Introducing a different and more appropriate technology, such as a solar cookstove or oven, will lead to an even better type of improvement. No biomass fuel is used, and no unhealthy smoke is produced. The solar cookstove is still relatively new and not yet widely used. Early efforts to introduce the new technologies were unsuccessful because many social factors, such as community needs and customs, were not considered. Simple considerations, such as including local artisans as stove makers, could often not only make new technologies more acceptable to the local population but also produce jobs for the community. Thus, simple actions such as improving cookstoves and including local artisans as stove makers will not only reduce harm to the environment and people's health, but also improve living standards. It is an example where developing appropriate technologies that are needed by the poor simultaneously tackles an environmental problem and improves the livelihoods of the poor. It is also a good example of how well-planned actions can break a vicious circle of poverty and environmental degradation.

It should also be noted that too often we deal with the consequences of poverty rather than the underlying causes.

In fact, the causes of poverty are often environmental in nature. For instance, environmental factors are responsible for almost a quarter of all disease in developing countries. The poor, particularly women and children, are most affected by environmental health problems. The most important hazard, particularly for urban populations in developing countries, is faecal contamination of water and food due to poor or nonexistent sewage systems and inadequate hygiene, compounded by unreliable and unsafe domestic water supply (see Chapter 12). There are other significant hazards. According to the World Health Organization (WHO), 90% of the global burden of malaria, which is estimated to kill 1 in 20 children under 5 years of age in sub-Saharan Africa, is attributable to environmental factors (WHO, 2009).

Tackling the causes of poverty, including environmental ones, is one of the world's major challenges in the twenty-first century. As already mentioned, the Johannesburg Summit on Sustainable Development agreed on the target to halve by the year 2015 the proportion of people living in extreme poverty.

But quite what this target might mean is obscured by the bewildering ambiguity with which the term 'poverty' is used, and by the many different indicators proposed to monitor poverty. There is no single definition of poverty. The term has been used to define the level of income obtained by households or individuals, lack of access to social services, as well as the inability to participate in society, economically, socially, culturally or politically (Maxwell, 1999). Different organizations, institutions and agencies use different concepts to describe poverty: income or consumption poverty, human underdevelopment, social exclusion, ill-being, lack of capability and functioning, vulnerability, livelihood unsustainability, lack of basic needs, relative deprivation and so on (Maxwell, 1999).

Different concepts imply different instruments to tackle poverty. Yet, defining poverty is only a start. Only by understanding causes can we begin to design, implement and evaluate programmes to alleviate poverty. In designing poverty programmes, it is advisable to

respect the understanding of poverty articulated by poor people themselves. In some cases, this may mean implementing measures to increase income. But in others, the priority may be to reduce variability of income, or strengthen women's autonomy by improving the legal system, or improving the access to environmental resources and services.

Poverty is, indeed, a complex issue, and we cannot do it justice in this short chapter. Environmental issues are, of course, part of wider set of factors which contribute to making people poor. Breaking the 'vicious circle' of poverty and environmental degradation is, however, critical for sustainability. There are a number of practical actions that the international community can take in addressing this issue. These actions have been recognized and summarized by the UNDP and EU Poverty and Environment Initiative (UNDP-EU, 1999a, 1999b):

- strengthen participation of the poor in the preparation and implementation of national and local plans, policies and strategies;
- protect the current natural asset base of the poor through protecting the access they already have to critical resources (such as entitlements to land, water, trees, pastures, fishing grounds) – especially in cases where the poor are in a weak position to resist appropriation of these resources by other groups, and through protecting the environmental resources upon which the poor depend on their livelihoods;
- expand the natural asset base of the poor through transferring ownership of natural assets to the poor (such as the recognition of community forest law, the creation of community forest rights or rights to other resources) and promoting pro-poor land reform;
- co-manage and co-invest in environmental services and resource with the poor through promoting and strengthening community management of environmental resources, and assisting the poor to overcome the high initial costs for receiving better quality environmental services (such as water supply and sanitation, renewable energy and waste management);
- promote environmental infrastructure and technology that benefit the poor through a greater focus on tackling the environmental problems and hazards that impact most upon their health and livelihoods and through developing affordable and environmentally sound technologies that are needed by and can be used by the poor; and
- make resource transfers to the poor through reducing subsidies for environmental services that benefit the non-poor (such as energy and water) and increasing investments in areas in which the poor live and work.

Working up such programmes will be challenging. Yet, eradicating poverty and improving quality of life of the poor is an imperative of sustainable development. How we approach these issues will play a major role in determining whether we move toward or away from more sustainable paths.

1.5.2 Intergenerational Equity

As already mentioned, the idea of sustainable development implies not only our responsibility to assist the presently needy, but also refers to our obligations to consider the well-being of future generations. Indeed, the need to safeguard the interests of future generations has been an integral part of sustainable development from the very beginning of the concept.

One of the earliest UK Government documents on sustainable development states that we have 'the moral duty to look after our planet and to hand it on in good order to future generations' (UK Government, 1995).

This moral duty is based on the recognition of legitimate interests and rights of future generations to live in a physically secure and healthy environment, and, consequently, as the recognition of our moral responsibility to protect the natural environment to such an extent that the survival and well-being of future generations are not jeopardized (Perdan and Azapagic, 2000). In other words, we have a moral duty to ensure that future generations have as good a life as we have now, or better.

One interpretation of intergenerational equity is that the welfare of society as a whole may not be allowed to decline for the indefinite future. It is sometimes expressed as 'the constant capital rule': the value of the overall capital stock must not be allowed to decline for the indefinite future. This is known as the 'weak' sustainability model because it assumes that the forms of capital[1] are completely substitutable for each other. It does not matter what form the stock of capital takes as long as the total does not decline. While this position is consistent with intergenerational equity in demanding that equivalent or increased amounts of capital are passed to future generations, it allows the form of this capital to change. This opens the door to passing on to the next generation less of one kind of capital (e.g. natural capital) so long as there is more of another (e.g. built capital) to balance it.

However, one may argue that some ecological assets, such as the ozone layer or biological diversity, are not substitutable – they form 'critical' natural capital and the destruction of this capital could threaten the very survival of the human race. Moreover, while most manufactured and human capital can be replaced, the loss of natural capital is often irreversible (i.e. once natural capital assets are lost it may not be possible to recreate them). This view is often called 'strong' sustainability, and it demands that the equivalent stock of natural capital is preserved for future generations.

This discussion of 'weak' versus 'strong' sustainability is not just a theoretical concern; it also has important practical implications. For instance, some people think there should be no economic activities in protected areas because such areas usually contain irreplaceable natural or human capital and, as such, should be beyond reach for any human activity that will disturb them (IIED/WBCSD, 2002). Others may prefer tangible economic benefits even if they would mean diminishing natural capital such as biodiversity (for an example of such contrasting views, see Chapter 17).

The ongoing theoretical debates about 'weak' and 'strong' sustainability, however, should not obscure the main message: the goal of sustainable development is to sustain improvements of human well-being over time, and to ensure that what we do today will not deprive future generations of the means to meet their own needs.

Perhaps one way of understanding how to achieve this goal is to follow general principles of intergenerational equity. The following two principles may provide us with some guidance:

[1] The idea of 'capital' has five main forms: *built capital*, such as machinery, buildings and infrastructure; *human capital*, in the form of knowledge, skills, health and cultural endowment; *social capital*, the institutions and structures that allow individuals and groups to develop collaboratively; *natural capital*, which provides a continuing income of ecosystem benefits, such as biological diversity, mineral resources, and clean air and water; and *financial capital*, the value of which is simply representative of the other forms of capital.

1. the principle of not closing down options for future generations (for example, by making irreversible changes, including the elimination of species, or the using up of resources); and
2. the principle of maximizing future choices by making a considered judgement as to what are the most central, significant or important things to preserve and protect; for example, clean air, energy, biodiversity, cultural values.

While most people accept these principles, the difficulty comes in agreeing how to apply them. In practice, the principles of intergenerational equity become entangled with the issues of intragenerational equity. In some cases it may be possible to advance all the goals of sustainable development simultaneously: improve material well-being for this generation, spread that well-being more equitably, enhance the environment and pass on enhanced stocks of capital to future generations. In others, there may be a conflict between long-term sustainability objectives of preserving 'critical' natural capital, such as biodiversity, and immediate imperatives of providing basic needs of the poor, for instance through intensive agricultural development.

In many situations our decisions will have to involve trade-offs: between different objectives and dimensions, and sometimes between the current and future generations. However, if we apply the principles of sustainable development consistently, we stand a better chance of minimizing trade-offs amongst objectives of intra- and inter-generational equity, and finding the ways of integrating otherwise conflicting goals.

1.6 Conclusions

Sustainable development is an approach to environment and development issues which seeks to reconcile human needs and the capacity of the environment to cope with the consequences of economic systems. Despite its deceptively simple formulations, such as the Brundtland definition, sustainable development has multiple layers of meaning and some profound practical implications. In essence, it is a call to change our actions and to do things differently.

Sustainable development is a dynamic process that will continue to evolve and grow as lessons are learnt and ideas re-examined. Achieving its goals and objectives presents great challenges for all parts of society. Various means are available to facilitate putting sustainable development into practice. Some of these are well known; others are in experimental stages. In this introduction, we have argued that sustainable development depends both on reducing environmental destruction and on improving the quality of life of the world's poor, in ways that will not deprive future generations of means to meet their own needs.

A core principle of sustainable development is to improve human well-being and to sustain those improvements over time. This objective can be achieved by reducing excessive levels of production and consumption; that is, by limiting the material and energy throughput in the human economy, through a more efficient use of resources and by addressing the challenge of poverty eradication through concerted actions which tackle the causes of poverty and ensure that available resources are used to the benefit of all.

Sustainable development requires creativity and innovation at every level: social, economic, institutional and technical. There are many favourable trends underway and

new and promising developments that give us hope. Important agreements have been reached to reduce global pollution, protect biodiversity and alleviate poverty. Many countries have begun to take steps to create economies that are better for the environment. Many businesses have introduced cleaner and more eco-efficient production processes that reduce pollution and other environmental impacts while delivering competitively priced goods and services. New technologies are also helping solve problems, as are individual actions. The public has become more aware that, as individuals, we each have a right, a role and a responsibility to contribute to sustainable development. Recycling rates are increasing and we, as consumers, are becoming ready to pay more for organic and other environmentally sound products. At the policy level, a greater attention has been paid to integrating the three conventionally separate domains of economic, environmental and social policy. A wide variety of activities ranging from consultation hearings as part of an environmental impact assessment, to co-management of natural resources are indicating that institutional processes are changing too, starting to recognize that increasing public participation in decision making is an important aspect of sustainable development.

These are encouraging signs, but there is still a lot more to do. In the final analysis, sustainability means securing a satisfying quality of life for everyone. We know what we have to do to achieve this goal – now it is time to do it.

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