# Green Households?

## Domestic Consumers, Environment and Sustainability

Edited by
Klaas Jan Noorman and
Ton Schoot Uiterkamp

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# Preface

What could be more familiar than a household? Indeed, when something is widely recognized it becomes a "household" word, but paradoxically, this familiarity is not reflected in the attention given to households as an important socioeconomic sector with its corresponding environmental impacts. To date, much more attention has focused on the environmental impacts of industry, agriculture, and commerce, i.e., on the production side of the economy.

The generous grant awarded by NWO, the Dutch National Foundation for Scientific Research, has given a team of researchers at universities in the Netherlands the opportunity to conduct an interdisciplinary environmental research program on the vital yet relatively poorly studied household sector. The program, entitled HOMES (Household Metabolism Effectively Sustainable), is being conducted under the auspices of the NWO priority research program on sustainability and environmental quality. The HOMES program focuses on the diagnosis, evaluation, and changes in the rates of household metabolism in the Netherlands, i.e., the flows of energy and materials through households, and the production of waste. The program draws on a wide range of empirical research, using the examples of energy consumption, the use of domestic appliances (particularly "white goods" such as refrigerators and washing machines), and the use of the car.

This volume presents the findings of the first, diagnostic phase of the HOMES research, which consisted of a comprehensive investigation of past and present characteristics and trends of specific metabolic flows through households. The sustainability and environmental quality aspects of these flow patterns were investigated. This first phase of the program concluded with a joint HOMES/IIASA (International Institute of Applied Systems Analysis) workshop in Vienna in late 1995, at which working drafts of several chapters in this volume were presented.

Throughout the text, many of the data are expressed in Dutch guilders (Dfl). At the time of writing (October 1997), Dfl 100 = £32 = US$50.

The volume begins with an introduction by Professor Kerry Turner, followed by an exploration of the concept of household metabolism in the context of sustainability and environmental quality. The next eight chapters have been written from various disciplinary perspectives, ranging from the environmental sciences,

geography and urban studies, to social psychology, economics, and public policy. Finally, we present an overall diagnosis and evaluation of household metabolism in the Netherlands in the past 50 years. The volume addresses what would constitute sustainable domestic consumption and lifestyles, and also how far there is to go to achieve this in an affluent, industrialized Western society.

We emphasize that the primary aim of the HOMES program is to address and explore the methodological issues surrounding relevant household–environment interactions. We hope that this volume will demonstrate the exciting and challenging aspects of this field of research and its relevance for all societies. We will strongly pursue work in this field and are looking forward to combining forces with related research activities elsewhere.

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We acknowledge especially the outstanding editorial work of Val Jones.

Finally, we thank Professor Kerry Turner for his thorough midterm review of the HOMES program, and for contributing the introduction to this volume.

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# Contributors

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# Household Metabolism and Sustainability
## Some Introductory Remarks

*R. Kerry Turner*
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In recent decades, a pervasive feature of many Western societies has been the contrast between static or slow-growing populations, and the sharply increasing total number of households, the average size of which is diminishing (see van Diepen, Chapter 4). This trend has significant implications for the use of resources and the generation/disposal of waste, linked to the direct flows of resources through households and to the supply of resources necessary to support these flows. Household metabolism is therefore linked to a complex feedback process involving environmental, economic, social, psychological, and cultural factors and relationships. The diagnosis and evaluation of the household metabolism process in the Netherlands are the core objectives of the HOMES research program. The results of the diagnostic phase are reported in this volume. The HOMES project represents and excellent attempt to champion research that is both interdisciplinary in scope and likely to provide policy relevant findings.

The policy context today cannot be considered without recognition of the increasingly influential policy objective of sustainable economic development (see Noorman *et al.*, Chapter 1). Sustainable development as a concept is meant to encompass both wealth creation and quality of life/environment dimensions. It is clearly value-laden and its precise interpretation will differ according to which world view is adopted. Thus the notion of a sustainable household can be quantified in terms of material and energy flows over time, but will also be connected to attitudinal, social, and cultural factors and trends. The sustainable household concept is a very effective way of demonstrating the obligations that informed citizens in a sustainable society must fulfill. Household members will have to face up to the fact that modifications and/or changes in lifestyles are necessary. In this context, there is a need for information that will enable and inform individuals, and a set of incentives/regulations to steer behavioral responses.

Economists define sustainable development in terms of non-decreasing levels of utility, or income per capita, or real consumption per capita over time. In broad terms, it involves providing a bequest from the present generation to the next of an amount and quality of wealth that is at least equal to that inherited by the present generation. This requires a non-declining capital stock over time and is consistent with the criterion of intergenerational equity. The most widely publicized definition of sustainable development, credited to the World Commission on Environment and Development, also included an intragenerational equity criterion. Sustainability therefore requires a development process that allows for an increase in the well-being of the present generation, with particular emphasis on the welfare of the poorest members of society, while simultaneously avoiding uncompensated and "significant" costs, including environmental damage costs, on future generations. Such a cost liability would reduce the "opportunities" for future generations to achieve a comparable level of well-being. The sustainability approach is therefore based on a long-term perspective; it incorporates equity, as well as efficiency criteria, and it may also emphasize the need to maintain a "healthy" global ecological system.

A spectrum of overlapping sustainability positions, ranging from very "weak" to very "strong", can be distinguished, as illustrated in *Figure 1*. Weak sustainability requires the maintenance of the total capital stock, composed of manufactured or reproducible capital, human capital (the stock of knowledge and skills), and natural capital, exhaustible and renewable resources, together with environmental structures, functions and services through time, with the implicit assumption of infinite substitution possibilities between all forms of capital. The Hartwick rule is also used to buttress the weak sustainability position by regulating the intergenerational capital bequests. The rule states that the rent obtained from the exploitation of the natural capital stock by the current generation, should be reinvested in the form of reproducible capital, which would form the inheritance of future generations. This inheritance transfer should be at a level sufficient to guarantee non-declining real consumption and well-being through time.

The implicit assumption of capital substitutability underpins the further argument that extensive scope exists over time for the decoupling of economic activity and environmental impacts. The decoupling process is mediated by technical progress and innovation. While total decoupling is not possible, and with the important exception of cumulative pollution, society's use of resources can be made more efficient over time, i.e., the amount of resources used per unit of GNP goes down faster than GNP goes up and the aggregate environmental impact falls. From the weak sustainability perspective a key requirement for sustainability will be increased effective research and development, i.e., new knowledge properly embodied in people, technology, and institutions.

From the strong sustainability perspective the watchword is co-evolution, the idea that socioeconomic systems and environmental systems are now so

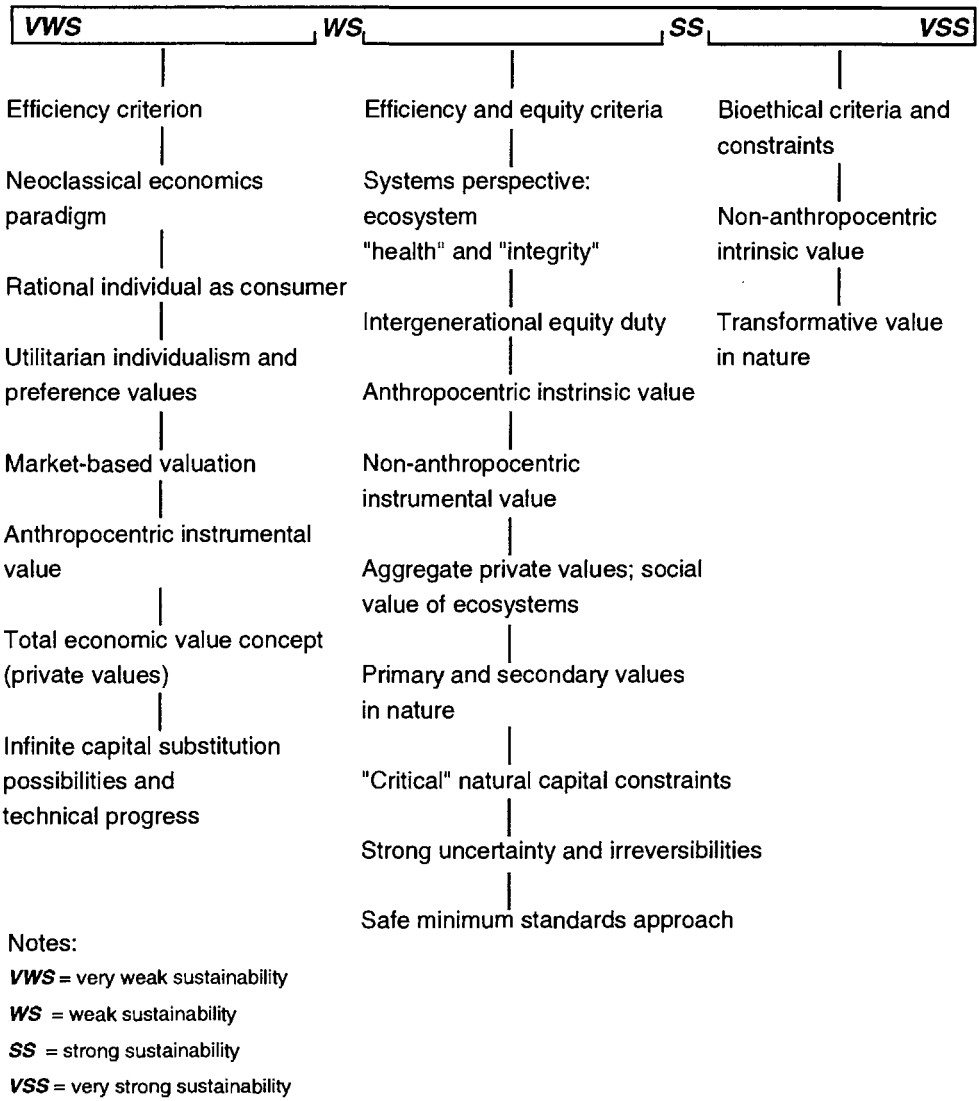


**Figure 1.** Spectrum of overlapping sustainability positions. Source: Adapted from Turner (1993).

interrelated, because of the sheer extent and pace of economic activity and change, that the components are now jointly determined in a continuous feedback process. The central assumption is that some elements of the natural capital stock cannot be substituted (except on a very limited basis) by man-made capital, and therefore there is a concern to avoid irreversible losses of environmental assets. Some of the functions and services of ecosystems, in combination with the abiotic environment, are essential to human survival. They are life-support services, e.g., biogeochemical

cycles, and cannot be replaced. Other multifunctional ecological assets are at least essential to human well-being, if not exactly for human survival, including the landscape, space, and relative peace and quiet. We might therefore designate those ecological assets that are essential in either sense as being "critical natural capital". Supporters of the "deep ecology", very strong sustainability (VSS) position argue for a particular type of non-substitutability based on an ethical rejection of the trade-off between man-made and natural capital. The strong sustainability position is based on an ethical rejection of the trade-off between man-made and natural capital. The strong sustainability rule therefore requires that we at least protect critical natural capital and ensure that it is part of the capital bequest to future generations.

The combination of the risk of irreversible environmental losses and the high degree of uncertainty surrounding past and future rates of resource degradation and loss, as well as the full structural and functional value of ecosystems, leads the advocates of strong sustainability to adopt the precautionary principle. Conservation of natural capital and the application of a safe minimum standards approach are therefore important components of a strong sustainability strategy. The message is that environmental degradation and the loss of natural resources represent one the main ways in which today's generation is creating uncompensated future costs. Hence, the restoration and conservation of natural resources and the environment are crucial to achieving sustainable development.

A number of sustainability rules, which fall some way short of a blueprint, for the sustainable utilization of the natural capital stock can be outlined as follows:

- market and policy intervention failures related to resource pricing and property rights should be corrected;
- the regenerative capacity of renewable natural capital should be maintained, i.e., harvesting rates should not exceed regeneration rates; and cumulative pollution that could threaten waste assimilation capacities and life-support systems should be avoided wherever feasible;
- technological changes should be steered via an indicative planning system such that switches from non-renewable to renewable natural capital are fostered, and efficiency-increasing technical progress should dominate throughput-increasing technologies;
- resources should, wherever possible, be exploited, but at a rate equal to the creation of substitutes (including recycling); and
- the overall scale of economic activity must be limited so that it remains within the carrying capacity of the remaining natural capital. Given the uncertainties present, a precautionary approach should be adopted with a built-in safety margin.

The HOMES researchers have succeeded in identifying significant pressure points and potentially unsustainable trends in resource usage through the household metabolism concept. This analysis also demonstrates the different levels – local,

national, and international – at which the global process of environmental change manifests itself. To take just one illustrative example, the rapid growth in the total number of households imposes a major burden on infrastructure support (space, basic utilities provision, transport links, etc.), on the economy, and on the environment. The increasing demands on water resources, which have capacity limits, represent a problem that can only be exacerbated by global climate change. The increasing number of households in coastal and other flood-prone areas poses additional environmental risks.

Particular pressure points/trends that can be highlighted include the household use of energy (for heating), domestic appliances, and the car, reflecting mobility/lifestyle changes. But it is important to differentiate between the household sector, individual households, and per capita levels. At the sectoral level, aggregate trends in resource use are continuing to rise. Resource efficiency gains, such as in domestic heating systems, electrical appliances, and the installation of building insulation, have been offset by the steep rise in the total number of households, family dilution (falling average size of households), and improved access to energy/water distribution systems (van der Wal and Noorman, Chapter 2).

Clearly, in a geographically small but densely populated country such as the Netherlands, the amount of "environmental space" per capita is an important aspect of sustainability. Analysis suggests that while population density has increased, the total amount of space available per person has inevitably fallen. But the amount of built-up area per head of population has increased significantly, and the capacity of neighborhoods to contribute to household welfare also seems to have declined (van Diepen, Chapter 5).

Bus and Voogd (Chapter 6) take a fresh look at existing urban neighborhoods and investigate whether the application of the principles of "ecological urban renewal" can rebuild the functional value of neighborhoods.

Within Dutch households, differences in income levels and age, together with spatial (rural/urban) location, account for significant differences in expenditures on durable consumer goods and in perceptions of what are the highest priority quality of life indicators. For example, in the survey conducted by Gatersleben and Vlek (Chapter 7), older respondents seem to value nature and the environment, personal privacy, safety, comfort, and aesthetics more highly than younger respondents. Middle-aged people consume most and have the most materialistic perceptions of welfare.

Economic theory would indicate that proper (i.e., efficient) resource pricing will significantly influence resource usage patterns and trends. This is confirmed for the Netherlands if one considers the aggregate resource usage trend increases for energy and water between the 1950s and 1980s. Over this period, the real prices for these goods actually fell, and those for fuel fluctuated (as car ownership more than doubled). But during the 1990s a reorientation of fiscal policy towards increased taxation on energy and waste has started to mitigate the problems arising from

the trend towards the overconsumption of resources (Linderhof and Kooreman, Chapter 8).

The study of policy effects represents another key element in the eventual success of the HOMES program. In Chapter 9, Ligteringen highlights the concept of policy (intervention) failures, first analyzed in a series of studies funded by the OECD (Paris), covering transport, wetlands, and forestry sectors. The OECD work demonstrated that most policy failures were a combination of inefficiently targeted and/or uncoordinated policies, resulting in unintended negative or positive spillover effects.

This study in the Netherlands found that increased car ownership and use have been stimulated by the indirect effects of policies deployed in other sectors fiscal and welfare policy, and educational policy. The same positive stimulation effects also served to increase the use of domestic appliances. However, in the context of the use of energy for domestic heating, there was a much reduced policy spillover effect and, if anything, a net restraining impact was fostered by coordinated energy and environmental policy measures. Other positive policy effects were found in traffic/transport, public housing, and products policies.

## References

Turner, R.K. (1993) Sustainability principles and practice, in: R.K. Turner (Ed.), *Sustainable Environmental Economics and Management*, Belhaven/Wiley, Chichester, ch. 1.

# Chapter 1

# Household Metabolism in the Context of Sustainability and Environmental Quality

*K.J. Noorman, W. Biesiot, and A.J.M. Schoot Uiterkamp*

## Abstract

This chapter introduces the concept of household metabolism within the domains of sustainable development and environmental quality. It is argued that sustainable development refers to (value-laden) options for social development that pursue quality of life as well as quality of natural life-support systems. Both the natural and social sciences contribute to our understanding of the complex reality that is dealt with in sustainable development research. Since different normative perspectives on sustainable development lead to different development paths that vary considerably in their dynamics, various perspectives or "world views" are presented in this chapter. When designing development routes towards a more sustainable future, biophysical constraints are crucial. The metabolism concept is applied as a metaphor to relate the use of large amounts of materials and energy within human societies to pressure on the environment. The various aspects of sustainable development and environmental quality are brought together at the end of this chapter, where the HOMES (Household Metabolism Effectively Sustainable) research program is introduced.

## 1.1. Introduction

The twentieth century has seen a sharp increase in the number of problems originating from new forms of human interaction with the environment. Most of these problems are associated with the over-exploitation of natural resources, the generation of waste, accelerated extinction of species, and the degradation of many ecological functions. This growing environmental awareness is symbolized in the

phrases "sustainable development" (SD) and "environmental quality" (EQ), which became widely known after the publication of the Brundtland report *Our Common Future* (WCED, 1987).

Social responses to environmental problems have largely been restricted to fighting short-term symptoms and, at least until the 1980s, focused largely on the production side of economic activities. This focus gave rise to social and technological responses such as clean(er) production aimed at mitigating and preventing the negative environmental impacts of industry and agriculture. Nevertheless, the scientific and public discussion concerning possible constraints on growth trends continues. Such constraints might be different in magnitude and in nature (physical, technical, economic, social, cultural or institutional). Little is known about their combined influence, but it can hardly be ignored. It is increasingly being realized that the main driving forces underlying the environmental problems we are facing today have not changed over time: continuing population growth, combined with technical, economic and social development, have led to rising per capita consumption. Clearly, if the number and/or the affluence of consumers (expressed as consumption per capita) increase, so will their overall collective impact on the environment.

Only recently has attention shifted partly towards the consumption side of economic activities as a starting point for environmental protection. The notion that consumer activities (centered around households) can be linked through integral chain management programs and life cycle analysis to the complex pattern of inputs and outputs of the economy (production/transport of goods and services), and thus to the associated environmental loadings, has been taken as a starting point for the interdisciplinary environmental research program HOMES (Household Metabolism Effectively Sustainable).[1] The HOMES program focuses on the interactions between human systems (at the level of households in the Netherlands) and the natural environment. The timescale is that of decades: the consumption patterns of the past five decades, and options for future decades up to 2050.

This introductory chapter positions the HOMES program within the domain of SD-related research. *Figure 1.1* illustrates the development of SD and EQ from concept to application, and the combination with the terms metabolism and households. First, Section 1.2 provides a brief overview of the growing awareness of environmental issues since the middle of this century leading to the coining of the term sustainable development.

Section 1.3 elaborates the concept of sustainable development. It is argued that, in essence, SD refers to (value-laden) options for social development that pursue quality of life as well as quality of natural life-support systems. Given the time-dependent sets of norms and values within and between societies, SD can be characterized as a dynamic and normative concept: different normative perspectives on SD lead to different development paths that vary considerably in their dynamics.

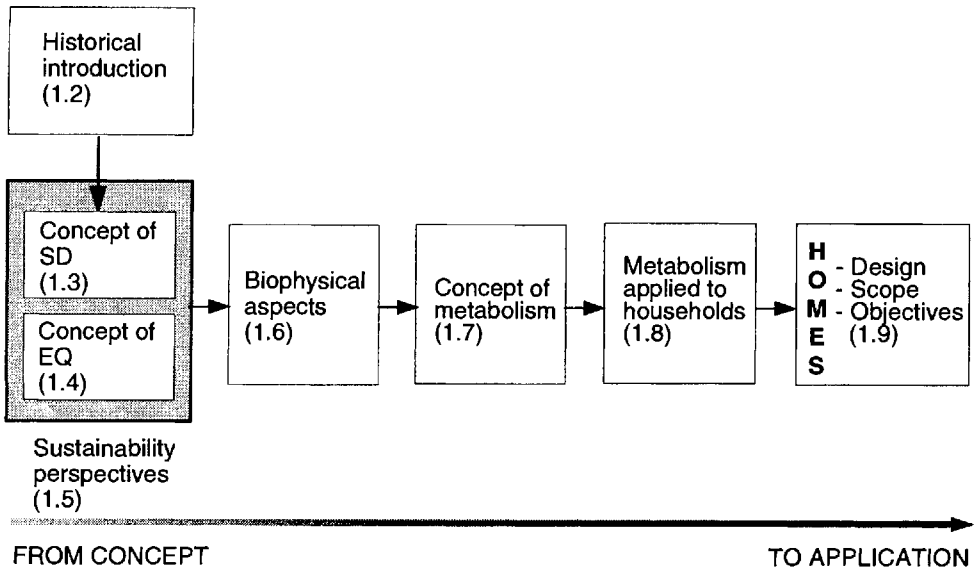


**Figure 1.1.** Outline of Chapter 1.

Some authors consider environmental quality issues as part of the more encompassing SD problem, while others treat them as two distinct concepts. It is therefore useful to discuss the concept of environmental quality separately; this is done in Section 1.4.

Sustainable development refers to system-wide, complex and long-term processes, including biophysical, economic, social, cultural, and institutional aspects. Scientific knowledge derived from various branches of the natural and social sciences (including their interdisciplinary connections) can contribute to our understanding of this "complex reality". Redirecting social behavior towards a more sustainable relationship with nature requires more than this, due to the existence of beliefs and values in social decision-making processes. Science can contribute here by exposing the implications of the various normative positions for SD routes. The latter are known as "world views" or "perspectives". Section 1.5 outlines some of these proposed perspectives.

When designing development routes towards a more sustainable future, consideration of biophysical constraints (such as the availability of natural resources, waste assimilation capacity, the functioning of atmospheric processes, etc.) is regarded as crucial. Section 1.6 deals with the biophysical constraints on SD, and Section 1.7 introduces the concept of metabolism as a metaphor to relate the use of large amounts of materials and energy within human societies to pressure on the environment. The concept of metabolism is also applied in Section 1.8 to household

activities. Finally, the various aspects of SD and EQ are brought together in Section 1.9, where the HOMES program is introduced.

## 1.2. Sustainable Development: An Historical Introduction

It was only in the 1960s that environmental issues received significant attention in society.[2] Before then, the adoption of the neoclassical economic paradigm, together with the rise of industrialization at the end of the nineteenth century induced the large-scale disregard of many environmental problems. Neoclassical theory emphasizes the role of the market, and the price mechanism is assumed to properly reflect the preferences of economic agents. Since ideally relative scarcity is reflected in the price, the market is considered to take care of the optimal allocation of scarce factors of production (traditionally three factors of production are distinguished: capital, labor, and natural resources). However, the preferences for natural resources can be only partly reflected in the exchange relations in the market (see Dietz and van der Straaten, 1992). Consequently, the importance of the natural environment as a contributor to increasing welfare has received only limited attention in economic decision processes. The concept that natural resources are taken into account only as far as they are being traded in the marketplace is increasingly regarded as a shortcoming of neoclassical theory. Pigou (1952) was among the first to suggest a price correction (the so-called Pigouvian taxes) to internalize these negative externalities of economic activity (such as pollution or the exhaustion of natural resources) into economic decision making, in order to achieve the optimal allocation of scarce resources in the marketplace. Practical problems related to Pigouvian taxes include the difficulty in placing a value on environmental services in monetary terms, and in relating (future) environmental benefits to current financial costs.

Since the 1960s the emerging social awareness of environmental degradation has led to the recognition that the market-oriented neoclassical model can only partly deal with the complex dynamic interplay between economic activity aiming at increasing welfare levels, and the long-term impacts of these activities on the natural environment. Human societies and the physical environment interact strongly in many ways; the feedbacks within and among these systems are numerous, complicated, and are by no means yet fully understood. This complexity has led to the notion that the relationships between social activities, the physical resource requirements related to production and consumption processes, and the environmental impacts of these activities can not be studied within the domain of a single discipline. The application of the knowledge, models, concepts and tools of "traditional" disciplines has resulted in a number of interesting alternative approaches. Many of these approaches share the view that the (physical) environmental constraints imposed on economic activity should be taken as points of

departure (Boulding, 1966; Kneese *et al.*, 1970; Georgescu-Roegen, 1971; Schumacher, 1973).

*The Limits to Growth* (Meadows *et al.*, 1972) was one of the first environmental reports to have a profound social impact. It considered the combined trends in population growth, industrialization, pollution, food production and the rate of exhaustion of natural resources, which seemed to be leading to levels that would be unsustainable in the future. Also in 1972, in response to the growing awareness of the interdependence of economic growth and environmental degradation, the UN Conference on Human Ecology, held in Stockholm, 1972, established the UN Environment Programme (UNEP). In spite of the increase in public awareness of environmental issues in the 1970s, however, few adequate policies were implemented to deal with them (van den Berg and van der Straaten, 1994).

The World Conservation Strategy, formulated in 1980, emphasized the ecological constraints on human activities and advocated the maintenance of essential ecological processes, life-support systems, and the preservation of genetic diversity to ensure the sustainable utilization of species and ecosystems (WCS/IUCN, 1980). The Brundtland report, *Our Common Future* (WCED, 1987), stated that existing patterns of economic growth were not ecologically sustainable, and that solutions for environmental problems had to be found. The WCED renewed interest in the concept of sustainable development as a yardstick for long-term environmental policies, describing it in broad terms: *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*. Thus the Commission linked the current and future (basic and less urgent) needs of mankind to the environmental resource base. In this definition, sustainability issues are associated with social structures and the full range of human activities aimed at fulfilling human needs, and also with safeguarding the quality of life and the physical and biological environment.

Global environmental concerns led to the UN Conference on Environment and Development, held in Rio de Janeiro in 1992. The outcome of this conference, *Agenda 21*, outlined the global actions that would need to be taken to achieve a sustainable world within the next century. Since then many efforts have been made under this banner to achieve a more sustainable future.

The references cited in this section carry the long-term relationship between man and nature as a common characteristic, and provide broad introductions to the various views, concepts, methods and applications of the concept of sustainable development. As already noted by many authors, there are many definitions of sustainable development, each reflecting a different interpretation. In Sections 1.3 and 1.4 the concepts of sustainable development and environmental quality are discussed separately in more detail in order to underpin the starting point of the HOMES program.

## 1.3. The Concept of Sustainable Development

In essence, sustainable development concerns the (long-term) relationship between humans and nature. Many authors have offered definitions of sustainability (Pearce *et al.*, 1989; Pezzey, 1989) that differ widely in scope and focus. This indicates that the concept of SD lends itself much more easily to philosophical debate than to interpretation and implementation. Although the concept of SD has been generally accepted as a guiding principle in research, development planning, environmental management and public policy, there has been little consensus on the implementation of sustainable development due to the differences in stakes and interpretations.

Much of the confusion begins when interpreting the two components of the term "sustainable development". In this context, *sustainable* is generally associated with "the (long-run) ability to maintain or uphold" rather than "extending in duration". The second term, *development*, refers to a "process of change" rather than "growth" (which usually means "more of the same"). Although often used synonymously to convey the notion of "economic well-being", the terms growth and development have definite different meanings in current world affairs. Economic growth denotes the (quantitative) increase in economic production, often measured in terms of GDP or GNP per capita. Although some authors use the term "sustainable growth", many others believe that this is a contradiction in terms, since there can be no such thing as "sustainable growth in a physically finite world" (Daly and Cobb, 1989). Pezzey (1992) objects to this view, arguing that economic growth is fundamentally growth of the *value* of the output, which does not necessarily imply growth of physical requirements.

Economic development pursues improvements in the quality of life in general, and might be termed sustainable in the sense of "upholding" given above, in so far as such improvements do not lead to an increase in the amounts of natural capital consumed. Development suggests the presence of elements of qualitative change rather than purely quantitative growth. These qualitative changes can refer to different processes; they may concern the quality and composition of the output, or they could be interpreted as changes in the economy or society as a whole that are commendable from an ethical or a social perspective (see van den Bergh, 1991). As economic activity and the status of natural resources are strongly linked, development can also be seen as an evolutionary process with (nonlinear) feedbacks between a continuously changing economy and its corresponding environment. This broader interpretation can be found in the "Brundtland definition" of development: a coherent process of change with regard to the allocation of investments, the use of natural resources, technology and institutions.

The WCED is often credited as having been the catalyst for the renewed interest in the concept of sustainable development. The Commission acknowledged that the social, cultural, economic and technological development of human society had been made possible by biophysical inputs. From this one may argue that the concept