SUSTAINABILITY AND THE ECOLOGICAL FOOTPRINT: COMPARING HUMAN DEMAND WITH NATURE'S SUPPLY

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ABSTRACT

There is a growing concern that current levels of economic activity have outgrown the physical limits of the planet. In the face of global constraints, humanity continues to deplete nature, through resource harvesting and waste generation, faster than nature can regenerate itself. The UN World Commission on Environment and Development (WCED) introduced the idea of sustainable development in 1987, with the release of *Our Common Future.* Sustainable development has since become a powerful and controversial theme, creating seemingly impossible goals for policy makers.

Sustainable indicators can be a key mechanism for encouraging progress in the right direction by providing a measuring tool that gives a clearer understanding as to whether sustainability is being achieved. The ecological footprint has emerged as an innovative technique to measure the ecological dimension of sustainability.

The research tests the ecological footprint as a tool for guiding humanity towards sustainability. The research establishes whether or not the ecological footprint provides an effective accounting framework for the biophysical services that a given society requires from nature. With Guernsey as the case study, the research investigates whether or not the ecological footprint is a comprehensive tool for local policy decision-making. Considering the methodology of the ecological footprint, its use for time series analysis and the development of scenarios does this. The ecological footprint is also tested for its ability to act as a tool to communicate the ideas of sustainability.

In conclusion, while containing some limitations, the ecological footprint is a tool that can facilitate the comparison of policy choices society inevitably must face. At the local level, the ecological footprint is a valuable part of the sustainable indicator tool kit. The use of the ecological footprint as a communication tool for sustainable development is invaluable. It is an indicator that can be understood by the general public and one that links individual lifestyle choices to global environmental problems.

The ecological footprint is only an empirical tool and in itself cannot change anything. It is a first step in a process of change and the political will and desire to change must be the driving force. Its great advantage over other sustainability indicators is that it is holistic and makes connections

between different activities and impacts. However, the ecological footprint is based on assumptions as the ratios/equations calculated by others.

In conclusion, the ecological footprint demonstrates that intelligent rationalisation of means and prudent moderation of ends is the only solution. By providing common ground, the ecological footprint builds bridges between different worldviews and amplifies the resonance between all disciplines working on sustainability.

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PREFACE

The idea for the Ph.D. came about from an interest in the idea of self-sufficiency. I wanted to understand whether a small community could live 'within the means of nature'. To understand this it would be necessary to monitor the mass balance of a community. Guernsey came into the picture, as I believed it would be possible to measure the consumption of an island more effectively than a community within the United Kingdom. After taking advice and some preliminary research I was attracted to the ecological footprint. I found it both simple and transparent. As the research started I became more and more interested in the ecological footprint and it became the main focus of the thesis.

I realised that people who talked a lot about sustainability just interpreted as they saw fit. I was appalled by the UK Government's concept of sustainable growth. I wanted to place the concept of sustainable development, which I feel can offer some real solutions to our ecological and social crisis, in concrete terms. From this point, the thesis rapidly developed with the ecological footprint as its central theme.

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For my parents

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GLOSSARY

BFF	Best Foot Forward
COP6	Conference of the Parties
DETR	Department of Environment, Transport and Regions
DGXI	Directorate General for the Environment
EAP	Environmental Action Programme
EEA	European Environment Agency
EF	Ecological Footprint
ESA	Environmental Space Analysis
FoE	Friends of the Earth
FAO	Food, Agriculture Organisation
FG	Focus Groups
Flexmex	Flexible mechanisms
GDP	Gross Domestic Product
GNP	Gross Domestic Product
Gj/t	Giga-joules per tonne
Gtc	Giga-tonnes of carbon
GWh	Giga-watt hours
Ha./per cap	Hectares per capita
IDC	Island Development Committee
IPCC	International Panel on Climate Change
kWh	Kilo-watt hours
IUCN	International Union for the Conservation of Nature
LA21	Local Agenda 21
LCA	Life Cycle Analysis
LGMB	Local Government Management Board
MIPS	Material Intensity per unit of Service
OECD	Organisation for Economic Co-Operation and Development
Pj	Piga-joules
SEB	States Electricity Board
SPI	Sustainable Process Index
TJ	Terra Joules

UNDP	United Nations Development Programme
UN	United Nations
UNIDO	United Nations Industrial Development Organisation
UNCHE	United Nations Conference on the Human Environment
VRLD	Vehicle Registration and Licensing Department
WCED	World Commission on Environment and Development
WRME	Wood Raw Material Equivalents

"Earth provides enough to satisfy every man's need, but not for every man's greed."

Mohandas Karamchand Gandhi

CHAPTER 1: INTRODUCTION

1.1 The Challenge

There is a growing concern that current levels of economic activity have outgrown the physical limits of the planet. However, economic activity shows no sign of declining, as Gross World Product is set to increase by four percent a year (Brown et al, 1992). This represents a doubling of the world economy in less than 20 years (UNDP, 1993). There is a real concern that world population has gone 'Beyond Limits' (Meadows et al, 1991) and is degrading natural capital. In the face of global constraints, humanity continues to deplete nature, through resource harvesting and waste generation, at a faster rate than nature can regenerate itself (Wackernagel, 1994).

Conventional economic development has become a principal constituent of most nations' political agendas since the Second World War. Its primary aim has been to increase industrial production through the integration of local economies into the global market (Smith 1994; Ohmae 1990). This increase in resource consumption has failed to satisfy the basic needs of the world's poorest people. According to the United Nations, the richest 20% of the world population receive over 83% of the world resources, while the poorest 20% receive only 1.4% (UNDP 1993:12). This 20%, representing over 1 billion people, live in 'absolute poverty' (UNDP 1993:12). Therefore, the conventional economic development approach has been questioned for not effectively dealing with the needs of the poor (Dube 1988; Friedmann 1992; Laquian 1993).

The United Nations World Commission on Environment and Development (WCED) introduced the concept of sustainable development into the political arena in 1987, with the publication of *Our Common Future*. The WCED discussed the destructive social and ecological impacts of humanity's current approach.

Sustainable development has since become a powerful and controversial theme, creating seemingly impossible goals for policy makers (Barkin, 1998). The concept provokes the examination of economic, political and social systems, questioning individual lifestyle choices and personal wealth. Sustainable development does not just encompass an environmental agenda; it reflects the widespread fear of the deterioration in the quality of life of people. It also combines the concerns of environmental limits and social equity.

At the heart of the sustainability debate lies the issue of consumption. Past literature highlights that present levels of per capita consumption in the richer countries cannot possibly be generalised to people living in the rest of the World (Girardet 1992, Wackernagel et al, 1997, Brown, 1998). In this discourse, resources include not just inherited natural capital, including raw materials (such as soil, air, water, forests and oceans) but also the earth's capacity to absorb the wastes produced by our productive systems (Wilson, 1992).

Sustainability, as a concept, works on many levels, from global to local. There are the fundamental questions concerning the sustainability of the global structure that perpetuates high degrees of international inequality. A strategy for sustainability must focus on the importance of local participation and control over the way in which people live and work. The question of local autonomy is an important part of any discussion of national and international integration. It suggests a better balance between global interdependence and regional self-sufficiency.

The abstract nature of sustainability and sustainable development has been blamed for the lack of progress towards a sustainable society. To eliminate this problem we must measure sustainable development in an attempt to understand the concept of sustainability; this is the challenge. It must not be abstract or ambiguous to the public and to policy decision-makers. It should be possible to say whether each individual decision, either by a government or by an individual, will bring us closer to a sustainable society. Without such measures it is impossible to inaugurate change.

The ecological footprint (EF) has emerged as an innovative technique to measure the ecological dimension of sustainability. It has grown in popularity over the past 5 years within the fields of academia, central and local government and business.

1.2 The Purpose of the Research

The purpose of the research is to test the ecological footprint as a tool for guiding humanity towards sustainability. The thesis will answer the following research questions: -

1. Does the ecological footprint adequately measure the ecological dimension of sustainability?
2. Can the ecological footprint be used as an effective planning tool to guide a region towards sustainability?
3. Can the ecological footprint help communicate the ideas of sustainability to the general public?
4. In conclusion, can the ecological footprint offer new insights into what a sustainable society consists of?

The research will establish whether the ecological footprint is a simple, yet comprehensive tool and whether it provides an accounting framework for the biophysical services that a given society requires from nature. The ecological footprint of a designated population is the area of productive land and water ecosystems required to produce the resources that the population consumes and assimilate the wastes that the population produces, wherever on Earth the land and water is located (Rees 1996, 2000; Wackernagel and Rees 1996). It is suggested that the ecological footprint is both an analytical and heuristic device for understanding the sustainability implications of different kinds of human activities. It serves as an awareness-raising tool and an action-oriented planning tool for decision-making towards sustainability (Wackernagel 1994).

The ecological footprint has added to the debate of carrying capacity (Meadows et al 1972; Ehrlich 1982; Goodland and Daly 1995; Pimental and Pimental 1990, 1994). It originates in the teaching and research of Professor William Rees (University of Columbia) and Dr Mathis Wackernagel (formerly UBC, now at Redefining Progress in San Francisco). The concept has already found many applications (Beck 1993; Bicknell 1998; Deutsh et al 2000; Simmons, Lewis and Barrett 2000) and at the same time has received criticism (Levett 1998; van den Bergh and Verbruggen 1999; Herendeen 2000; Ayres 2000).

1.3 The Structure of the Thesis

Chapter 2: 'Exploring Sustainability', acts as the literature review for the thesis. It explores the ecological and social crisis by considering the pressure on the environment from consumption, waste and population. From a social perspective the issue of poverty is discussed. As well as assessing the pressure on the environment, the effect of consumption is considered by addressing the depletion of resources. The chapter moves on to critically assess allegations of limitless substitutability, market prices of resource scarcity and scientific fraud.

The concept of sustainable development is introduced; a critical analysis is conducted of the concept by considering its history, definition, criticisms and its political context. Sustainable development is then discussed in terms of ecological and social dimensions. The chapter explores the implementation of sustainable development at the global, European, national and local level, concluding that while problems exist at the local level this is the most effective arena for its implementation.

Finally, the chapter moves the discussion on to measuring the ecological dimension of sustainability, considering what makes a good indicator, providing a critique of government indicators (particularly GDP). It also assesses alternative biophysical indicators to compare the ecological footprint with ('Sustainable Process Indicator', 'Environmental Space', 'Material Intensity per unit of Service').

Chapter 3 introduces the methodology of the ecological footprint, from its origin, to its appealing nature, and its context within ecological, economic and ethical terms. The detailed description of the compound footprinting methodology is provided considering the different land types and the relevance of efficiency factors to the calculations. The chapter addresses what a sustainable footprint is and discusses this in the context of past examples.

The compound ecological footprint of Guernsey is introduced. A carbon balance for Guernsey is also calculated. The chapter considers how the ecological footprint functions as an indicator for sustainability, followed by a critique of the concept. The critique gives particular attention to the carbon dioxide land issue, probably the most controversial component of the footprint.

Chapter 4 assesses the ecological footprint as a decision-making tool for sustainable development. The component footprint approach is introduced and then calculated for Guernsey. Time series analysis has been applied to the passenger transport and waste data, considering how the ecological footprint has changed over time and the effectiveness of past policy.

Chapter 5 develops a sustainable model for Guernsey using the three scenarios of waste, transport and energy. The chapter also considers the metabolism of the island addressing the concept of bioregionalism.

Chapter 6 considers the use of the ecological footprint as a tool for communicating sustainability. The methodology used in this process (focus groups) is explained and justified. The results from the focus groups are discussed and analysed and used to consider the main barriers for achieving sustainability.

The conclusions of the thesis are presented in Chapter 7. This is structured around the four research questions featured at the beginning of section 1.2. Questions 1 to 3 relate directly to Chapters 2 to 5. Research question 4 takes the discussion one step further by confronting world development and global economics, discussing the greatest challenges to sustainable development and providing a brief, but comprehensive, understanding of what a sustainable society may be.

1.4 The Scope of the Research

There are always limitations connected with any study and outlining these at an early stage is essential. The research has focused on the ecological dimension of sustainability and the measurement of it using the ecological footprint. Although the social dimension of sustainability is considered and brought into the debate it is not the main theme of the research. This does not mean that it is insignificant compared to the ecological dimension of sustainability[1]. The author believes it is as equally important, but is beyond the scope of this research.

Rather than discussing detailed strategies for developing sustainability, the research explores the measurement of the ecological dimension of sustainability. However, detailed scenarios for Guernsey have been provided in an attempt to demonstrate the decision-making potential of the tool. Therefore, the thesis has focused on the ecological footprint, its applications and its perceived usefulness.

The thesis documents the example of Guernsey using both the compound and component ecological footprint. In the compound approach land was divided into 6 categories[2], while consumption has been divided into over 140 categories from over 3,000 consumption items. The application relies on a simplified operational definition that permits the assessment of the ecological footprint's magnitude rather than documenting the land appropriation with a percentage precision. All data used for calculating the consumption figures were gained from various primary sources in Guernsey. A database was constructed to make the task of calculating consumption figures more accurate and less laborious.

The component footprinting approach contained four main categories (transport: freight and passenger, waste: domestic and commercial, utilities: gas, electricity and water, bio-resources: food, timber and resources). The component footprint for Guernsey was calculated using local primary data sources.

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[1] The concepts of the social and ecological dimension of sustainability are discussed in section 2.3.
[2] These categories include forest land, carbon sequestration land, arable, pasture, sea and built land.

For exploring the tool's value to the public, 15 focus groups, involving over 120 people, were undertaken on Guernsey, using socio-economic categories and targeting specific groups. The views of all the Guernsey politicians (57) were sought by the use of a detailed, qualitative questionnaire. Semi-structured interviews were also conducted with a group of ecological footprint experts.

1.5 The Significance of the Research

The ecological footprint is still a relatively new indicator of sustainability and until recently has only been developed by a small groups of researchers. The research has received a lot of interest from both practitioners and academics. In the academic arena it has resulted in a number of publications in both journals and conferences and is being used as a case study in a book on the ecological footprint, published in October 2000. Guernsey has decided, after many reports and presentations, to adopt the ecological footprint as their main indicator for sustainable development. The author is currently working together with Liverpool City Council to use the ecological footprint in order to bring together Liverpool's extensive range of indicators. The Northwest Regional Development Agency, Environment Agency, Government Office Northwest, Liverpool City Council and Northwest Water fund the project.

The other significant areas of the study have been: -

1. A clear understanding of biophysical limits and translating this down to the local level;
2. An understanding into the competing uses of nature, thus making it possible to compare the ecological footprint of transport, waste and energy;
3. A tool for explaining sustainable development more clearly, where people can link their everyday lifestyle choices with global problems;
4. An understanding into the fundamental changes required in the approach to global economics and international development.

1.6 The Case Study - Guernsey

Guernsey has already been mentioned during the explanation of the structure, scope and significance of the research. In this section the reasons for selecting Guernsey as the case study along with an explanation of Guernsey in geographical, historical and social terms is provided as background information.

1.6.1 Geographical Position

Located a few miles off Mont St Michel in Normandy, France, the Channel Islands comprise the major islands of Jersey and Guernsey, and the smaller islands of Alderney, Sark, Herm, Jethou and Brecqhou (See Figure 1.1). Guernsey is the second largest of these islands and is 63.1 square kilometres in size. For a small island Guernsey has a relatively high population of 60,000 residents. This can increase to 80,000 during the tourist season. Guernsey also has its own airport, harbour, telecommunications service, postal service and most significantly, its own parliament.

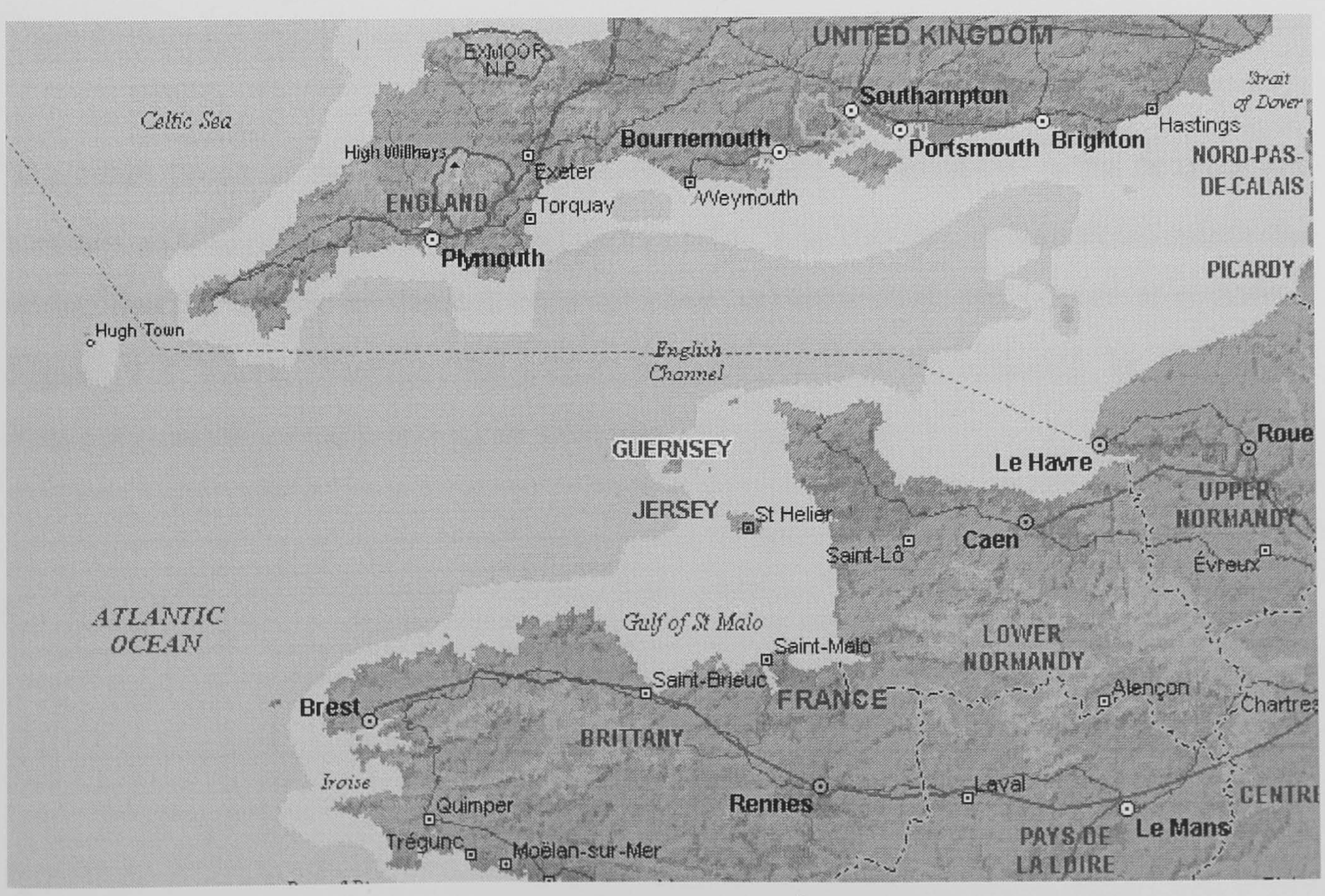


Figure 1.1: The Channel Islands, in relation to the UK and France

Source: Microsoft World Atlas (2000)

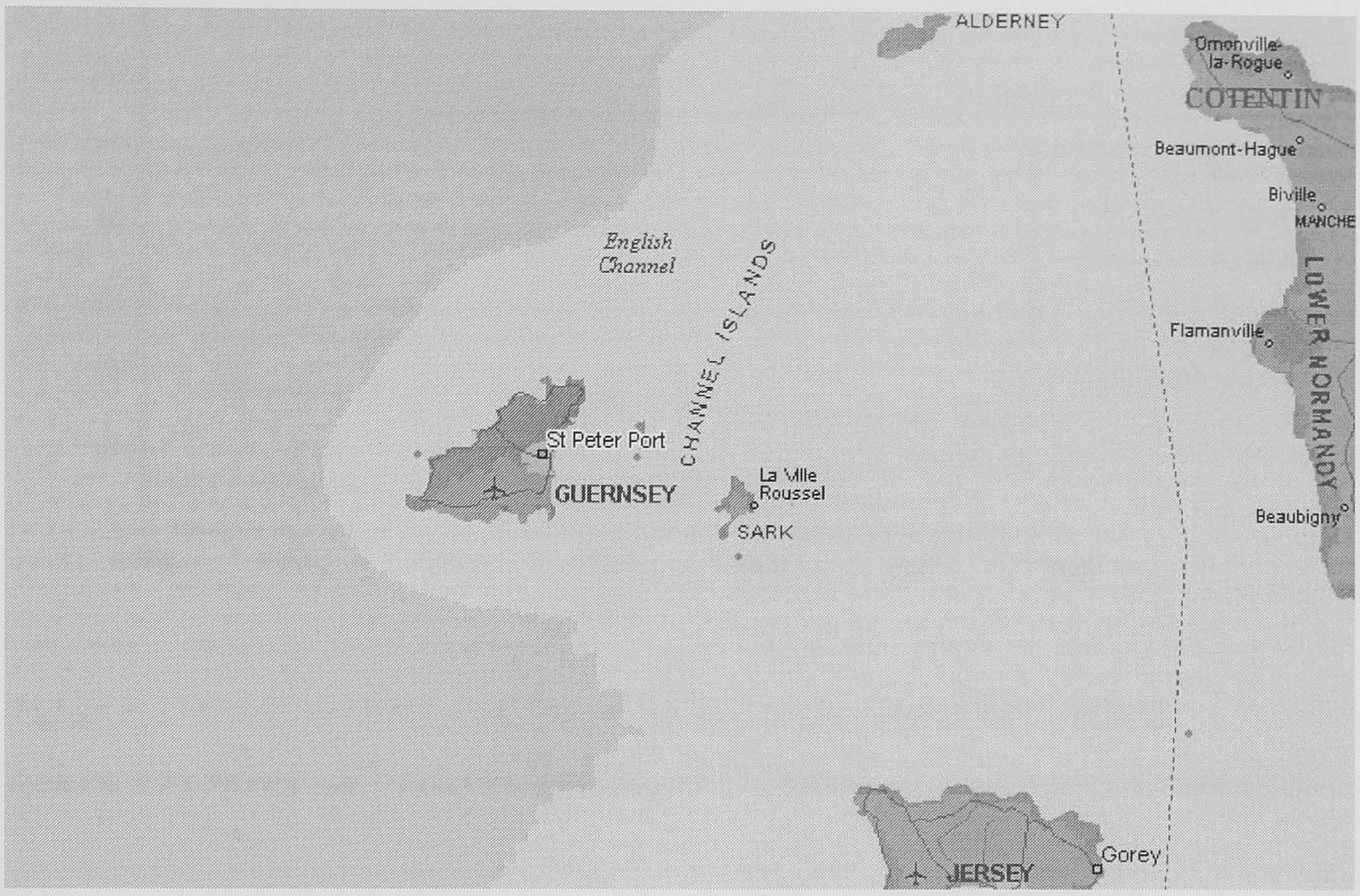


Figure 1.2: The Bailiwick of Guernsey (Channel Islands)
Source: Microsoft World Atlas (2000)

1.6.2 Economic Development

The main focus of the future economic development of Guernsey is the finance and tourism industry. Guernsey is considered to be a "Tax Haven", in a position where the island has the ability to control taxation rates, separate from the United Kingdom [3]. Figure 1.3 below displays the importance of the finance industry to the island economy and the steady and rapid shift that has occurred.

[3] Guernsey is considered as a Crown dependency to the United Kingdom. It has its own parliament, courts etc.

Figure 1.3: The Contribution of Export Sectors to the Guernsey Economy
Source: Economic and Statistics Review, 1997 (Advisory and Finance Committee).

Figure 1.3 demonstrates that the main contribution to economic growth has been the steady expansion of the finance sector. An assessment conducted by the Economics and Statistics Unit and the Guernsey Financial Services Commission concluded that the annual contribution from the finance sector to the Guernsey economy was £285 million, this in an island with a population of 60,000 (Economic and Statistics Review, 1997).

Many factors have the ability to affect future economic growth in Guernsey. Due to the strong reliance on one industry, Guernsey can be considered to be in an unstable economic situation, even though there has been a constant rise in the Gross National Product since 1965.

Consumer spending also displayed an increase from 1995 to 1996. A growth of 5% occurred, which encompassed increased holiday travel, increased consumer spending on leisure goods, food, clothing and footwear. This growing demand has been accompanied by higher prices in the case of leisure goods. Consumer spending on larger items such as household goods and motoring remains subdued, but the highest increase in consumer demand, which occurred for housing materials, was 8% higher than the previous year.

The export earning sectors contribute to a positive balance on the Island's current account. The island's exports can be considered to be very diverse and vary widely in terms of customer contact. Horticultural produce and manufactured goods are exported mainly to the UK. Companies in the export services and finance industry administer many off-Island clients who provide fee income and the opportunity for interest margin income within banking operations. This attracts a great deal of business visits to the island, as well as tourists, who spend money on local goods and services and contribute tax income to the public sector. Finance sector profits provide a substantial contribution to the economy. While horticultural income has grown, the sector has become increasingly reliant on off island labour and is employing fewer Guernsey born workers.

Even though local economic prospects for the island remain high, the reliance on one industry is of a concern. This suggests that profitable diversity should be sought in the economy.

1.6.3 Population Growth

Guernsey has seen a steady growth in population since 1831 to the present day. With the island only 63.1 km^2 this is of great concern. The population of Guernsey now stands at 60,000 (Census Office, 1997). This produces a population density of 1075.3 m^2 per person, one of the highest in Europe. Figure 1.4 displays the population of Guernsey from 1831 to 1996.

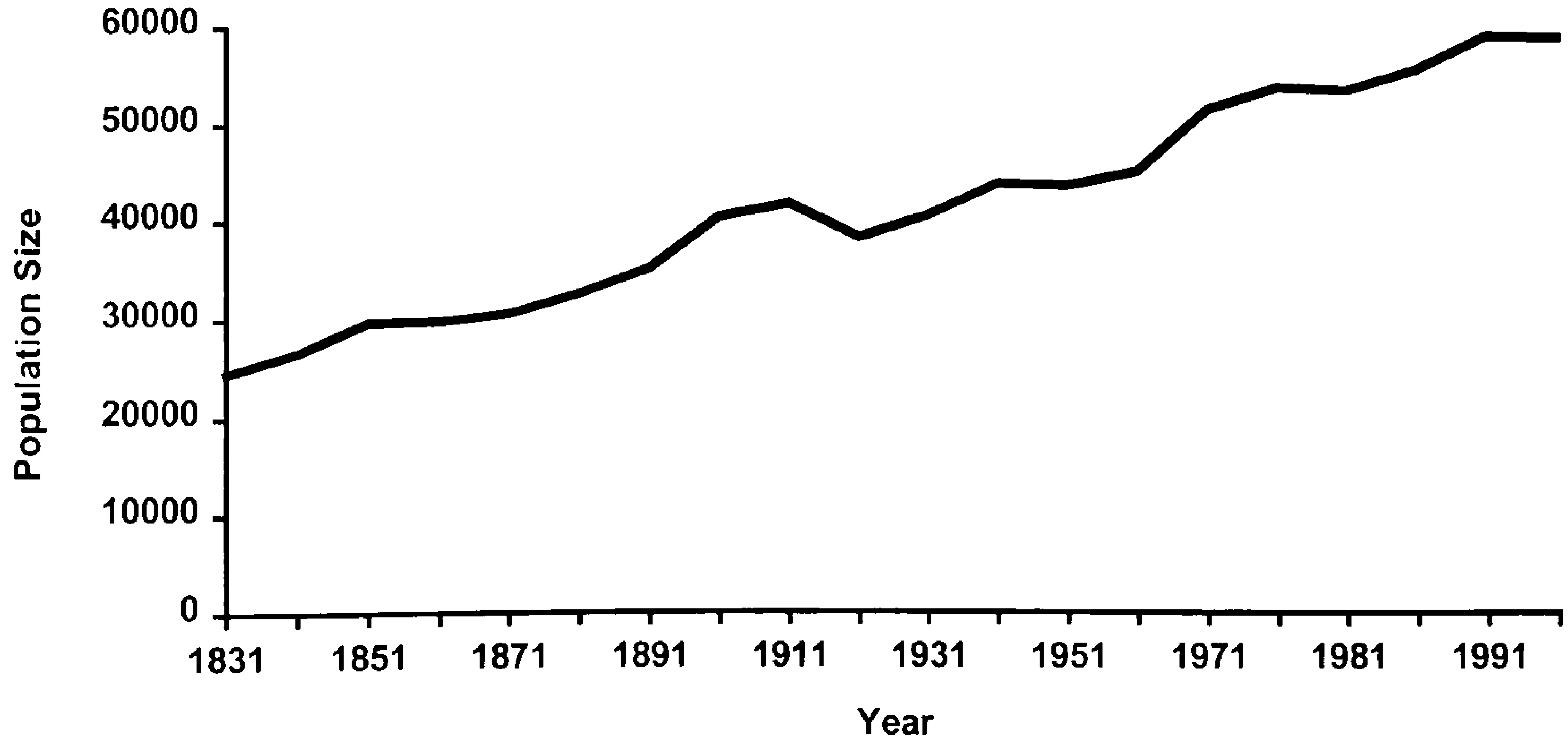


Figure 1.4: Guernsey Population, 1831 – 1996. Source: Guernsey Census Office.

The States of Guernsey has recognised the importance of adopting a policy for reducing, or at least stabilising the present population. Little has been done to the present day to understand the importance of a reduction in population. The Strategic and Corporate Plan 1996/97 highlights that the growth in population should be limited to as low a level as possible, suggesting tighter licensing laws and the continuation of the "Right to Work" scheme.

1.6.4 Influence of Tourism

The visitor economy in Guernsey has contributed to and will continue to be a key contributor to the Island's Gross National Product. It is also clear that the visitor economy is an integral part of the success of the Financial Services Sector particularly in helping maintain the necessary infrastructure and external transport links for the business visitor. Due to the popular and cheap package holidays to other foreign countries, Guernsey has not experienced an increase in tourist numbers. Figure 1.5 below displays the number of visitors to Guernsey from 1986 to 1996.

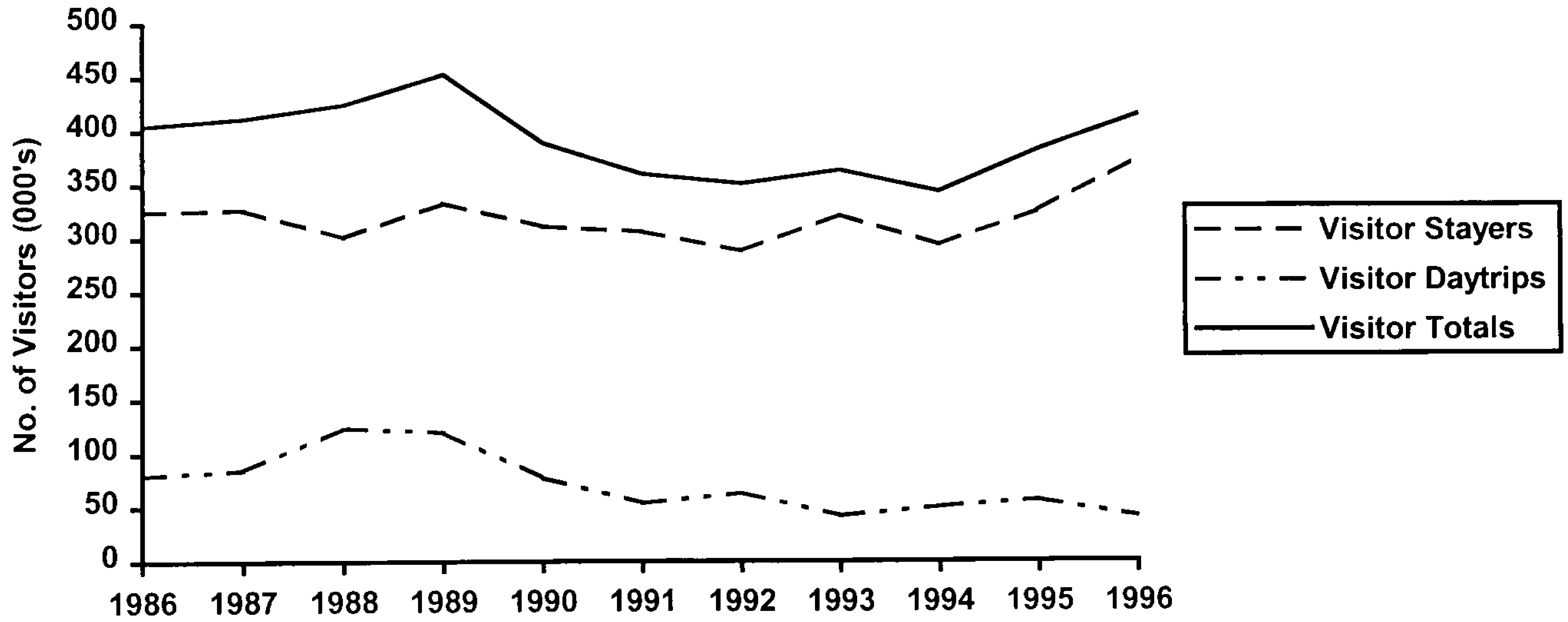


Figure 1.5: Visitor Departures from Guernsey (000's).

Source: 1997, Economics and Statistics Review.

The island possesses many features that, if protected and enhanced, will continue to attract visitors in the future. Its natural beauty, climate and overall ambience, are very important assets in the maintenance of a successful tourism industry.

1.6.5 The Built Environment

The projections of future housing requirements, which have formed the basis for planning in the Strategic and Corporate Plan to date, were that the population would rise approximately to 61,500 by the end of 1993. This was an over-estimation as the population in 1996 now stands at 60,000. The 1991 Census also revealed a decline in the average size of households, which now stands at 2.61 per household as compared to 2.76 ten years ago. The implication is that if the population levels remained static until early into the next century and this decline in average household size continued, albeit perhaps at a slower rate, then a further 1,300 to 2,000 new units of accommodation would have to be created.

The States of Guernsey has resolved that the major part of any new development should take place in the urban area in order to prevent the wholesale urbanisation of the Island. It has also resolved that in the case of housing, provision should be made in the Urban Area Plan to meet projected requirements for the 5 year statutory life of the plan and that land should only be released for housing development when needed.

Guernsey is extremely sub-urbanised. There is a continual sprawl of semi-detached housing that is spreading over the island. Provision for housing has been included in the Rural Area Plan (Phase 1). In the context of a strategy for conserving and enhancing the rural environment, there may be opportunities for limited housing provision in the Rural Area Plan (Phase II) and in the subsequent review of the Rural Area Plan (Phase I) over and above the number of new homes likely to be created by the development. The Island Development Committee may, therefore, zone land for small housing developments where this would not undermine the objective of protecting and, where appropriate, enhancing the rural character and natural environment.

1.6.6 The Natural Environment

Guernsey's natural environment can be considered to be quite diverse. It has a valuable marine environment surrounding the island with 50 km of coastline. There is also an area of moorland in the north of the island. One of Guernsey's main tourist attractions is the outstanding beauty of the natural environment. Baseline research has been conducted by University College London, of the local wildlife habitats and species. Key conservation objectives are in the process of development under the three headings below.

- What can be done within the existing resources and the existing legislative framework;
- What could be done with limited additional resources and minor changes in legislation;
- What would require more substantial resources and major new legislation?

The States of Guernsey intend to identify the roles and responsibilities of individual agencies in the preparation and implementation of Action Plans for the protection of wildlife and habitats.

1.7 Critique of Environmental Policy within Guernsey

The Environmental Policy Statement outlines the structure of the future strategy that is to be adopted by the States of the Guernsey. Section 4.11 supplies an insight into the future aspirations of the community and the corresponding relationship with the environment. Section 1.b, without mentioning sustainable development provides a definition similar to that of the Bruntland Report (1987) on sustainable development. This being,

"Humanity has the ability to make development sustainable - to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs." (Our Common Future, 1987).

The concept of intra and inter-generational equity is introduced, without fully understanding the complexity of these concepts. The environment is to be protected for human use, no mention of preserving the environment for the sake of its own existence (intrinsic and inherent value of nature). Asking for such a mention within a policy report is maybe too optimistic. Guernsey is not alone with its anthropocentric approach in defining sustainable development. On a European and United Kingdom level, a definition of sustainable development does not seek to preserve the environment for any other reason than that of human life, present and future.

The next important statement (page 675, 1.c.) takes a forward-looking approach to environmental policy and can be considered to be a bold comment within the planning report.

"Immediate and longer term environmental factors are given equal consideration alongside economic and social factors." (1997 Policy and Resource Planning Report).

This implication of "equal consideration" may not be fully understood and could be interpreted in many different ways. Very few policy statements would agree to consider economic, social and environmental factors on an equal level. The reality of the statement is yet to be seen.

1.7.1 Implications of the Environmental Policy

The Environmental Policy Statement continues by providing the implications of policies and programmes specifically to Guernsey. The two main suggestions of implementation within the report are,

> "...Overall enhancement of the environment..."
> "...Minimise any detriment to the environment."

Both comments are very vague and used regularly within environmental policy; this is not unique to Guernsey. We are left to guess what is meant by the comments and the implications they have in practical terms. There is no definition of "overall enhancement" or a "detriment" to the environment. There is a clear conceptual leap from theoretical conceptions to a practical framework for action within the policy statement.

The term "overall enhancement" has been derived from the policy concerned with National Parks in England and Wales. At this level such a comment has provided obscurity proving such comments should be left alone.

1.7.2 A Legislative and Administrative Framework

In Part 2 of the policy statement there is a promise of a "legislative and administrative framework" in the protection of the environment. Guernsey, being separate from both E.U. and U.K. Environmental Policy is left to devise its own policy framework. This places Guernsey in a unique position giving them the opportunity to introduce forward-looking environment policy. Guernsey also has the opportunity to totally ignore any calls from Europe for the implementation of environmental policy, something the member countries cannot do. At present, Guernsey severely lacks any legislation directed specifically at environmental protection. This policy statement has brought this to attention, which is encouraging; understanding the inadequacy of the present situation has to be the first logical step for Guernsey.

Within this section the idea of setting targets with a legislative framework is introduced. The idea of setting targets is becoming popular within European and United Kingdom environmental policy. A particular example of this is the issue of rising carbon dioxide levels. Targets have been set within the U.K. to reduce levels of CO_2 by 20% by 2010 on a 2000 baseline. This idea, for Guernsey, is too advanced for their present situation, concerning emissions. The island has no official measurement technique for establishing current levels of emissions. With no idea of present levels, setting targets are impossible. There is little mention within the report of introducing an established protocol of the island's present situation.

1.7.3 Political and Administrative Structure

Owing to its unique political history, the Island is officially described as a 'Crown Dependency'. Guernsey has its own legislative assembly, *The States of Guernsey*, and comprehensive legal, fiscal and administrative systems. Acts of the UK Parliament do not apply to the Island unless by prior agreement and specific inclusion in a UK Act. Guernsey's relationship with the European Union is also ambivalent. Guernsey is outside the EU for fiscal harmonisation and financial services, and inside the Union for trade in agricultural and industrial goods. As a consequence, access to financial support under the Common Agricultural Policy, Social, Development and Structural Funds is prohibited. Although EU Directive do not apply to the Island, in practice, Guernsey policy makers have used the Directives as indicators of best practice and adapted them to the Island.

1.8 Why Select Guernsey as the Case Study

The following list outlines the reasons why Guernsey has been selected as the case study for the research.

- Guernsey, although unique in many ways, is like a very small country. It has its own parliament, administrative system, harbour, airport and a power station that supplies the whole island. This provides a model for larger countries.
- Guernsey is at the stage where it wishes to develop its environmental policy further. The research has practical implications for the States of Guernsey.
- Being an island, data collection becomes an easier process, with accurate port and air import statistics.
- Guernsey has total control over their decisions, meaning that there is a real opportunity for change.
- The States of Guernsey are in full support of the research and have committed themselves to help in any way they can.

While Guernsey acts as the only case study, the research is not intended to concentrate solely on Guernsey. The implications of the research for the UK are considered, as well as considering the ramifications on a global level.

1.9 The Research Methodology

Before establishing a coherent research methodology, it is important to understand that there are many alternative methods of gathering information and of analysing the resultant data. The role of social research is to understand and explain social phenomena, to focus attention on particular issues and to challenge held beliefs about social and natural worlds, by employing the most suitable method (Layder, 1993).

Attempting to establish the "most suitable method" within the realm of social science poses many questions concerning objectivity, deduction or induction, validity and reliability, just to mention a few. The nature of the selected methods and types of data that they should collect are open to dispute. Justification of the selected methods is essential. To understand the assumptions and justifications, which are required within social research, it is necessary to examine their complex relationships.

Figure 1.6, (Kolb's Experimental Learning Cycle illustrated below) gives an indication of the procedure for the development of knowledge. It suggests the iterative relationship among theory, empirical research and personal experience. The premise for understanding phenomena is one of learning through the testing of assumptions.

The model suggests that the research process and the place to begin the research can be identified at any point in this complex process. One of the key aspects of the model is that the research never stops. There is a continual process of learning from each stage to the next.

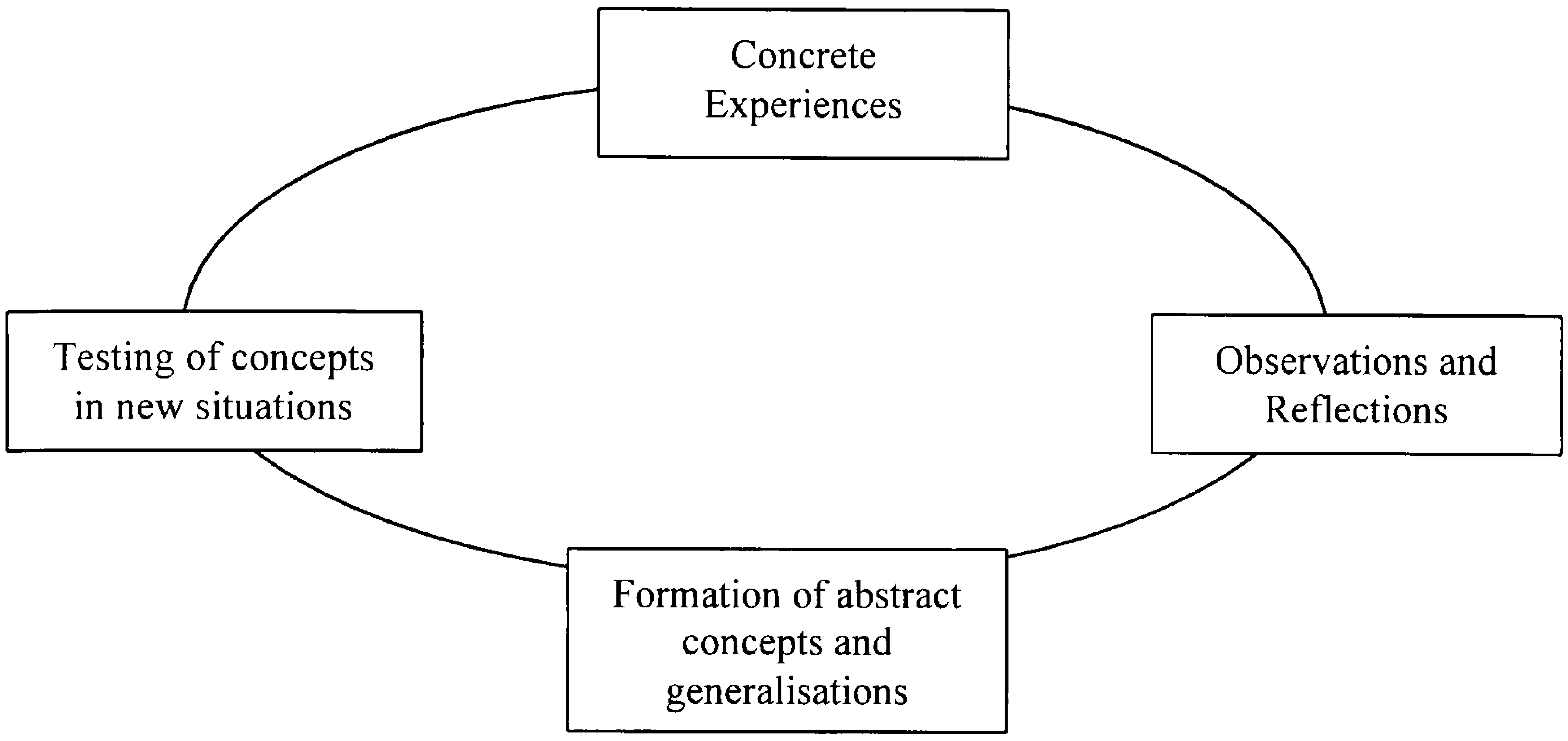


Figure 1.6: Kolb's Experiential Learning Curve

Source: Kolb, Rubin and McIntyre (1991:32)

According to Kolb, Rubin and McIntyre (1991), the above processes are linked to how human beings learn. Learning might start with an experience of an event, which the individual then reflects upon in an attempt to make sense of it. This may lead to the generation of explanations that can then be used to form an abstract rule that can be generalised to new events of a similar type to that already experienced. Learning can start at this point where such a rule is merely received from others by the learner, along with its web of explanations and expectations, and is subsequently applied by that learner and thereby tested out. Whether the rule is received or generated out of the prior experience and reflection, its testing in new situations creates new experiences that enable consequent reflection, observation and ultimately new rules (Kolb, Rubin and McIntyre, 1991).

1.9.1 Deductive and Inductive Research

According to May (1993) research is more than the simple replication of our opinions and prejudices: it either substantiates, refutes, organises or generates our theories and produces evidence which may challenge not only our own beliefs, but also those of society in general. Two main processes for conducting research have been established in the generation of theories; induction and deduction. A discussion of the two contrasting opinions of research has been conducted. Fundamentally, the display of approaches for the testing and judging of hypotheses can be visualised along a spectrum of methodologies, from the deductive tradition to inductive methods. Figure 1.7, below, displays the relative position of various research techniques along this spectrum of research methods.

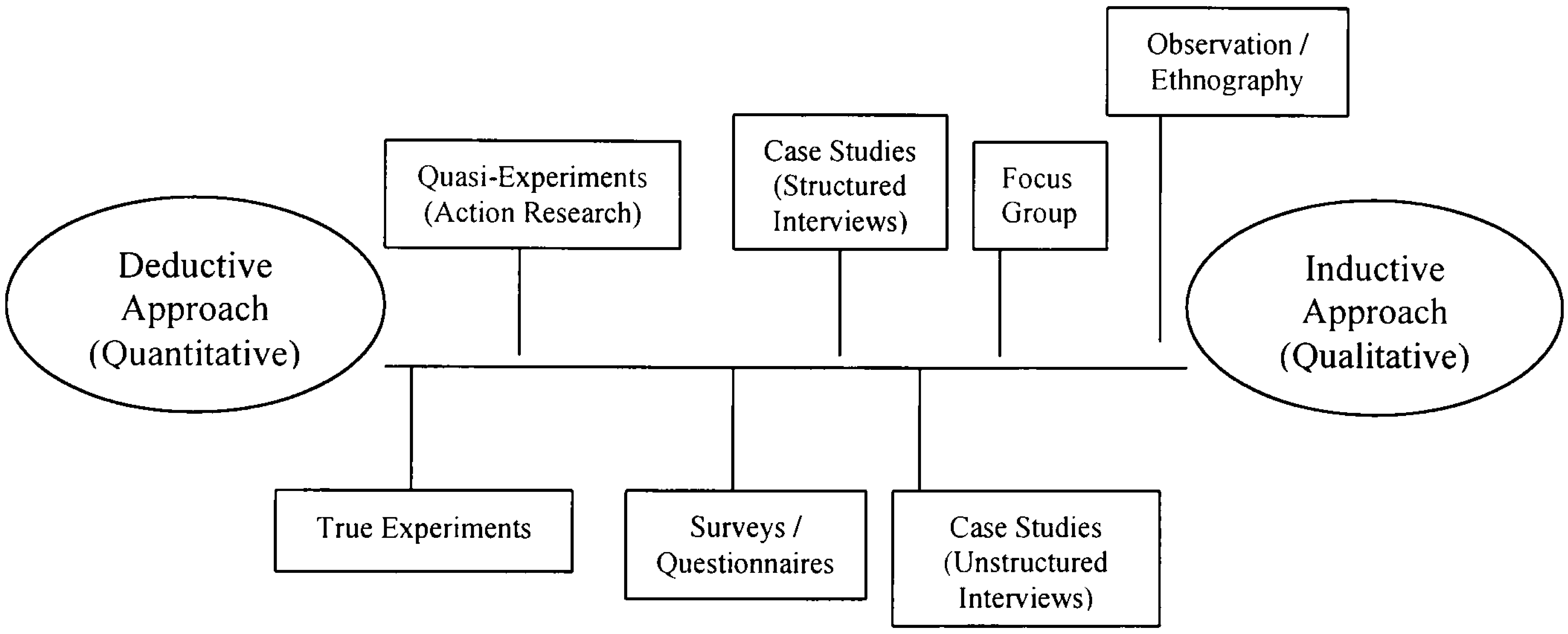


Figure 1.7: Spectrum of Research Methods
Source: Author

A deductive research method entails the development of a conceptual and theoretical structure prior to its testing through empirical observation. Deduction corresponds to the left-hand side of Kolb's experimental learning cycle since it begins with abstract conceptualisation and then moves on to testing through the application of theory so as to create new experiences or observations.

The logical ordering of induction is the reverse of deduction as it involves moving from the 'plane' of observation of the empirical world to the construction of explanations and theories about what has been observed. Induction relates to the right-hand side of Kolb's learning cycle (Figure 1.6). In contrast to the deductive method of research, in which a conceptual and theoretical structure is developed prior to empirical research, theory is the outcome of induction.

Two main arguments have been proposed to why an inductive method should be adopted within the field of social science. First, for many researchers working within the inductive tradition, explanations of social phenomena are relatively worthless unless they are grounded in observation and experience. The second argument arises out of a critique of some of the philosophical assumptions embraced in positivism (deductive tradition).

One of the main themes of the deductive tradition in the social sciences is a conception of scientific method constructed from what is assumed to be the approach of the natural sciences, particularly physics. This entails the construction of laws that explain the past and predict the future, through causal analysis and hypothesis testing. This is constructed as follows: -

A causes B

Or

Variation in A causes variation in B

That is

Stimulus A causes Response B

This form of explanation and prediction provides the initial point of departure for the following critique that justifies much of inductivism in the social sciences. Inductivism in the social sciences rejects the causal model illustrated above. This is because there are fundamental differences between the subject matter of social sciences and natural sciences. This position is illustrated clearly by Laing (1967) who points out the error of blindly following the approach of the natural sciences in the study of the social world.

"The error fundamentally is the failure to realise that there is an ontological discontinuity between human beings and it-beings ... Persons are distinguished from things in that persons experience the world, whereas things behave in the world."

Laing (1967) draws attention to a number of key concerns: -

1. The aim of social science is to understand internal logic. Human action has an internal logic of its own which must be understood in order to make action intelligible.
2. Natural sciences do not have this subjective comprehension of its own behaviour – it does not have an internal logic that the scientist must tap into in order to understand its behaviour. Therefore, the natural scientist can impose an external logic upon the behaviour of the subject matter in order to explain it. But such a methodology is inappropriate and does not explain the actions of human beings due to their subjectivity.
3. The social world cannot be understood in terms of causal relationships, which do not take account of the situation that human actions are based upon the actor's interpretation of events.
4. It follows that research in the social sciences must entail analyses, where explanations of human action derive from the meanings and interpretations of those conscious actors who are being studied.

Therefore, the stimulus-response model of human behaviour is rejected in favour of

a) stimulus → experience and interpretation → response
b) interpretation and meaning → action.

Within example (a) the actor's subjectivity is taken to be an 'intervening variable' that mediates between the stimuli coming from the external social reality and subsequent human responses expressed as behaviour or action. In (b) the actor's subjectivity is accorded greater 'formative or creative' power in its own right. The interpretation of reality has a projective quality in the sense that such subjective processes create the reality in which action arises, and the conception that subjectivity mediates external stimuli becomes rather meaningless (Laing, 1967).

Giddens (1976) outlines how this creates serious objections to the positivist contention that social phenomena might be treated as being analogous to the 'things' of nature and thereby are amenable to a similar type of causal analysis in which the subjective or international dimension is lost. This consideration creates the need for social scientists to explain human behaviour adequately. The methodological implications of this perspective entail the avoidance of the highly structured approaches of deduction; these, it is argued, prevent and ignore the penetration of actor's subjectivity. This involves research that allows for access to human subjectivity, without creating distortion, in its natural or everyday setting.

1.9.2 Selection of the Research Methodology

The choice between different research methods can depend upon quite pragmatic matters. For instance, if the purpose of the research is to discover how people intend to vote, then a quantitative method, such as a social survey for example, may seem most appropriate. Although, if the research wanted to understand why people voted the way they did (concerned with exploring people's wider perceptions), then qualitative methods may be favoured. The methodological implications of this perspective involve the avoidance of highly structured research. Gill and Johnson (1997) argue that neither the deductive or inductive methods is intrinsically more appropriate for research of a sociological hypothesis. Both approaches have advantages and disadvantages in terms of practical, philosophical and ethical considerations.

There are, of course, more complex questions concerning the selection of a particular research methodology. Table 1.1 shows how imprecise evaluative considerations come into play when researchers describe qualitative and quantitative methods.

Qualitative	Quantitative
Soft	Hard
Flexible	Fixed
Subjective	Objective
Political	Value-free
Case study	Survey
Speculative	Hypothesis-testing
Induction	Deduction
Grounded	Abstract

Table 1.1: The features of qualitative and quantitative methods
Source: Halfpenny (1979) in Miller and Dingwall (1997:13)

It is important to understand the results that best answer the research questions. When this has been established the most suitable methods must be applied. Table 1.1 gives the opportunity to establish the best method of data collection using the two contrasting disciplines of the qualitative and quantitative traditions.

1.9.3 Matching Research Questions with Strategy

In the case of this particular research project, there are many practical considerations that dictate the chosen methodology including limited resources, limited time, financial constraints and a lack of manpower. Additionally, the research is to be conducted on an island where the researcher does not live, meaning a limitation on the amount of visits to the island.

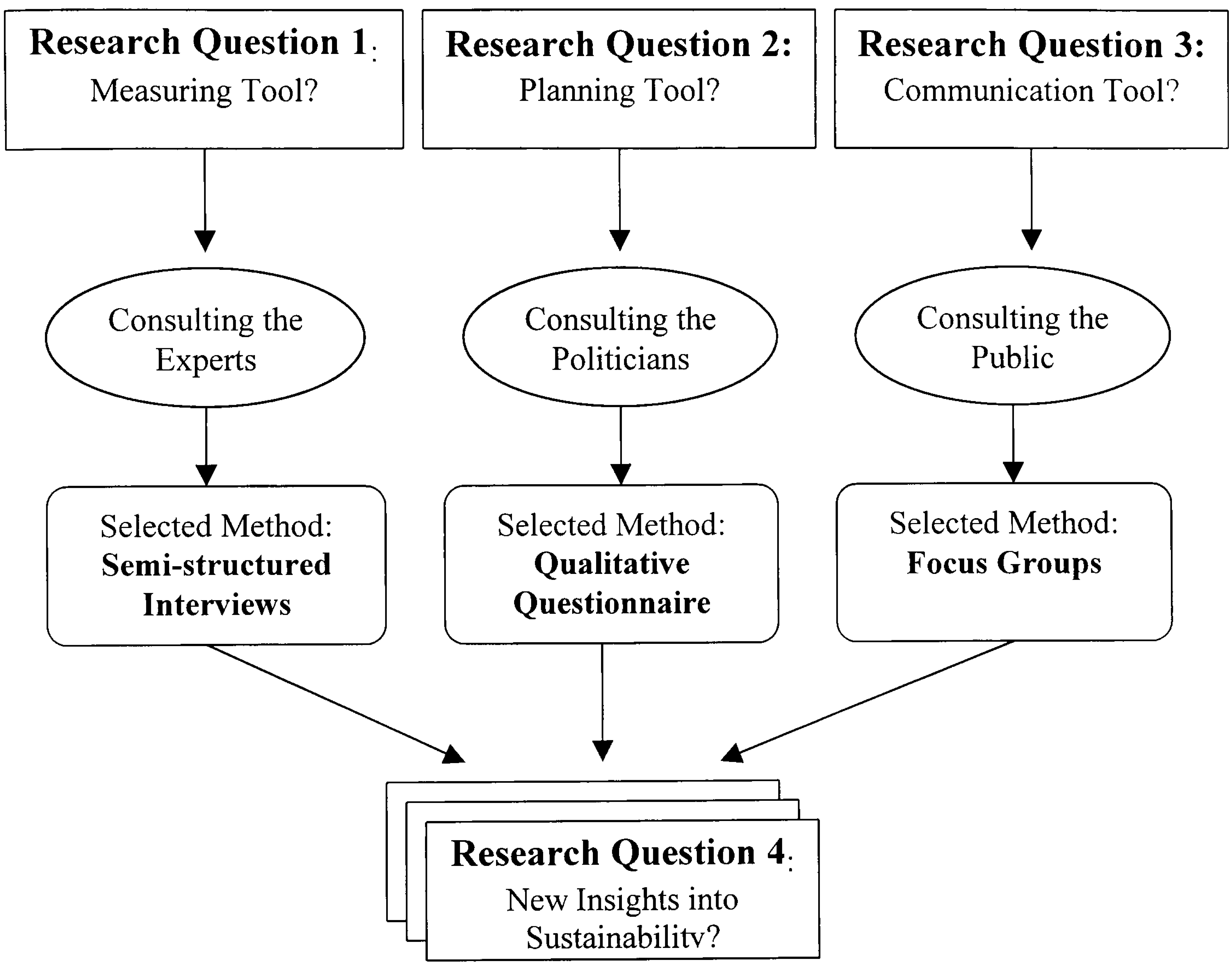
However, there are still many methodological choices open. These limitations merely set the context within which philosophical and ethical choices can be made. For example, the nature of the research question makes an experimental approach unsuitable. The research is attempting to gain insights into opinions and behaviour, rather than actual results. The hypothesis involves many variables that are subjective in nature and need to be explored in depth. It would be impossible to truly understand someone's emotions and beliefs by adopting an experimental approach.

Therefore, a range of qualitative techniques has been selected for the research, including focus groups, semi-structured interviews and questionnaires. A discussion of the methodological approaches has been included within each relevant chapter (for example, Chapter 5, which discusses the ecological footprint as a communication tool includes the methodology of the focus groups). However, below is a diagram that represents the research methods that were considered and the ones that were adopted.

1.9.4 The Methodological Plan

The following diagram is a visual snapshot of how the research questions and the methods selected inter-link in order to fully address the questions. The research questions are the same as the questions posed in section 1.2. These research questions will be revisited in the conclusions chapter (chapter 7). The second row in the diagram below represents the investigation that was required in order to explore the research questions. The next row identifies the methods used to acquire the necessary information for each question. Justification for each methodological selection has been given within the relevant chapter[4]. Finally, question four draws on all the findings from the first three questions in an attempt to discover whether the ecological footprint can offer new insights into the sustainability debate.

[4] It was felt that it was more appropriate to justify each methodological selection within each relevant chapter as it allows each topic to be focused upon independently and fully.



Research Question 1:
Measuring Tool?
Research Question 2:
Planning Tool?
Research Question 3:
Communication Tool?
Consulting the Experts
Consulting the Politicians
Consulting the Public
Selected Method:
Semi-structured Interviews
Selected Method:
Qualitative Questionnaire
Selected Method:
Focus Groups
Research Question 4:
New Insights into Sustainability?

CHAPTER 2: EXPLORING SUSTAINABILITY

2.1 Introduction to the Chapter

The last century has been a century of growth. Growth in population, growth in wealth and growth in resource use. Western society has demonstrated how to dominate economic markets and dominate the resource consumption of the planet. While economists continue to consider means for more effective and faster growth there is a real possibility that overshoot may have occurred (Meadows, 1992).

The World Commission on Environment and Development (WCED) in 1987 revealed many fundamental concerns about the current human condition. The WCED suggested that humanity is not living within nature's productive capacity, thereby gradually destroying it.

This chapter will investigate whether humanity has 'gone too far' by exploring the anthropocentric influences on the sea, land and air. Before this analysis is conducted the chapter explores the facts concerning human consumption, waste, population, poverty and the depletion of natural resources.

The chapter also questions whether high consuming societies will be able to maintain their increasing level of consumption, and can the resource use of developing countries emulate their lifestyles.

The chapter explores the concept of sustainability and asks whether it is the answer to an environmental and social crisis. This is achieved by considering the meaning of sustainable development and an examination of its implementation at various levels. Finally, the chapter considers the necessary indicators that are required to guide humanity towards a more sustainable existence.

2.2 Are we facing a changing period in human life?

In relation to this question, five issues are considered; trends in consumption, waste, population, poverty and the depletion of natural resources.

2.2.1 More Consumption

Between 1950 and 1997 there has been an unprecedented rise in consumption. Within this timescale, timber use and grain consumption have tripled, fossil fuel consumption has quadrupled, the amount of fish caught by fivefold and paper use has increased sixfold (FAO, 1998, FAO, 1998a, USDA, 1999, UN, 1998). While economic indicators show positive increases in investment, production and trade, the key environmental indicators illustrate increasingly negative results. The effect of economic growth has been devastating to the environment, as described by Lester Brown (Worldwatch Institute),

"Forests are shrinking, water tables are falling, soils are eroding, wetlands are disappearing, fisheries are collapsing, range-lands are deteriorating, rivers are running dry, and plant and animal species are disappearing" (Brown, 1998:4).

Lester Brown paints a bleak picture of the future. It is becoming more and more recognised that economic growth (as currently structured) cannot continue into the future with ecosystems deteriorating at their current rate. Daly (1991) suggests that this expansion-oriented approach is supported by most of the governments in the world and organisations such as the World Bank and the Organisation for Economic Co-operation and Development (OECD). The underlying philosophy is growth and has permeated every corner of the earth[1].

Neo-classical economics assumes that we are far from limits and far from the limiting carrying capacity of the environment. This denial of biophysical limits merely ignores

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[1] 'Growth' is the rate of flow of matter and energy through the economy (from the environment as raw material and back to the environment as waste), and the stock of human bodies and artefacts (Daly, 1992).

the facts and fails to understand the significance of consumption by the industrialised countries. Figure 2.1 below shows that industrial production is growing.

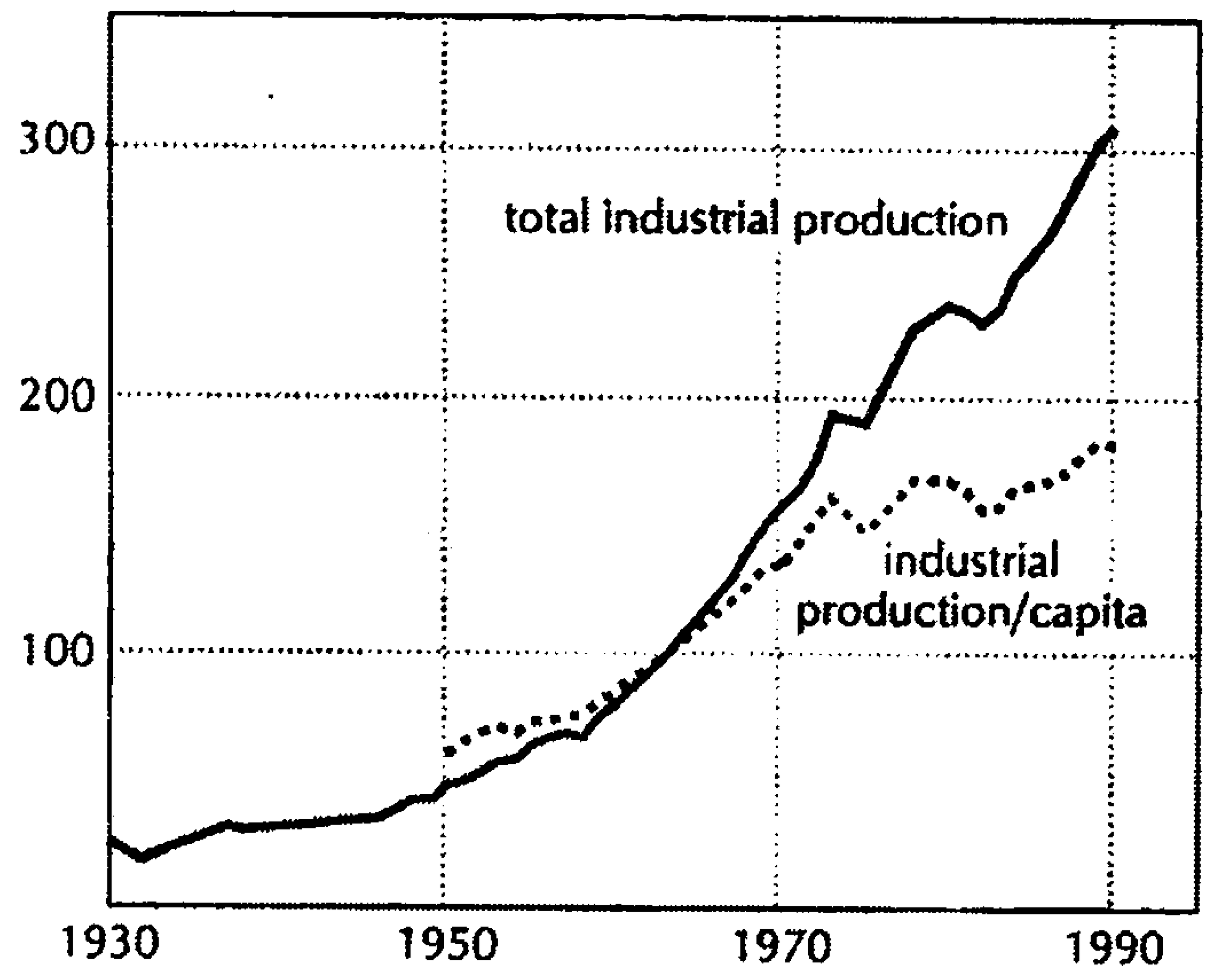

Figure 2.1: World Industrial Production (relative to the base year 1963).
Source: United Nations; Population Reference Bureau in Meadows, Meadows & Randers (1994:5)

Figure 2.1 shows the exponential increase in production, despite fluctuations due to oil price shocks. The growth rate between 1970 and 1990 was an average of 3.3% per year, while the per capita growth of production was 1.5% per year.

Meadows et al (1994) see this increase in consumption as no surprise. In the developed countries world economic growth is seen as the answer to employment problems, social mobility and technical advancement. For the developing countries economic growth is visualised as an answer to poverty. The capitalist system makes the search for growth inevitable.

Table 2.1 demonstrates the significant increase in consumption for a range of products, highlighting humans' propensity to growth.

	1970	1990
Registered automobiles	250 million	560 million
Oil consumption/year	17 billion barrels	24 billion barrels
Natural gas/year	31 trillion cubic feet	70 trillion cubic feet
Aluminium/year	72,700 tonnes	1,251,900 tonnes
Beer consumption/year	125 million barrels	187 million barrels

Table 2.1: Consumption of a range of selected items for 1970 and 1990

Source: Adapted from Meadows et al, 1994

Between 1970 and 1990 the consumption of many of the products listed in table 2.1 has more than doubled. The increase in the use of aluminium has increased at a staggering rate.

Another example that provides an insight into the increase of consumption is fertiliser use. Figure 2.2 demonstrates how the use in world fertiliser consumption is increasing exponentially with a doubling time of ten years. According to the data, the total use of fertiliser is now 15 times higher than it was in 1945.

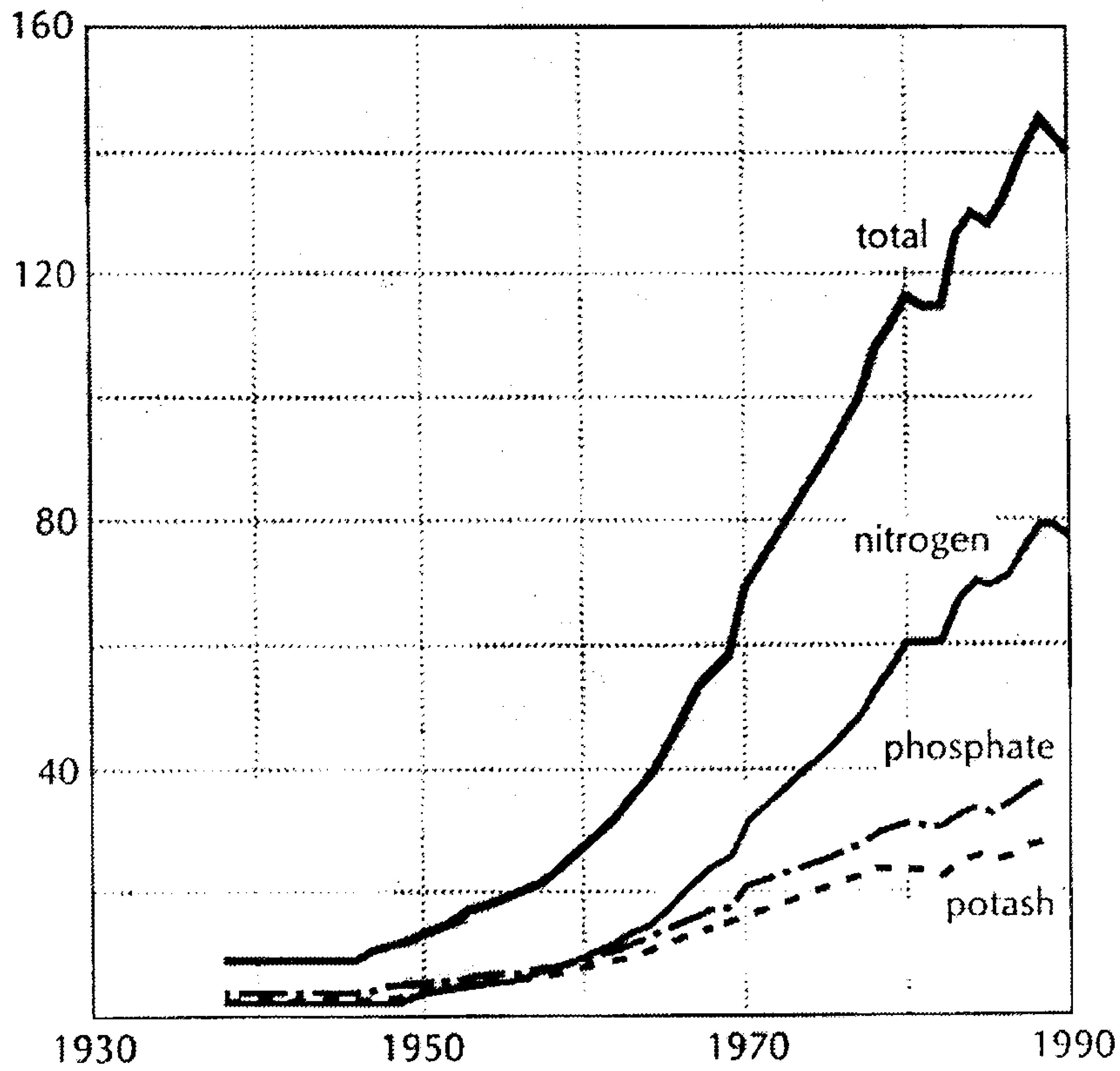

Figure 2.2: World Fertiliser Consumption (1938-1990)
Source: United Nations (1991:17)

Overall, Wackernagel & Rees (1996) have estimated that there has been a total increase in human consumption by fivefold since 1950, with some resources being consumed at an exponential rate over the same time period.

2.2.2 More Waste

The increased level of production and consumption has been responsible for an increase in waste generation. The level of waste generation has been responsible for a series of environmental and human health impacts. Improper management of waste is responsible for soil contamination, groundwater contamination, and threats to human health (EEA, 1995). In 1990, OECD countries produced a total amount of 9 billion tonnes of waste, including 420 million tonnes of household waste, 1.5 billion tonnes of industrial waste and another 300 million tonnes of hazardous waste (OECD, 1991).

Figure 2.3 shows the waste production trends in European countries.

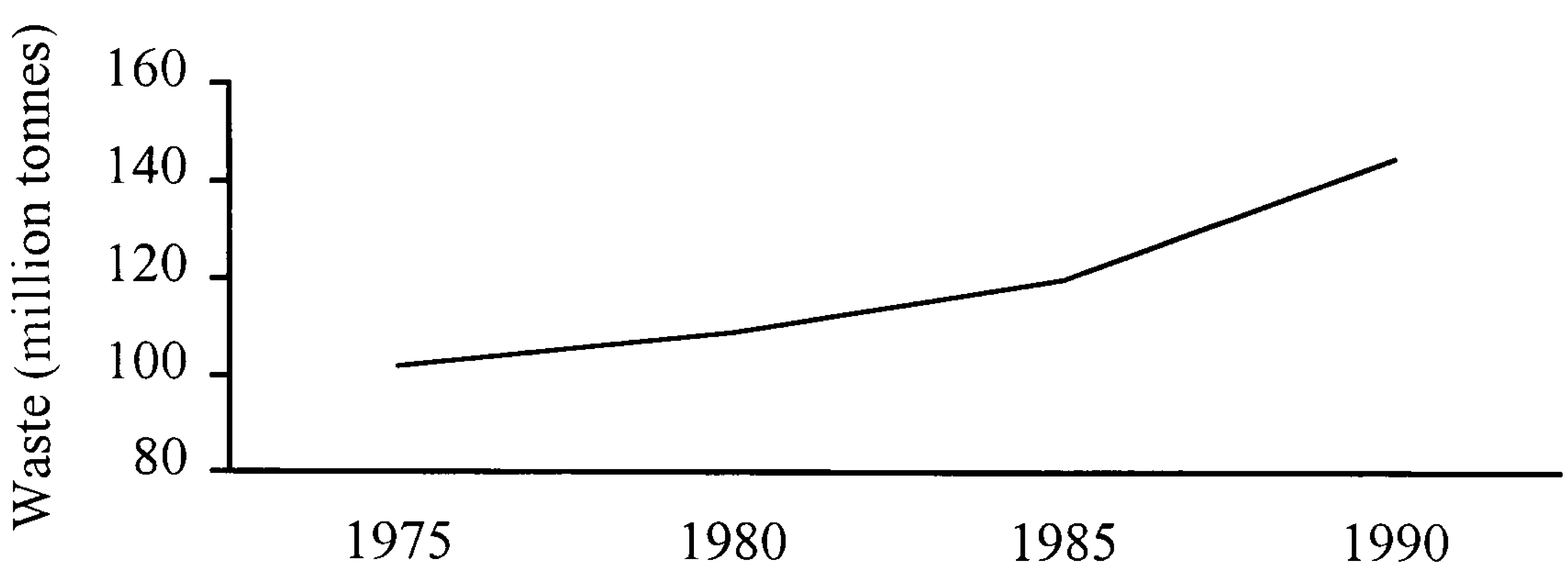

Figure 2.3 Waste Production in European countries from 1975 to 1990
Source: OECD (1993)

Figure 2.3 includes all waste production. The biggest increase in Europe has been municipal waste. In the OECD European area, the production of municipal waste has increased by 30% over a 15-year period. The growth rate for municipal waste increased by only 1% per year between 1980 and 1985, while the growth between 1985 and 1990 was 3% (EEA, 1995).

A similar pattern can be seen when looking at industrial waste production. Between 1985 and 1990, industrial waste increased by an average of 3% per year, representing an increase of 9 million tonnes per year in European countries (EEA, 1995).

When considering who is responsible for producing the waste, Girardet (1996) suggests that 'the richer the city, the more waste each citizen throws away'. In the United States, the use of aluminium demonstrates the enormity of the waste produced. For example, in 1963 1 billion aluminium cans were consumed in the US compared to 66 billion cans in 1993 (Girardet, 1995). The majority of these cans were disposed of by landfill. An example of the amount of waste produced on a per capita basis demonstrates the vast difference in waste production between the industrialised and developing countries. Los Angeles produces 3kg of waste (per capita/per day), while New York produces 1.82 kg, Tokyo 0.93kg, London 0.83kg, while Mexico City produces 0.4kg (per capita/per day) and Jakarta 0.38kg (Myers, 1995).

Not only has waste production increased but the movement of waste has also increased. This, in turn, is responsible for the negative effects of freight transport. The country that produces the waste is not always responsible for the problems associated with the disposal of the waste. Not all waste produced in Europe is disposed of within Europe. In 1994, the EU member states were responsible for sending 120,000 tonnes of hazardous waste to developing countries (EEA, 1995). It is clear to see that an increase in consumption has been accompanied by a subsequent increase in waste production, especially in the industrialised countries.

2.2.3 More people

In October 1999 the United Nations calculated that the world population had now reached 6 billion having doubled in size in less than 40 years (UN Population Division, 1999). Currently, world population is growing at a rate of 1.3 % per year, with an average annual addition of 78 million persons during 1995-2000.

According to the medium variant (see figure 2.4) of the UN population estimates and projections, world population will reach 7.2 billion by 2015 (UN, 1991a). There will still be an increase of approximately 50 million persons a year during 2010-2015. However, this demonstrates a slight slow down in population increase.

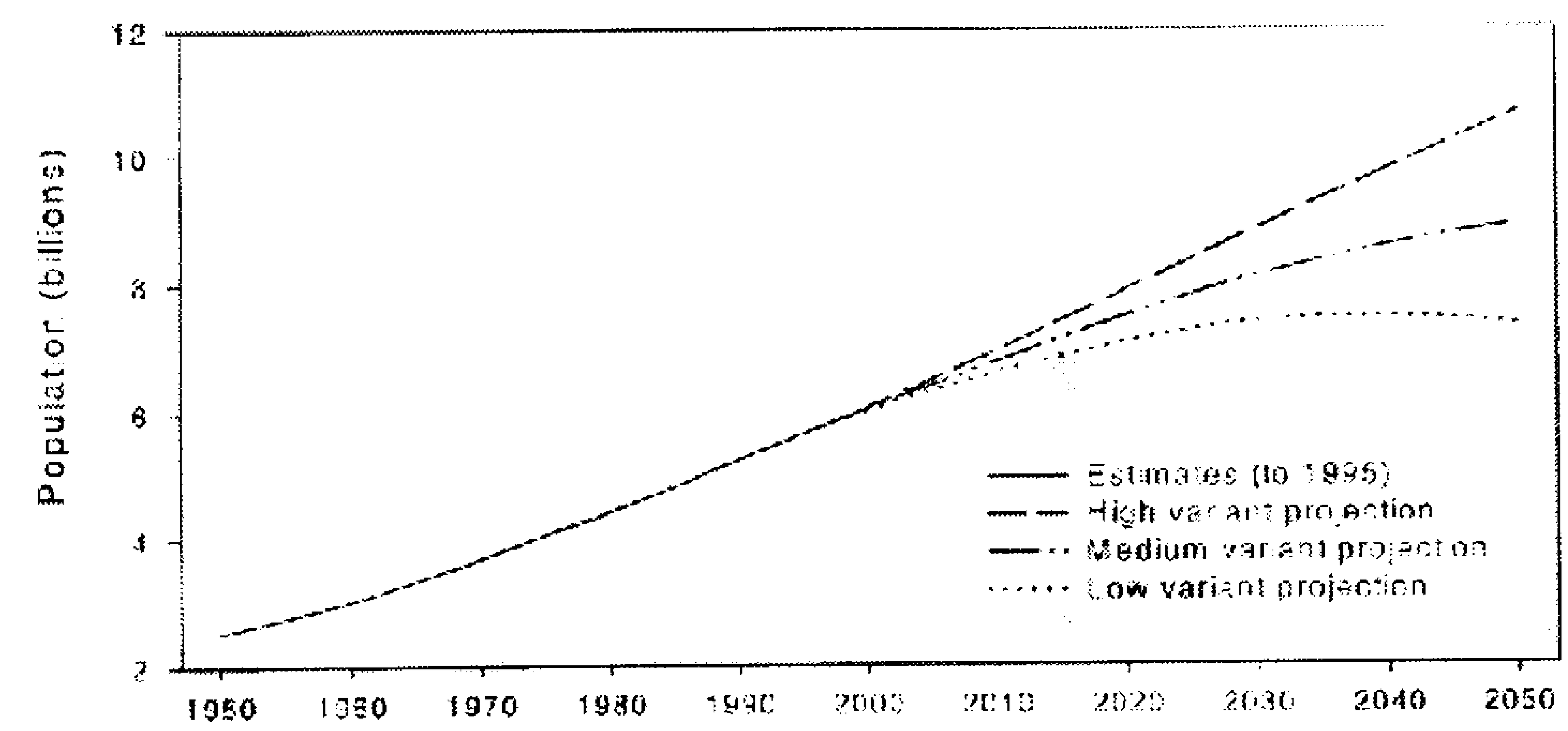

Figure 2.4: Estimated and Projected Growth of the World Population, 1950-2000
Source: World Population Prospects: The 1998 Revision (Page 9)

By 2050, the world population is projected to reach 8.9 billion. According to the high and low variant projections, world population could be as low as 7.3 billion and as high as 10.7 billion in 2050.

One fifth of the world's population currently lives in the developed regions, including Australia, New Zealand, Europe, Japan and North America. The remaining 80% live in the developing countries (Africa 13%, Asia 58%, and Latin America 8 %). The less developed countries are projected to absorb 98% of the population growth between 1999 and 2015 (see figure 2.5).

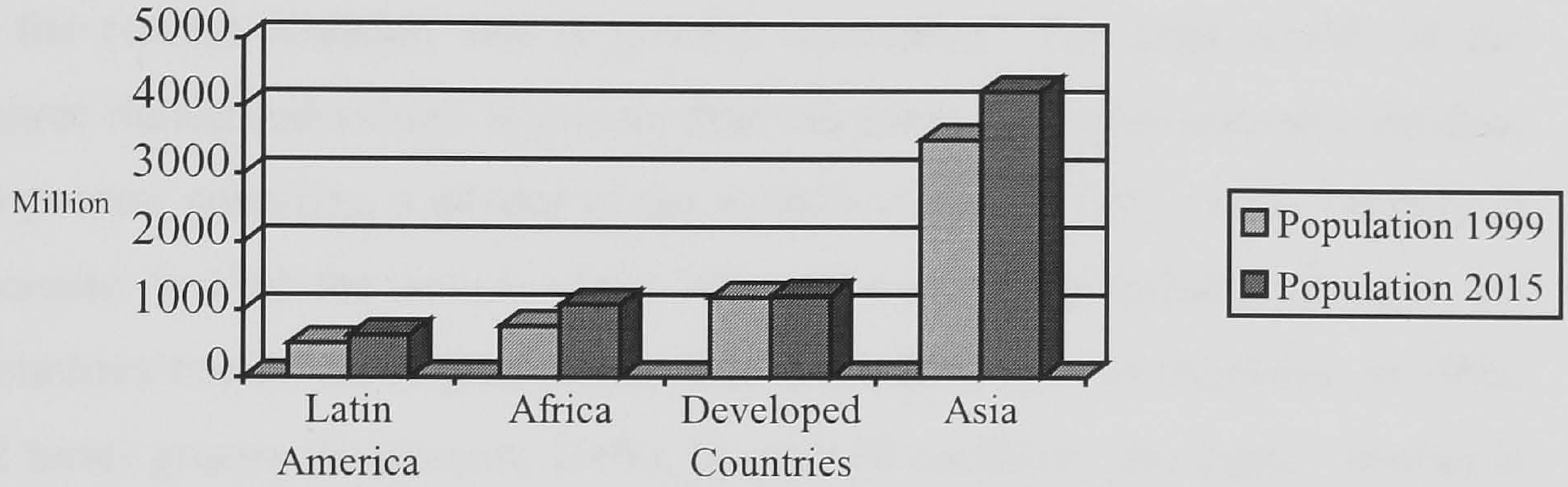

Figure 2.5 Distribution of World Population in 1999 and projected distribution in 2015.

Source: United Nations, 1999a: 13

With a growing population it is almost inevitable that consumption will grow and the subsequent waste will increase.

2.2.4 More poverty

The Worldwatch Institute reported on the 4th March 2000, that for the first time in history, the number of overweight people rivals the number of underweight people. While the world's underfed population has declined slightly since 1980 to 1.1 billion, the number of overweight people has surged to 1.1 billion. The number of hungry people remains high in a world that has a food surplus. Some 80% of the world's hungry children live in countries where there is a food surplus and the common thread that runs through all hunger, in rich and poor countries, is poverty (Worldwatch Institute, 2000).

Poverty can be said to exist in a given society when one or more persons do not attain a level of economic well being that is deemed to constitute a reasonable minimum by the standards of that society (Ravallion, 1994). All over the World, disparities between the rich and the poor, even in the wealthiest nations, are rising sharply.

"The poor are poor because the rich are rich and have the power to enforce trade agreements that favour their own interests more than the poor nations" (Shah, 2000:1)

What is the current situation and is poverty increasing? The total wealth of the world's three richest individuals is greater than the combined gross domestic product of the 48 poorest countries, a quarter of the world's states (UNDP, 1998). Poverty is on the increase. In 1960 the income of the 20% of the world's population living in the richest countries was 20 times greater than that of the 20% poorest countries. In 1995, it was 82 times greater (Ramonent, 1998). In over 70 countries, per capita income is lower today than it was 20 years ago (UNDP, 1998). Almost three billion people, half of the world's population live on less than two dollars a day (UNDP, 1998).

The UN has calculated that the basic needs for food, drinking water, education and medical care of the world's poor could be covered by a levy of less than 4% on the accumulated wealth of the largest 225 largest personal fortunes (Shah, 2000). In contrast, Ramonent (1998:2) suggests that hunger exists as a political weapon.

"Hunger is a strategy pursued with unbelievable cynicism by governments and military regimes whom the end of the cold war has deprived of a steady income."

Brunel (1998:2), is concerned about governance, and has expressed similar views by stating that,

"They are starving their own populations in order to cash in on media coverage and international compassion, an inexhaustible source of money, food and political platforms."

2.2.5 Depletion of natural resources

With substantial increases in consumption and population it is almost inevitable that natural resources are being depleted at a faster rate than they can regenerate. For example, recent UN estimates suggest that the majority of marine fish stocks and the world's entire primary fishing grounds have reached peak production and are in decline. The landings of the most commercially valuable species have dropped by a quarter since 1970 (McGinn, 2000). In the course of depleting prized species, fisherman are quickly unravelling the food chain and disrupting marine ecosystems. In the South Pacific, the catch of the 'Orange' fish roughly plummeted by 70% in just six years (McGinn, 1999).

While there is major concern about resource depletion due to growing human demands (Dunlap, 1993) there remain some scholars who deny limits to natural capital. Their main arguments are summarised below.

1. The allegation of limitless substitutability

Weinburg (1979) put forward the argument that if humans run out of one resource that they will replace it with another. This may be true for some resources, such as copper, but cannot apply to all the ecological services on which human activities depend. This assumption ignores the fact that humans depend on the critical life-support functions of nature (Rees, 1990). Human activities require more than just industrial resources, but also the renewable biological resources and waste absorptive capacity for which there is no satisfactory substitute. An example of this is the issue of carbon dioxide emissions. Even though the raw minerals may be available, the excessive use of fossil fuels has unbalanced the planet's atmospheric system[2]. As Daly demonstrates,

"The growth of the economic subsystem is limited by the size of the overall system, by its dependence on the overall system as a source of flow-entropy inputs and as a sink for high-entropy waste outputs." (Daly in Markandya & Richardson, 1992:37)

2. The assumption that market price indicates resource scarcity

The argument of a free market economist is that as resources become scarce their price will rise and substitutes will be encouraged. The problem with such a solution is that resources that are threatened are mostly those without markets, an example being the greater part of the world's biodiversity (Pearce, 1994). Moreover, attempting to understand the increases in economic reserves of non-renewable assets ignores the fact that the total stock is declining, and that it may become increasingly difficult to exploit such stocks in the future.

3. Scientific fraud and mis-information

Pearce (1994) suggests that a useful indicator of scarcity is the 'reserves to production ratio', i.e. the total reserves of a resource divided by the annual production of that resource. Research by Ozdemiroglu (1993) found the following relationships between price and scarcity: -

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[2] For more information on the effects of climate change and the ability of the planet to absorb carbon, see Chapter 3.7 entitled 'Carbon Sequestration'.

- Petroleum, natural gas, aluminium, gold – no statistically significant relationship (no price trend could be detected)
- Thermal coal, copper, zinc, coconut oil and jute – prices followed a statistically significant time trend in the form of an 'U' (prices rose at first then fell, indicating no resource scarcity.
- Timber exhibited no trend other than a possible rising scarcity for Philippines logs.

(Source: Ozdemiroglu (1993), in Pearce et al, 1994: 6)

What is intriguing about Ozdemiroglu's findings is that he predicts that many of these resources will be scarce in the future. At present levels of resource consumption, it is not possible to exploit all these resources into the future. Timber and oil provide examples of this. The areas of the world's forests, including both natural and forest plantations, is estimated to be 3,454 million hectares in 1995, or about one fourth of the land area of the earth (FAO, 1999). Figure 2.6 compares the forest area between 1980 and 1995.

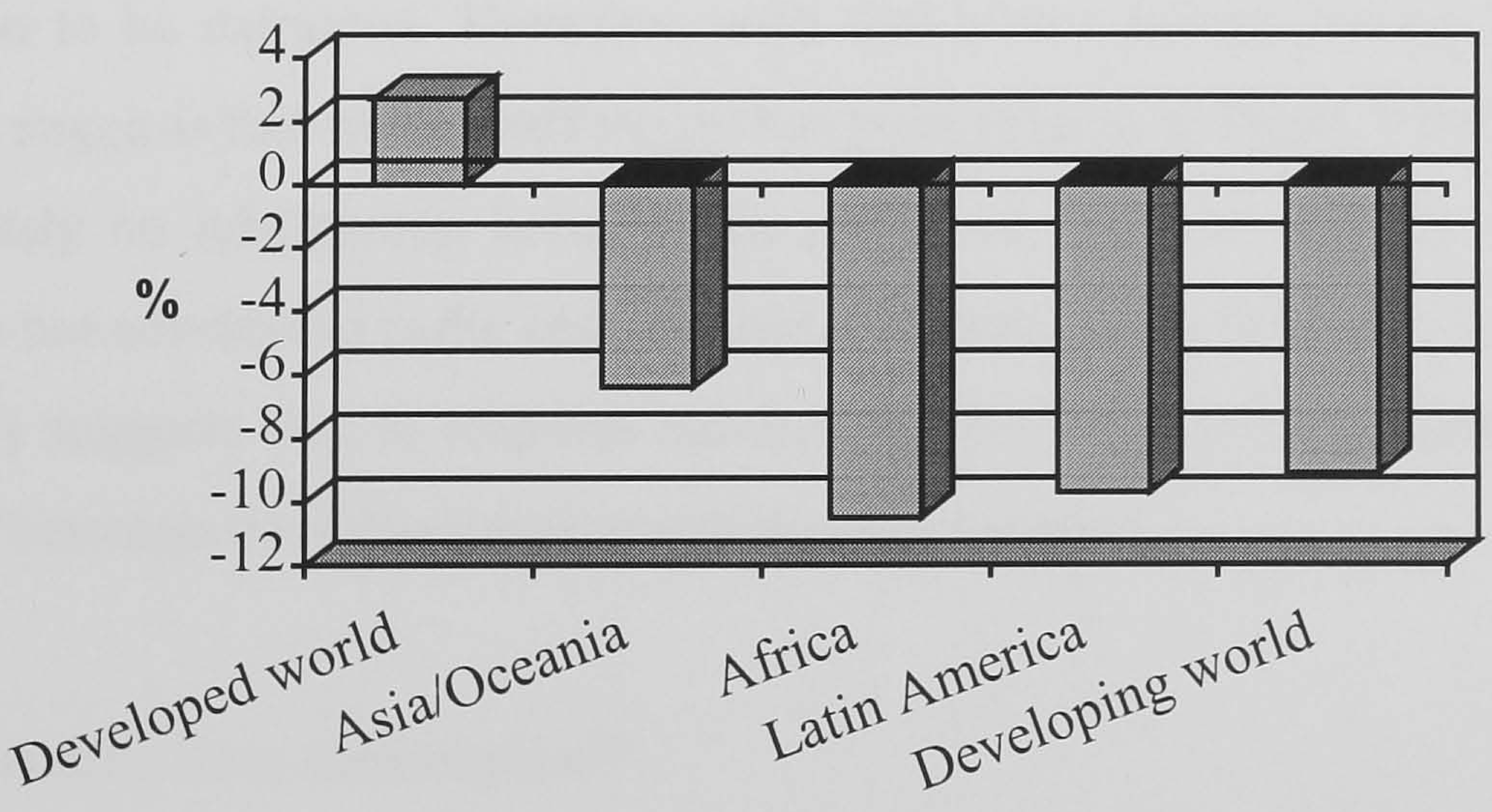


Figure 2.6: The Percentage Difference of Forests, comparing 1980 to 1995

Source: FAO, State of the World's Forests, 1999:2

Between 1990 and 1995, there was a decrease in the world forests by 65.1 million hectares (FAO, 1999). Between 1960 and 1990, one fifth of all tropical forest cover was lost (Abramovitz, 1998). Deforestation is not the only threat; there has also been a serious decline in forest quality. For example, 95-98% of forest in the United States has been logged at least once since settlement from Europe (Abramovitz, 1999). What the economic markets have not been able to detect is the unsustainable loss of forests across the world, both forest cover and the quality of forests. There is also the issue of biodiversity protection, particularly when considering tropical rainforests. Various attempts have been made to estimate the rate of species extinction. Reed (1992) estimated that 1-1.5% of species will be lost each decade, another important ecological crisis ignored by economic markets.

The price of energy is nearly as low as it has ever been. Flavin and Dunn (1999) suggest that the ability to find new energy sources that are more convenient, reliable, and affordable than fossil fuels is beyond the imagination of many experts. Although oil markets have remained relatively stable for the last 10 years, approximately 80% of the oil produced today comes from fields discovered before 1973, most of which are in decline. According to a recent analysis of data on world oil resources, geologists Colin Campbell and Jean Laherrere estimate that roughly 1 trillion barrels of oil remain to be extracted. Therefore, with 800 billion barrels having been used already, this suggests that nearly half the oil has gone (Flavin & Dunn, 1999). There is quite obviously no relationship between the price and resource scarcity. The other factor that is not considered is the cost of climate change due to the burning of the oil. Bolin (1998) suggests that to stabilise atmospheric carbon dioxide concentrations a reduction of between 60-80% in carbon emissions is required.

2.2.6 Who benefits from consumption?

While the ecological and social problems of consumption have been considered it is important to discuss the benefits. Consumption of all products generates wealth. The World Bank (2000) states that 16% of the world's population receive over 78% of the world's income, while the poorest 22% receive only 6%. It is quite clear who benefits from consumption. However, the burden of environmental degradation does not fall directly upon those who reap the benefits of the activities in question.

2.2.7 Conclusions to section

The preceding information has demonstrated that there will be more people to feed, more carbon dioxide will be produced with less forest land to absorb it, there are less natural resources to exploit and yet humanity is exploiting resources at a faster rate than ever.

This has established the task for humanity. In relation to the original question, are we facing a changing period in human life, the answer is yes. These opposing trends show how human consumption has come to exceed the global productive capacity of nature. Wackernagel (1994) suggests that today's human requirements in three of nature's functions (namely food, forest production, and CO2 sequestration) already exceed terrestrial carrying capacity by nearly 30%.

Furthermore, one of the most alarming prospects, as highlighted by the UNIDO, is that the current levels of world industrial output would have to be increased by a factor of 2.6, if consumption of manufactured goods in developing countries were to rise to current levels in industrialised developed countries (WCED, 1987:213).

2.3 Reacting to a changing period in human life

In this section we will discuss the evolution of sustainable development and consider the concept in depth.

2.3.1 Sustainable Development: Introducing the Answer?

By providing information on consumption, waste, population, poverty and natural resources it has become clear that humanity is growing further away from a sustainable society every year. This period of change has resulted in an increase of the environmental and social problems that humanity faces. There is little doubt that the ecological crisis is deepening. There is also a clear link between these environmental and social problems.

Sustainable development is seen by some as an answer to the conflict between environment and development. Over the last ten years the term 'sustainable development' has dominated the environmental agenda. One of the main reasons for this is the flexibility of interpretation. There is much disagreement about the meaning of the concept.

The debate on sustainable development has developed from initial narrow concerns with resource depletion and nature conservation to a holistic discourse that recognises the social, cultural, environmental, economic and political processes (Collins, 1996).

2.3.2 The Evolution of Sustainable Development

The concept of living within the means of nature was first advocated in 1972 at the United Nations Conference on the Human Environment (UNCHE), in Stockholm, Sweden. Although concerns about environmental degradation had been expressed before Stockholm, those concerns tended to be regional (Sunkin et al, 1998). The significance of the Stockholm conference was that for the first time, environmental degradation and its effect upon the human populace were identified as a global issue. In other words, action at the local level was having a global impact, from which there was no hiding place. Principle 2 of the Stockholm conference stated:

"The natural resources of the earth, including the air, water, land, flora and fauna and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate" (UNCHE, 1972, cited in Sunkin et al, 1999:39).

Since Stockholm, the notion of protecting and securing the Earth's resources have climbed the political ladder of importance.

In 1987, the World Commission on the Environment and Development (WCED) responded to the question of human wants and nature's ability to provide by declaring that

"People can build a future that is more prosperous, more just and more secure" (WCED, 1987:1)

The WCED insisted that such a future could be reached by sustainable means. However, to attain prosperity, justness and security, society in developed countries would need to adopt different lifestyles. The WCED suggested sustainable development as the solution to the conflict between humans and the natural environment. Sustainable Development was defined as,

"Development that meets the needs of the present without compromising the ability of future generations to meet their needs" (WCED, 1987: 43).

The report argued for change in a wide range of political, social, economic and industrial systems in order to foster greater environmental protection (WCED, 1987). The Bruntland report also brought the idea of inter-generational equity into the political arena.

The Brundtland report outlined seven critical objectives for sustainable development.

- Reviving growth;
- Changing the quality of growth;
- Meeting essential needs: jobs, food, energy, water, sanitation;
- A sustainable production;
- Conserving and enhancing the resource base;
- Reorienting technology and managing risk;
- Merging environment and economics in decision-making

Figure 2.7: The Key Areas of the Brundtland Report

The main emphasis of the Brundtland Report is still economic growth to secure social and environmental aims. After providing a definition of sustainable development, the report suggests that sustainability is to be attained by,

"A more rapid economic growth rate in both industrial and developing countries, in the belief that economic growth and diversification will help developing countries mitigate the strains on the rural environment." (WCED, Brundtland Report, 1987:213)

This is a major shift from the ideas presented by Meadows in the Club of Rome's Report, 'The Limits to Growth' where economic growth is seen as the problem, not the cure. Severe criticism has been aimed at the WCED suggesting that supporting economic growth to achieve sustainable development, merely compounds and extends environmental problems (Collins, 1996). The Brundtland Commission fails to examine the underlying causes of poverty and inequity, the ability of the required growth to remain within ecological limits, or the argument that prevailing conditions of liberalised trade and conventional efficiency gains, may work against sustainability (Timmer, 1999).

2.3.3 Defining Sustainable Development

The definition, provided by the Bruntland Report (1987), has since been explained and adapted creating a situation where sustainability encompasses everything but defines nothing. Redclift (1992:18) emphasises the significance of such an occurrence,

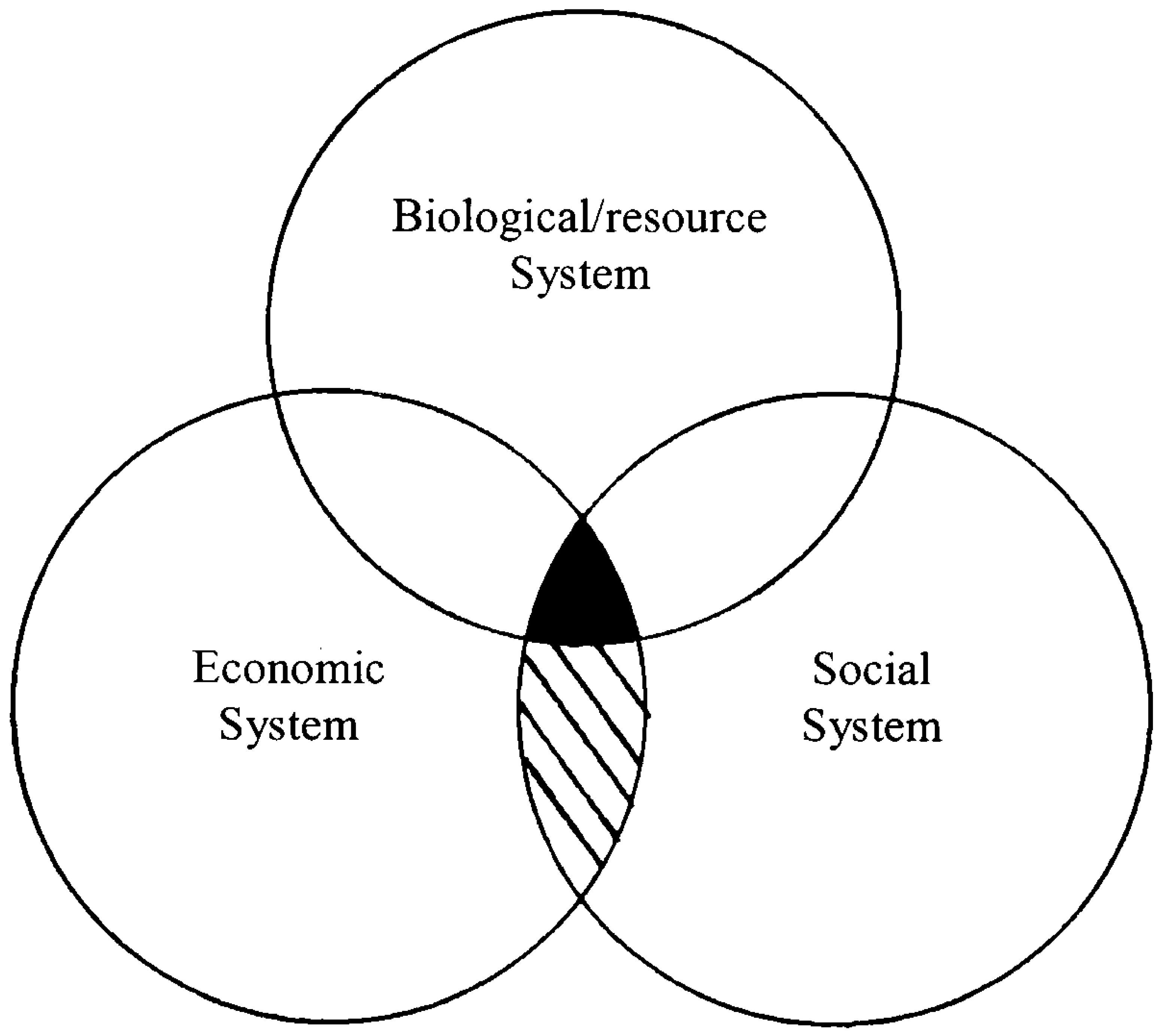
> "The term 'sustainable development' has been used in a highly normative manner to express desirable forms of action, consequently this has affected the seriousness with which the concept is viewed."

Goodland and Daly (1996) clearly highlighted this problem stating that sustainability must not become a landfill dump for everyone's environmental and social wish lists. The situation should not occur where many contrary interpretations of the concept have served to create the unclear public understanding of the concept.

An ambiguous concept provides little direction for change and that is why many academics have attempted to redefine sustainable development in more concrete terms. The Brundtland Report leaves too many unanswered questions such as; what are the implications of these terms and how are they to be implemented for future generations? What is a sustainable level of resource consumption? How are 'essential human needs' defined?

Barrow (1995) agrees with Redclift's view and redefines sustainable development as a three dimensional concept whereby the biological and resources systems are intrinsically combined with the economic and social systems (See Figure 2.8). Redclift (1987) believes that sustainable development should apply ecological lessons to economics and encompass ecology, economics and importantly, the political arena.

Fig 2.8: Representation of the concept of sustainable development



Shaded area = maximisation of goals across the three systems and, in effect, represents sustainable development.

Notes: Goals of biological system: keep genetic diversity, maximise productivity.

Goals of economic system: supply basic needs, improve equity, and improve goods and services.

Goals of social system: sustain institutions, improve social justice, and improve participation.

Conventional economic maximises economic system and social system.

Based on Barrow, 1995:67.

Macnaghten & Jacobs (1997) propose a different model for sustainable development believing that Barrow's model of the three inter-locking circles fails to address the issue of quality of life sufficiently. Barrow's model characterises the present situation in industrialised countries in terms of trade-offs between economic, social and environmental elements. This cannot be sustainable, as the essence of sustainability is not a matter of trade-offs but the development of all three aspects in the same direction. Economic growth may generate rising incomes (that could potentially improve quality of life) but will probably not contribute to an environmentally benign future. If the problem is economic growth it is hard to see how it can offer a solution to the sustainability crisis. Within Barrow's model, environmental degradation is then related to a decline in the quality of life, including aspects such as employment security, health and personal safety (Macnaghten & Jacobs, 1997).

In Macnaghten & Jacobs alternative model entitled "The Desired State of Sustainability" (see Figure 2.9), the same three elements are present but there is one fundamental difference; this being that there are no longer any trade-offs.

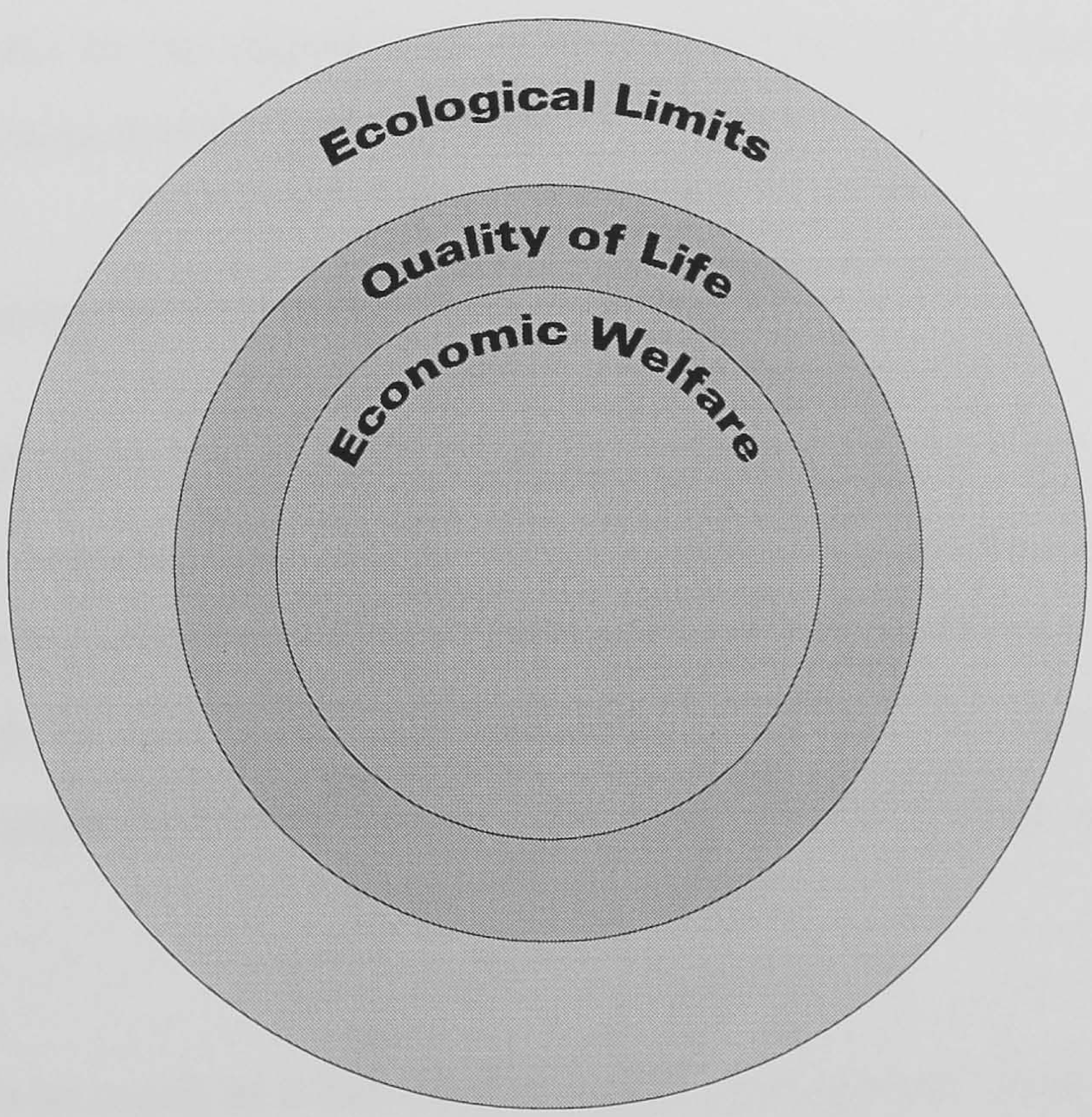


Figure 2.9: The Desired State of Sustainability
(Adapted from Macnaghten & Jacobs, 1997:9)

The most important difference between the models that are represented in figure 2.8 and 2.9 is that economic growth is not seen as an entity in itself. It does not exist outside society and economic welfare is now seen as only one component of quality of life. Quality of life should take precedence over economic growth. The model also provides a new dimension to the idea of ecological limits. Society must live within ecological limits to be regarded as sustainable, imposed by the capacity of the biosphere to provide society with all its resources.

This model helps to reach a more definitive and common sense definition of sustainable development. It helps remove the ambiguity of sustainability that can now be defined as, achieving the highest possible quality of life for everybody within the means of nature. By understanding the Earth's ecological limits, it is possible to improve the quality of life for the most disadvantaged communities whilst always remembering that we live in a world with a finite resource base.

Another dimension of sustainable development is the method by which society moves from the unsustainable present to the sustainable future. The transition must be a democratic process to be regarded as sustainable, with action being taken by the government, business and the general public.

2.3.4 Negative Response to Sustainable Development

Many of the criticisms aimed at sustainable development are concerned with the ambiguity of the concept, believing this may lead to continual economic growth and a tokenistic response to both ecological limits and social inequalities. This corresponds to the very weak or weak sustainability stance (table 2.2) as described by Pearce (1993) in his 'Sustainability Spectrum'. This view is clearly held by Taylor (1992) who states that,

"It is a menace in as much as it has been co-opted (by the mainstream)...to perpetuate many of the worst aspects of the expansionist model under the masquerade of something new." (Taylor, 1992:28)

Holmberg and Stanbrook in their book entitled 'Policies for a Small Planet' state that they "hate the term (sustainable development) with a passion, since it appears to license economic growth and is often interchanged with sustainable growth." (Holmberg and Stanbrook, 1992:21)

Gligo, in his article entitled "Sustainabilism and Twelve Other-Isms" claims that the "overly casual use" of the term sustainable development and the "generalised ignorance of what it means" has enabled "many social actors to adopt a cosmetic approach to development projects that does not assure substantial changes in their treatment of environmental problems" (Gligo, 1995:72-73).

All these criticisms highlight one important issue; that if sustainable development is to be a useful concept for improving people's quality of life and considering ecological limits, it must not be paid lip service to and be treated as a tokenistic effort for change. With the critics' ideas in mind, a strong sustainability stance is important to bring about any real change.

One of the most prominent critics of sustainable development, for substantially different reasons than the ones listed above, is Wilfred Beckerman. In his book entitled, 'Small is Stupid: Blowing the Whistle on the Greens', Beckerman (1995) suggests that sustainable development,

"...Has been defined in such a way as to be either morally repugnant or logically redundant." (Beckerman, 1995:125)

He continues by suggesting that environmental issues have been ignored in economic policy in the past but that this can be amended without elevating sustainable development to the status of some overriding criterion of policy. Beckerman demonstrates the valuable fact that sustainable development should, ideally, be defined so that one could specify a set of measurable criteria. This is essential, in that it moves the concept from being an abstract ideology to a realistic goal.

Beckerman's other criticisms include the assumption that the western model of development is both relevant and beneficial to poorer countries, thereby creating a conflict between improving quality of life and environmental concerns, suggesting that sustainable development is an 'oxymoron'. The example provided by Beckerman to demonstrate this point is a mining project in a poor country. He continues to suggest that the project might be the best way for the people concerned to obtain a decent quality of life, but this is inherently unsustainable due to environmental consequences of the project. What Beckerman fails to address is the issue of whether a Western model of development would actually be suitable and improve the quality of life for poor people. The project may be economically successful, but successful for whom?[3]

2.3.5 The Political weakening of sustainable development

How to achieve sustainable development is still fraught with controversy because of its many interpretations. The controversy arises when one particular goal of sustainable development is promoted above the others. It could be argued that politics has done much to weaken the concept of sustainability by putting economic development first. Table 2.2 below, developed by David Pearce, demonstrates how sustainable development has been weakened to mean everything and therefore means nothing at all. By describing so many things as sustainable, whether weak or strong does little to help provide a robust definition of sustainable development.

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[3] The development issue is discussed in more depth in chapter 7, addressing the issue of enforcing western ideologies on poorer countries.

	Technocentric		Ecocentric	
	Cornucopian	Accommodating	Communalist	Deep Ecology
Green labels	Resource exploitative, growth-orientated position	Resource conservationist and managerial position	Resource preservationist position	Extreme preservationist position
Type of economy	Anti-green economy, unfettered free markets	Green economy, green markets guided by economic incentive instruments	Deep green economy, steady-state economy regulated by macro-economic standards	Very deep green economy heavily regulated to minimise 'resource-take'
Management strategies	Maximise economic growth Unfettered markets in conjunction with technical progress will ensure infinite substitution possibilities	Modified economic growth, Decoupling important but infinite substitution rejected	Zero economic growth; zero population growth. Decoupling plus no increase in scale. Systems perspective – health of whole ecosystems very important	Reduced scale of economy and population. Scale reduction imperative. Literal interpretation of Gaia as a personalised agent
Ethics	Support for traditional ethical reasoning; instrumental value	Extension of ethical reasoning: 'caring for others' intragenerational and intergenerational equity	Further extension of ethical reasoning; interests of the collective take precedence over those of the individual	Acceptance of bioethics, intrinsic value in nature
Sustainability labels	Very weak sustainability	Weak sustainability	Strong sustainability	Very strong sustainability

Table 2.2: The Sustainability Spectrum
(Adapted from Pearce, 1993:18-19)

What are required are not a spectrum of different sustainability possibilities but a clear and concrete understanding of what the ecological dimension of sustainability means and how to define 'quality of life'.

2.3.6 The ecological dimension of sustainability

Pearce (1993) suggests that the mechanism whereby current generations can compensate the future is through the transfer of capital bequests.

"What this means is that this generation makes sure that it leaves the next generation a stock of capital no less than this generation has now." (Pearce, 1993:15)

Therefore, capital provides the ability to generate goods and services for future generations. If used at a sustainable level, this continues into the future. Even though the concept of natural capital has not been developed into an operational definition, there are various interpretations of natural capital. Barbier (1992) identifies natural capital in the narrowest of terms as commercially available renewable and non-renewable resources. However, a more complete definition should include the waste sinks that are needed to support the human economy as well as the biophysical resources. Another important factor concerning natural capital is the relationship among those entities and processes that provide life support to the ecosphere (Wackernagel, 1994). In summary, natural capital cannot merely be viewed as an inventory of resources, but must include the components in the ecosphere whose organisational integrity is essential for the continuous self-production of the system itself (Maturana & Varela, 1992). An example of this is maintaining the balance of carbon in the atmosphere. The issue goes beyond the sustainable use of the resource but also the energy required forming the resource into a meaningful consumer item.

As Wackernagel highlights,

"Geoclimatic, hydrological, and ecological cycles do not simply transport and distribute nutrients and energy but are among the self-regulatory, homeostatic mechanisms that stabilise conditions on earth for all contemporary life-forms, including humankind." (Wackernagel, 1992:53)

The debate arises as to what form natural capital should be left in for future generations. Does natural capital have to remain constant (strong sustainability) or is it acceptable that natural capital is lost through an equivalent accumulation of human-made capital (weak sustainability) (Contanza & Daly 1992, Pearce et al 1989, Pezzy 1989). According to Daly (1992:250) natural capital cannot be substituted by human-made capital, but rather it remains a prerequisite for human-made capital and becomes the criterion for judging whether humanity is ecologically sustainable. In conclusion, the ecological dimension of sustainability is achieved when the following generation inherits an adequate stock of biophysical assets, independent of the human-made capital stock. This gives future generations the ability to meet their own needs through the availability of resources. Wackernagel & Rees (1996) have described this in a simplistic way as 'living within the means of nature'.

2.3.7 The Social Dimension of Sustainability: Achieving Quality of Life for All

Quality of life is an elusive concept, incorporating social, environmental and economic elements. Moreover, Huby (1998) argues that quality of life is highly culture specific and dependent on personal attitudes and preferences. Huby (1998) believes that it is impossible to compare, for example, the relative quality of the lives of people living on low incomes in a beautiful environment with others on high incomes in a degraded environment. It is also important to realise that quality of life and standard of living are not the same thing. Redclift (1996) argues that above a certain threshold, improvements in standard of living, accompanied by increased negative environmental effects of consumption can contribute to a fall in quality of life.

Defining quality of life is a more subjective process than defining the ecological dimension of sustainability. Goodland and Daly (1996) outline three factors that must be achieved for the social dimension of sustainability.

1. Community participation and a strong civil society
2. Social cohesion – cultural identity, diversity, solidarity, comity, sense of community, pluralism
3. Human capital – investments in the education, health, and nutrition of individuals.

The above list highlights some of the fundamentals of a sustainable community although it fails to address some of the key social problems on a global and local basis. It is still possible to generalise and outline some of the key requirements for achieving quality of life even though a precise definition remains elusive. The first and foremost requirements must concern the provision of adequate food and nutrition, water and shelter. Maslow's hierarchy of needs helps define what the basic requirements are for life. Maslow (1954, in Huitt, 1998) attempted to synthesise a large body of research related to human motivation. Maslow created a pyramid of needs where the deficiency needs are at the bottom and growth needs at the top. The first four needs defined by Maslow are: -

1. Physiological needs: hunger, thirst, bodily comforts;
2. Safety/security: out of danger;
3. Belonginess and love: affiliate with others, to be accepted;
4. Esteem: to achieve, be competent, gain approval and recognition

Maslow argues that it is only when the deficiency needs are met, is a person ready to act upon the growth of needs (the top four needs in the hierarchy). These are: -

5. Cognitive: to know, to understand, to explore;
6. Aesthetic: symmetry, order, and beauty;
7. Self-actualisation: to find self-fulfilment and realise one's potential;
8. Transcendence: to help others find self-fulfilment and realise one's potential.

What is interesting about Maslow's hierarchy of needs is that to achieve each level, material wealth and continual economic growth are not required. Maslow's 'needs', as with quality of life issues, theme in on requirements from basic survival to personal self-actualisation.

Another major issue concerning quality of life goes beyond the mere provision of basic resources to maintain life; it must also include emotional contentment. This is highlighted by Beck in his discussion of the post-modern risk society,

"Traditional forms of coping with anxiety and insecurity in social-moral milieus, families, marriage and male-female roles are failing. To the same degree, coping with anxiety and insecurity is demanded of individuals themselves." (Beck 1992: p.153)

Figure 2.10, illustrates the results from a survey attempting to understand what Americans believed where the most important aspects to improve their quality of life.

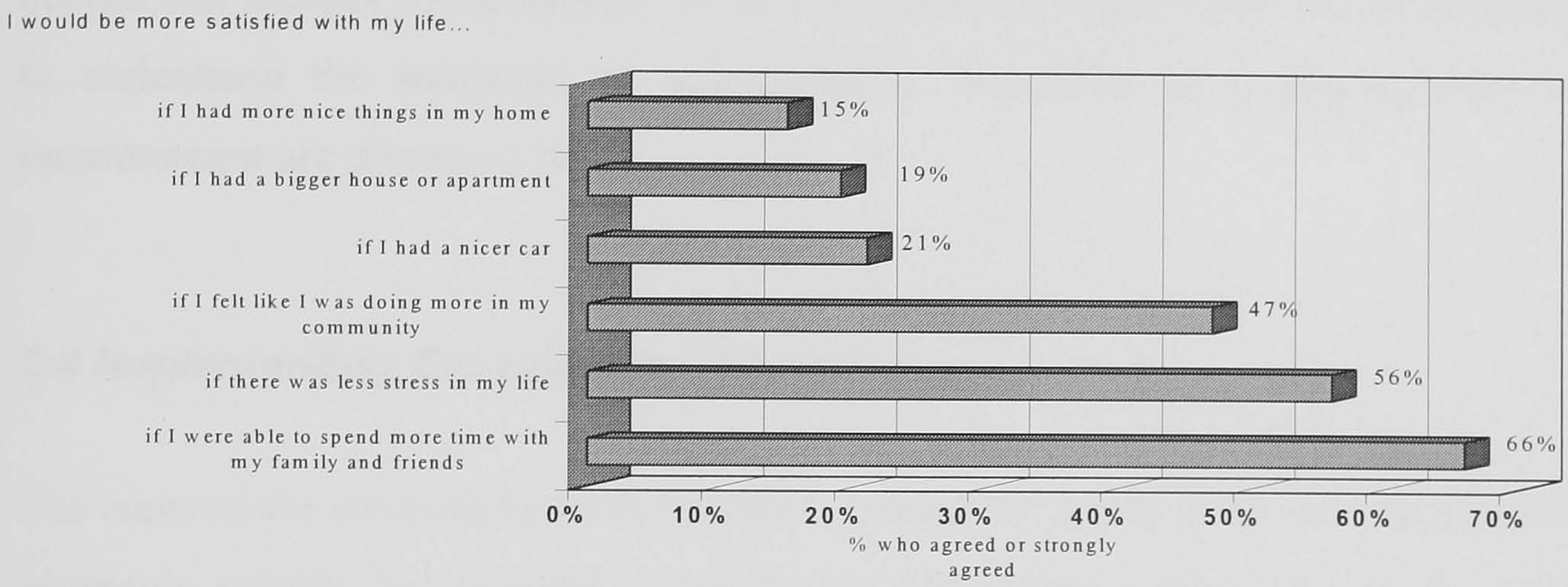

Figure 2.10: American Aspirations
Source: Sharing the Earth/Merck Family Fund

What is most clear from the survey is that economic gain, although present on the list, is not the most significant aspect to Americans for improving their quality of life. Easily the three most important aspects concern time with family and friends, a less stressful life and feeling part of a community. These can be described within Maslow's hierarchy as; stage 3: belonginess and love, stage 4: esteem and stage 8: transcendence, respectively.

2.3.8 Conclusions on Defining Sustainable Development

For Wackernagel and Rees (1996:32), sustainable development is a simple concept that means "living in material comfort and peacefully with each other within the means of nature". This simplistic approach to defining sustainable development offers a valuable insight. It has considered the limits to natural capital, the importance of social equity and believes that it is not possible to achieve sustainability in a world divided by war and conflict. Would, if implemented properly, sustainable development solve problems such as waste, poverty, and climatic imbalance? Could sustainable development guide development in the right direction and at what level has it and could it be in the future, the most effective level of implementation?

In response, sustainable development can potentially solve conflict between development, the environment and society. If implemented properly sustainable development does have the ability to guide society towards a more environmentally benign and socially just existence. However, there is a requirement for more thought to understand the semantics of sustainability. The issue of implementation and measurement are discussed below.

2.4 Implementing Sustainable Development

The concern for environmental degradation, attributed largely to the selfish pursuit of economic growth, has resulted in sustainable development being placed on various agendas ranging from the local to the global scale. The aim of this section is to demonstrate at what level sustainable development can best be achieved. The section demonstrates that the local community level is the most effective scale to implement sustainable development. At present, strategies to achieve sustainable development are predominantly top-down (O'Cinneide, 1999)

The argument below does not perceive that the only level to implement sustainable development is at the local level. For achieving sustainable development implementation and integration at all levels are required. This discussion is developed to greater depth in chapter 6, whilst here; the evolution of sustainable development at the global, European, national and local levels is discussed.

2.4.1 Sustainable Development within a global context

After the Brundtland Report, sustainable development was further endorsed and strengthened at the United Nations Conference on Environment and Development (UNCED), which was held in Rio de Janeiro, Brazil, in 1992. The conference was a global event, attracting 179 countries, in an attempt to develop practical measures to implement sustainable development. O'Riordan (1993) described the conference as being 'hopelessly naïve' in implementing sustainable development due to the complexity and diversity of the topics. However, five agreements were established relating to climate change, biological diversity, the establishment of 'Agenda 21' and the Rio Declaration and Forest Principles (Grubb et al., 1993). The key point concerning the Rio Conference was not how many agreements were signed but the strength of those agreements. The extensive negotiation processes often weakened agreements in an effort to achieve consensus among the 179 countries (Koch & Grubb, 1993; Bartelmus, 1994).

Not one international agreement has been able to truly address the ecological crisis, despite meetings like the Rio Summit and agreements on particular issues. In spite of all these meetings the ecological crisis has not diminished. Moreover, some key environmental concerns have not been addressed at the global level, such as soil erosion, deforestation and the issue that frightens all politicians, consumption.

By looking at the various organisations that have adopted responsibility for sustainability it is clear to see the ineffective nature of global sustainability measures. By looking at the effectiveness of the Rio Summit and climate change agreements, it is possible to assess the 'global sustainability effort'. COP6 was the sixth "Conference of the Parties" of the UN Climate Convention, which was created at Rio in 1992. This agreement was achieved after the inclusion of 'flexible mechanisms' (known as 'flexmex') that seriously weakens any progress to real reductions. Matthews (2000) believes that the major problem with the 'flexmex' is that it completely changes the environmental effectiveness of the protocol signed in Rio. This demonstrates, that although there were good intentions at Rio, the reality of implementation means a weakening of the key agreements. There are three main flexmex's: -

1. Emissions trading between annex B countries: In principle, trading does not change the total emissions, it only redistributes them between the trading countries. However, the quotas allocated to Russia and Ukraine[4] were too large. Since 1990, Russia carbon emissions have halved and Russia now has the ability to sell surplus 'hot air' to the US. The Rio protocol, supposedly a revolutionary

[4] Both these countries are considered to be in annex B. Their per capita emissions in 1990 were much higher than in western Europe, yet zero reduction was required on the basis of economic collapse in these countries.

international agreement, set unchallenging and inequitable targets (Matthews, 2000a)

2. Clean Development Mechanism: Annex B countries can fund a particular project in a developing country and claim credit for emission reductions as a result. Two examples of the reality of this demonstrate the ineffectiveness of the policy. The first example concerns hypothetical baseline scenarios. For example, some group could say, "we are going to cut down this forest, but if you pay us and gain emission reduction credits we will not". It makes no difference as to whether this was intended or not. A similar example is "if you pay us we will shut down this steel works". The actual situation could be that it was old and inefficient and making an economic loss that was going to be shut down anyway. Clean development mechanisms are merely a process where real emission reductions will not be achieved.
3. Enhancement of Sinks: Chapter 3 addresses the issue of the effectiveness of 'planting our way out of global warming' and demonstrates that this is not an effective approach for real reductions. Australia has a special clause on land-use changes that effectively allows them a massive increase in emissions (Matthews, 2000b).

This clearly demonstrates that Rio, concerning carbon reductions, is politically convenient and environmentally ineffective after 8 years.

2.4.2 Sustainable Development within a European context

The European Union is one of the three main economic areas of the world. Its primary goal is to strengthen the competitiveness of companies of its Member States in global competition with North American and Asian economic areas (Oja, 1999). It is important to remember that from its origin to the present day, economic development is the most important goal of the EU.

The original Treaty of Rome, signed in 1957, set the task for the European Community[5] as the promotion of, "A harmonious development of economic activities, a continuous and balanced expansion, an increase in stability, an accelerated raising of the standard of living, and closer relations between the States belonging to it" (Treaty of Rome, 1957).

In 1987, the Single European Act came into force and gave no mention of sustainable development but did, for the first time, introduce a legal underpinning for the Community's already developing environmental policy (Wilkinson, 1997). In 1993 the Maastricht Treaty on European Union (EU) was introduced and even though the Earth Summit (1992) had inaugurated a global commitment to sustainable development, it is only given limited coverage where the main objective is,

"To promote economic and social progress which is balanced and sustainable, in particular through the creation of an area without frontiers, through strengthening of economic and social cohesion." (Maastricht Treaty, 1992)

The European Commission adopted the 5th Environmental Action Programme (5th EAP) in 1992, three months after the UNCED and the development of Agenda 21. The 5th EAP was prepared in conjunction with the Rio agreement so that it shares many of the strategic objectives and principles (Wilkinson, 1997). The 5th EAP was responsible for setting the strategy for the EU's environmental policy between 1992 and 2000. The 6th EAP is now in place but it is too early to evaluate the success. The 5th EAP entitled "Towards Sustainability: A European Community Programme of Policy and Action in Relation to the Environment and Sustainable Development", focused on 10 major environmental concerns, and five economic sectors (industry, agriculture, energy, transport, tourism). For each of the different themes and target sectors, the programme set out the policy objectives, the necessary instruments and timetables for achieving them, the key actors from whom action was required, including the EU, member states, local authorities and industry (Wilkinson, 1997).

The fundamental objective of the programme was the integration of environmental concerns into all policy areas. Other important features included the acknowledgment that individual behaviour change was required and must be achieved in a spirit of

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[5] Changed to the European Union with the introduction of the Maastricht Treaty (1992)

shared responsibility among the main stakeholders (central and local government, public and private enterprise and the general public).

The 5th EAP is not binding to the European Council. Moreover, the ministers were careful to establish that the proposed actions did not impose legal obligations upon the Member States (Wilkinson, 1997). Any of the proposals could be rejected in the Council (the most powerful body of the EU). A review of the 5th EAP in 1995 demonstrated that the Commission had failed to act upon one quarter of the programme. There was also no requirement for the member States to report on the progress that had been made in achieving the objectives.

As previously stated, the most important element of the programme was integration. It almost seems farcical that environmental policy stands alone separate from the areas of energy, transport and waste issues. DGXI (the Environment Directorate) has no power over the other DGs. This problem was highlighted by the Environment Commissioner of the time, Ritt Bjerreegaard,

"I am a bit like someone in charge of a car-park where none of the issues which are parked there under the name of environment are really ones I call my own. In reality they are in fact issues which really need to be resolved elsewhere by some of my other Commission colleagues..." (Speech by Mrs Bjerreegaard to ERM/Green Alliance Forum, London, 1995, in Wilkinson, 1997).

Within DGXI, the 'Integration Unit' have attempted to integrate environmental appraisals within each DG. The reality of the situation however, is that it has had very little practical effect. O'Riordan and Voisey (1997) in their analysis of the European Commission suggest that DGs are not attuned to thinking laterally or environmentally.

"Sharing of responsibility may be a European ideal, but it has yet to become part of the highly sectorised and self-protected administrative culture of Brussels." O'Riordan and Voisey, 1997:16).

The issue of nuclear power emphasises the unsustainable nature of EU policy. According to new European Commission report, at least 85 new nuclear power plants must be built in Europe in order to prevent carbon dioxide emissions from increasing, in order to meet the EU's targets set in Kyoto. Under the Kyoto Protocol, the EU is committed to reducing carbon dioxide levels by 8% from 1990 levels by the five year period 2008 to 2012 (ENDS, 2000). However, Europe's nuclear power stations are due to be phased out over the next 30 years. German chancellor Gerhard Schroder rebuffed a new attempt by three opposition-run state governments to derail the federal administration's nuclear phase-out policy (ENDS, 2000a). The pro-nuclear head of Bavaria, Edmund Stoiber, has complained to the Commission over Germany's plans.

This demonstrates two very important factors about the EU's approach to achieving the carbon dioxide reductions established at Kyoto. Firstly, it emphasises a weak sustainability approach by ignoring alternative methods by which to achieve the Kyoto targets, such as a reduction in energy use and renewable energy. Secondly, it demonstrates that the EU may actually block moves by member states to implement environmentally benign policies. In summary, the EU is predominately a body that promotes continuous economic growth.

2.4.3 Sustainable Development within a national context

Since 1990, the UK Government has managed to produce a vast range of literature on sustainable development without taking the concept seriously. The idea of sustainable development within British politics was set in motion in 1990 with the publication of the Government's White Paper, *This Common Inheritance* (DOE, 1990). The document committed the Government to adopt and implement emerging concerns for sustainability in all policy areas (Collins, 1996). In 1994, the UK Government published the document entitled *Sustainable Development: the UK Strategy* (UK Government, 1994). The strategy set out the methods by which the UK would achieve the agreements made at the Rio Summit 1992. It was criticised for being 'top-down' rather than 'bottom-up' in its approach (Collins, 1996) and failed to consider the specific guidelines established in Agenda 21 and the IUCN's World Conservation Strategy (IUCN et al, 1991). The UK Strategy stressed the role of market forces in preference to regulation (Collins, 1996) demonstrating a weak sustainability stance (see figure 3.4). The UK Strategy does not directly identify sustainable development with economic growth, Collins (1996) argues that it 'does little to discourage those who do'.

In 1998, the UK Government released *Opportunities for Change: Consultation paper on a revised strategy for sustainable development* (HMSO, 1998). From this consultation the UK Government produced its latest strategy for sustainable development entitled *A Better Quality of Life* (HMSO, 1999). Chapter 1 of the document starts by defining sustainable development, which immediately provides an insight into the UK Government's attitude to the concept.

"(Sustainable development) means ensuring a better quality of life for everyone, now and for generations to come." (HMSO, 1999:8)

There is no mention of ecological limits within the definition so therefore not placing any limits on consumption and continuous economic growth. Economic growth is actually encouraged by placing the idea in immediate conflict with the model presented in figure 2.9, 'The Desired State of Sustainability'. The document states that 'our economy must continue to grow, we need increased prosperity so that everyone can share in higher standards and job opportunities in a fairer society'

(HMSO, 1999:14). Numerous authors have demonstrated that the 'trickle down effect' of a capitalist approach is merely a myth and that this approach has been responsible for increased levels of poverty and social exclusion (Huby, 1998, Selman, 1996, Trudgill, 1990). There is also the concern about increasing living standards as opposed to quality of life. This underlies the government's commitment to increased resource use and higher levels of consumption. The document compounds this view even more in Chapter 4: Guiding Principles and Approaches, 'Sustainable Development requires a global economic system which supports economic growth in all countries' (HMSO, 1999:22). Economic growth is responsible for the high level of resource consumption that ignores the issue of finite resources and has, over the last century, created a situation of gross inequality between the developing and developed countries.

There is also little discussion of targets within the report, as a reduction in carbon emissions is the only set target for the UK, this only occurring because of international agreements. Overall, the UK strategy for sustainable development displays an even greater commitment to economic growth than past strategies and fails to deal adequately with ecological limits and some of the UK's serious social problems.

2.4.4 Sustainable development within a local context

At the local level contradictions between policies are still present. However, there is something intrinsically different. As already emphasised, sustainability is about bringing the many stakeholders together, of which the general public is a critical element. To truly incorporate ideas of grass-root democracy and the development of sustainable communities the implementation of sustainable development at the local level is essential. This makes the local level more responsive to local needs, attitudes and the distinct local environment.

One of the key features of the United Nations conference in Brazil was Agenda 21. Agenda 21 promotes new forms of collective action with the involvement and co-operation of relevant social actors. Chapter 28 of Agenda 21 identifies local political authorities as pivotal actors. Under the auspices of Agenda 21, local authorities are to "take responsibility for introducing, interpreting, adapting and eventually implementing the most relevant aspects of Agenda 21 for their local communities" (Lafferty and Eckerberg, 1998, p2).

Agyeman and Evans (1994) stress the importance of the involvement of such communities because it is local participation that is required to secure the commitment of democratic control. There will always be a need for hierarchical guidance but "it is local policy and action which will ultimately deliver sustainability" (Agyeman and Evans, 1994). This view is also supported by the Local Government Management Board who argue that,

"Local authorities are ideally placed to formulate a multilevel corporate strategy for the sustainable management of the local environment." (LGMB, 1992, cited from Gibbs et al, 1998:1351)

Gibbs (1998) believes that local authorities have actively pursued the environmental turn in policy and that this builds upon a long history of environmental concern at the local level (Healey & Shaw, 1994).

Young (1998) proposes that in order to achieve sustainability there should be a bottom-up (as opposed to government dictation of policy) strategy with a two-way dialogue between the community and the local authority, which is based on information sharing. Furthermore, greater empowerment should be given to the local people; the local authority should adopt a listening and learning stance and permit the community to set the agenda. Participants should own the process and have a real role in decision-making and an input to the formulation of policies.

In recent years, some local authorities in the UK have shown a genuine interest in the concepts of sustainable development and sustainable cities. However, in order to meet their objectives, it is imperative that they involve and importantly work with their communities if the goal of a sustainable city is to be reached. It is clear that politicians and councillors alone cannot achieve sustainable development; it must include all citizens. Therefore, it is essential to establish what the general public perceives sustainable development to be and what it means to them. According to Macnaghten and Jacobs (1997) public involvement can result in at least two positive outcomes. The general public can *directly* involve themselves in proactive activities, such as energy conservation or waste minimisation. Secondly, taking part in consultation exercises on matters such as policy can *indirectly* influence political decision-making.

It is important to highlight that problems do exist in the implementation of LA21. Most of the problems that exist do not necessarily mean that the local level is not the best forum for achieving sustainable development. What the problems do demonstrate is a lack of funding for sustainable development initiatives and an imbalance between social and environmental concerns. These, of course, are key areas that need to be resolved for local sustainability. Healey & Shaw (1994) argue that in the early stages of LA21, local authorities had focused on traditional environmental issues, such as open space and planning, instead of issues concerning policy integration and the adoption of a holistic approach to policy.

In Gibbs' (1998:1352) study of local authorities, he demonstrated that 'there are substantial contradictions between economic development and the environment' within local authorities. Gibbs (1998) found in his survey[6] of local authorities that: -

- Only 41% of the respondents had signed the UK Local Government Declaration on Sustainable Development organised by LGMB;
- 79% of the local authorities had produced an environmental statement. However, very few documented information on the local environmental baseline;
- Only 29% had conducted an internal environmental audit;
- Finally, only 24% had produced a State of the Environment Report.

Voisey (1998) in her research into LA21 had similar results. Particular problems that Voisey discovered were: -

- LA21 responsibilities are most commonly added to the work of existing officers;
- An holistic approach is not always employed as it is often left out of issues concerning health, building and works, and community services committees;

- Not many local authorities have established partnerships with other sectors, such as local businesses.

While both Gibbs and Voisey paint a bleak picture of the effectiveness of LA21 they both believe there is a lot of potential and enthusiasm within local authorities. What these findings do highlight are the barriers to change, that there is an uphill battle for local authorities before sustainability can be incorporated within all policy areas.

Despite these problems and criticisms, LA21 has the potential to be the grassroot catalyst for serious institutional innovation. Furthermore, it is the most appropriate forum for informal community initiatives in job trading, credit unions, civic protest, and educational reform. It is also the basis for both empowerment and revelation through such devices as visioning and co-ordinated roundtables (O'Riordan & Voisey, 1997). The key factor that determines this is the internal mobilisation of collective respect amongst local authorities and their stakeholder alliances in the context of a need for more political autonomy and a greater sense of democratic proximity. The local level is where the transition to sustainability is most likely to take place.

2.5 Indicating Sustainability

Trudgill (1990) in his book, entitled 'Barriers to a Better Environment' highlights a lack of knowledge as a barrier to sustainable development. Even with a clear and precise definition, it is not always possible to understand how sustainable development applies to different topics. For example, defining a sustainable transport system requires the solving of complex social, environmental and psychological problems. It has already been made clear that sustainable development means different things to various individuals. Developing strategies for what is perceived to be an elusive goal makes implementation a troublesome task.

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[6] Gibbs' survey had a low response rate. A total of 120 local authorities responded from a survey of 192. This is an average response rate of 62.5%.

2.5.1 Sustainable Indicators in Context

Sustainable indicators can be a key mechanism for encouraging progress in the right direction. They provide a measuring tool that gives a clearer understanding as to whether sustainability is being achieved. However, a problem does exist in that different indicators can provide conflicting conclusions. Selecting indicators that truly reflect sustainable development is crucial. To force governments and business to act, it is argued that information will need to be provided showing declining conditions or unsustainable trends. This is another comprehensive argument for indicators that help define targets for action and measures into achievements (Macnaghten & Jacobs, 1997). As previously noted, public participation may take on two main forms. Firstly, it is the responsibility of governments to implement sustainability polices and secondly, it is the responsibility of each individual to examine their own behaviour. Both of these forms require the dissemination of communicative indicators to articulate politically the new definition of economic and social progress. Indicators can also demonstrate to ordinary people how their individual activities can contribute to a wider change.

Voisey (1998) defines the steps of the LA21 process of which measuring, monitoring and reporting on progress towards sustainability are critical element. The necessary steps have been defined below.

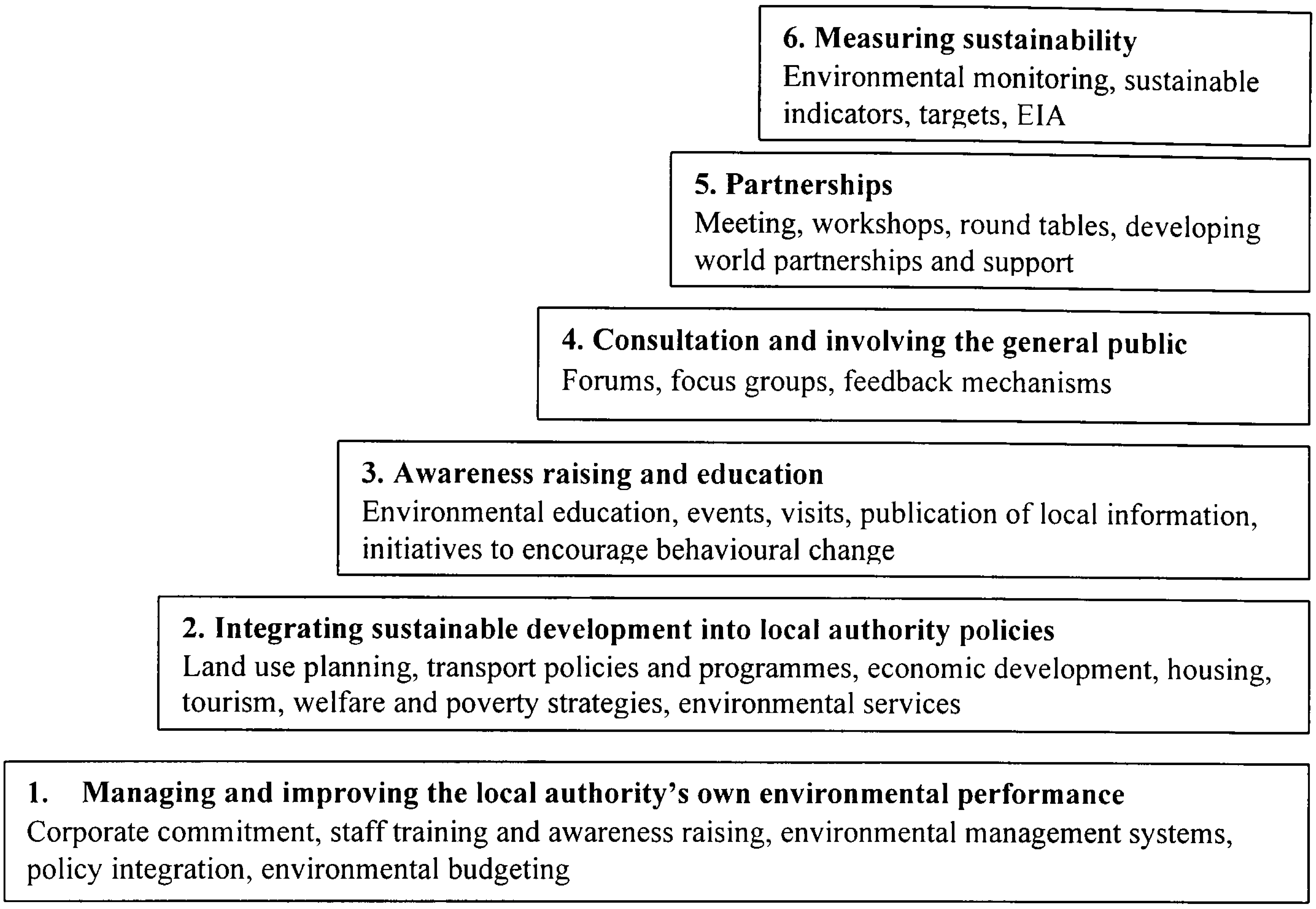

Figure 2.11: Steps in the LA21 Process

Source: Voisey (1998:242)

The steps in figure 2.12 provide a set of criteria by which to assess the effectiveness and usefulness of sustainable indicators. The following indicators discussed below have been assessed using these criteria, highlighting their deficiencies.

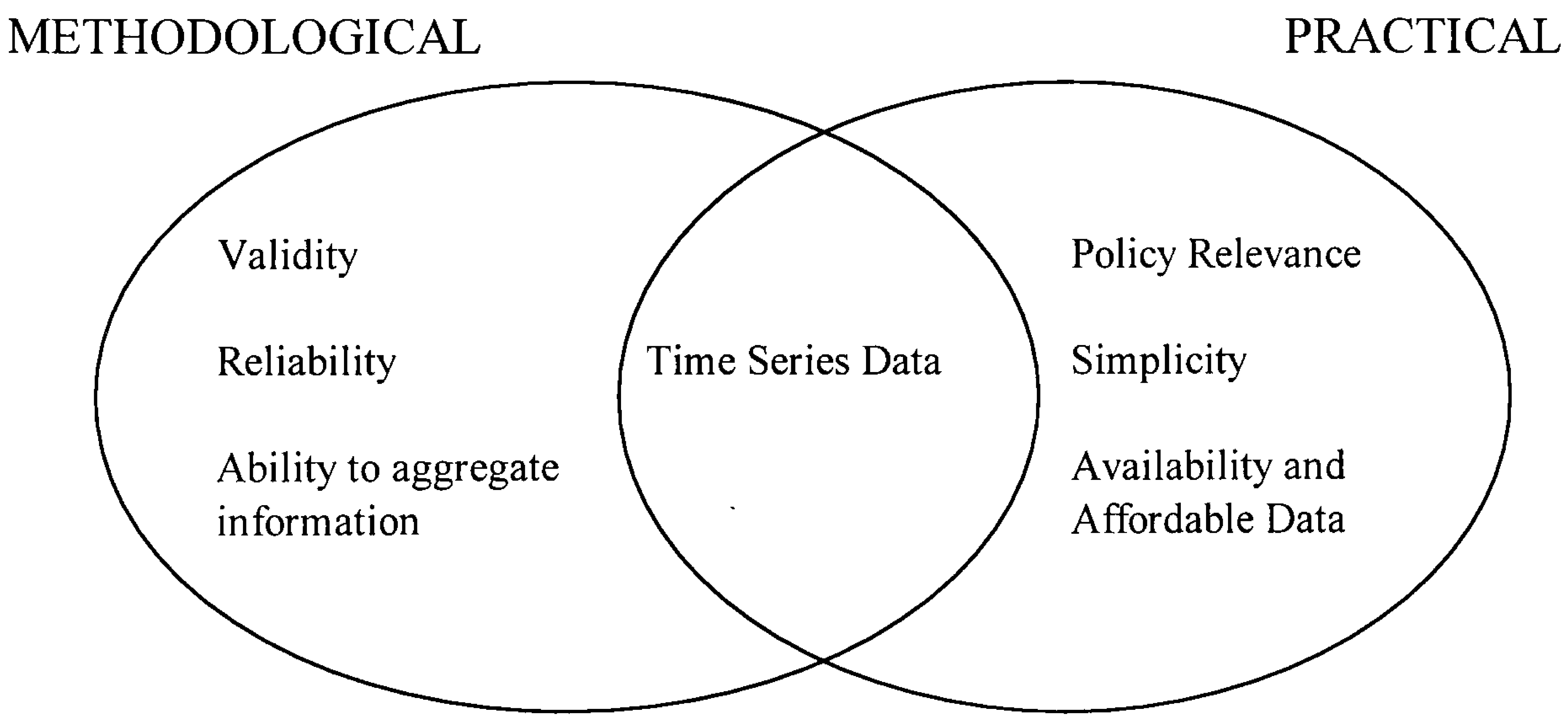

Figure 2.12: Assessment of Sustainability Modelling Approaches (Hardi and Pinter, 1995)

As well as considering the above criteria for good sustainability indicators, another important element is the issue of consumption. Within the UK, and especially within Guernsey, some manufacturing has been out-sourced to poorer developing countries. By measuring, for example, pollution emissions from manufacturing within the UK, this does not give a clear indication of the environmental consequences of the UK population. The first section of this chapter demonstrated the detrimental consequences of a high consumption, throwaway society. Therefore, as well as being relevant to policy, simple and valid, the issue of consumption must be at the heart of indicators for the ecological dimension of sustainability. It is essential that indicators address the issue of a world that has biophysical limits.

Indicators concerning the ecological dimension of sustainability have been considered below after a review of the UK approach to the development of sustainable indicators.

2.5.2 The UK's Approach to Sustainable Indicators

The UK Government has acknowledged the fact that indicators are required to measure society's progress towards sustainability.

The UK Government has established 13 'Headline Indicators' to guide the UK towards achieving sustainability, published in a document entitled 'Sustainability Counts' (DETR, 1998). What is important is how sustainable development is defined in 'Sustainability Counts'. According to the UK Government the most important dimension of sustainable development is,

'The maintenance of high and stable levels of economic growth and employment' (DETR, 1998:3)

This immediately places the focus of sustainable development as being economic growth, ignoring the pressing environmental and social issues. This is also in immediate conflict with Figure 2.9 (The Desired State of Sustainability). 'What you count counts' emphasises the significance of this decision to place economic growth at the forefront of sustainability. What is meant by this is that indicators are policyloaded. What is measured defines what the UK Government perceives to be important.

1. **Economic Growth** – Total output of the economy (Gross Domestic Product)
2. **Social Investment** – Investment in public assets (transport, hospitals, schools)
3. **Employment** – People of working age who are in work
4. **Health** – Expected years of healthy life
5. **Education and training** – Qualifications at age 19
6. **Housing quality** – Homes judged unfit to live in
7. **Climate change** – Emissions of greenhouse gases
8. **Air pollution** – Days of air pollution
9. **Transport** – Road traffic
10. **Water quality** – Rivers of good or fair quality
11. **Wildlife** – Populations of wild birds
12. **Land use** – New homes built on previously developed land
13. **Waste** – Waste and waste disposal
Source: 'Sustainability Counts' DETR (1998:5)

Figure 2.13: The 13 'Headline Indicators' from 'Sustainability Counts'

The document claims that these 13 indicators will give a broad overview of sustainable development and helps people to understand what it means. It is argued below that they don't do this and that they won't in the future.

Firstly, according to Levett (1999) the indicators are defiantly sectoral and un-integrated. They fail to understand the importance of integration and the adoption of a holistic approach. Moreover the indicators fail to deal with the issue of consumption or introduce any idea of a 'global fair share' of resource use. Levett (1999) believes that these omissions cannot be blamed on a lack of understanding so therefore the reasons must be political. The major reason why these omissions have occurred is because they would point to policy measures such as energy conservation, public transport and localised, low-input and labour-intensive food growing. All of these measures are in conflict with the UK economic strategy of continual economic growth and relentless globalisation. They would reveal the horrors of international trade, deregulation and competitiveness. Levett describes the indicators as.

"These ones are such meaningless agglomerations of the good, the bad and the ugly that they could show nice positive trends if we carry on spending more private money

driving in congested traffic, more public money building roads to accommodate it and hospitals to treat the injuries and respiratory and sedentary illnesses it causes…"
(Levett, 1999:2)

Another major problem with these indicators is that they will provide no indication as to whether the UK is moving closer or further away from sustainability. One of the criteria defined in Pinter's model, demonstrates that an indicator must be relevant to sustainability and that it must be possible to monitor progress over time.

The most astonishing inclusion as a headline indicator is GDP. GDP is a tally of products and services bought and sold, with no distinctions between transactions that add to well being, and those that diminish it (Redefining Progress, 2000). The major factor that GDP fails to understand is that spending more money doesn't always mean life is improving. GDP fails on issues of debt, health, natural habits and developing countries.

Concerning debt, GDP increases as more and more individuals get into debt. About half of retail sales today are sold with credit (Cobb et al, 1995). Not only does GDP increase with the selling of a product but also increases on the money made through the charging of interest on the debt. A reduction in debt would mean a reduction in GDP, something that governments all of the world are obsessed with increasing.

Cobb et al (1995:8) established the economic hero of any country is a,

"…Terminal cancer patient who is going through a costly divorce."

This would increase GDP because it causes money to exchange hands. In fact, pollution is added on twice to GDP. An example of this is a chemical factory that produces a toxic by-product and when the nation spends billions on the clean-up operation more money has exchanged hands and the GDP continues to rise. GDP also ignores the contribution to the social realm of volunteer work. Therefore, the more families and communities decline and the monetised service sector takes its place, the more GDP rises. GDP ignores the distribution of income. There is no distinction between the quality of the job or whether an individual is working for minimum wage or in a high-tech job.

Finally, the effects of GDP fixation can be seen most vividly in developing countries (Cobb et al, 1995). Specifically, the policies of the World Bank are to promote any projects that promote GDP in developing countries. A development strategy based on raising the GDP might undermine the household economy, trample on the native culture of the country and continue to enforce western values of development.

2.5.3 Alternative Indicators

The need for comprehensive indicators of sustainable development has never been so important.

Below, three alternative indicators have been discussed. This provides an understanding as to why the ecological footprint was chosen and not 'Environmental Space', 'Sustainable Process Indicator' (SPI) or 'Material Intensity per unit of Service' (MIPS).[7] All the indicators discussed are flow-based measures concerning the ecological dimension of sustainability. Although mass and energy flows are not the only indicators of the ecological dimension of sustainability they do represent a very important class of environmental pressures (Krotscheck, 1997). Almost all natural processes on our planet involve the exchange of mass and energy flows, so natural processes can be seen as a complex network of mass flows that use solar energy as the driving force. The same applies to the atmosphere, where processes are defined by the exchange of mass and energy flows. The flow of energy does not only exert an influence where it enters the system, but causes a much more complex reaction affecting interrelated systems (e.g. the exchange of energy between the ecosphere and the atmosphere).

Mass flows are also at the heart of any human activity (Krotscheck, 1997). Industrial metabolism is excellent examples where raw materials are extracted that provide a

[7] The ecological footprint has not been discussed at this stage as the remaining chapters all focus in on the ecological footprint. An analysis of the ecological footprint using Pinter's model has been conducted in Chapter 4. It was felt the ecological footprint, after initial reviews, was the most

service or product and then are disposed of where the in-built energy is lost or recovered. In order to fully understand these mass flows through the human economy, it is important to understand a whole chain of processes, from the provision of a material to its use and disposal. All these indicators follow the 'Life Cycle Analysis' (LCA) approach. It is important to acknowledge that mass flows and energy transfers are very complex and that any measurement will be a simplification of a complex system.

In summary, the main advantages of material flow indicators are: -

- Attempt to understand the real-life situation of complex interrelationships of mass and energy flows;
- It makes it possible to compare different processes within a system on the same variable, something that it not possible with single indicators;
- In some cases, an aggregated indicator has the ability to make the whole issue of sustainability more transparent;
- They help practitioners to think systematically about the issues;
- They can help to predict and identify scenarios and the impact of policy choices on a range of issues (e.g. transport, waste and energy use).

Sustainable development is a multi-faceted concept and the following indicators do not attempt to understand the social dimension of sustainability. However, this does not mean that understanding the social dimension of sustainability is unimportant but it is beyond the scope of one study to address both the ecological and social dimension of sustainability indicators in depth.

2.5.3.1 Environmental Space

"Environmental space" is the degree of pressure from socio-economic activity which ecosystems can sustain whilst remaining healthy (Opschoor & Costanza, 1995). Friends of the Earth (1996) have defined environmental space as,

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promising of the four indicators and provided the clearest understanding of sustainable development at this stage in the research.

"...The total amount of resources we can use (in a given period), without compromising future generations' access to the same amount."

It can therefore be interpreted as the ability and adaptability of the environment to provide the physical and non-physical resources humans need. These resources include; the provision of energy and raw materials, the absorption of wastes, genetic diversity and fundamental life support services such as climatic regulation. The current rate of consumption of many of these resources can be measured and compared with the sustainable rate.

The resources chosen are energy, timber, land, water and four non-renewable materials (cement, pig iron, aluminium and chlorine). For all these, with the exception of chlorine, quantitative sustainability constraints can be identified.

As with the ecological footprint the measurement tool starts from the premise that natural and human systems can only sustain a finite level of impact and resource depletion. There is also the understanding that technology may not be adequate to reduce or keep impact below the necessarily critical levels. Also, similar to the ecological footprint, it implies that the level of consumption may need to vary.

The particular resources that have been selected within the analysis have adopted the following principal constraints, based on the best available data. The energy figures are based on the IPCC[8] targets for reductions in the rate of carbon dioxide emissions, and a judgement that use of nuclear energy is unsustainable, principally because of its legacy of radioactive wastes.

The land use figures are based on the combination of targets for protected areas set by the IUCN[9] of 10% of land area protected for nature conservation purposes, the area needed to provide food from sustainable agriculture, and a principle of no net effective import of land.

[8] International Panel on Climate Change
[9] International Union for the Conservation of Nature

Timber production is constrained by the availability of land for timber in the long term. The basic assumptions are that there should be no logging of primary/old-growth forests, and no new plantations can produce timber by 2010. From these constraints figures for global timber produced can be estimated. There is approximately 1.2 billion ha. of timber in production. At an estimated maximum sustainable yield, total annual supply will be just 2.3 billion m^3. With a more conservative estimate of yields, the supply may be as little as 1.2 billion m^3. These figures compare with the current global consumption of 1.7 billion m^3.

The next process of the analysis is to allocate the targets to specific sectors in accordance with their share in consumption. The methodology breaks down consuming sectors according to the following framework: agriculture, transport, industry[10], construction, services[11], and domestic. This is done so that debate can be generated within relevant business and political groups as to how the targets can be met, and focus policy on those sectors where largest absolute cuts are needed.

Research undertaken by the Institute for Climate, Energy and Environment in Wuppertal has provided initial estimates of the environmental space available in Europe, and the average reductions required in consumption of the selected resources to achieve sustainability. The quantified sustainability targets derived from their findings are presented below (table 2.3).

These figures can be seen as the benchmark for sustainability, and therefore the sustainability gap can be calculated (the gap between current consumption and sustainable consumption).

[10] Industry includes chemicals, paper and steel.
[11] Services include sports and tourism.

Resource	Current Consumption (Per capita per year)	Sustainable Consumption (Per capita per year)	Sustainability Gap (Percentage)
Energy Use	123 GJ	60 GJ	50
Fossil Fuels	100 GJ	25 GJ	75
CO2 Emissions	7.3 t	1.7 t	77
Land Use			
Agricultural Land	0.441 ha	0.190 ha	57
Productive Land	0.164 ha	0.138 ha	16
Protected Area	0.003 ha	0.061 ha	+1933
Wood	0.66 m3	0.30 m3	55
Non-Renewables			
Cement	536 kg	80 kg	85
Aluminium	12 kg	1.2 kg	90
Pig-Iron	273 kg	36 kg	87
Chlorine	23 kg	0 kg	100

Table 2.3: Sustainable Consumption Figures for Europe: Using the Environmental Space Model.
(Friends of the Earth, 1995)

While 'Environmental Space' has the advantage of setting sustainable targets there are still some disadvantages with this approach. Targets are set on 'best estimates' and do not take into account properties of different materials. They also fail to convey interactions between usages of different resources and are difficult to make relate to the individual (Simmons & Chambers, 2000). The indicator is inherently subjective. For example, the idea concerning no logging of old growth trees and the ideas behind the exclusion of nuclear energy are subjective policy decisions and it is not the realm of indicators to decide this. Comparing environmental space with the criteria set out in figure 2.13 demonstrates, that it does have many of the key features of a comprehensive sustainable indicator. It is valid, reliable, and relatively simplistic and can be used for time series. However, it does not have the ability to aggregate information and has little meaning to individual lifestyle decisions.

2.5.3.2 Sustainable Process Indicator (SPI)

SPI is a measure developed to evaluate the viability of processes under sustainable economic conditions (Krotscheck & Narodoslawsky, 1996). SPI is based on the assumption that in a sustainable economy the only real input that can be utilised in the long term is solar energy (Krotscheck, 1997). It also includes the assumption that land is a limited resource because the surface is finite, similar to the ecological footprint. For raw materials it is assumed that the pressure exerted on the environment is proportional to the area necessary to generate the raw material or to generate the energy to produce the material (DGXI, 1996).

Therefore, in simple terms, SPI is the fraction of the land per inhabitant related to the delivery of a certain service (Krotscheck, 1997). The major problem with SPI is that it is a model made by experts for experts and has little use within a regional context. The model is very complex and lacks policy relevance because it does not relate to key policy areas, such as transport and waste.

2.5.3.3 Material input per unit service (MIPS)

The material input per unit service, developed by Schmidt-Beck (1993) lists the masses moved to produce a certain good, regardless of the quality of these mass flows (Krotscheck, 1997). Therefore, it is a measurement of the movement of mass and energy flows through an economy, suggesting that this relates to sustainability, namely through the reduction of mass flows. These flows have the practical application of determining the overall mass transformed for a given process. The model measures the input into the biosphere (minerals, water, air, biomass and energy) and the outputs (Waste deposits, wastewater, emissions to air, fertiliser and pesticide losses) (DG XI, 1996).

The advantages with such a model are that it illustrates materials and energy intensity of production and services and can link the use of nature to the value created.

However, there are a number of disadvantages. Firstly, MIPS do not illustrate cumulative effects and fails to link to global ecological capacity (i.e. there is no understanding of a sustainable level of resource flow) (Simmons and Chambers, 2000). Secondly, there are problems associated with the measurement. It is difficult to attain precise information of energy and resource input and the output from the mass flow. Finally, individuals with no scientific knowledge of the subject do not easily understand it, as it does not relate to specific issues of transport, energy and waste production.

2.6 Conclusions for the Chapter

This chapter has demonstrated the severe ecological crisis that humanity faces and the possible answers to these problems through the implementation of sustainable development. The chapter has also investigated the various levels of implementing sustainable development and demonstrated that local sustainability is an effective level for its implementation. Finally, the chapter established the importance of measuring sustainable development and the use of mass flow indicators.

One of the main purposes of the ecological dimension of sustainability indicators is to steer action. Therefore, the indicators must be understood by the general public and be relevant to policy decision-makers. There must also be an indication as to when the ecological dimension of sustainability has been achieved. In simple terms, we must know where we are now and where we wish to be. The final criterion must be that the indicator is scientifically robust and is a true interpretation of human appropriation.

The mass flow indicators considered above have limitations. The most common limitation is that the general public will have difficulty understanding them. Both Environmental Space and SPI understand the importance of establishing a sustainable limit, but are tools for decision-makers and will have very little influence on an individual's everyday decisions. It is important to remember that these indicators are not in competition with each other, but support and compensate the others weaknesses. They all have a role in the sustainability indicator debate but fall short of Pinter's criteria.

It is believed that the ecological footprint has the ability to overcome many of these problems. The literature suggests that it is scientifically robust, it can resonate with the public, and it establishes sustainable targets and is relevant to policy. (Simmons, Lewis & Barrett, 2000, Wackernagel 1997, 1999, 1999a, Levett, 1998) Therefore, the ecological footprint has been selected to fully investigate these claims. The ecological footprint will be assessed on the grounds of its effectiveness for measuring the ecological dimension of sustainability as well as its ability to offer a new insight into the sustainability debate.

CHAPTER 3: THE METHODOLOGY OF THE ECOLOGICAL FOOTPRINT

3.1 The methodology of the ecological footprint

The last chapter involved a detailed discussion of sustainable development, considering the economic, social and environmental requirements of a sustainable society. The main conclusion of the chapter is that a society that chooses to adopt sustainable development is a desirable one. It offers a unique opportunity in history to improve the life of every individual (both short-term and long-term), whilst considering the environmental consequences of human actions. Chapter 2 also demonstrated that even though progress on a political level may be slow, there is an agenda and willingness to change. Moreover, international agreements have been signed to commit countries to sustainable development (Agenda 21). The lack of progress is often attributed to not understanding whether actions are sustainable or not. Therefore, it is important to understand what is required to become a sustainable society. How far are we away from sustainability? Are we already sustainable? What will happen in the future if we adopt a 'business-as-usual' attitude to development?

The need to measure sustainable development is imperative. The need to measure progress towards a desired conclusion is not a new phenomenon. Industry has constantly established economic targets to achieve over a certain time scale. National governments set targets for economic growth and development. Therefore, measuring environmental impact is a necessary requirement in our progression to a sustainable society.

Wackernagel and Rees (1996: 40) echo this statement by suggesting that,

"Gaining acceptance for strong sustainability hinges on finding a meaningful unit to measure the natural capital requirements of the economy," In addition, it is also important to understand what sustainable development means within the context of a region[1]. Chapter 4 justifies the significance of regional sustainability and why it is important within the global picture.

How can a region assess whether it is living within the global capacity? What resources are available to that region without appropriating more than their share of the earth's resources? It is one thing to understand global carrying capacity, but quite another to understand whether the United Kingdom, or in this study, whether Guernsey is sustainable.

At present, many problems exist in understanding regional sustainability. We have some understanding that if we continue to chop down our tropical rainforests and we keep burning fossil fuels there are likely to be some destructive global consequences. This scale is partially understood. We can actually define limits that should not be crossed, very much the reason for global meetings such as Rio and Kyoto. Despite this awareness, we fail to understand the reality of the situation within the context of a city or even an island such as Guernsey.

There is a genuine obscurity about the debate. The UK Sustainable Strategy does not get to grips with one key issue. If we outsource all our manufacturing goods (for example, Reebok don't make any shoes in Britain) but as a nation we buy lots of shoes, then have we achieved sustainability by reducing our CO^2 output? There is now a theoretical problem, an empirical problem and a boundary problem[2]. Within the context of Guernsey the study is attempting to be a lot more specific about these issues. The major question we face is what sustainability is and what it means particularly in the context of a regional definition.

This highlights the importance of measuring the consumption of a region. It is important not to drift into a situation of 'imported sustainability[3]'. Deciding how to

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[1]Chapter 2 (2.44) demonstrated that regional sustainability is the most likely place to incorporate sustainable policies into the political and public agenda.
[2] Further explanation of these barriers will evolve during the chapter.
[3] This is highlighted within Pearce et al (1993) with their useful concept of "imported sustainability". The region still lives at the expense of the environment. A quasi-sustainable development is simulated. The inherent risk of this "imported sustainability" is the result of pushing the unsustainable processes out of the system, but constantly receiving imported unsustainable processes. It is more (continued...

monitor our progression to a sustainable society is of extreme importance. Therefore, it is important to select indicators that point us in the right direction[4].

This chapter provides: -

- A detailed explanation of the ecological footprint and the calculation procedure;
- The appealing nature of the ecological footprint;
- Understanding the importance of the ecological footprint in ecological, economic and ethical terms;
- An analysis of past ecological footprint calculations;
- The empirical research of Guernsey's compound ecological footprint, with an explanation of the calculation differences from past footprints;
- A carbon balance for Guernsey;
- How the ecological footprint scores against a set of indicator criteria;
- A critique of the ecological footprint;
- Conclusions of the chapter.

3.2 What is the ecological footprint?

The ecological footprint has received a lot of attention recently as a potential aggregated indicator for sustainable development. It has grown in popularity having now been applied to countries, regions, industry, product evaluation and individual case studies (Rees, 1992; Wackernagel and Rees, 1996; Rees, 1997; Simmons and Chambers, 1998). Each year the ecological footprint has become more refined, portraying a more and more accurate figure of the land appropriated by humans.

The ecological footprint is a measurement of the ecological dimension of sustainability illustrating the reality of living in a world with finite resources. It provides a final figure in land area (hectares) that is required to support an individual, city, region, country or the entire world population. It provides a visual picture of

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of a flow of energy through a system (an open system) than a closed-loop system (Wallner, Narodoslawsky, Moser, 1996).

carrying capacity. This is one of the most important reasons for its popularity: individuals can resonate with a land area. It has many important features that have close connections with one of the central themes of sustainable development: ecological limits. Within this study the results are presented for the ecological footprint of Guernsey using both the compound and component approach[5].

Wackernagel provided the first robust definition of the ecological footprint in 1994. The concept is defined as: -

"The aggregate land (and water) area in various categories required by the people in a defined region

a) to provide continuously all the resources and services they presently consume, and
b) to absorb continuously all the waste they presently discharge

Using prevailing technology."
(Wackernagel 1994: 68)

In other words, the ecological footprint is the total land area required to support a given population with the resources they consume and absorb all the waste they produce. It provides a valuable insight into the carrying capacity of the earth and human appropriation of resources. The ecological footprint has made it possible to compare 'human demand and nature's supply'.

The ecological footprint provides a biophysical assessment of human needs, based on the view that resources are finite and is established around the belief of carrying capacity. Carrying capacity can be defined as: -

"The maximum population that can be supported indefinitely in a given habitat without permanently impairing the productivity of the ecosystem(s) upon which that population is dependent." (Rees, 1988: 285)

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[4] It is important to remember that the indicator that is being considered only measures the environmental dimension of sustainability. This is discussed in more detail in section 3.4.

The concept of carrying capacity provides an objective basis for defining ecological sustainability. The same idea can be applied to human populations, where the carrying capacity is the maximum amount of people that the earth can support, which can be sustained in the long term without impairing ecological integrity and productivity (EEA, 1995). This immediately questions population increases and problems of living on a planet with an estimated 12 billion people by 2025 (Zuckerman, 1996). In many respects, the concept of carrying capacity only provides one solution to the sustainable development debate, that of reducing human population to live within the ecological means of the global environment. The ecological footprint had turned the concept of carrying capacity on its head and considers not the amount of people the earth can support, but the current level of consumption by humans and the land area this requires.

As Wackernagel (1994:69) suggests,

> "It is the total ecological impact that counts, not population alone."

The ecological footprint immediately opens up many possibilities for achieving ecological sustainability. Population control is now one option among others including resource conservation, the re-use of resources and improved productivity through technological advances. The ecological footprint further supports Ehrlich and Holdren's definition of human impact on the environment. This being:

$$I = PAT$$

Where I is Impact, P is population, A is affluence, and T is technology (Ehrlich & Holdren, 1971).

In the Ehrlich-Holdren formulation the impact (I) corresponds to a population's ecological footprint and is a function of population size and consumption (converted

[5] An explanation of the differences between the compound and component approach is provided in Chapter 4.

into a land area) (Rees, 2000). Consumption is a function of affluence (A) and the state of technology.

By considering carrying capacity the current blame for unsustainability is often placed on countries with a high level of population growth, which is often the developing countries. It is the view of many people that the rapid increase in world population poses a threat to the future depletion of resources. In this respect, the developing countries of the world are being blamed for the substantial exploitation of resources by the developed world since the industrial revolution. By reflecting on the amount of land required by a country, city or region, it becomes clearer who is responsible for resource exploitation and firmly places a lot of the responsibility for sustainable development on the shoulders of the developed countries. This, in many respects, emphasises the controversial nature of the ecological footprint. It is now possible to demonstrate who is responsible for world unsustainability. The ecological footprint uses land area as a proxy for the three important forms of natural capital, these being the land, the atmosphere and the sea.

3.3 The Appealing Nature of the Ecological Footprint

Van Vuuren, Smeets & de Kruijf (1999) have suggested six reasons why they believe the ecological footprint has attracted so much attention as a potential indicator for sustainable development. This list acts as a summary explaining its popularity.

1. The Consequences of Consumption

In the past, the approach of environmental policy has been towards the reduction in pollution levels and achieving safe standards for emissions (considering environmental and human health consequences). Increasing levels of consumption were, and still are, partly ignored. The ecological footprint has the ability to highlight the true consequences of consumption and is proposed as the indicator that demonstrates this more clearly than any other.

Van Vuuren, Smeets & de Kruijf (1999:19) believe that EF has the ability to focus on three key issues associated with consumption. These being: -

- The squandering of resources;
- Impacts of the size and composition of consumption patterns;
- Geographic re-allocation of environmental pressures.

2. Renewable resources

The ecological footprint identifies key resources for achieving sustainable development that are included in the calculation procedure, these being land and carbon dioxide levels. UNEP (1999) have highlighted the importance of land as a resource believing land is becoming increasingly scarce. Lester Brown (State of the World, 1999) sees land as a finite resource believing this to be one of the major challenges for sustainable development.

"The effects of the acute cropland scarcity emerging in some countries could affect many other areas of human activity."
(Worldwatch Institute, 1999: 123)

3. Distribution of environmental resources and ecological limits

The ecological footprint establishes an ecological 'bottom line' that should not be crossed if a sustainable society is to be achieved. This places the issues of rapid population growth and the development of poorer countries in perspective. During this century, rapid growth in population will occur in the present poor countries, placing an increasing pressure on resources. The ecological footprint raises the question as to how we are going to distribute our environmental space to cope with the proposed increase in consumption, a key point raised by Lester Brown.

"This impressive century of growth unfortunately has not translated into adequate food supplies for the Earth's inhabitants. An estimated 841 million people remain hungry and undernourished..."
(Worldwatch Institute, 1999:116)

4. Environmental consequences of trade

The ecological footprint has been criticised for promoting regional self-sufficiency over global interdependence. However, Wackernagel and Rees (1996) have stated that it is not anti-trade per se, but is examining trade from an ecological perspective. It is clear that the aim of trade is to increase the flow of resources across the world,; this is evident in the opening up markets that did not even exist at the beginning of this century. The ecological footprint is making the link between environmental impact and human consumption.

5. EF as a communication tool

The ecological footprint is both a powerful and visual tool, this explains its popularity among many groups. It can be calculated on all levels from the individual to the entire earth, thus helping to relate the issue of individual's lifestyle to global environmental problems, such as global warming. Each individual has the potential, through the eyes of ecological footprint, to understand their contribution to the global environmental crisis.

6. Aggregation

The aggregation process within the ecological footprint has been criticised for only being able to provide a rough indication of sustainability. However, this does provide a means to compare the impact of various activities on the same level. This has been seen as a powerful element of the tool.

3.4 Understanding the importance of the ecological footprint in ecological, economic and ethical terms

3.4.1 Ecological understanding of the Ecological Footprint

An explicit understanding of natural capital is essential when planning toward sustainability. The tool must emphasise the impact of human life on the biosphere. The ecological footprint has the ability to convert many different uses of the biosphere into a land area and total up all these uses. Wackernagel (1994) suggested the use of land is essential and,

"...Represents the ecosystems and their photosynthetic productivity, and thereby the essence of natural capital."
(Wackernagel, 1994:78)

From an ecological perspective, it offers an insight into the use of finite resources. It considers the cumulative impact of human beings on all the different productive land types (e.g. arable, pasture and forest). By placing the various kinds of human uses in land areas, it makes it possible to understand ecological impacts of these uses and compare each of the uses. Folke et al (1997) demonstrated the significance of being able to place all the different human uses of the biosphere into a land area. They estimated the appropriated ecosystem area of major cities in the Baltic by considering the consumption of wood, paper, fibres and food (including seafood). Figure 3.1 provides a visual depiction of the land area required to supply the resources to the cities.

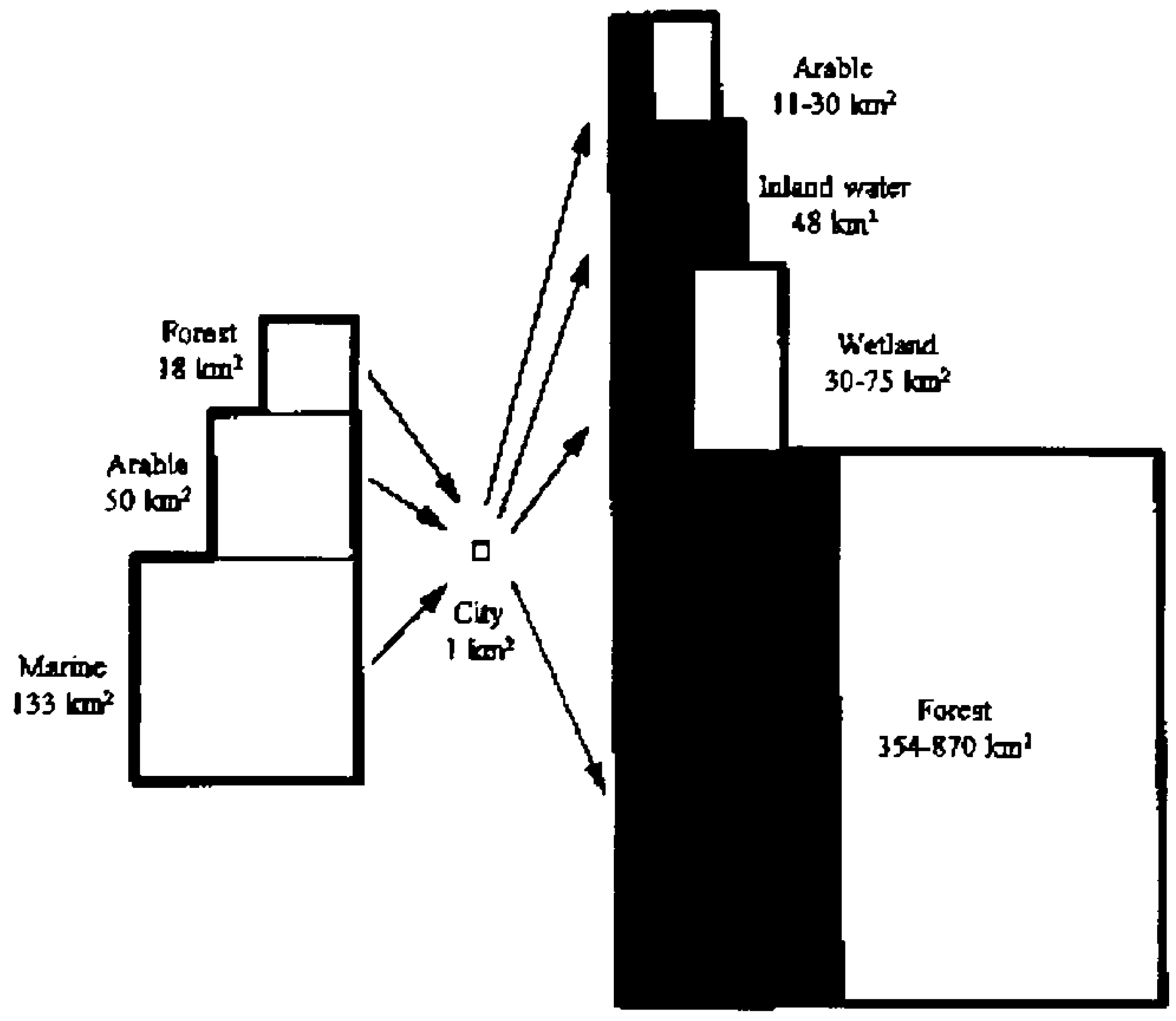

Figure 3.1: The ecological footprint of the 29 largest cities in Baltic European[6]. (Source: Folke et al, 1997: 168)

The ecological footprint corresponds with Liebig's 'Law of the Minimum'. The law recognises that an organism is constrained by the essential mineral nutrients available to it in amounts that most nearly approach the minimum requirements for the survival of that organism (White et al, 1992). Similarly, if available supplies of one factor are committed to one thing, someone else cannot use them. In the study by Folke et al of Baltic cities, someone else cannot use the resources they are appropriating. There is a competing use of nature between individual, cities and countries. The same also applies to the right side of figure 3.1 (waste assimilation). One use of a sink may prohibit another use of a sink or a source.

3.4.2 Economic Understanding of the Ecological Footprint

Chapter 2 addressed the issues concerning the selection of economic indicators to measure sustainable development, providing a critique of an over-reliance on economic measurement. The ecological footprint has the ability to understand the relationship between an economy and its resource requirements. As Wackernagel (1994) has suggested, the major limiting factor to the world economy is natural

[6] The left side of figure 3.1 indicates the ecosystem appropriation for natural resources production. The ride side indicates the ecosystem appropriation for waste assimilation, while the shaded area = low-range estimate. For more information refer to UN Habitat II Conference (1996).

capital. Whatever an economist states about the future being one of a technological age, 'information is the key to economic success', resources will still be consumed and must come from natural capital. For a country to be economically sound a sufficient supply of natural capital will be essential. Within the wealthy countries, the ecological footprint can demonstrate the extent to which they have appropriated the productive capacity of the ecosphere through trade. Many experts are now suggesting that most wars will (and many in the past) be 'Resource Wars' highlighting the conflict over natural capital.

Within the context of a global economy, countries and individuals are competing for an ever-decreasing amount of resources and it makes sense for a country to analyse its current and future demand for natural capital. The ecological footprint offers the opportunity to understand resource requirements in the future to satisfy human activity. It can form part of a long-term analysis of the ability of an economy to cope with resource scarcity.

3.4.3 Ethical Understanding of the Ecological Footprint

The ecological footprint is merely a demonstration of human appropriation and has no moral implications. However, there are some principles that can be drawn from the footprint. From an ethical standpoint the ecological footprint demonstrates human dependence on nature. It emphasises that humans are a part of nature and dependent on a continual supply of resources; intrinsically part of the Earth's 'Web of Life' (Wackernagel, 1994:88). It also questions the very fabric of the current economic system responsible for an uneven distribution of wealth, disputing whether economic growth should have precedence over equity and achieving a decent quality of life for all. Wackernagel (1994: 89) takes this one step further believing that it:

"...Challenges the predominant extensionist perspective about humanity's right to appropriate a large percentage of nature, while being only one of several million species living on the planet."

Pepper (1996) highlights the consequences of the individual philosophy of existentialism suggesting that there are no objective, external facts or laws governing our social existence. One of the first reactions to ecological footprint is the extensive difference between poor and rich countries believing that there should be a more even distribution of wealth but at the same time understanding how difficult this task is[7]. Pepper (1996:116) also believes that an idea of collective responsibility is the important direction for a green society.

"Paradoxically, approaches to creating a green society that hinge on individualism could be regarded as fundamentally at odds with the holistic philosophy of radical ecology."

3.5 The calculation procedure for the compound ecological footprint

The ecological footprint calculation is based on two simple assumptions: -

- That it is possible to determine the amount and type of resources consumed and waste produced by a given population,
- That it is possible to convert these resources into a land area equivalent to provide all these functions.

Within a globalised economy, our resources will come from all over the world. The ecological footprint helps to sum up the total land area required by a given population, wherever that land might be. For example, the UK imported 184,000 tonnes of cheese in 1993 that could have potentially come from all over the world (Wackernagel et al, 1997). The ecological footprint calculates the land area required in supplying the UK with all its cheese. To understand the consumption of a given population it is necessary to know the imports, exports and production. By adding the imports to production and subtracting the exports, the consumption level is calculated.

After establishing the level of consumption of Guernsey, it is necessary to determine the land area appropriated per capita. This is calculated by dividing the annual consumption of each individual item (meat or vegetables for example) and calculating

[7] This was the view of most of the participants in the focus groups that were conducted. Their views and opinions are discussed in Chapter 6.

the average annual productivity or yield. This provides the amount of kilograms that is produced per hectare per year. It is possible to use either international yield factors or distinctive regional yield factors. These can vary greatly from country to country for example, it is estimated that arable land in Guernsey is 2.8 times more productive than the average global productivity of arable land (this is discussed in more detail in section 3.53). For the ecological footprint of Guernsey global yield factors have been applied throughout. The following reasons for this are: -

1. The ecological footprint of Guernsey is solely an analysis of imports. It is estimated that 95% of all consumption on the island is imported.
2. It is impossible to know where the items were produced making it virtually impossible to assign a national yield factor to individual products. With over 3,000 different items classified this task would also be extremely time consuming.
3. A point that Wackernagel has made concerning the use of global yield factor is that everyone has an equal right to the most productive land in the world. Therefore, a global yield factor should be applied to all calculations[8].

To determine the final footprint figure the following equation can be applied.

$$\text{Footprint Component} = \frac{\text{Import (tonnes)}}{\text{Yield (kg/ha)} \times \text{Population size}} \times 1000$$

[8] Many individuals have disagreed with this statement for example, van den Bergh & Verbruggen (1999) and van Vuuren, Smeets & de Kruijf (1999). Their vastly different opinion is discussed in detail in section 3.10.

The following equation provides the final analysis to establish the ecological footprint of a product.

$$EF = \sum_{i=1}^{i=n}(D + N)$$

Where EF = total ecological footprint; D = direct land use; N = additional land requirement

i represents the number of component parts to the footprint.

It is not necessary to divide the final figure by the population. However, a per capita figure does provide a useful tool for comparison with other countries. For example, it is estimated that the UK required 269.1 million hectares in 1993 to supply all its resources, while for India this figure was 730.2 million hectares (Wackernagel et al, 1997). However, this gives us little understanding of the relative sustainability of each country. The per capita figure for the UK in 1993 was 4.63 hectares while India's was 0.81 hectares. These figures provide a useful comparison, where the UK has an ecological footprint of more than five times higher than India on a per capita basis.

3.5.1 Land Categories

The most comprehensive ecological footprint analysis contains six different land types: -

1. Arable land
2. Pasture land
3. Built-up land
4. Forest
5. Sea
6. Carbon Sequestration land (energy land)

These various categories are considered under the ecosystems of land, atmosphere and sea. Figure 3.2 demonstrates the connection between consumption of different materials and land types.

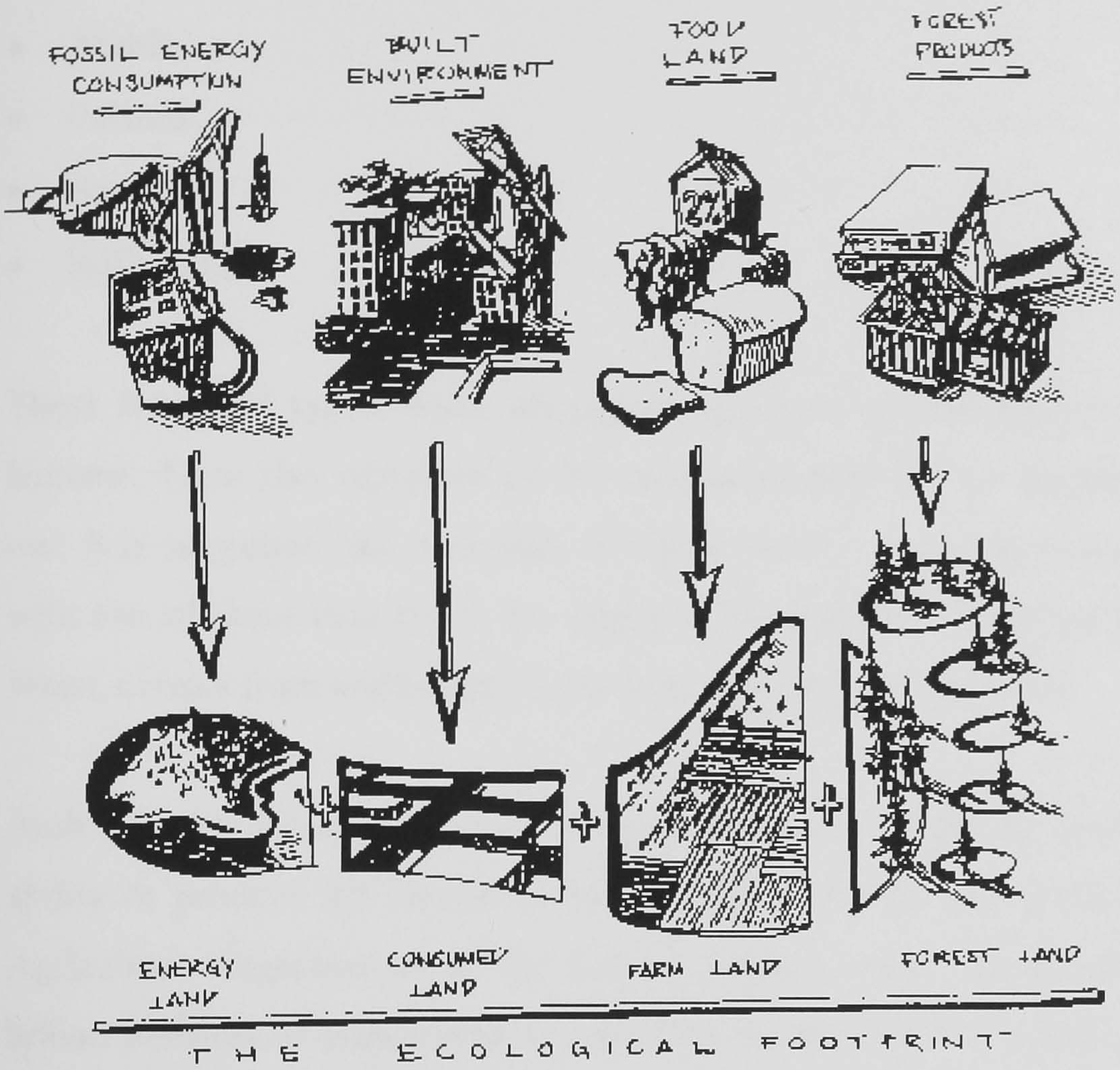

Figure 3.2: Various Land Categories within the Ecological Footprint
Source: Wackernagel & Rees (1996:67)

3.5.2 Land Use and Footprinting

To be sustainable it is considered important to balance all three ecosystems. This means not using more resources than can be replenished and avoiding the degradation of natural capital. The ecological footprint calculation considers all three ecosystems (the biosphere, the atmosphere and the hydrosphere). For the biosphere, this is quite simple. To be sustainable humans can only appropriate the land without degrading natural capital and the same applies to the oceans. However, the atmosphere is a more complex issue. The ecological footprint adopts the view that to 'balance' the atmosphere it is necessary to control the level of carbon dioxide emissions in an attempt to counteract global warming.

The ecological footprint of land is divided into four sections: -

- Arable
- Pasture
- Forest
- Built Land

These four land types, when aggregated represent all the different uses of land by humans. They also represent all the productive land that is appropriated for human use. It is suggested that each item of consumption (excluding sea) can be associated with one of these land types, for example, the paper we consume will come from a forest, cereals from arable land, meat from pasture land and so on.

Arable land is considered to be the most productive of all the land types. It has the ability to produce the largest amount of plant biomass per hectare. The Food and Agriculture Organisation of the United Nations (FAO) have calculated that 1.53 billion hectares of arable land are currently in use. With a world population over 6 billion people, this equates to 0.25 hectares per capita of the world's most productive land. There is also the problem of a loss of arable land for reasons of soil erosion, urbanisation and serious degradation. Pimental and Pimental (1996) suggest that the world is losing 10 million hectares of arable land each year.

Pasture land provides humans with all the necessary meat and dairy products that are consumed. It also includes the production of leather and other animal based products. For the Guernsey analysis this also includes wool and shoes as well as leather products. Pasture land is considered to be less productive than arable land. This is derived from the simple biological fact that conversion efficiencies from plant to animal biomass reduce the available biochemical energy to humans by typically a factor of ten (Wackernagel et al, 2000). Lindeman efficiencies express the loss of energy from one trophic level to the next as the ratio in the rates of ingestion. These ratios are what Lindeman termed the progressive efficiencies of the food chain (Lindeman (1942) in White, Mottershead & Harrison, 1992). FAO estimate there to be 3.35 billion hectares of pastures, worldwide. This equates to 0.6 hectares per capita (Wackernagel et al, 2000).

Forests include natural and artificial forest for wood production that has the potential to yield timber. Obviously, forests are not purely for producing timber for human consumption; they are multi-functional, helping to regulate climate, the hydrological cycle and biodiversity. The FAO suggest that the earth has a coverage of 5.1 billion hectares, which corresponds to 0.9 hectares per capita. For the Guernsey EF an extensive range of timber products have been calculated ranging from raw timber, to furniture, magazines, newspapers and wood pulp.

The built land is the amount of land degraded as a result of buildings, roads, pavements and land that is unsuitable for productive use. Built land is represented as the loss of productivity by not using that land and not the actual amount of land that is degraded. For example, if Guernsey's land is twice as productive as world productivity then the actual amount of land lost is double that of the actual land area (this is explained in more depth under the equivalence factors). Worldwide, built up land represents 0.06 hectares per capita (Wackernagel et al, 2000).

Oceans cover 36.3 billion hectares of the planet. On a per capita basis this equates to 6 hectares per person. However, 8 percent of this area, concentrated along the continental coasts, provides over 95% of the sea's ecological production (Wackernagel and Yount, 1998). In per capita terms, there are 0.5 hectares of ecologically productive sea space out of these 6 hectares of ocean. Measuring the ecological activity of the sea by its area (and not its volume as one might intuitively think) makes sense ecologically. It is the area that limits its productivity, as both the capturing of solar energy and gas exchanges with the atmosphere are proportional to surface area.

Carbon dioxide sequestration land. As highlighted at the beginning of section 3.1 the EF adopts the opinion that a sustainable level of carbon dioxide is essential and considers the amount of land required to sequester a given population's emissions of carbon dioxide. This has been the cause of much controversy (van Vuuren, Smeets &

de Kruijf, 1999, van den Bergh & Verbruggen, 1999)[9]. Carbon dioxide emissions are accounted for by assessing the area of carbon-sink forest required to sequester the 'greenhouse' gas emissions associated with the burning of fossil fuels (van Vuuren, Smeets & de Kruijf, 1999). This land does not necessarily exist (as with the other land categories) but is the amount of forest needed if we were to reduce carbon dioxide emissions to a sustainable level. While most footprint calculations aggregate all the land types to create one total, van Vuuren, Smeets & de Kruijf (1999) prefer to view land use, sea space and carbon sequestration land separately. This clearly separates 'virtual' land from land appropriated for crop and animal production.

In Wackernagel and Rees' publication entitled 'Our Ecological Footprint' (1996) they introduce three methods for footprinting the 'energy land' component. Many of the numerous suggestions revolve around the idea of how much land would be required if wishing to replace fossil fuel consumption with an alternative source (for example biomass).

- Option 1: The replacement of fossil fuels with plant based alternative

Wackernagel and Rees' (1996) assumption is that it is preferable to use carbon that is cycling actively than to release carbon from a locked-up source. Ethanol is a fuel that can be seen as a biologically produced substitute for liquid fuel. The EF could represent the amount of land that is required to produce the equivalent amount of ethanol. Wackernagel and Rees (1996) suggest that ethanol productivity could be as high as 80 GJ/per ha/per year, while Ferguson (1999) suggests the modest figure of 47.3 GJ/per ha/per year.

- Option 2: Carbon Sequestration by Forests

The second and chosen method by Wackernagel and Rees (1996) is the amount of land required to sequester the production of carbon dioxide through forests. The main net accumulators of CO^2 are considered to be forest and bog ecosystems. Wada

[9] Section 3.10.4 re-examines the carbon sequestration figure used within footprinting. One of the major issues concerns the ability of the sea to absorb carbon emissions. However, this does not change the sequestration rate of 100Gj/per Ha./per year.

(1994) suggests that the average forest can accumulate approximately 1.8 tonnes of carbon per hectare per year. Applying this carbon absorption rate suggests that forests are capable of a sequestration rate of 100 GJ/per ha/per year. This is the figure that has been applied to the EF calculations[10].

It has always been the philosophy of Wackernagel to adopt the most conservative method believing it is better to underestimate human appropriation of nature than face the criticism of an overestimate. The same idea has been applied to the Guernsey calculation. By assuming a generous sequestration rate by forests, the Guernsey footprint will be an underestimate of land appropriation.

- Option 3: The Rebuilding of Natural Capital Stock

The third method involves assessing the land area required to rebuild a natural capital stock at a rate that is equivalent to fossil fuel use (Wackernagel, 1994). The argument was put forward by the economist Salah El Serafy (1988). El Serafy suggests that it is possible to use non-renewable resources in a sustainable society on the grounds that the resources are replenished at the equivalent rate of its consumption. Wackernagel (1994) estimates that one hectare of average forest can accumulate approximately 80GJ of energy per year.

3.5.3 The Equivalence Factors

With all the latest ecological footprint calculations, including Guernsey's, equivalence factors have been added to the different land categories. The equivalence factor compares the biomass of all the different land types to assess the amount of productive area that is being appropriated. More precisely, these factors inform us about the category's relative yield as compared to world average land. Biomass yields, measured in dry weight, are taken from statistics from the FAO. World-average has consequently an equivalence factor and a yield factor of 1 (WWF, 2000). Thus, the physical extensions of the global areas of biologically productive space and those areas are adjusted with the equivalence and yield factors add up to the same

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[10] An excel spreadsheet of global forest sequestration rates has been included in Appendix 6. This outlines how the figure of 100GJ/per Ha./per year has been derived.

global total (WWF, 2000). For example, the average arable land is considered to be more productive than pasture (see table 3.1).

The equivalence factor does not change the total amount of global land available, it merely considers the productivity of land comparing country by country. Table 3.1 provides the equivalence factors that have been used in the Guernsey study. They are the same as those used for the United Kingdom.

Land Type	Equivalence factor
Arable	2.8
Pasture	0.4
Forest	1.2
Co2 land	1.2
Sea	0.1
Built	1.0
Average	1.2

Table 3.1: Global Equivalence Factors for Different Land Types
Wackernagel et al (1997)

Arable land, as mentioned, is the most productive land available and is therefore considered to be 2.8 times more productive than average global land.

Fossil energy land is given the same equivalence factor as forests. The only applied method of carbon sequestration today is through the growing of forests that cannot be harvested. If they are harvested the CO^2 has the potential to be re-released into the atmosphere[11].

3.5.4 Fair Earthshares

Wackernagel has also calculated an approximate ecological footprint figure that can be considered sustainable. This has been calculated on the premise that every individual in the entire world has an equitable right to land. By adding up all the various productive land types (see table 3.2) 2.3 hectares of biologically productive space is available per person (Wackernagel, 2000a).

Productive Land Type	Hectares available per capita
Arable Land	0.25
Pasture	0.6
Forest	0.9
Built-up land	0.06
Sea Space	0.5
Total	**2.3**

Table 3.2: The ecological benchmark for sustainability (Wackernagel, 2000)

However, it is important to protect some of this land for biodiversity. With a planet of over 30 million other species, not all this land can be considered purely for human use. This inclusion of land for biodiversity also helps with the criticism that the ecological footprint can be too utilitarian in its approach. The World Commission on Environment and Development has suggested that 12% of productive land should be preserved for the biodiversity protection. However, this has been criticised as being insufficient but may be a politically feasible target (Noss & Cooperrider, 1994). Meadows & Meadows (1992) highlight the importance of biodiversity protection believing that the annual rate of species loss is 1,000 times higher than the natural rate of extinction.

It is almost impossible to derive one figure that is necessary for biodiversity. Each region or country will need to understand the distinctive nature of biodiversity for their region, making an overall figure inconsequential. Moreover, Noss and

[11] It is possible to store CO_2 from harvested timber if it is locked up in long lasting product (furniture

Cooperrider (1994) believe that a minimum percentage of bio-productive land that needs protecting is 25%. Therefore, the following figures can be calculated for a sustainable earthshare per capita: -

- If the view is adopted that no land needs to preserved for biodiversity protection = 2.3 ha./per capita
- If the WCED figure of 12% is adopted = 2 ha./per capita
- Finally, if Noss and Cooperrider minimum figure of 25% is accepted = 1.6 ha./per capita

This figure is constantly changing due to the rapid rise in world population; therefore less land has to be divided by more people. Wackernagel et al (2000) suggest that within the next 30 years the bio-productive land per capita could decline to 1.2 hectares with a world population of 10 billion.

3.6 An analysis of past footprint calculations

The first time the ecological footprint was used to its full potential was at the country level (Wackernagel et al, 1997). An international analysis was conducted that considered the ecological footprint of over 50 countries.

Table 3.3 outlines many examples of 'The Footprint of Nations' report (Wackernagel et al, 1997). The final figure for each country is listed in hectares. However, not all this land exists, such as the land for carbon sequestration. The footprint is not just calculating the land currently used by a specific country but the land area required if the country were to sequester the amount of carbon they produce. Therefore, even though the final results within the 'Footprints of Nations Report' have been provided as one aggregated figure, table 3.3 distinguishes between land and sea use and carbon sequestration. Examples of 14 countries have been provided from the report. These examples also provide a valuable opportunity to compare the ecological footprint of Guernsey in section 3.6.

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or timber frames for houses)

Country	Ecological Footprint				Ecol. Capacity	Ecological Surplus
	Land Use	Carbon Seq.	Sea	**Total**		
	Ha./cap	Ha./cap	Ha./cap	Ha./cap	Ha./cap	Ha./cap
Australia	5.15	3.61	0.20	8.97	13.98	+5.01
Bangladesh	0.48	0.04	0.03	0.54	0.27	-0.28
Belgium	2.44	2.33	0.23	5.00	1.22	-3.78
Canada	4.06	3.43	0.25	7.74	9.60	+1.87
China	0.67	0.50	0.04	1.20	0.78	-0.42
Germany	2.39	2.70	0.23	5.32	1.91	-3.41
Hong-Kong	1.94	3.79	0.34	6.06	0.03	-6.03
India	0.62	0.20	0.02	0.84	0.47	-0.38
Indonesia	1.05	0.23	0.12	1.39	2.62	+1.23
Netherlands	2.51	2.72	0.09	5.32	1.74	-3.59
Sweden	3.67	1.87	0.32	5.87	7.05	+1.18
UK	2.12	2.84	0.23	5.18	1.72	-3.46
U.S.A.	4.95	5.15	0.25	10.34	6.72	-3.62
World	**1.68**	**0.96**	**0.12**	**2.76**	**2.12**	**-0.64**

Table 3.3: The Ecological Footprint of 14 Selected Countries

Source: Wackernagel et al, 1997

Column 1 signifies the country, while columns 2 to 5 provide the calculation of the ecological footprint for the separate categories. The final two columns look at the amount of biologically productive land within the specific country. For example, Australia has more available bio-productive land than any other country in the world on a per capita basis. The final column identifies the ecological surplus/deficit of each country. This is calculated be simply subtracting the countries total EF/per capita by the ecological capacity per capita.

Each country selected raises a different issue about the methodology. The first and most evident observation is the vast difference in the ecological footprints between developed and developing countries. For example, the USA has an ecological footprint of 10.34 ha./per capita compared with India's of 0.84 Ha./per capita. This provides a valuable insight into the sustainability debate. The ecological footprint immediately places the responsibility of implementing sustainable development on the developed countries.

Even though the ecological footprint identifies which countries are responsible for high levels of environmental impact, it is objective in the sense that it does not state the amount by which to reduce that consumption. The discussion in section 3.5.4, entitled 'A Fair Earthshare' did recommend that a sustainable footprint would be between 1.6 and 2.3 ha. /per capita. However, this is merely a calculation and does not imply that those countries must reduce their footprint to this level. An example of this can be seen when looking at Australia. They are one of the few countries with an ecological surplus (5.01 Ha./cap). Even though Australia has one of the highest ecological footprints, it would be possible to read into the calculation that they do not need to reduce their footprint. Australia could state that they're living comfortably within their ecological capacity. This outlines the objectivity of the model[12]. It is merely a calculation procedure and does not suggest the necessary ethical and moral implications of the interpretation.

This raises the question, whether any country should be punished for having a high population, or very little productive land or lacks the technology in order to improve the yield of their productive land. This issue was discussed earlier in section 3.5.3 (Equivalence Factors). In many respects, sustainable development is about an equitable right to the same resources as the privileged few. India provides a perfect example of this. Even though the ecological footprint is very small, (0.84 Ha./capita) due to a population of 1 billion people the country is in ecological deficit. It is also important to recognise that countries that do have an ecological footprint within the ecological capacity of the country still export and import numerous amounts of resources. Looking at the ecological footprint of Canada, they sufficiently demonstrate the irony of globalised capitalism, which can be seen in the following example. While Canada imported some 247,745 tonnes of dairy products in 1995, they exported 247,770 tonnes (Wackernagel et al, 1997). This makes very little sense, because of the excessive amount of extra transport that is required for the transaction of the same good. It is more understandable to import a product that cannot be produced in Canada, bananas being an excellent example.

[12] The author does not consider the EF to be a totally objective model, but this is one area that outlines the objectivity of the EF. This discussion is addressed in more depth in section 3.8.

All the European countries from figure 3.3 have an ecological deficit. These countries can only exist with their present population and lifestyle because they can rely on using the ecological capacity of other lands. Another interesting observation when considering the ecological footprint of European countries is the large proportion of their total footprint, which is carbon sequestration land. Van Vuuren, Smeets & de Kruijf (1999) identified that the share for carbon sequestration ranges from about 20% for the non-industrialised countries to slightly more than 50% for the industrialised countries. This represents the large production of carbon dioxide produced through the consumption of the industrialised countries and also outlines the importance of understanding carbon sequestration within the calculation. This has proven to be a controversial issue and one that is discussed in section 3.8.

3.7 The ecological footprint of Guernsey

The ecological footprint of Guernsey has been calculated using two footprinting approaches: compound and component. Below are the details of a compound ecological footprint for Guernsey. Guernsey is the first place where both of the ecological footprint methods have been calculated providing a valuable opportunity for comparison of methodologies and results.

3.71 Differences between the methodology of Wackernagel et al (1997) and the methodology used for Guernsey

Table 3.4 summarises the most important differences between the calculation method of Wackernagel and Rees[13] and the calculations applied to Guernsey.

	Approach by Wackernagel	This Report
Categories	92 product categories (i.e. meats, dairy products etc.)	144 product categories[14]
Built Land	The equivalence factor used is 2.8	The equivalence factor used is 1 (world average productivity)
Imports	Includes both production and imports	Only includes imports due the fact that Guernsey imports nearly all of its resources
Modelling	Provides a final accounting figure for the total footprint	As well as providing a final accounting figure, offers a range of figures for the controversial elements of the calculation
Energy Intensity	Does not include the energy intensity of products	The energy intensity of all the product categories has been calculated and documented as embodied energy of products[15]
Nuclear Energy[16]	Considered to have the same footprint as fossil fuel	A new calculation for nuclear energy considering degraded land

Table 3.4: The Differences in Methodological Choices between Wackernagel's approach and the Guernsey footprint.

[13] The chapter may seem too dependent on the approach used by Wackernagel and Rees. However, they are the co-founders of the ecological footprint and have been responsible for developing the tool further than anyone else. Their ecological footprint model is considered to be the most accurate and precise approach available. Excluding work done by Simmons and Chambers this approach is universally accepted. However, some researchers have made minor changes to the model ((van Vuuren, Smeets & e Kruijf, 1999).

[14] For the Guernsey footprint it was possible to divide all the consumption into 144 categories due to very precise import data from the ports.

[15] The Energy Intensity Figures have been established using Life Cycle Assessment Statistics, particularly referring to the work of Hofstetter's CO2 studies (1992)

3.7.2 Data Collection

The data for the ecological footprint were derived from a large range of sources, of which the predominant source was information gained from import data collected from seaports (both St Peter Port and St Sampson). Guernsey being an island made it possible to gain very accurate information, making this study one of the most accurate footprint analyses to ever be conducted. Other information was gained from a variety of sources that have been listed in figure 3.3 below.

1. Island Waste Survey
2. 1997 Policy and Resource Planning Report
3. Island Development Committee
4. Guernsey Water Board
5. Guernsey Board of Administration
6. Island traffic Committee
7. Guernsey diary

Figure 3.3: Data Source for the ecological footprint compound calculation for Guernsey
Source: Author

Over 3,000 different items of information relevant to the calculation were collected. It was then possible to fit all these items into 144 different EF categories (for example cheese, tinned meat, tomatoes etc.).

[16] The footprint of nuclear energy is discussed in Section 3.8 (A Critique of the Ecological Footprint)

All these categories were placed under 7 different types, which were: -

1. Animal based food products
2. Animal based non-food products
3. Plant based food
4. Timber products
5. Other plant fibres
6. Embodied energy of products
7. Energy consumption

The final analysis of the compound ecological footprint calculation aggregates all these categories to determine a final figure for Guernsey. The columns in the tables below signify the use of global average yield per year, the energy intensity of the raw materials and manufactured products and the import of the material. Using data from the Food and Agriculture Organisation of the United Nations (FAO) of world average yield and carbon dioxide absorption, the consumption figures for each separate item are translated into the appropriated biologically productive land area[17]. (the last column). This is the ecological footprint of each separate item that has been analysed.

The embodied energy figure in the analysis of Guernsey is limited by data availability. It has only been possible to derive a conversion factor (explained below) as opposed to fully understanding the embodied energy of each product.

The embodied energy for each product has not included the following information in the analysis. This includes: -

- Energy requirement for the use of tractors, fertilisers and pesticides
- The processing of the product (domestic transportation, packaging, distribution and cooking)

When considering energy consumption for Guernsey, it is not only the fuels that are consumed on the island that are included in the calculation. The energy analysis considers the energy required to produce the products and goods consumed on the island but produced elsewhere. The energy balance considers the consumption of fuel for domestic and industrial (in the case of Guernsey this is mainly oil), and fuel used by vehicles (both private and commercial use). Therefore, to include the embodied energy in the materials imported to Guernsey the following calculation is made.

$$C \times \frac{\text{Import}}{\text{Yield} \times \text{Population}} = \text{EF component (Ha./Cap.)}$$

C represents the conversion factor for the raw material that is required to produce one unit of manufactured product (Wackernagel et al, 1999). Wackernagel (1999) provides an example for cheese, where it takes 10 litres of milk to produce 1 kilogram of cheese. Therefore, cheese is given a conversion factor of 10. It has been easy to avoid the problem of double counting for Guernsey. The problem of double counting occurs when industrial energy consumption and the embodied energy of an item are both included. By only considering imports into Guernsey, this does not weaken the footprint analysis. It is estimated that 95% of all consumption on the island are imports. The remaining 5% of local produce are very difficult to calculate due to its method of production. Within Guernsey it is possible to buy locally grown vegetables from boxes on the roadside. These are positioned all over the island and produced from a wide variety of sources making it nearly impossible to calculate. The only other vegetable produce produced on the island is an 'organic box scheme'. This, even though proving to be successful, is insignificant to the amount of vegetables sold through the supermarkets on the island.

In column 3 of the tables below, the energy intensity (Gj/t) has been established for each of the products. Life Cycle Assessment (LCA) data has been used[18]. Two

[17] 1998, FAO yield factors were published in August 1999. The 1999 Statistics will not be available until August 2000.

[18] Note that the energy balance is corrected by the embodied energy in net import of goods to get a more accurate picture of energy consumption. This traded energy is calculated by multiplying, for each trade category, the amount of net import by the typical embodied energy of these commodities. The energy intensity figures are taken from Hofstetter, P. 1991. Persönliche Energie - und CO2-Bilanz. (Personal Energy and CO2 Balance) and H.C. Wilting, R. M. J. Benders, et al. (1999) EAP - Energy Analysis Program.

references were used in an attempt to understand the various economic transactions, resource requirements and environmental emissions for a particular product or service. A complete set of the energy intensity calculations was obtained from IVEM (Interfacultaire Vakgroep Energie en Millieukunde: Center for Energy and Environmental Studies, Groningen, Netherlands) and Hofstetter. These two sources provided a complete set of energy intensity for products. All the figures used are European averages.

Local production data have been applied to two items. This includes milk and fish production. There are distinct reasons why this has been done. Concerning milk, no supermarkets are allowed to import any milk into the island. This decision was based on protecting the local market for milk (Guernsey cows). For fish, two figures were available concerning consumption; one from imports and one from local consumption (including local catches). It was not clear as to whether the local consumption included imports; therefore it was decided to use the higher of the two figures (which included local production).

The spreadsheet employed for the ecological footprint analysis was designed in Excel so that when the consumption data were entered, the footprint figure for each separate product was calculated. Every effort has been made to make sure the final figures used were accurate within certain time constraints. Sensitivity tests have also been applied to the data in an effort to check the validity of the data gained.

Table 3.5 demonstrates the ecological footprint of animal food products consumed in Guernsey[19]. Dairy products have proven to have one of the highest impacts as well as a large proportion of fish. This is not surprising on an island with a large number of seafood restaurants.

	Global Yield (Kg/ha/yr.)	Energy Intensity (Gj/t)	Consumption (t)	Footprint (hectares)	Land Type	Embodied energy (Pj)
Living animal[20]	72.1	5.00	29.20	**0.01**	Pasture	0.0001
Beef (fresh, cooled or frozen)[21]	32.0	80.00	16.00	**0.01**	Pasture	0.0013
Other meat, mainly pigs and chicken[22]	135.6	80.00	1694.90	**0.08**	Arable	0.1356
Milk	489.3	10.00	6921.83	**0.24**	Pasture	0.0692
Cheese	48.9	65.00	2039.33	**0.71**	Pasture	0.1326
Eggs	0.04	65.00	1.07	**0.05**	Arable	0.0919
Fish[23]	28.9	100.00	2396.00	**1.41**	Sea space	0.2369
Fodder (fish-based)	28.9	100.00	1.53	**0.04**	Sea space	0.0065
Total Footprint for Animal Based Products				2.55	Hectares	0.7 Pj
Associated with the relevant land types: -				0.13	Arable	
				0.97	Pasture	
				1.45	Sea	

Table 3.5: The Ecological Footprint of Guernsey Meat, Dairy and Fish Consumption
Source: Column 1 FAO, 1999; Column 2 Economic Input/ Output LCA Software (see footnote 18; Column 3-6 Author

[19] There is a further discussion of the calculation procedure with specific examples in Appendix 8.

[20] This figure is mainly made up of horses imported into the island. Since keeping horses is not a use, but a maintenance of stock, the calculation is different from the other product categories. It is analysed by considering how much pasture space is necessary to fed the number of horses.

[21] The production of beef is considered to be a raw material and it is assumed that they are produced from pasture only. This is an assumption as some cattle may be feed with fodder. However, there is a lack of information, meaning there is room for improvement.

[22] All other meat (for example, chicken and pigs) is considered to be manufactured product. This assumption is based on the theory that they will be fed on fodder.

[23] The data for fish consumption were gained from two main sources: 1. There is a fish market on Guernsey that sells local fish; 2. The import of manufactured fish products (or example, fish fingers).

Table 3.6 below provides an analysis of the non-food animal products consumed within Guernsey[24].

	Global Yield (Kg/ha/yr.)	Energy Intensity (Gj/t)	Consumption (t)	Footprint (hectares)	Land Type	Embodied Energy
Wool	15.99	10.00	9.47	**0.01**	Pasture	0.01
Shoes	31.99	20.00	26.62	**0.09**	Pasture	0.09
Leather products	31.99	20.00	164.22	**0.01**	Pasture	0.01
Other animal based raw materials	72.08	10.00	45.33	**0.01**	Pasture	0.01
Total Footprint for Non-Animal Based Products				0.12	Hectares	0.12 Pj
Associated with the relevant land types:-				0.12	Pasture	

Table 3.6: The ecological footprint Non-food animal products

Source: Same as table 3.5

[24] There is a further discussion of the calculation procedure with specific examples in Appendix 8.

The non-animal food analysis has been able to divide the food into 33 different categories. Table 3.7 below displays all the trademarks of an affluent society enjoying high levels of consumption with items such as alcoholic drinks and pet food.

	Global Yield (Kg/ha/yr.)	Energy Intensity (Gj/t)	Consumption (t)	Footprint (hectares)	Land Type	Embodied Energy Pj
Wheat and rye (not ground)	2440	10.00	3656	**0.0255**	Arable	0.0366
Rice	3686	10.00	246	**0.0011**	Arable	0.0025
Barley and other fodder grains	2669	10.00	6754	**0.0431**	Arable	0.0675
Fodder (cereal-based)	2669	10.00	593	**0.0038**	Arable	0.0059
Corn (but not sweet corn)	4136	10.00	3496	**0.0144**	Arable	0.0350
Other cereals	2811	10.00	7	**0.0000**	Arable	0.0001
Wheat flour and flakes[25]	2440	20.00	92	**0.0006**	Arable	0.0018
Other cereal flours and flakes	2811	10.00	479	**0.0029**	Arable	0.0048
Finished cereal products	2440	20.00	106	**0.0007**	Arable	0.0021
Roots and tubers	15268	5.00	4753	**0.0053**	Arable	0.0238
Pulses	834	10.00	587	**0.0120**	Arable	0.0059
Vegetables	18000[26]	5.00	1526	**0.0014**	Arable	0.0076
Vegetables grown in greenhouses	18000	100.00	37	**0.0000**	Arable	0.0037
Vegetables (prepared)	18000	20.00	2555	**0.0024**	Arable	0.0511
Fruit	12000	10.00	731	**0.0010**	Arable	0.0073
Sugar[27]	5060	15.00	3345	**0.0113**	Arable	0.0441
Sweets	5060	20.00	45	**0.0002**	Arable	0.0502
Coffee	528	75.00	2	**0.0001**	Arable	0.0000
Cacao	439	20.00	2	**0.0001**	Arable	0.0001
Chocolate	439	50.00	183	**0.0071**	Arable	0.0092
Tea	1182	75.00	8	**0.0001**	Arable	0.0006
Spices	1182	75.00	23	**0.0003**	Arable	0.0018
Oil seeds[28]	1312	10.00	150	**0.0019**	Arable	0.0015
Margarine	590	40.00	41	**0.0012**	Arable	0.0017
Fodder (oil-based)	1312	20.00	2247	**0.0292**	Arable	0.0449

[25] Concerning flour, it is assumed that there is no material loss, and thus the conversion factor is 1.
[26] All the vegetables have been given the same yield factor. This assumption is taken from Wackernagel et al (1999) and is an estimate across various vegetables as listed in FAO.
[27] The sugar yield is adjusted for the loss of refinement (It needs 2350kg of sugar beet for 369kg of raw sugar) (Wackernagel et al, 1999)
[28] The content of oil within oil seeds is estimated at 45% (Wackernagel et al, 1999)

Dog and cat food	2440	20.00	1878	**0.0131**	Arable	0.0376
Tomato ketchup	5060	30.00	6	**0.0000**	Arable	0.0002
Mustard	5060	30.00	4	**0.0000**	Arable	0.0001
Vinegar	7164	20.00	18	**0.0000**	Arable	0.0004
Seasoned sauces	2440	20.00	75	**0.0005**	Arable	0.0015
Prepared pasta	2440	20.00	6	**0.0000**	Arable	0.0001
Malt extracts	2440	20.00	1	**0.0000**	Arable	0.0000
Non-alcoholic drinks	50595	10.00	144	**0.0000**	Arable	0.0014
Alcoholic drinks	7164	10.00	10742	**0.0256**	Arable	0.1074
Total Footprint for Plant Based Food				0.21	Hectares	0.56 Pj
Associated with the relevant land types:-				0.21	Arable	

Table 3.7: The ecological footprint of plant based food

Source: Same as table 3.5

FAO (1999) suggests that the global average wood productivity is 1.99 m3/per ha./per year. Guernsey's main wood demand comes in the form of paper. This is not surprising, as over 80 banks are present on the island requiring a large amount of paper for office duties. Furniture also forms a considerable demand for wood.

	Global Yield (Kg/ha/yr.)	Energy Intensity (Gj/t)	Consumption (t)	Footprint (hectares)	Embodied Energy Pj
Fire wood (not waste) [m3]		0	1		0
Wood chips and refuse in [m3]		5	3594		0.02
Directly used roundwood [m3]		5	37286		0.19
Sawn wood		10	1171		0.01
Wood-based panels		10	2602		0.03
Furniture[29]		15	14720		0.22
Wood pulp		10	0		0
Paper products		35	25781		0.90
Printed material		35	742		0.03
Total: Round wood equiv. [m3][30]	0.735587499[31]		85898.3613	**0.735587**	1.4
Total: Round wood equiv. [m3]		85898.3613		0.735587	
Associated with the relevant land types: -				0.74	Forest area

Table 3.8: The ecological footprint of timber and wood products

Guernsey's demand from arable land goes further than merely providing food. Clothes, tobacco and rubber form part of a small but noticeable EF. Together they require an area of 1200 hectares of arable land.

[29] There is a further discussion of the calculation procedure with specific examples in Appendix 8.

[30] Roundwood equivalent the amount of timber that is required from trees. For example, the wasted timber is taken into consideration. The waste factors tell how much round wood is necessary per unit of manufactured product. The factors are estimated from forest statistics. FAO statistics estimate that the standing volume in trunks is 20% more than the harvested wood (FAO, 1999a). Roundwood is expressed in cubic metre solid volume excluding the bark.

[31] The same global yield factor is used for all the timber products.

	Global Yield (kg/ha/yr.)	Energy Intensity (Gj/t)	Consumption (t)	Footprint (hectares)	Land Type
OTHER PLANT FIBRES					
Cotton and other plant fibres	1000.00	10.00	478.31	**0.0082**	arable
Cotton based yarn and fabrics	1000.00	10.00	92.08	**0.0016**	arable
Other yarn and fabrics (mostly synthetic)	1000.00	50.00	181.98	**0.0031**	arable
Clothes (half assumed to be cotton, half synthetic)	2000.00	45.00	286.22	**0.0024**	arable
Jute	1638.00	5.00	18.78	**0.0002**	arable
Synthetic fibres	-	50.00	305.00		
Used/recycled fibres	-	0.00	0.00		
NON FIBRE, NON FOOD PLANTS					
Raw tobacco	1496	10.00	94.77	**0.0011**	arable
Processed tobacco	1496	40.00	6.61	**0.0001**	arable
Flowers and ornamental plants	18000	10.00	96.97	**0.0001**	arable
Rubber products	1000	20.00	211.63	**0.0036**	arable
Inedible waxes and fats (here assumed to be plant based)	-	40.00	49.63		
Other plant based raw materials (incl. Seeds)	18000	10.00	86.42	**0.0001**	arable
Total Footprint for other plant fibres, Non-fibres and non-food plants:-				0.0204	Hectares
Associated with relevant land type:-				0.0204	arable

Table 3.9: The ecological footprint of non-food, plant based products

Table 3.10 considers the energy requirements for a range of consumable items brought into the island. Again, it is not possible to measure the embodied energy of every item that enters the island, but this analysis has captured the majority. Electrical equipment of office machinery has proven to be the largest amount of consumable items. The analysis has included nearly all categories, ranging from sports equipment to guns.

	Energy Intensity (Gj/t)	Consumption (t)	Embodied Energy Pj
Inorganic chemicals	40.00	8.21	0.0003
Dyeing, tanning and colouring materials	40.00	2112.30	0.0003
Medical and pharmaceutical products	200.00	88.35	0.0845
Essential oils, raisins and perfumes	40.00	60.82	0.0177
Synthetic fertilisers	100.00	0.00	0.0024
Refined plastic	50.00	43.57	0.0022
Plastic products	50.00	140.77	0.0070
Other chemical products	40.00	70.59	0.0028
NON-METALLIC MINERAL MANUFACTURES			
Glass and pottery	20.00	55.24	0.0011
Other	5.00	467.07	0.0023
METALLIC PRODUCTS			
Iron and steel	30.00	223.93	0.0067
Non-ferrous raw metals	35.00	2.56	0.0001
Manufactures and structures out of metals	100.00	600.06	0.0600
Heavy machinery	100.00	6002.29	0.6002
Office machines, computers, telecommunication, radios	140.00	9878.07	1.3829
Other electrical equipment	140.00	57950.58	8.1131
Road vehicles and other transportation equipment	100.00	229.69	0.0230
Other transportation vehicles	100.00	9.44	0.0009
Equipment for building installations	100.00	1522.64	0.1523
Research instruments and optical equipment	140.00	40.11	0.0056
Sports equipment, writing tools, art work, music instruments and tapes	100.00	278.33	0.0278
Total Embodied Energy: -			10.5 Pj

Table 3.10: Embodied Energy of Imported Products

Table 3.11 provides an analysis of the energy balance of Guernsey. The Guernsey Electricity Board and Guernsey Gas provided detailed energy statistics.

At present, Guernsey Electricity Board is able to supply electricity to the entire island through the use of its oil-fired power station. This explains the high consumption of liquid fossil fuel. However, table 3.11 also includes the embodied energy in net imported goods into the island, which forms the most significant proportion of the Guernsey energy balance. Embodied energy in net import of manufactured goods is calculated as liquid fossil fuels. The ecological footprint of fossil fuel consumption, as previously explained, is evaluated in terms of CO^2 uptake of immature forests. At present, Guernsey has virtually[32] no renewable energy sources.

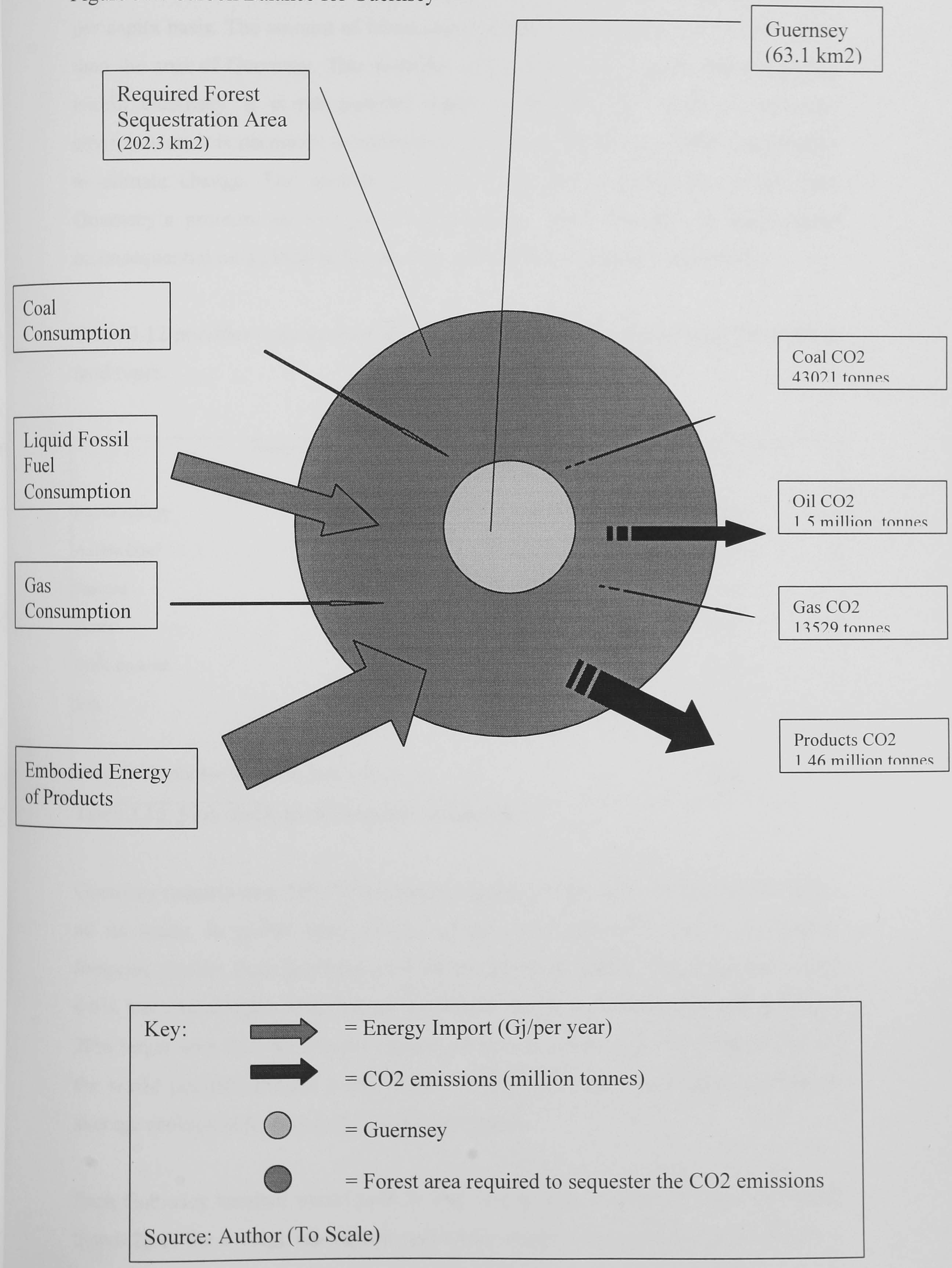
Moreover, the situation is set to change, as Guernsey is now investing in a cable link to France that will provide all the energy to the island and the original power station will be seen as an emergency back-up system. As France's predominant source of energy is nuclear (about 80%) in the future this will make the energy balance EF a more complex calculation. The issue of footprinting nuclear energy is discussed in section 3.10.5. Figure 3.4 provides a diagrammatic understanding of the ecological pressure of Guernsey energy demand.

	Global Yield (Kg/ha/yr.)	Consumption [Gj/yr./cap]	Footprint (Hectares)	Land Type
Coal consumption	55.00	8.8	0.17	Energy Land
Liquid fossil fuel consumption	71.00	103.1	1.4	Energy Land
Fossil gas consumption	93.00	8.3	0.1	Energy Land
Energy embodied in net imported goods	55.00	224.6	3.2	Energy Land
Total Energy Footprint			4.87	Energy Land

Table 3.11: Energy Consumption Analysis

[32] I say virtually because there are a few privately owned renewable energy producers but there are insignificant to the energy balance of the island.

Figure 3.4: Carbon Balance for Guernsey



Source: Author (To Scale)

Figure 3.4, provides a clear indication that the impact of Guernsey is substantial on a per capita basis. The amount of forest sequestration land required is 3.2 times larger than the area of Guernsey. This provides a clear message for environmental policy within Guernsey. It is not possible solely to consider the impact on the local environment; it is necessary to understand and act on Guernsey's global contribution to climate change. The ecological footprint provides an invaluable insight into Guernsey's pressure on the global environment. While Guernsey is small, even inconsequential on a global scale, on a per capita basis its impact is substantial.

Table 3.12 provides a summary of the total EF of Guernsey combining all the various land types.

	Footprint per land category	Equiv. Factor	Equivalent total
Fossil energy	4.9	1.17	5.69
Arable land	0.4	2.83	0.99
Pasture	1.1	0.44	0.48
Forest	0.7	1.17	0.87
Built-up area	0.2	1.00	0.20
Sea	1.4	0.06	0.09
Total Footprint for Guernsey (per capita)			**8.32**

Table 3.12: Final Ecological Footprint for Guernsey

Guernsey requires over 500,000 hectares to supply it with all its resources and absorb all its waste. In global terms, 95.2% of the world population has an ecological footprint smaller than Guernsey's (Wackernagel et al, 2000). Therefore, these elite 4.8% has a total share of 30.2% of humanity's footprint, which represents at least a 20% larger area than the current capacity of the biosphere. The remaining 95.2% of the world population have a total share of 69.8% of humanity's footprint with an average ecological footprint of 1.76 Ha./per capita.

Each Guernsey resident would need to find four people willing to consume no more than 0.26 of the average bio-capacity per capita world-wide, so that all five could live within the means of nature (Wackernagel et al, 2000). This has major issues associated with world equity and poses the question why privileged individuals have the right to a larger pool of resources. For example, Guernsey consumes 10 times more resources per capita than India and over 3 times more than the world average. Guernsey defies the laws of natural carrying capacity. The more prosperous the island becomes, the larger the stress it places on the environment through the ever-increasing demand for consumption. But, unlike many developing countries where isolated communities would not be able to survive with a population that is larger than the local carrying capacity, Guernsey has no difficulties. The island places very little ecological stress on its local environment. Guernsey is responsible for the use of productive land that supplies all its materials for consumption all over the world. Guernsey can only survive by draining resources from other lands. No other indicator highlights the issue of the consequences of consumption clearer.

3.8 Assessing the ecological footprint: The methodological approach

To strengthen the critical appraisal of the ecological footprint methodology the opinions of academics and practitioners involved within the field of sustainable indicators is invaluable. By establishing an in depth understanding of the ecological footprint it is possible to suggest the future of the methodology within the field of policy at a European, national and local level, as an awareness raising tool and for future advances within the field. To gather this information a comprehensive group of experts were approached regarding the future of the ecological footprint using semi-structured interviews.

Information from the interviews is used in chapters 3, 4 and 6, although it is most relevant to this chapter.

King (in Cassell & Symon, 1994) notes that research interviews are "without doubt, the most widely used qualitative method in organisational research..." He suggests this is because it is a highly flexible method, which can be used almost anywhere and is capable of producing data of great depth. Moreover, it is a method with which most participants feel "reasonably comfortable".

For the purposes of definition, King quotes from Kvale, who defines a qualitative research interview as:

"an interview whose purpose is to gather descriptions of the life-world of the interviewee with respect to interpretation of the meaning of the described phenomena ... neither in the interview stage nor in the later analysis is the purpose to obtain quantifiable responses" (ibid., p. 14)

In order to achieve this, qualitative research interviews generally have the following characteristics:

1. A lower degree of structure imposed by the interviewer.
2. Prevalence for open-ended questions.
3. A focus on "specific situations and action sequences in the world of the interviewee" (ibid, p. 15) rather than abstractions and general opinions.

Fontana & Frey (in Denzin & Lincoln, 1994) observe a key feature of the qualitative interview is to treat the interviewee as a 'participant', helping to shape the nature and direction of the interview process. This in contrast to a quantitative interviews that treat the interviewee as a 'subject' and the interview as a 'relationship-free' data gathering procedure.

King (op cit.) identifies five stages in the construction of qualitative research interviews. These stages have been defined below in context with this specific research.

(1) Defining the research questions
The questions should focus on how the participants describe and understand specific aspects of the ecological footprint. The primary concern is not to quantify the participant's experience. Questions must be framed so that they do not reflect the researcher's own presuppositions and biases.

(2) Creating the interview guide

A formal schedule of questions is not required. However, an interview guide, listing general topics and issues to be covered during the course of the interview is desirable (see appendix 1). The sources of these topics include the literature review; the researcher's own knowledge and experience; and informal preliminary discussions with other individuals with experience in the research area. The development of the interview guide should be 'organic', being modifyied as new issues emerge through the course of the interviews. Thus, a typical question might be followed by a prompt to clarify it, possible further questions depending on the type of response and notes to probe specific issues.

(3) Recruiting participants

In deciding how many participants to recruit, the amounts of time and resources available are critical factors. King (ibid.) mentions that the in-depth analysis of a single one-hour interview could take an experienced transcriber two or three working days to transcribe. Furthermore, interviewees will expect significant feedback for the time they have provided.

(4) Carrying out interviews

King (ibid.) remarks that flexibility is the key factor in successful interviewing. Instead of rigidly following the interview guide, the interview should flow like a conversation, with the topics arising 'naturally'. The interview should open with a question with which the interviewee will feel comfortable. More difficult questions should be left until the participants have had time to relax and get through the 'getting to know you' stage.

Fontana & Frey (Op Cit) consider careful phrasing of questions is essential to the success of the interview. Multiple questions and leading questions should be avoided. Instead, questions should be asked singly and as simply as possible without becoming patronising. Furthermore, the answer to a question is never so obvious that it need not be asked. Moreover, the interviewer should not interpret the meaning of answers for the interviewee.

3.8.1 Design of the interview structure

Wackernagel believes that the ecological footprint has the ability to assist governments, businesses and NGOs shape sustainable development. These organisations now have available a clear and comprehensive measurement tool for assessing human impact on the Earth. The ecological footprint is not a static measurement, but more a dynamic tool in measuring what direction we need to go, and which programmes and projects move us nearer to the concept of sustainability. The claim is that the tool can take the subjective, and difficult to quantify, concept of sustainability and makes sustainability a concrete term which has a realistic goal. It is the aim of the interviews to test the reality of this. The focus groups, attempting to understand public perceptions of sustainability, through the use of the ecological footprint, have addressed the educational value of the ecological footprint (Chapter 5). Although, these issues are raised within the interview the main analysis is concerning the use of the ecological footprint within the field of policy decision-making.

Although a qualitative approach has been selected a rough interview guide was established to make sure that all the important issues were discussed. The interviewees were allowed to digress and explore a particular area of interest to them. Each interviewee was sent a copy of the interview guide before the interview. This gave them a clear indication of the issues that were to be addressed and also gave them time for any preparation of this specialised subject. A separate interview guide was constructed for each interviewee in an attempt to identify particular areas relevant to each particular person. For example, Craig Simmon's interview guide concentrates on the methodology of the footprint, while Roger Levett's interview concentrates more on the ecological footprint as a decision-making tool. The topic guides can be found in Appendix 1.

Five EF experts were selected for the interviews. Every interview was conducted in person except for Roger Levett's interview, which was done over the phone.

1. Mathis Wackernagel (Redefining Progress, San Francisco)

Wackernagel was selected for interview, as he was the co-founder of the ecological footprint. He has continued to develop the ecological footprint into a more defined management tool and has published numerous papers and reports on the subject. He is considered to be the world-authority on the ecological footprint.

2. Roger Levett (CAG Consultants, London)

Levett has been a strong advocate of the ecological footprint for many years conducting work for the UK 'Going for Green' campaign. He has also been responsible for publishing a valuable critique of the footprint and is considered to be an expert in the field of sustainable indicators.

3. Nicky Chambers (Managing Director, Best Foot Forward)

No other company has applied the use of the ecological footprint more than Best Foot Forward. They are responsible for deriving a whole new approach to footprinting with a particular interest in local sustainability. They have applied it to products (for example, nappies), companies (Anglian Water) and regions within the UK (Isle of Wight).

4. Craig Simmons (Technical Director, Best Foot Forward)

Simmons founded Best Foot Forward with Chambers in 1997 and has been responsible for developing user-friendly ecological footprint software for 'Going for Green'. This includes 'EcoCal' (see Appendix 2) and 'EcoCal for Schools' which has now been installed in every school across the UK, both based on the ecological footprint.

5. Andrew Ferguson (Optimum Population Trust)

Ferguson has been responsible for publishing many articles on the ecological footprint, providing a critique of the energy land issue. He has also been responsible for research concerning biomass and its relevance to the ecological footprint.

3.9 How does the ecological footprint measure up as an indicator for Sustainability?[33]

The sample criteria for indicators are[34]: -

1. Simple – clearly defined and readily understandable by the community. A good indicator is judged to be simple, requires no special knowledge to interpret it and relates to experiences and activities with which a community would be readily familiar.

The ecological footprint clearly relates to individual lifestyle choices (specifically the component approach discussed in chapter 4). Chapter 5 considers the use of the ecological footprint as an educational tool and finds that individuals with no prior knowledge of sustainable development could grasp the issues. Roger Levett's experience of using the ecological footprint as an educational tool found similar results, believing it to be a simple and effective communicator of sustainable development.

2. Easily measurable - based on information that is accessible, affordable and reliable. An indicator is judged easily measurable if reliable secondary data are readily available (usually from official sources). Where an indicator requires primary research or relies on unofficial sources, a judgement is made as to whether this would be within the capabilities of a small group.

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[33] Section 3.9 combines the views and ideas of the interviewees with the empirical research from Guernsey.
[34] The criteria are taken from the City of Santa Monica, Task Force on the Environment (1998)

One of the problems with the ecological footprint is the enormous amount of data that is required to conduct the analysis. While data on a national level are readily available through FAO sources problems exist gaining the necessary data for a more localised analysis. However, if governments (at a local and national level) are to take sustainable development seriously it is important to measure the necessary components to make an informed policy decision. Roger Levett believes this is not the fault of the footprint but a problem of data availability stating:

"It is not a criticism of EF, it is rather EF revealing that we don't have enough information to make sensible environmental decisions. We simply don't put nearly enough effort into collecting information to make decisions. We are making lunges in the dark all the time. We are involved in a range of different sustainability management tools and all of them reveal the need for more data, more information, more effort, more resources."

3. Achievable – Is the Community willing and able to achieve the target? Unrealistic goals can lead to inertia. For example, setting a target of reducing the number of smokers to zero may be an important health goal but unachievable.

Wackernagel stated that the ecological footprint is not about how bad humans' demand on nature is, but how is it possible to reach achievable goals with the ecological footprint as a tool to guide this progress. In this respect it is an objective tool. It is a picture of the current appropriation of nature by humans and leaves the decision-making process to consider what is a feasible reduction. Chapter 5 discusses simple methods by which to reduce the ecological footprint of Guernsey demonstrating that achievable goals can be reached.

4. Relevant - Is it relevant to the community? Does it encourage partnership working; does it provide a link between more than one area of sustainability (i.e. economy and social need)? An indicator is judged to be relevant if improvements in performance will bring a community closer to sustainability (environmental, social and economic).

The ecological footprint is only relevant to one area of the sustainable development debate; that of ecological limits (living within the means of nature). It does not inform a community how to improve quality of life but does create an interesting framework for discussion. It questions whether it is possible to achieve a decent quality of life for all within the means of nature. It is now possible to consider ecological limits alongside the other key issue of sustainable development (quality of life).

5. Timely - does the target facilitate a long-term view, with consistent data available over many years? Will changes in the indicator accurately reflect changes in performance in a timescale that permits effective action? An indicator is unlikely to be of assistance if data are only available every 10 years or if it measures an irreversible outcome.

The use of the ecological footprint as time series data is probably one of its most valuable components. Year on year, it is possible to measure the ecological footprint to understand whether the community is coming closer or further away from ecological sustainability. The methodology has already improved and will continue to improve providing a more and more accurate tool for measuring ecological sustainability.

It is important to recognise that there is no such thing as a 'perfect' indicator. An indicator should be something that helps a community understand where it is and where it is going and how far it is from where it wants to be, something that the ecological footprint can do in a coherent and scientific manner. A good indicator should also have some diagnostic value. It should alert a community to problems and assist with fixing them. The ecological footprint has the potential to provide a community with a clear and comprehensive analysis of the community's ecological overshoot.

3.10 Critique of the ecological footprint

3.10.1 The Objectivity of the Ecological Footprint

No model can be completely objective. Simply deciding to measure a particular issue implies, with some subjectivity, that the issue is of importance. However, the ecological footprint is a measuring tool that is objective and has quantified human impact on the biosphere in a clear and precise manner. Being a complex aggregated indicator, certain simplifications and assumptions are almost expected. Moreover, due to reasons of data availability and a desire to understand accurately the impact of humans on the biosphere, some assumptions are built into the accounting tool of which some individuals have objected.

What is important is not the fact that assumptions appear in ecological footprinting but whether or not these assumptions are true and fair. The following critique of the ecological footprint addresses these issues specifically.

3.10.2 Other Issues Related to the Ecological Footprint

Van den Bergh & Verbruggen (1999) have published a critique of the ecological footprint methodology. Their criticisms range from the use of hypothetical land, no distinction between methods of land use, or the way the ecological footprint deals with energy, aggregation, policy relevance, yield factors and trade. The issue of policy relevance is addressed in chapter 5 while all the other issues are discussed below. Another critique was published by Gordon & Richardson (1999); their main uncertainty with the ecological footprint is the fundamental use of an indicator that relies on bio-physical assessment, believing that economic markets provide a more precise and relevant indicator of resource scarcity. Roger Levett (one of the interviewees) published the only other critique, which praised the ecological footprint but also highlighted areas of caution.

A detailed discussion of the problems embedded within the ecological footprint is provided below.

3.10.3 A discussion of yield factors: Using Global or Local Factors

One of the key objections to the ecological footprint is the aggregation and weighting process (van Vuuren et al, 1999, van den Bergh & Verbruggen, 1999). Van den Bergh & Verbruggen (1999:4) suggest that the summing up of all the consumption types and converting these into land types is incomplete.

"Evidently, this conversion is necessarily incomplete, while no account is taken of regional and local features of land types and land use."

At present, Wackernagel prefers to apply global yield factors to all countries, the premise being that an individual who lives in an area of poor productivity should not be disadvantaged by circumstance. Every individual has an equal right to resources, irrespective of location. This is an assumption, but not necessarily a wrong one. It does have close relevance with the equity issue of sustainable development. Van den Bergh & Verbruggen (1999) have noted the substantial difference in yields from country to country suggesting that countries with the highest rates of consumption often have the highest yields per capita. What is also important to consider is the energy input required to achieve a high yield. In Van den Bergh & Verbruggen (1999) the ecological footprint of four countries has clearly highlighted the large variations between the productivity of countries. Figure 3.13 highlights the variations in productivity for two crops for 1994 (cereals and pulses).

Country	Pulses (tonne/ha)	Cereals (tonne/ha)
Benin	0.6	1.0
Bhutan	1.0	1.2
Costa Rica	0.6	3.4
Netherlands	4.3	7.3

Table 3.13: A Comparison of Productivity

Source: FAO (1996) in Van den Bergh & Verbruggen (1999)

Large variations can be seen between the potential yields of developed and developing countries.

The argument put forward for the use of local yields within this report is that,

"For national governments, however, land use based on local yields might be much more relevant since these can be influenced, for instance, by increasing the productivity (which might result in unsustainable land use practices). Moreover, using local yields means that the calculated area is equal to the real, touchable, area used for the consumption of a specific country." (Van den Bergh & Verbruggen, 1999: 23)

The key point is that by using local yields the authors believe the ecological footprint becomes more responsive to local changes. By doing this Van den Bergh & Verbruggen have removed an in-built assumption (an equal right by all to the most productive land). Their approach can also be viewed as slightly greedy. The decision implies the idea that 'we are alright with our high productivity, so bad luck', which does not adhere to previously discussed definitions of sustainable development. This raises the issue of whether assumptions should be built into the footprint analysis potentially questioning the objectivity of the tool.

Figure 3.14 below provides an analysis of the differences in the ecological footprint when applying local and global yields for the UK. It is not possible to conduct such an analysis for Guernsey as it only considers imports and does not attempt to measure local productivity.

Land Type	Global Yields	Local Yields
Arable	0.8	0.3
Pasture	0.6	0.5
Forest	0.3	0.2
CO2 Land	2.5	2.1
Sea	0.1	0.1
Built-up area	0.4	0.1
Total (Hectares)	4.7	3.3

Table 3.14: A Comparison of using Global and Local Yield Productivity within the Ecological Footprint
Source: Author

Is increasing yield factors an answer to a decreasing amount of land per capita? It is important to remember that high yield factors can mean a higher amount of embodied energy within the final product. To obtain higher yield factors requires greater energy imports in the form of more fertilisers, an increased use of energy intensive machinery and transport.

If the most fertile lands in the world are intended to supply the world population an intensive and high energy consuming transport system is required to distribute these resources.

3.10.3 Footprint and value judgements

Does the ecological footprint truly measure sustainable development?

The ecological footprint has never pretended to provide a complete analysis of sustainable development. Many of the criticisms concern issues that it has never claimed to do. Van den Bergh & Verbruggen (1999:4) are guilty of such accusations.

"The physical weights used are regarded by the authors as consistent with ecological principles and thermodynamic laws, but they do not necessarily correspond to social weights."

The ecological footprint has never attempted to or pretended to address the social equity/quality of life issue of sustainable development. It does not address important issues, such as culture, landscape, aesthetics, recreation. Roger Levett provides an interesting suggestion; viewing the ecological footprint as part of a 'Sustainable Indicators Tool Kit'.

However, the ecological footprint does address some of the key sustainable issues demonstrating the importance of including it in any 'Sustainable Indicators Tool Kit', such as: -

- Reallocation of environmental pressure to other countries
- Squandering of resources and the energy issue of resource use
- Impacts in the use of renewable resources, trade and changes in consumption patterns

Source: van Vuuren, Smeets & de Kruijf, (1999:7)

3.10.4 The CO^2 land issue

As discussed, the energy footprint is calculated by considering the amount of forest land that is required to sequester the carbon produced by a given population. At present, even though a number of methods exist to assess the carbon dioxide/energy land question, Wackernagel has justified this as the best approach to adopt. Recent studies have raised doubts about the ability of forests to act as carbon sinks and doubt has been raised about the absorption figures for carbon dioxide that are used in Wackernagel's calculations. Again, this does not reflect on the overall methodology of the ecological footprint, but questions the need for refinement and more precise and reliable scientific backing. De la Court (2000:45) suggests, "It is not even virtual reality but it is virtual guessing. We have very little understanding of the real absorption capacity."

Pearce (1999) has raised concerns in a recent article in New Scientist about carbon sequestration as a means of CO^2 reduction suggesting,

"Carbon sinks will swiftly become saturated and begin returning carbon to the atmosphere, temporarily increasing global warming."

"It sounded like a good idea, but planting trees to absorb CO^2 is no substitute for cutting fossil fuel emissions."
(Pearce, 1999:20)

The article demonstrated that it is not possible to plant our way out of trouble. Each year, 6 billion tonnes of carbon are released into the atmosphere (Pearce, 1999). Pearce suggests that one third of this is absorbed by forest ecosystems. Through the process of photosynthesis plant matter has the ability to absorb CO^2, but trees also have the ability to release CO^2 back into the atmosphere through the process of respiration. This raises concerns about the accuracy of the forest sequestration applied in the calculation. The IPCC initially believed that forests could sequester 290 billion tonnes of carbon in the next century without any extra tree planting. Pearce suggests that CO^2 absorption by trees may have already peaked and that respiration may be about to accelerate. The Hadley Centre predicts that by 2050, forests could have released as much as they have absorbed.

The key point to this discussion is that fossil fuel CO^2 is additional to the natural balance of the carbon cycle and therefore requires new 'sinks'. The ecological footprint has never stated that the energy land required to absorb CO^2 from fossil fuel burning actually exists. In this respect, the sequestration rate of 100 GJ/per ha/per year becomes almost arbitrary. The ecological footprint is merely demonstrating that, at present levels, humans are not 'balancing' the atmospheric ecosystem. It does not imply that the method for solving the problem of a build-up of atmospheric CO^2 is by planting trees. Wackernagel suggested that the only real method to create equilibrium for CO^2 is its reduction. This does not mean it is not important to try and understand a more accurate figure for carbon sequestration. The more accurate the ecological footprint becomes the more credible it is seen in the eyes of governments and decision-makers. At present, it is a large underestimate of the amount of land required if trees are not the carbon sinks they were once thought to be.

Another method to tackle this problem was suggested by Levett within his interview.

"The way I have always thought of this is that if you have got a coal burning power station how many hectares would you need to grow trees to provide the same final energy the power station produces. That gets round the age problem if you harvest those trees at the optimum point for carbon sequestration before that starts dropping off."

This demonstrates that the ecological footprint is flexible and adaptable enough to deal with new scientific discoveries, providing comprehensive answers to complex problems. The details of what the Guernsey energy footprint would be, under the two different methodologies, have been given below.

Category	Forest[35] Sequestration (EF/per capita)	Ethanol Productivity & Rebuild Natural Capital (EF/per capita)
Coal	0.2	0.25
Liquid Fossil Fuel	1.5	1.9
Fossil Gas	0.1	0.13
Embodied Energy in net imported goods	3.2	4.0
Total	4.87	6.28

Table 3.15: A Comparison between Forest Sequestration and Ethanol Productivity within the footprint calculation
Source: Author

Wackernagel has selected the most modest approximation for energy land. Adopting such an assumption weakens any criticism against the ecological footprint.

[35] Discussed in detail in section 3.5.2

The other issue concerning carbon sequestration concerns the exclusion of the sea as a sink. Folke et al (1997) suggests that it is unlikely that oceans can add additional capacity to absorb CO^2. In fact, some climate models (like the Princeton model) suggest that climate change may lead to lower productivity of the oceans, thereby increasing the CO^2 concentration in the atmosphere (Alan Kisson, 1997 in Wackernagel et al, 1999). The global carbon cycle shows the reservoirs (in Gtc) and fluxes (Gt./C/yr.) relevant to the anthropocentric perturbation (Eswaran et al, 1993; Potter et al, 1993; Siegenthaler and Sarmiento, 1993). Figure 3.5 provides a summary of the carbon cycle.

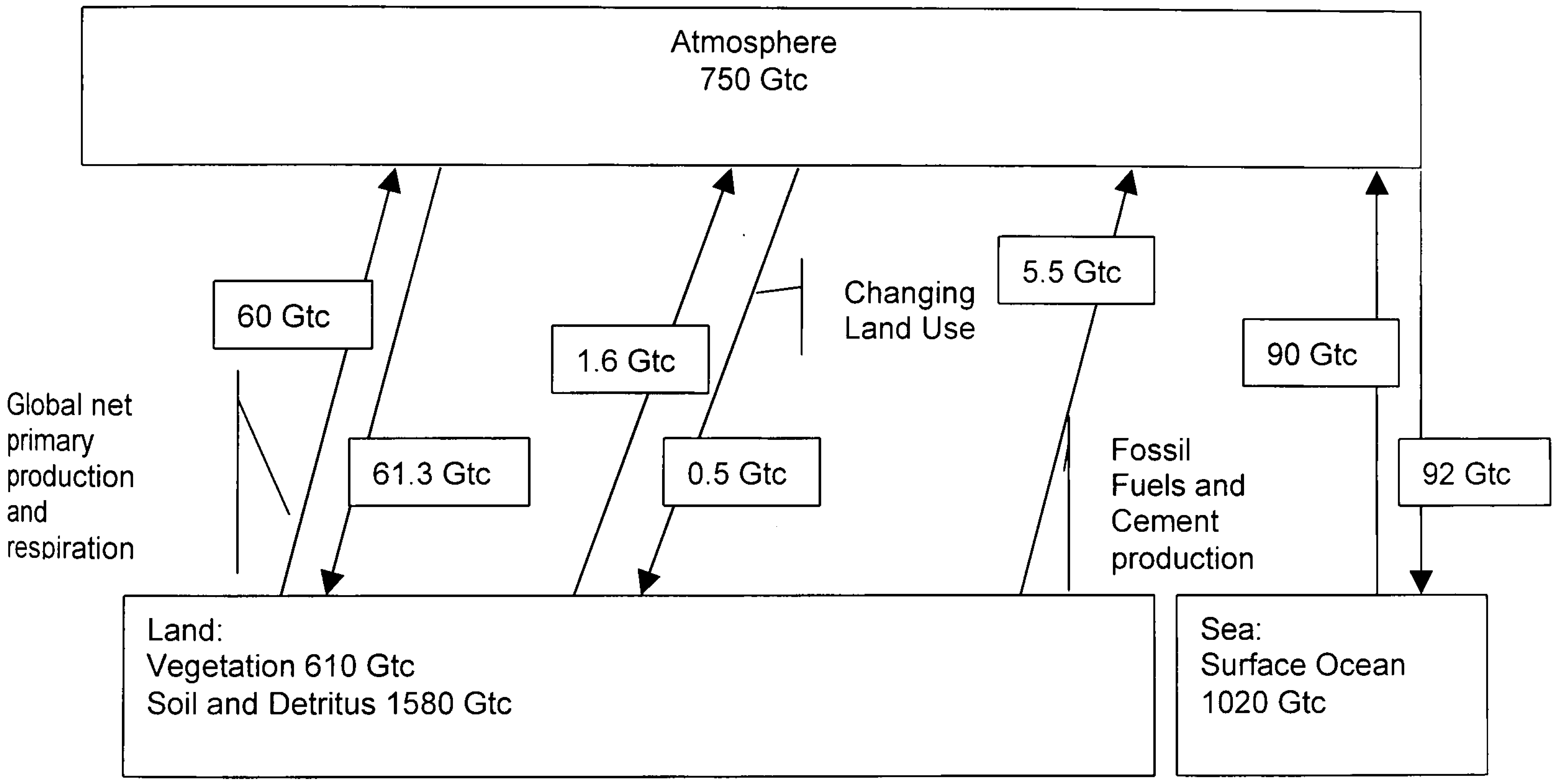

Figure 3.5: The Global Carbon Cycle

Source: Intergovernmental Panel on Climate Change (1996:77)

In contrast to the static view conveyed by these figures (Figure 3.5), the carbon system is clearly dynamic and coupled to the climate system on seasonal, inter-annual and decadal time scales (Schimel and Sulzman, 1995). The latest figures concerning carbon sinks and emissions suggest that emissions from fossil fuels are now 6 Gtc and land use changes are 1.4 Gtc[36]. Concerning sinks, the terrestrial biosphere sink is 1.9 Gtc, while the ocean sink is 3 GtC. This means an increase in the atmosphere of 3.3

[36] Provided by Dr. Matthews, UEA (personal correspondence)

GtC/per year. The fact that the ocean sink is left out of the footprint does not change the necessary reduction in carbon; it still remains at 3.3 GtC. Moreover, it is not realistic to assume that this sink will increase without technological innovation, where it is easier to visualise how the biosphere sink can be increased and maintained. As previously stated the use of forestland for the carbon sequestration element of the footprint does not imply that this is the solution to increasing levels of carbon in the atmosphere. It merely provides a visual picture, in the form of land, of excessive emissions of carbon due to extravagant consumption.

It would be a mistake of gigantic proportions for the ecological footprint not to include a carbon dioxide analysis within the calculations. The future effect of rising atmospheric CO^2 has not been fully understood, one of the problems being that CO^2 emissions changes take decades to manifest themselves fully into the climate system (IPCC, 1999:1). It is correct in suggesting that future CO^2 concentration in the atmosphere are subject to uncertainties arising from our incomplete understanding of the carbon cycle. This finding does not weaken the ecological footprint but highlights that the only real reduction in atmospheric CO^2 is not to release it from fossil fuels, which should be considered as the ultimate carbon sink. The IPCC (1996) have also suggested that,

"Slowing deforestation and assisting regeneration, forestation and agroforestry constitute the primary mitigation measures for carbon conservation and sequestration" (IPCC, 1999: 6)

3.10.5 The issue of nuclear energy

The ecological footprint cannot deal with the issue of risk, meaning that certain assumptions are required when considering nuclear energy. As the ecological footprint is a snapshot of the current situation it is difficult to incorporate potential loss of land in the future due to land contamination from nuclear disasters. Moreover, nuclear energy does not release any significant amount of carbon through its production. The present decision adopted by Wackernagel is to give nuclear fuel the same footprint as fossil fuel. The argument for this is that sustainable development is about protecting our environment for future generations and leaving them with toxic waste that can last for millions of years is inherently unsustainable. In many respects, Wackernagel is right; nuclear energy is inherently unsustainable. However, this decision means an in-built value judgement. The nuclear land issue has the potential to open up the footprint to unnecessary criticism. This is an issue that could discredit the approach even if the other elements are methodologically sound. There are other indicators that clearly demonstrate the health and risk problems of nuclear energy.

The other approach that could be adopted is to attempt to understand the amount of land that suffers from toxicity due to nuclear energy production and allocate this over time. For example, it was estimated that 3,000 km2 of land were made unproductive due to the Chernobyl disaster (Wackernagel, 1998:222). However, there is a lack of data concerning the overall effect of nuclear power on (un) productive land.

3.10.6 A lack of available data: the concerns of proxy data

Levett (1998) warns of dangers of using inaccurate data and particularly proxy data from national sources, believing that the exciting potential of the ecological footprint could be lost if these issues are not addressed. Levett (1998:70) describes the issue as,

"This limitation is currently unavoidable but it must be recognised as a serious one."

- The first key problem arises when national proxy data are applied to cities or regions of that country. This offers no new insight into the ecological footprint of the city. In the Guernsey study, all the necessary data were available, therefore no proxy data were required. Wackernagel (1998) had to use economic data to predict the ecological footprint when looking at Santiago, believing that environmental consumption is proportional to income.

This is not so much a limitation on the methodology, more a problem of data availability that must be addressed. Levett (1998:70) clearly indicates the problems that can be caused if this issue is not taken seriously.

"Until we have real data at the spatial scale we want to footprint, we must recognise the danger that subnational footprinting calculations will simply reflect back as bogus factual discoveries, clothed in spurious numerical mystique, whatever assumptions and prejudices their authors have fed in about how the ostensible subject area conforms to or differs from the national norm."

3.10.7 The Ecological Footprint and the technological fix

The ecological footprint has been accused of being anti-technological innovation (Ayres, 2000). However, the ecological footprint provides a valuable analysis for us to consider what advances can be made through technological innovation and when a reduction in consumption is required. One valuable finding of the ecological footprint is that it is going to be very difficult to achieve the ecological dimension of sustainability through technology alone. Wackernagel and Rees (1996) provide a valuable example of this with agricultural efficiency. While yield factors have increased at a rapid rate the energy requirements for this to happen have been substantial. The use of fertilisers, pesticides and machinery mean that the efficiency gains may even be negative.

In this respect, the ecological footprint is an objective tool. It does not inform us how to reduce our footprint; it merely frames the debate.

3.10.8 Dealing with different land functions

While a single piece of land may carry out to ecological functions, it is only counted once in the ecological footprint calculation. This is why the footprint refers to "mutually exclusive" biotically productive spaces. For example, in the case of double-cropping, photovoltaic use of roofs for energy supply, or water collection in a sufficiently humid timber plantation, only one utilisation is added to the footprint. However, some forest uses are mutually exclusive. Biodiversity protection may depend on undisturbed ancient forests that cannot serve for timber-production without endangering biodiversity. On the other hand, recent research indicates that forests, which produce timber and agroforestry crops may also be credited with significant carbon dioxide (CO_2) sequestration in its soils and the long-lived forest commodities such as furniture or housing components (Moffat, 1997; Janzen, 1997).

This is a limitation of the ecological footprint. While, in the case of forests, they may have to be left undisturbed, it is possible to combine some conservation techniques with agriculture (for example, traditional haymaking techniques that promote the growth of wild flowers). In this case, is the land classed as biodiversity land or agricultural land? By highlighting this assumption, it is imperative to consider other indicators in tandem with the ecological footprint, such as the amount of agricultural land that promotes biodiversity.

3.10.9 Accusations of Being Utilitarian

The ecological footprint has been accused of being too utilitarian in its approach by failing to consider the needs of other species.

Levett argues that it is almost impossible not to consider the world in anthropocentric terms.

"With any sort of judgement about environmental policy, we are being anthropocentric. Thinking of the earth in one sense as our playground, our stock room and our rubbish dump is almost inevitable and unavoidable, so in that sense I don't have any problem saying the whole of it should be in the ecological footprint. The important equation is, is the human species collectively consuming faster than the planet in total can provide for."
(Roger Levett Interview)

3.10.10 The Ecological Footprint and Trade

The comment below highlights one of many criticisms of the ecological footprint concerning the issue of trade. It is postulated that the ecological footprint is anti-trade, ignoring the benefits that it entails (using ecologically comparative advantages for countries, providing income).

'It implies that ecological autarky is desirable, hence that trade is undesirable, which is almost certainly not the case.' (Ayres, 2000: 348)

Believing that trade is a totally benign activity is ignoring factors concerning the environmental consequences of freight transport and the potential lack of stringent environmental policy in countries. The ecological footprint looks at trade from an ecological perspective, suggesting that there is more to trade than the transfer of money and goods. Guernsey, while drawing most of its resources from other countries provides an inconsequential amount of ecological productivity to the world. Not every country can be in this advantageous situation, like Guernsey, of being net importers[37]. There is no doubt that expanding world trade leads to increased global resource flows that are responsible for accelerating the depletion of global natural capital. The other consequence of trade is the problem that net importers of goods become spatially and psychologically detached from the resources that sustain them. The consumer is thus, unaware of the environmental consequences of his or her consumption.

In summary, the issue is not trade as such, but its composition. Indeed, if a trade strategy is ecologically benign, it will show up in a smaller footprint (Wackernagel & Silverstein, 2000).

3.10.11 The Ecological Footprint and Political Reality

The quote below demonstrates how some academics believe that the ecological footprint presents impossible goals for achieving sustainability.

'In the first place, the method of calculation postulates a sustainability scenario that is unrealistic, which fails to reflect many technological possibilities.' (Ayres, 2000: 348)

Whether it is politically realistic or not for everyone to live off their fair earthshare has nothing to do with the calculation of the ecological footprint. It is merely demonstrating what the current situation is and what level of consumption is considered sustainable. If, as Ayres suggests, this is an unrealistic goal under the present socio-economic system, then it may be necessary to question the idea of global economics and development.

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[37] I say 'advantageous' because other countries in the world receive the environmental problems associated with production (pollution from industry and transport) while Guernsey merely consumes it.

3.10.12 The Ecological Footprint and Excessive Simplicity

Some commentators have stated the ecological footprint is too simplistic in its approach, claiming that it over-simplifies both nature and society (Herendeen, 2000). In some respects, this is true. The ecological footprint is an under-estimate of human appropriation and does not claim to understand all of the complex interactions of a system (i.e. the earth). However, this does not take away the powerful message of the ecological footprint; humanity is living beyond its ecological means. The comment below, by the co-founder of the ecological footprint, demonstrates this point very clearly.

'A complex explanation is unnecessary where a simple one suffices.' (Rees, 2000:373)

3.11 Conclusions

The bio-geophysical interpretation used by the ecological footprint concept has two advantages. First it makes the results more accessible. Everyone has experience of space thus making it easier to visualise, while many other quantities (such as embodied energy content or erosion rates) may require more technical skills to interpret or to appreciate. Second and more importantly, the human "demand" for ecological space can be compared easily to the earth's finite "supply" of space. Therefore, the available ecologically productive space must be finite. By providing the means of comparing human demand and nature's supply in the same units, the assessment results show clearly, at each geographical scale of analysis, the magnitude of the human load on the biosphere.

The strong point of the ecological footprint is the way it focuses on several issues directly related to the sustainable development debate in an integrated way: impacts of consumption patterns, reallocation of pressures, distribution of available resources and the impacts of trade.

It is important to recognise the limitations of the ecological footprint so that there are no false expectations about its results. One important limitation is that the ecological footprint pays no attention to the sustainability of current land use practices, in particular concerns of soil erosion. A similar problem still exists with regard to multi-functional land use. While only one function is given to a certain amount of land, in reality, land can have many functions.

Despite the problems associated with the ecological footprint, it warrants further development, giving it credit and making it a valuable asset. One issue that requires further attention is the use of the ecological footprint within the decision-making process. What policies can a more localised footprinting methodology suggest and what is the value of such a tool?

CHAPTER 4: THE COMPONENT ECOLOGICAL FOOTPRINT AS A DECISION-MAKING TOOL: APPLYING TIME SERIES DATA

4.1 Shifting from resources to activities

The compound approach to the ecological footprint can be used to analyse the resources that are consumed by a given population. The compound approach has the advantage of being replicable. By applying the same methodology it is possible to compare the results of countries, cities and individuals. The main disadvantage of this approach is that it fails to demonstrate activity areas and is thus less informative when targeting improvements. This reduces its value as a decision-making tool.

In contrast, the component-based approach to the ecological footprint has a more simple and informative structure. It has more relevance to the local and personal level, as the calculation procedure is ordered around activities such as transport, waste and water consumption. The activity-based model has the added advantage of facilitating data collection where detailed resource usage statistics are not available (Simmons, Wackernagel & Chambers, 2000).

The aim of this chapter is to apply the component ecological footprint to the decision-making process. One of the main criteria for a successful indicator is policy relevance. If the ecological footprint cannot provide a tool for helping to make sustainable decisions at a policy level it is merely an academic toy. There are very few examples of the application of the ecological footprint as a tool for decision-making. This is not entirely due to any weakness of the ecological footprint as an indicator, as political barriers have also played an important role.

Chambers and Simmons (interviewees) consider the decision-making application to be one of the valuable features of the ecological footprint. To provide a tool that is more relevant to policy and to individual lifestyle choices, Chambers and Simmons are responsible for creating component footprinting. This is still based on the same footprint principles discussed in Chapter 3.

This chapter explores the following issues: -

- What are the current views and opinions of the ecological footprint as a decision making tool?
- What comparative studies have been conducted?
- The development of a component based model
- Testing the tool – a component footprint of Guernsey
- Testing the tool – time series data analysis
- Comparison of the component and compound methodologies
- The response to the ecological footprint as a tool for decision makers from practitioners and politicians

4.2 Past opinions on the ecological footprint as a decision-making tool

Wackernagel & Yount (1997) in their paper entitled 'The Ecological Footprint: An Indicator of Progress Toward Regional Sustainability' have claimed that the ecological footprint can act as an indicator for monitoring the progress toward sustainability. The following discussion examines some of their claims and considers some of the limitations that are present in the compound ecological footprint approach at achieving this task. The following discussion also acts as a critique of the compound ecological footprint, highlighting issues related to using the approach as a decision-making tool.

1. 'Monitoring footprint assessments over time can reveal progress toward sustainability by tracking a country's or a region's ecological deficit'. (Wackernagel & Yount, 1997:10)

The ecological footprint clearly reveals the trade balance of a country, but how important is the trade balance of a city? It is a useful visual exercise to understand the amount of land a city requires to function but the compound method offers little very little understanding into the effects of transport, waste and energy. For regional sustainability to be achieved a localised understanding of these issues is essential.

This comment also implies that it should be possible to live within the capacity of your own ecosystem. This, especially for cities, is unrealistic. What is more important is whether or not each occupant of the city is living within the means of nature on a global scale.

2. "With the gradual extension of the global economy, a community's security may no longer be provided by government institutions. In the lack of institutional or market support, local natural capital therefore becomes the ultimate source of security and wealth."(Wackernagel & Yount, 1997:10)

This comment makes economic sense, as the countries with the most resources will be able to support their population. However, on a city or community level it is difficult to envisage how, for example, a city like London could supply all of its own resources. Herbert Girardet's (1996) study of London revealed that the ecological footprint is 125 times the surface area of the city. A common feature within the UK is that large urban populations are not near the source of the food they consume. Referring to the example of Guernsey this point is clarified further.

Guernsey has 63.1 km2 of land (6310ha). Of this land over 1000 ha have been built on and an estimated area of 1000ha is unproductive or given over to biodiversity protection. Potentially, Guernsey could provide 4,000 ha of farmland at a productive rate of 2.8 times more than the average global yield (Wackernagel et al, 1997). These figures demonstrate Guernsey's available area, in terms of worldwide productivity as,

4,000 ha x 2.8 = 11,200 hectares

Andrew Ferguson (one of the interviewees) believes that it is reasonable to argue that Europeans could make do with a more modest use of energy and reduce the footprint within a short timescale to 2.9 ha/per capita. This figure is based on the idea that energy land can be reduced from 5.69 ha/per capita to nearly zero. In fact, Guernsey with good offshore wind facilities and long sunshine hours might manage a modest footprint of only 2.5 ha/per capita (worldwide productivity). Accepting this as a feasible figure, the actual population that the island could support is 4480[1] citizens. At present the Guernsey population is over 60,000. Therefore, even with a low ecological footprint of 2.5-ha/per capita it is not possible for Guernsey to live on resources solely supplied on the island. Even though Guernsey has a strong policy on population control it is not possible to reduce the population to anywhere near this figure. Trade is inevitable and required for Guernsey residents to live. What is important is that that trade is built on equitable terms and that there should be no unnecessary trade. This issue has already been raised in Section 3.3 providing an example of dairy exports/imports to Canada.

If Guernsey can provide a local resource this should be encouraged. It provides a solid foundation for a local economy, helps build local communities and reduces the transport costs associated with imports.

3. "Essentially, the sustainability debate reduces to the fact that there are on average only 1.7 ha/per cap biotically productive hectares available per person on this planet. The ecological footprint provides a target for assessing progress." (Wackernagel & Yount, 1997:10)

This is one of the most powerful mechanisms of the ecological footprint. The policy relevance of this is clear; a community knows when it is sustainable and when it is not (in ecological terms). In contrast, many sustainable indicators fail to include a level when sustainability has been achieved. For example, distance travelled by cars and cycles. It is obviously clear that a higher figure for cycling is more sustainable but it does not inform decision-makers whether or not we are living within the means of nature.

Van Vuuren, Smeets & de Kruijf (1999) highlight the issue that as a sole indicator for sustainable development the ecological footprint is very limited as it fails to consider economic and social issues. Therefore, when considering the ecological footprint as an indicator to guide policy it is only under the remit of environmental topics.

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[1] This figure has been derived by dividing the available productive land on Guernsey by the ecological footprint of 2.5 ha./per cap/per year.

Policy measures to reduce the ecological footprint of an area would support many initiatives and ideas already in place, such as changing material flows and consumption patterns to a more sustainable level, and reducing carbon dioxide emissions through energy efficiency and the use of renewable energy.

More importantly, the ecological footprint could encourage countries or regions to understand the effect they are having on other countries, particularly concerning carbon dioxide emissions.

Furthermore, van Vuuren, Smeets & de Kruijf (1999) suggest that the ecological footprint cannot indicate the situation for more specific issues such as water consumption. This point is challenged by Simmons and Chambers whose approach to footprinting has demonstrated that water consumption can be included.

In summary, while offering a key insight into ecological overshoot the compound approach to footprinting fails to highlight some of the important areas of regional sustainability. A bottom-up approach is required that is more sensitive to regional requirements and an approach where data availability is possible.

4.3 The development of a component based model

The component approach relies on bottom-up data as opposed to the top-down data of the compound approach used by Wackernagel. It has a more dominant regional flavour and has attempted to make the ecological footprint a more useable and relevant package for regional sustainability.

Simmons and Chambers[2] (1998) have calculated a series of algorithms capable of converting resource use to land-area equivalence. They were responsible for the

[2] Simmons and Chambers are responsible for starting a consultancy and computer software company called 'Best Foot Forward'. The company has developed and applied the ecological footprint to numerous activities.

design of 'EcoCal'[3] of which the development was largely funded by Going for Green[4].

[3] 'EcoCal' is a software package that uses footprinting to demonstrate a household's ecological impact.
[4] 'Going for Green' is Britain's biggest environmental awareness campaign. It is funded by both the Department of Environment and the private sector.

Table 4.1 provides a summary of the topic categories used in EcoCal.

Category	Information gathered	
Transport	Distance travelled by car	Distance travelled by air
	Distance travelled by bus	Number of air trips
Energy	Electricity Consumption	Coal Consumption
	Oil Consumption	LPG Consumption
Water	No. of dishwasher runs	No. of baths and showers
	No. of washing machine runs	Hours of hosepipe use
Purchasing	Food bought in EU	No. of newspapers
	Food transported by air	No. of nappies purchased
House & Garden	Size and type of property	Volume of hardwood
	Volume of peat purchased	Size of plot
Waste	Categories of items recycled or composted	Weight of bulk waste purchased
	Weight of waste produced	Volume of oil disposed

Table 4.1: Overview of information gathered by 'EcoCal'
Source: Simmons & Chambers (1998:358)

Whilst not including all human activities that appropriate nature, EcoCal includes the categories that are relevant to an individual's everyday lifestyle. Some of the categories are difficult for individuals to calculate such as the volume of hardwood. The designers recognise that improvements to the component approach are required.

4.3.1 Footprinting Cities

Figure 4.1 provides the details of another study conducted by Best Foot Forward with an estimate of the ecological footprint of UK cities, using the component approach.

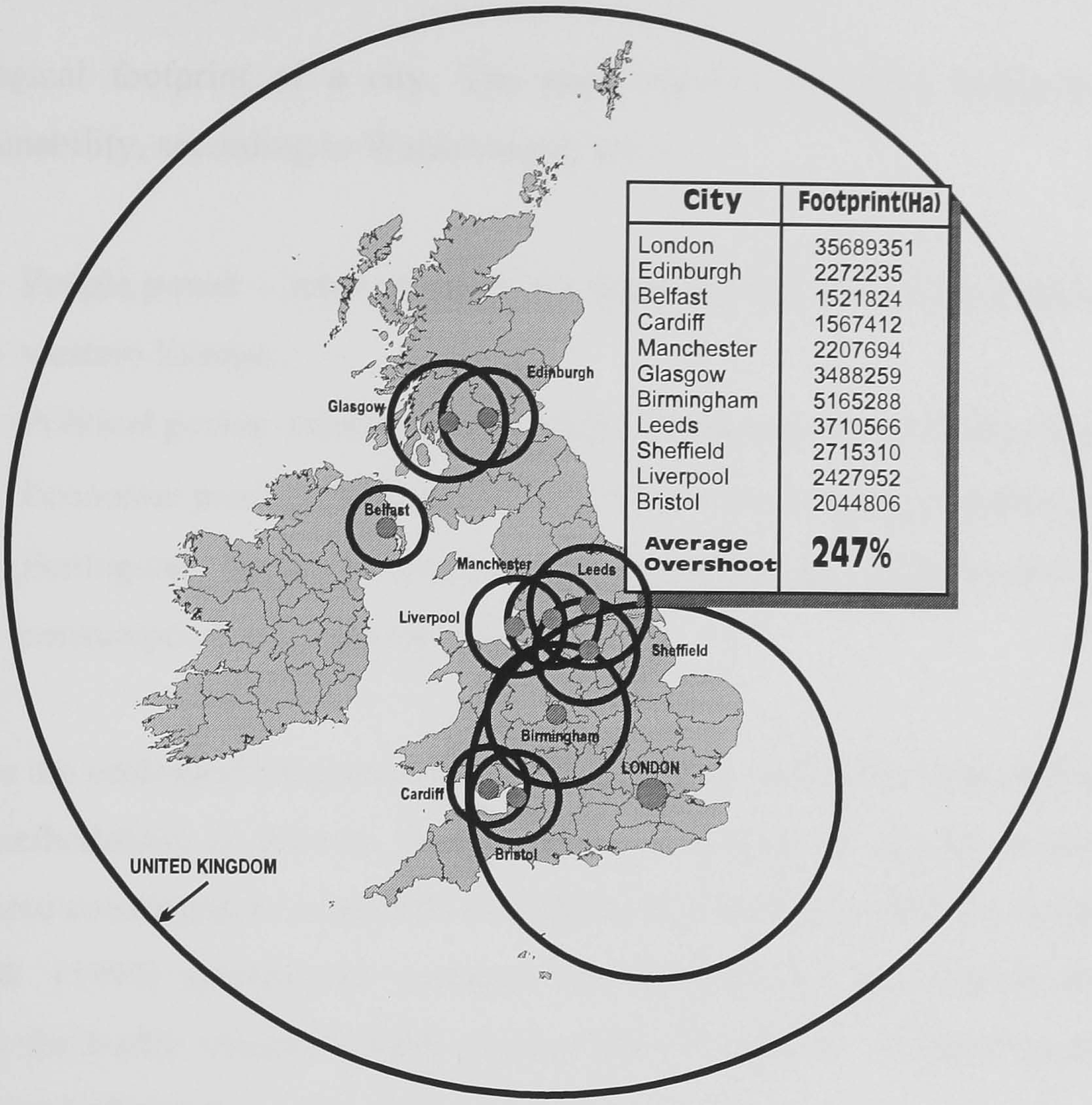


Figure 4.1: The Ecological Footprint of UK Cities
Source: Simmons and Chambers, 1998:360

Figure 4.1 provides a visual illustration of land appropriation by the major UK cities. To calculate the ecological footprint of the cities, UK proxy data were used. This, as highlighted by Levett in Chapter 3, ignores regional and localised characteristics and has very little policy relevance. However, as an educational and demonstrative model it provides a valuable depiction of land appropriation.

It is an essential requirement for the ecological footprint to be able to measure cities and regions. The majority of the most innovative approaches to sustainable development occur at the local level and comprehensive sustainable indicators are required to guide future policy choices.

Wackernagel (1998) carried out the only other ecological footprint of a city using the compound approach for Santiago. The paper clearly highlights the importance of tackling sustainability at a city level that justifies his attempt to calculate the ecological footprint of a city. The main reasons for cities being important for sustainability, according to Wackernagel, are: -

- People power – most of the world population live in cities, particularly within western Europe;
- Political power –economic and political decisions are made in cities;
- Economic power – cities are responsible for the largest generation of GNP;
- Ecological impact – cities are responsible for high levels of resource consumption and waste production.

While the ecological footprint of Santiago offers an insight into regional sustainability the methodology is dubious. Wackernagel has attempted to apply economic data to resource consumption, a decision that has been criticised, especially by Roger Levett. Levett (1998) provides the example that Wackernagel uses vehicle numbers as a proxy for traffic volume. Traffic volume and the distance travelled by cars are very different indicators.

It is clear that the compound method of footprinting is a very difficult task at a local level. It has only been possible for Guernsey due to very accurate port data. Without accurate data, shortcuts have had to be taken that weaken the methodology and leave the final results open to criticism. This is where the new approach (component footprint) designed by Best Foot Forward offers a new and meaningful insight into regional sustainability.

"The main aim was to make the method useable and in fact, you have got to remember, the time that we started, the Top-Down method that Mathis now uses wasn't really in the public domain. The easiest way to make it useable and accessible is to break it down into the data that people have. We weren't thinking at the national level."
(Craig Simmons Interview)

Best Foot Forward has developed complex algorithms to be able to divide the footprint into components. However, even though these may be complex the final result provides a transparent answer, understood by individuals without experience in footprinting, a point made by one of the designers.

"One of the joys about it is that no matter how complex the calculations are behind it you can still represent it in a very simple way."
(Nicky Chambers Interview)

4.3.2 The Calculation Procedure for the Components

In the component-based model the ecological footprint values for certain activities are pre-calculated using data appropriate to the region under consideration (Simmons, Lewis & Barrett, 2000). For example, to calculate the impact of car travel, data on fuel consumption, manufacturing and maintenance energy, land take and distance travelled are sourced for the country in question – then an average ecological footprint estimate derived for a single passenger-km or other appropriate unit (see Table 4.2). This can then be used to calculate the impact of vehicle use at the individual, organisational or regional level as required. The land categories originally proposed by Wackernagel & Rees (1996) are essentially retained; energy land, built (or degraded) land, bio-productive land and sea as well as biodiversity land.

COMPONENT	Inputs	CO_2 Emissions	Built-Upon Land	FOOTPRINT
[1]Petrol	0.094 Litres/Km	0.22 Kg/km		0.000043 Ha/Car Km
[2]Maintenance & Manufacture	0.0423 Litres/Km equivalent	0.10 Kg/km		0.000019 Ha/Car Km
[3]Road Space	2,581,747 Ha		2,581,747 Ha	
[4]Car Road Share	86%			
[5]Car Kms	362,400,000,000			
[6]Car Occupancy	1.6 persons			
Calculation				
FOOTPRINT			0.00000613 Ha/Car Km	0.000043 Ha/passenger-km

[1] Department of the Environment, Transport and the Regions (DETR 1997)

[2] Wackernagel and Rees (1996) state this as 45% of the fuel energy

[3] DETR (1997) report the length of road types and we have here assumed a conservative average road width of 7m.

[4] DETR (1997)

[5] British Road Federation (BRF 1998)

[6] DETR (1999) personal communication with the National Travel Survey

Table 4.2: An example analysis of the footprint of UK car travel per passenger-km. Source: Adapted from Simmons, Lewis & Barrett (2000)

To calculate the car transport figure built land is included in the total. This includes the amount of built-on land for roads. The total figure of 2,571,747 hectares represents the total built land. This figure is divided by the occupancy of cars on the road (i.e. the car road space). The final calculation is the total car kms travelled by cars in the UK to provide a Ha/per car km figure of built-upon land for cars. The final Ha./passenger-km figure for a car is calculated by adding the footprint of petrol, maintenance and manufacture and the built-upon land (i.e. roads), then divided by the average car occupancy.

The same process can be undertaken for other forms of travel as well as energy, waste, water, housing stock and food. The aim is to capture the majority of anthropogenic impacts. It is accepted that it will not be possible to understand all anthropogenic impacts but the methodology does include the most important impacts (Simmons and Chambers, 1998). To avoid double counting the energy used for the production and transportation of goods for example, the values for primary energy use and freight transport are adjusted based on assumptions about embodied energy (Simmons, Lewis & Barrett, 2000). Similarly, adjustments are made for any double counting of built land (explained in more detail below).

4.3.3 Data Accuracy

Table 4.3 provides a list of the data collected for Guernsey. This is similar to the one used for EcoCal but includes more components as the methodology has improved. Explanations for the algorithm behind each component have been given below.

COMPONENT IMPACTS	
Electricity (GWh) – domestic	Food (t)
Gas (GWh) – domestic	Wood Products (m^3 WRME[1])
Electricity – other (GWh)	Built Land (ha)
Gas – other (GWh)	Recycled waste(tonnes) – glass
Travel by car (Passenger 000's km/yr.)	Recycled waste-paper and card (tonnes)
Travel by bus (Passenger 000's km/yr.)	Recycled waste-metals (tonnes)
Travel by train (Passenger 000's km/yr.)	Recycled waste-compost (tonnes)
Travel by air (Passenger 000's km/yr.)	Recycled-other domestic(tonnes)
Road haulage (000 tonne-kms/yr.)	Waste – household (tonnes)
Rail freight (000 tonne-kms/yr.)	Waste – commercial (paper, metal etc.) (tonnes)
Sea freight (000 tonne-kms/yr.)	Waste - inert (brick, concrete etc.) (tonnes)
Air freight (000 tonne-kms/yr.)	Water – household (m^3)

[1]WRME = Wood Raw Material Equivalents

Table 4.3: List of component impacts considered for sub-national regions

The 'component-based' approach is not intended to be in any way a replacement for 'compound footprinting'. Each method has its benefits and uses - they are very much complementary styles of analysis (Simmons, Lewis & Barrett, 2000). They can be considered to be different kinds of ecological tape measures, both of which are trying to capture the same basic environmental impacts using the same evaluation unit. The analysis method chosen depends on the accuracy you require, the features of the item being measured and the purpose of the exercise to begin with.

The founders of the component approach are willing to accept that there is not enough data to provide a truly accurate picture of human appropriation.

“There are two types of data that are not available. There is the data about consumption patterns. If you are a householder you can’t find out about the material

flow through your house. There is also the data about environmental impacts, information about pollutant effects."
(Craig Simmons Interview)

The accuracy of the footprint is totally dependent on data availability. The footprint is flexible enough to cope with a diverse range of data, however assumptions need to be made. The better the data, the less assumptions and the more credible the final result becomes.

4.3.4 Further Explanation of Component Algorithms

4.3.4.1 Waste

The waste footprint is based on the loss of embodied energy through its disposal. If a waste item is disposed of by landfill the embodied energy is lost. The waste footprint also combines the transport requirements for waste (i.e. transporting the waste from domestic households to landfill). The statistics concerning the embodied energy of waste came from a wide range of sources. The details and the calculations can be found in appendix 9. It is possible to convert the energy lost from a product by understanding the contents of the average domestic bin.

4.3.4.2 Transport

The component ecological footprint of cars has already been explained above. Table 4.4 below explains the other forms of transport within the calculation.

Transport Type	Unit	Footprint (Ha./per year)	Assumptions
Car	1000 Passenger kms	0.04	• Average petrol car fuel consumption • Road space & average car occupancy • Embodied energy
Bus	1000 Passenger kms	0.02	• Fuel consumption • Embodied energy • Material energy • Apportioned road space
Train	1000 Passenger kms	0.02	• Estimate for diesel train • Fuel, manufacture & maintenance • Apportioned rail space
Air	1000 Passenger kms	0.07	• Based on data from UK Domestic Flight • Energy land • Degraded land

Table 4.4: Transport footprints

Source: Personal Correspondence with Best Foot Forward

4.3.4.3 Energy

All the energy component footprints are based on a relatively simple calculation; the amount of carbon dioxide produced by the forms of energy, multiplied by carbon sequestration rate for forests. For the component approach the same sequestration as Wackernagel uses is applied (100GJ/per Ha./per yr.). For example, the burning of coal releases more carbon than oil burning and oil burning releases more carbon than the burning of gas. Table 4.5 below has selected some examples of the EF of different forms of energy production including any assumptions made.

Energy Type	Unit	Footprint (Ha./per yr.)	Assumptions
EU Grid Electricity	GWh	138	• Based on modern hard coal condensing power stations • Predominant source of energy in the EU
UK Grid Electricity	GWh	95	• Based on the UK Energy Mix
Natural Gas	GWh	80	• Based on UK Data • Assumes that the technology used in the UK is similar to EU
Oil	GWh	129	• Based on UK • (Limited data availability)
Wind	GWh	4.3	• Embodied energy in construction • Direct land use • Assumed that energy used in production is EU Grid Electricity
Photovoltaics	GWh	17.6	• Cell's energy requirement • Direct land use

Table 4.5 Energy footprints

Data Sources: Best Foot Forward have used a variety of data sources to establish the ecological footprint of the various energy types. A list of these has been provided below.

(IPCC, 1996, Wackernagel, Lewen & Borgstrom-Hansson 1999, Barnard 1984 in Wackernagel, 1999, Ekvall et al, 1998, IEA, 1997, Gipe, 1999, American Wind Energy Association, 1999, Alsema et al, 1998, Alsema, 1996, Krotscheck & Narodoslawsky, 1996)

4.4 Life Cycle Approach to Footprinting

Even though the component approach has the added advantage of providing a detailed breakdown of the footprint, allocation problems do exist. The component model of footprinting is attempting to capture all human consumption for a particular given population. This can be seen in the figure 4.2 below.

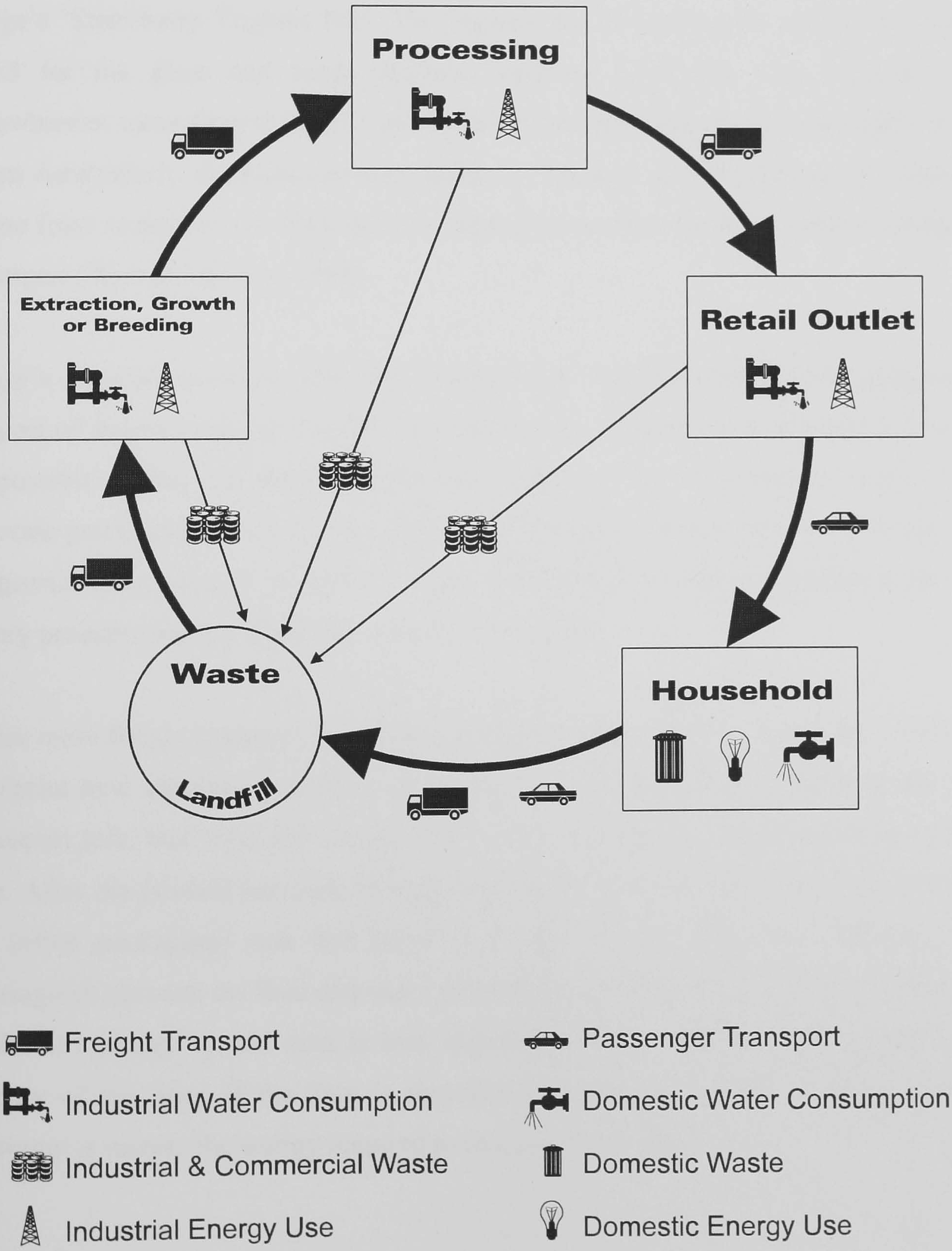


Figure 4.2: Model of the component footprint approach

Source: Author

Figure 4.2 provides an understanding of what can be calculated. Firstly, the model starts with the extraction of minerals, growth of crops or breeding of an animal for human consumption. Both energy and water use are associated with this procedure. Freight transport is then required to move the produce to the factory for processing. At this stage, there is a large demand on industrial energy and freight transport to bring the many different products to the factory. An excellent of example of this is Boge's 'Strawberry Yoghurt Pot'. The yoghurt and its ingredients and the materials used for the glass cup made journeys totalling 3,500 km. For example, the strawberries came from Poland to processed in Germany, the corn/wheat starch came from Amsterdam, via Koln and then finally to Stuttgart and the aluminium sheeting came from Australia, via Norway, then Neuburg (southern Germany) before reaching Stuttgart (Weizsacker et al, 1998).

Boge's calculations of the strawberry yoghurt not only demonstrated the substantial impact of freight transport but also the difficulty in collecting data like this. It is near impossible to find this much data for every product. The component footprint does provide part of the answer. It can calculate both freight transport (air, sea or road) and industrial energy use. It would be a major achievement to have a footprint figure on every product, but at present this would be unrealistic.

After more freight transport is used to deliver the final product to the retail outlet the footprint now attempts to include all the domestic impacts. These include passenger transport (car, bus, train and air) as well as domestic energy consumption and water use. After the product has been brought into the domestic environment it is disposed of (often packaging) and will leave as waste. At this stage the footprint can distinguish between the final disposal method. If the item is disposed of by landfill the embodied energy in that item is lost, therefore it has a footprint of the embodied energy of the item. If the item is recycled the embodied energy is saved, so the footprint is merely the energy required to recycle the product.

There are areas in this model where there is a serious lack of data. For example, there are no data available for the transport requirements to deal with the waste[5]. However, the component footprint has managed to include most of the appropriation of nature by humans, having the ability to understand the impact on the sea, land and air.

One of the other problems is the allocation of the separate components in the footprint. For example, energy could be viewed totally separately or attached to the activity (for example, the industrial energy associated with a product). It is possible to take the total footprint figure (8.55 Ha./per capita for Guernsey) and re-allocate the components in the dis-aggregated form.

What this does demonstrate more than anything is the holistic nature of environmental impacts. The components are so connected and inter-related that solutions must concentrate on consumption, as this is the root cause for a high footprint. Without the initial extraction, growth or breeding at the beginning of the model none of the other aspects (transport, energy and waste) would happen.

[5] This is a problem that Best Foot Forward is attempting to overcome. In a project that they are involved in at the moment (An Ecological Footprint of the Isle of Wight) they have included the transport of waste.

4.5 Component Footprint for Guernsey

The results from the component footprint of Guernsey have been presented below. The first major difference between the component and compound approach is the data requirement. For the Guernsey compound ecological footprint over 3,000 items of consumption were included in the calculations, taking over three months to calculate. The component approach required 24 data points.

There is an immediate advantage for local authorities that are largely under-resourced and have limits on time availability. The component ecological footprint has been sub-divided into four main categories (utilities, food/materials/wood, transport and waste).

Table 4.6 presents the results of the component footprint of Guernsey. The consumption items listed in the Table have been dictated primarily by data availability. Some items, such as plastics, are aggregated as part of the general waste stream.

Table 4.6: The component footprint analysis of Guernsey. (Source: Author)

	CONSUMPTION ITEMS	CONSUMPTION	FOOTPRINT (Ha)
UTILITIES	Electricity (GWh) domestic	591.20	76,143
	Gas (GWh) – domestic	159.4	6,186.4
	Electricity – other (GWh)	764.23	98,428
	Gas – other (GWh)	0.16	6
	Water – household (m^3)	12,500	124
		Sub. Utilities	**180,887**
TRAVEL AND FREIGHT	Sea Freight (000's tonnes kms)	27,901	167.41
	Air Freight (000's tonnes kms)	1,157.63	382
	Road Freight (000's tonnes kms)	5085	371
	Travel by car (Passenger 000's km/yr.)	2,160,000	91,721
	Travel by bus (Passenger 000's km/yr.)	13,170	242
	Travel by air (passenger 000's km/yr.)	46,656	2,204
		Sub. Travel & Freight	**94,487**
FOOD, LAND AND WOOD	Food (t)	60,000	89,052
	Built Land (sq. m)	10,286	10,286
	Wood Products (m3 WRME)	70,015	45,944
		Sub. Food, Land, Wood	**145,282**
WASTE & MATERIALS	Recycled waste (t) – glass	7,106	3,627
	Recycled waste-paper and card (t)	8,366	11,629
	Recycled waste-metals (t)	5,500	1,210
	Recycled-other domestic (t)	644	380
	Waste – household (t)	19,000	48,015
	Waste commercial (paper, metal etc.) (t)	12,500	23,484
	Waste – inert (brick, concrete etc.) (t)	60,000	3,968
		Sub. Materials & Waste	**92,313**

Population of Guernsey	60,000
EF of Guernsey (Hectares per year)	512,969
Hectares per capita per year	8.55

4.5.1 Justifying the Figures

The consumption data for the component ecological footprint of Guernsey were obtained from official sources. This immediately helps when having to justify the figures chosen for the model. The following calculations have been done to establish the consumption figures for Guernsey.

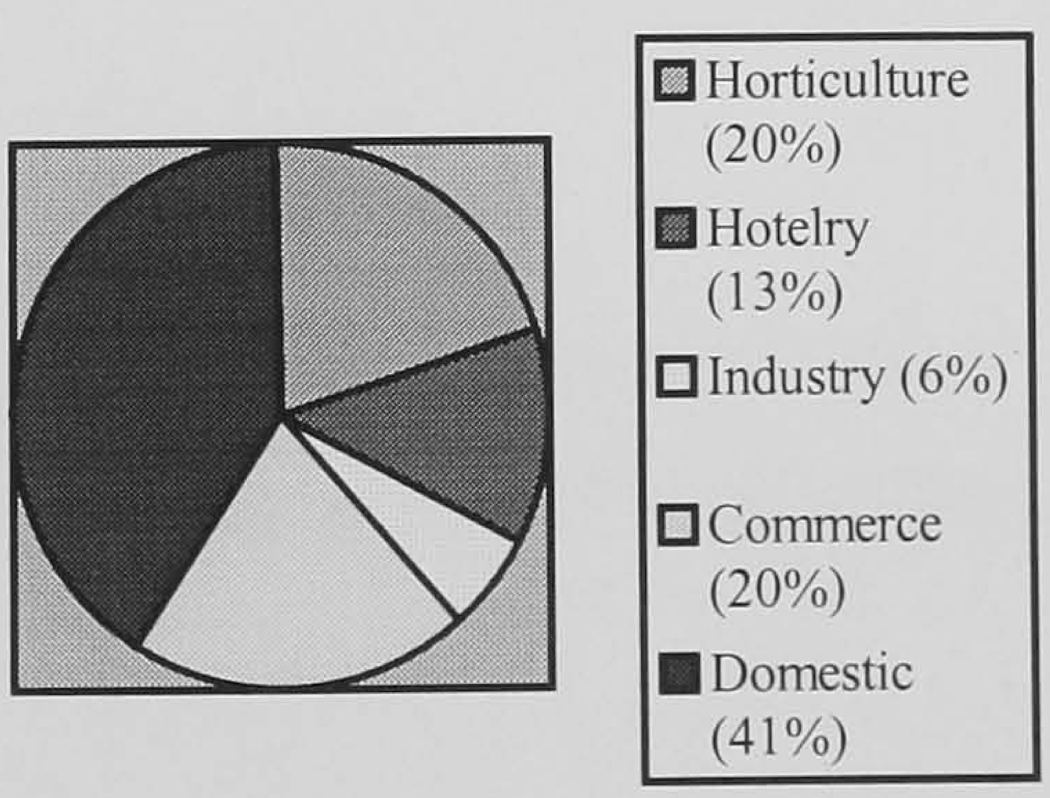
4.5.1.1 Utilities Section

This section includes the figures used for calculating consumption data for electricity, gas and water. Electricity is the most complex figure to calculate, as double counting is a danger that must be avoided. Industrial energy is removed from 'electricity and gas other' (see Table 4.6) components due to double counting. As shown above, embodied energy is incorporated in many components. Removing Industrial energy should correct the model for the embodied energy and produce a slightly more conservative estimate.

The States Electricity Board (SEB), which is responsible for supplying all the electricity on the island, provided electricity data. The most recent year with a full data set was 1997.

Data Provided By SEB

Total Fuel Import in 1997
= 5,191 Terra Joules (TJ)



Using the data it was possible to construct the following table.

5191 TJ	This figure is the total amount of oil imported into Guernsey in one year.					
=1441.94 GWh	(Conversion factor from TJ to GWh: 1 GWh = 3.6 Terra Joules)					
	Sectoral Split	Consumption	Unit	Conversion[6]	Footprint	Per Capita (Ha./per cap)
of which:-	Horticulture (20%)	288.39	GWh	128.8	37,143	0.62
	Hostelry (13%)	187.45	GWh	128.8	24,143	0.40
	Domestic (41%)	591.20	GWh	128.8	76,143	1.27
	Industry (6%)	86.52	GWh	128.8	11,143	0.19
	Commerce (20%)	288.39	GWh	128.8	37,143	0.62
	Total	1441.94			185,714	**3.01**

Table 4.7: Electricity EF for Guernsey, 1997

The conversion factor used for electricity converts the consumption figure in GWh to a footprint figure. This conversion factor represents the amount of land required to absorb the carbon dioxide produced by providing electricity from an oil power station.

The final figure of "Electricity Other" has had the industrial energy subtracted to avoid the double counting issue giving a figure of 1.64 Ha./per capita (total of 98,400 hectares). The final figure for domestic energy is 1.27 Ha./per capita (total of 76,143 hectares).

The Guernsey Water Board provided water data for annual consumption rates. The ecological footprint of water is a measurement of the energy consumption required to pump and distribute the water.

4.5.1.2 Waste & Materials Section

[6] Source for conversion is the 'Eco-Index Methodology Database' developed by Best Foot Forward. The conversion is the ecological footprint for electricity produced by oil.

Simon Furclough from the Department of Engineering (States of Guernsey) provided all the waste data. Guernsey collects very accurate data of tonnage for recycled material, as it needs to be exported from the island. It was also possible to gather accurate information on inert and municipal waste disposed by landfill. As the data came from one source there was no danger of double counting.

The ecological footprint of waste is a measurement of the amount of lost energy by disposing of the product. The embodied energy incorporated into the packaged product is lost if disposed of by landfill.

4.5.1.2 Food, Land & Wood

Both the food and wood data were easily the most difficult to collect. Port data were used to gain an approximation of both. A complex database was written to calculate these two figures from over 3,000 data points.

Damon Hackley from "The Island Development Committee" provided the necessary data to calculate a figure for the amount of built-on land on the island. Using Geographical Information System (GIS) it was possible to gain a very accurate figure including land degraded by car parks and roads.

Data Provided by IDC

Building:	5.983 sq. km
Roads:	2.731 sq. km
Car parking:	1.572 sq. km
Total:	10.286 sq. km

Within the component ecological footprint calculation built-on land is 1 hectare for 1 hectare, simply because this is the amount of built land consumed by Guernsey (ignoring the equivalence employed by Wackernagel).

4.5.1.3 Transport Section

Freight transport was calculated by combining port data with an approximation of the distance the freight had travelled. The States Harbour Authority and Guernsey Airport were able to provide data of the exact tonnage that entered the island for a complete year. However, they were not able to provide data concerning the starting point of the freight. Therefore, it was necessary to calculate an approximation of the distance travelled.

Most of the sea freight that arrives in Guernsey starts off in Weymouth. The exact distance between Weymouth and Guernsey is 74 nautical miles[7], which translates into 85.7 kilometres. With total tonnage and distance it was possible to calculate tonne/kilometres. However, this figure only includes the freight travel from Weymouth to Guernsey and does not include any freight movements before this. The same situation occurred with data for air freight.

The final figures were a noticeable underestimate of the distance travelled by freight as the comparison below demonstrates.

Guernsey EF for Air Freight (Ha./per capita/per year)	=	0.006[8] Ha.
UK EF for Air Freight (Ha./per capita/per year)	=	0.02 Ha.
Guernsey EF for Sea Freight (Ha./per capita/per year)	=	0.003 Ha.
UK EF for Sea Freight (Ha./per capita/per year)	=	0.006 Ha.

This leaves two choices for the final figure for freight transport. One option is to consider the freight movement to Guernsey extra and add this on to a UK average for freight movement. The second option is to use the underestimate for freight movement to Guernsey alone because more accurate data is unavailable.

[7] Discussions with the ferry operators in Guernsey (Condor Ferries)

[8] The source for both the UK freight figures was provided by Best Foot Forward who are working on an ecological footprint of the UK using the same components as the Guernsey study.

A more in-depth understanding of where Guernsey's consumable items come from is required for future calculations.

Figures for passenger transport were easier to calculate. The Vehicle Registration and Licensing Department hold accurate data on vehicle numbers and passenger kilometres travelled. Guernsey Bus was also able to provide data on the distances the buses had travelled for a one-year period. Guernsey has no train or tram system.

4.6 Analysing the Results for the Component Footprint

Guernsey's component ecological footprint is substantially higher than both the UK footprint and the global earthshare. This study estimates that the area of land required to sustainably support the population of Guernsey at current consumption rates and with prevailing technology to be 512,969 hectares of world average productive land.

The average Guernsey footprint (8.55ha) is around 50% higher than the UK average (4.6ha) – see Figure 4.3.

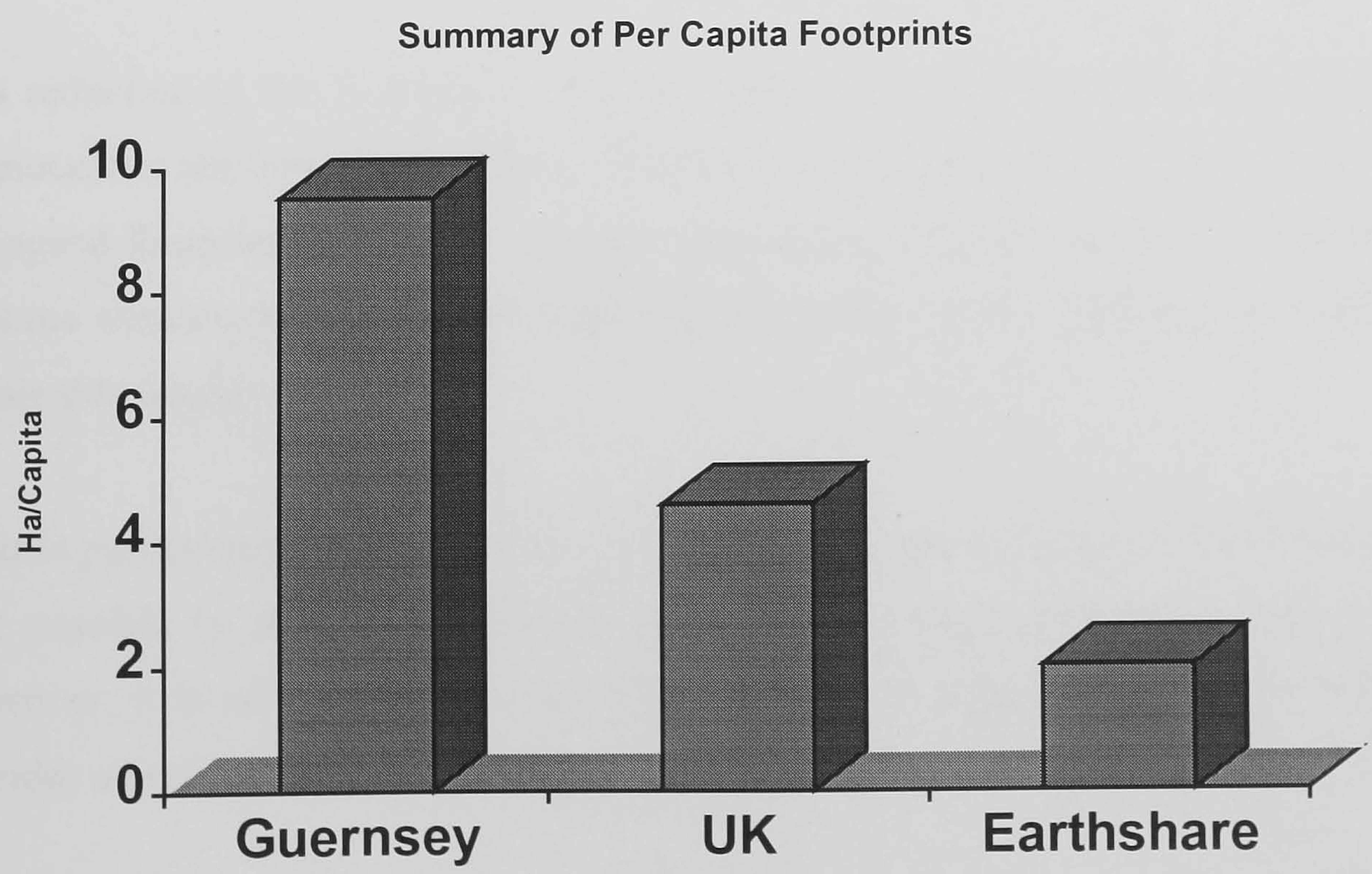


Figure 4.3: Summary of Per Capita Footprints

Some of the reasons why Guernsey has a higher ecological footprint than the UK could relate to the large number of tourists that visit the island and also the transport requirement to deliver imports to the island. Also, GNP is higher in Guernsey than the UK and is increasing at a rapid rate. A good way to view Guernsey is as a rich suburban area of the UK. With practically no unemployment on the island most of the population has a high disposable income.

A large amount of individuals in Guernsey also seem to have a high dependence on their cars. A considerable amount of individuals live on Guernsey because of its tax status, meaning they are very wealthy individuals. This means there is a multitude of expensive sports cars on the island, which is quite ironic as the maximum speed limit is 35 mph.

A methodological issue that may have affected the final figure is the accuracy of the Guernsey consumption data. With Guernsey being a small island very accurate data for the ecological footprint were available. There was no need for the use of proxy data in the calculation. With more data available, it is often the case that a higher ecological footprint is calculated. This may be responsible for some of the large differences between Guernsey and the UK.

This reduction in the ecological footprint cannot be accomplished by merely applying technocentric answers to the problem. While technology has a role to play in reducing the ecological footprint of Guernsey, changes on a larger scale are necessary. Reductions in resource consumption and waste minimisation are key tools to achieve an ecologically sustainable island.

What is particularly useful about the component ecological footprint of Guernsey is that is it possible to see a breakdown of areas that are responsible for a high footprint. Moreover, it is now possible to see where the largest saving can be made. Figure 4.4 provides a breakdown of the EF of Guernsey into the four main components.

Figure 4.4: Footprints (per capita) by activity

An analysis by category of impacts shows the highest impact category to be 'utilities', followed by 'food, land & wood', 'transport & freight' and then 'materials and waste'. The reason for the utilities being so high is due to a number of factors. Firstly, by Guernsey producing all its electricity with an oil power station the carbon releases are substantial. A gas power station, for example, produces roughly half the amount of carbon dioxide per kWh. Secondly, Guernsey has not made use of renewable energy sources available. The only positive way of viewing this is that there are many options still open to Guernsey in order to reduce carbon emissions.

High consumption of food and wood is indicative of a rich community. A lot of freight transport and waste are based around its consumption, even though in the figure above they have been listed separately.

Figure 4.5 (below) shows the distribution of impacts by component – ordered in terms of the size of impact. It can be seen that the largest 3 impacts are electricity (other), car travel, food and then electricity (domestic).

By gaining such detailed information and through the aggregation of the different components, scenarios can be generated in an attempt to understand the reductions that can be made with each component.

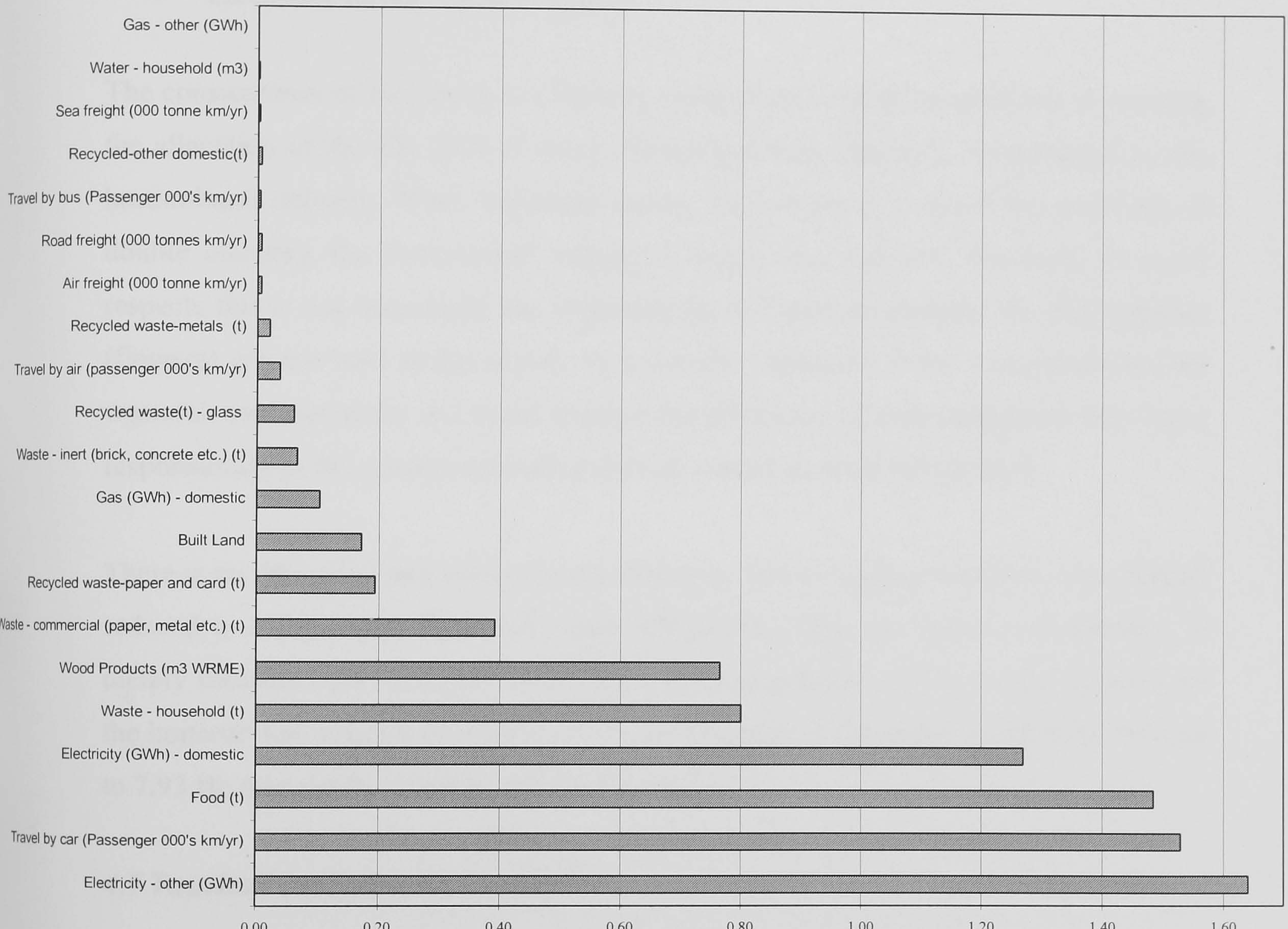


Figure 4.5: Guernsey Footprint (Ha./per capita) by component

When distributing the ecological footprint from an aggregated form into the separate components it is not always clear as to where the responsibility of the ecological footprint should be placed. An example of this have been given below: -

- Electricity for the 'Other category'

The consumption of electricity in Guernsey raises some interesting questions concerning the allocation of the EF. 20% of energy consumption in Guernsey is consumed by the horticultural industry. While industrial energy was removed to avoid the problems of double counting the horticultural industry's energy use was not. However, in many respects this is not necessarily the responsibility of Guernsey because the final product (flowers) are not sold in the island. As a counter argument, if the horticulturalists are wasteful with electricity and could improve the efficiency of their production then some responsibility of the subsequent carbon dioxide emissions must fall on them.

There is no right or wrong answer to this dilemma. The ecological footprint, even though reduced to a per capita figure for easier comparison, does not imply responsibility; it merely measures the ecological impact of a given population. If the energy demand for the horticultural industry is removed from the footprint of Guernsey the total EF reduces to 7.93 Ha./per capita, which is still a substantial EF.

4.7 Tourism footprint for Guernsey

Tourists can seasonally increase the given population of an area. Guernsey is a popular tourism destination, tourism being the second highest contributor to the GDP of the island. Tourism also raises the issue of allocation. Should Guernsey be responsible for the waste, energy use and transport emissions of tourists who visit the island? By calculating the EF of Guernsey on a per capita level the residents of Guernsey have the burden of the tourists' footprint. There are two solutions: -

- To correct the population figure in an attempt to include the tourist population
- To remove the footprint of tourists from the final EF calculation for Guernsey

The ecological footprint of tourism in Guernsey has been calculated below. This calculation is an approximation and with more extensive work a more accurate figure could be calculated. This merely provides a rough example of the reduction in the Guernsey EF when the tourists have been removed.

- Tourism EF for Energy

This has been calculated by determining the energy use of the hotels on the island. The States Electricity Board was able to provide an accurate figure for the energy use of hotels on Guernsey. The energy consumption in 1997 was 187.45 GWh with an EF of 24,413 hectares. There will also be an extra energy burden on restaurants and bars due to tourism that has been included within the figure above.

- Tourism EF for Transport

To calculate the passenger transport for tourists the number of hire cars was calculated for a one-year period. The Vehicle Registration and Licensing Department suggest that the minimum amount of hire cars for tourists in one year is 6,762. According to hire car companies, most of these cars are in consequent use and travel an average of 10,000 km a year[9]. A rough estimate of passenger/kms can be calculated.

6,762 cars x 10,000 kilometres = 67,620,000 passenger/kms

Therefore, the approximate EF of the transport EF for tourists in Guernsey is 2,908 hectares. This figure, in many respects, is an underestimate as some visitors bring their own cars over on the ferry. During the summer, approximately 150 cars arrive on the island from tourists. During the winter months, there is no service for tourists to bring their car to the island. The service is open for 30 weeks and the approximate time and the cars stay on the island is 10 days[10]. This equates to an extra 1,050 car a week on the island for 30 weeks (a total of 31,500 cars a year). There is no knowledge concerning how far these cars travel, however being tourists there is likelihood that they will travel further than a Guernsey resident (visiting attractions etc). The average distance of a hire

[9] Conversion with three hire car companies operating in Guernsey.

car is 10,000 km a year. It is assumed that tourists in their own car will travel a similar distance. This means that tourists in their own cars travel a total of 8,631,000 km. This is an ecological footprint of 371 hectares.

There is also the impact of tourists flying to the island. Tourism flights correspond to 45% of all the flights to Guernsey. Therefore, the tourist ecological footprint is 992 hectares.

- Tourism EF for Waste

Hotels are responsible for producing a substantial amount of on the island. Whalley and Polson (1999) suggest that hotels produce 40% of commercial waste on the island. Forty percent of the commercial waste footprint for Guernsey is 9,394 hectares.

- Total Tourism EF for Guernsey

While in Guernsey the visitors are also responsible for consuming food, and purchasing gifts and other consumable items with no data available it is difficult to estimate the effect of the tourism industry in these areas.

Because of the dubious nature of some of the calculations, the total EF of tourism in Guernsey can be viewed as a scale between the highest and the lowest estimates. Adding all the calculations above gives a tourism EF of 74,172 hectares. With food and other consumable items this figure could potentially rise to nearer 100,000 hectares[11]. This is a reduction in the Guernsey EF of between 1.24 and 1.70 Ha./per capita. Therefore, Guernsey's ecological footprint is between 6.85 and 7.31 Ha./per capita. The tourism factor partly explains why Guernsey has a substantially higher footprint than the UK (UK footprint is 4.9 Ha./per capita).

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[10] Personal correspondence with Guernsey Tourism Board

[11] This figure is obtained by considering the population of tourists in comparison to Guernsey residents. There are approximately over 120,000 tourists during a year and 60,000 residents.

4.8 Comparing the Methodologies

When comparing the accuracy of the different footprinting approaches, it very much depends on what primary data can be collected has to which one is more accurate. In most cases, the compound approach relies on material flow data at the national level, while the component approach is more sensitive to underlying data variations due to its reliance on local data. If one has access to detailed material flow and energy usage a more accurate result is obtained from using the compound approach. For Guernsey such localised data were available, although a lot of work was required to process the data. For regions within a country this data is not available at all. Even in the UK, with a long history of data collection and analysis it is a near impossible task to conduct a compound footprint without major assumptions and using proxy data. The advantage of the component approach immediately becomes apparent. The data requirements are more in line with local data availability.

It is remarkable that the final figures of the different approaches are so similar for Guernsey. Unfortunately, this is the first study where both the component and compound approach has been calculated for the same place, meaning that further validation is not possible.

A simple comparison of the results from the two methodologies is encouraging. The final result for the compound footprint of Guernsey was 8.32 ha/cap while the result from the component ecological footprint was 8.55 ha/cap. There is a difference of 2.7% between the final results. It is encouraging to see that both approaches reach a similar conclusion.

4.9 Guernsey: A Time Series Data Analysis

By considering the ecological footprint over a period of time it is possible to demonstrate the direction in which Guernsey is moving, i.e. closer or further away from sustainability. The application of time series data is also useful for evaluating the success of past schemes (for example, recycling). This has been done, where possible, for Guernsey. Not all the necessary data is available for a complete time series analysis. However, data in the area of waste and transport is available, providing a unique opportunity and insight into Guernsey's past and possible demands on nature.

4.9.1 Passenger Transport

Guernsey has seen a steady increase in both private and commercial motor vehicles registered on the island. Not only has there been an increase in vehicles but also an increase in the average distance travelled. Comprehensive data on both the numbers of vehicles and distance travelled have been obtained from the Guernsey Traffic Committee as far back as 1950.

In 1950 a total of 6,822 vehicles were registered in Guernsey, compared to 44,434 vehicles in 1996 (see appendix 3). There has also been an increase in the average distance travelled by vehicles. In 1950, it was estimated that the average vehicle travelled 4,000 kms per year, compared to 8,800 kms per year in 1996. The main two reasons for this are concerned with the patterns of jobs within the island and an increase in leisure activities. In 1950 the Guernsey economy was not dominated by the finance industry. More localised economies such as agriculture, horticulture and manufacturing were in place reducing the need to travel. Nearly all of the banks in Guernsey are situated in St Peter Port (the capital) of which the majority of workers use the car to get to work.

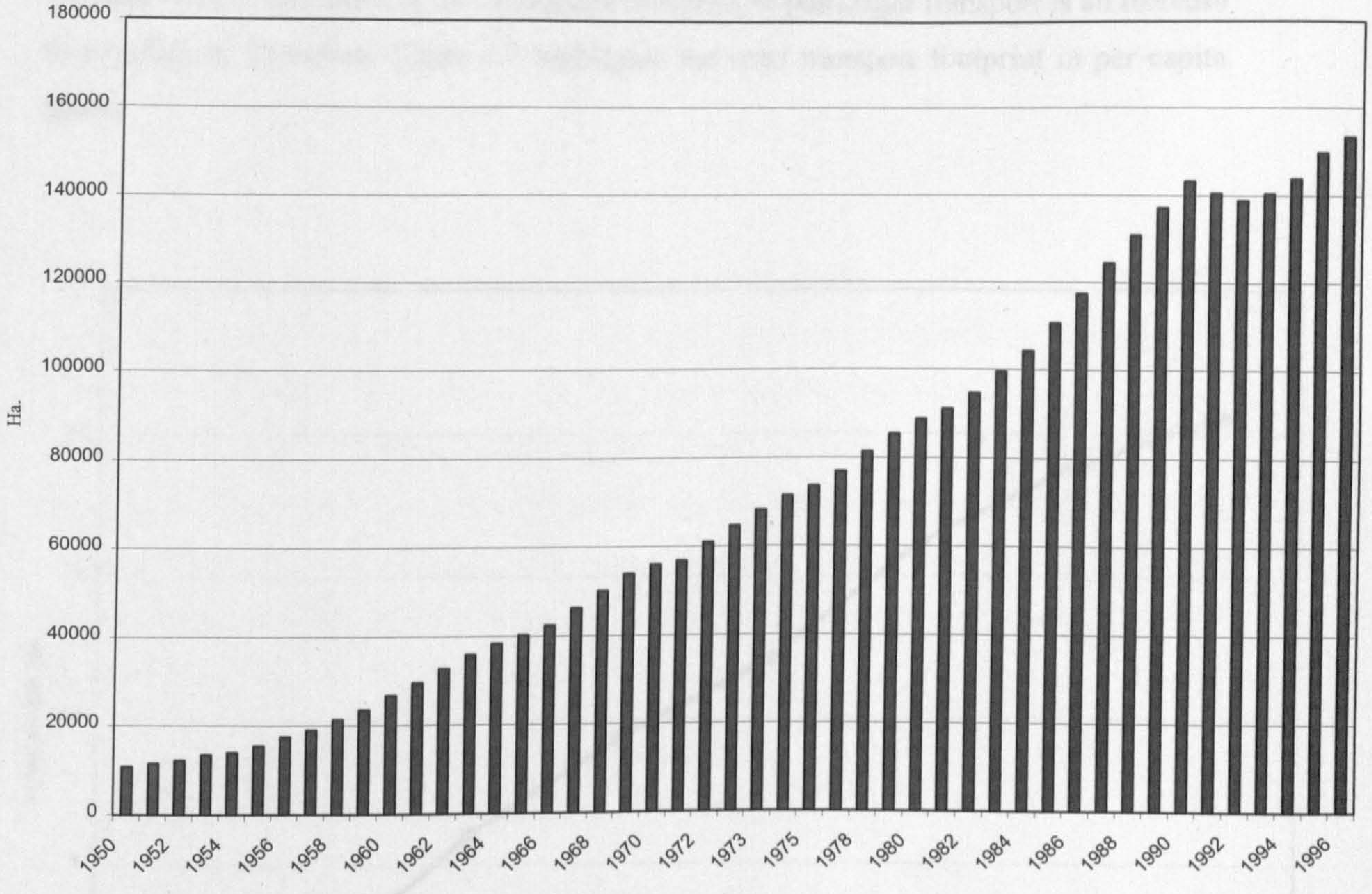


Figure 4.6: A Time Series Analysis of Road Transport in Guernsey (1950-1996)

Source: Author

Figure 4.6 demonstrates a steady increase in the ecological footprint of road transport in Guernsey from 1950. In the 1980s the footprint increased more rapidly while there are signs that the footprint was stabilising in the 1990s. This may be due to the recession; even though Guernsey was not as affected by this as much as the UK. Only two years (1993 & 1994) showed a decrease in the ecological footprint from the previous year out of a time period of 50 years.

Not one policy in Guernsey has been employed in an attempt to decrease road transport. While many options have been available, such as the introduction of car parking fees, an improved public transport system and the limiting of car parking spaces in St Peter Port, none of them have been adopted. There has also been no mention of introducing car-sharing schemes for office workers in St Peter Port.

On reason for the increase in the ecological footprint of passenger transport is an increase in population. Therefore, figure 4.7 highlights the road transport footprint in per capita terms.

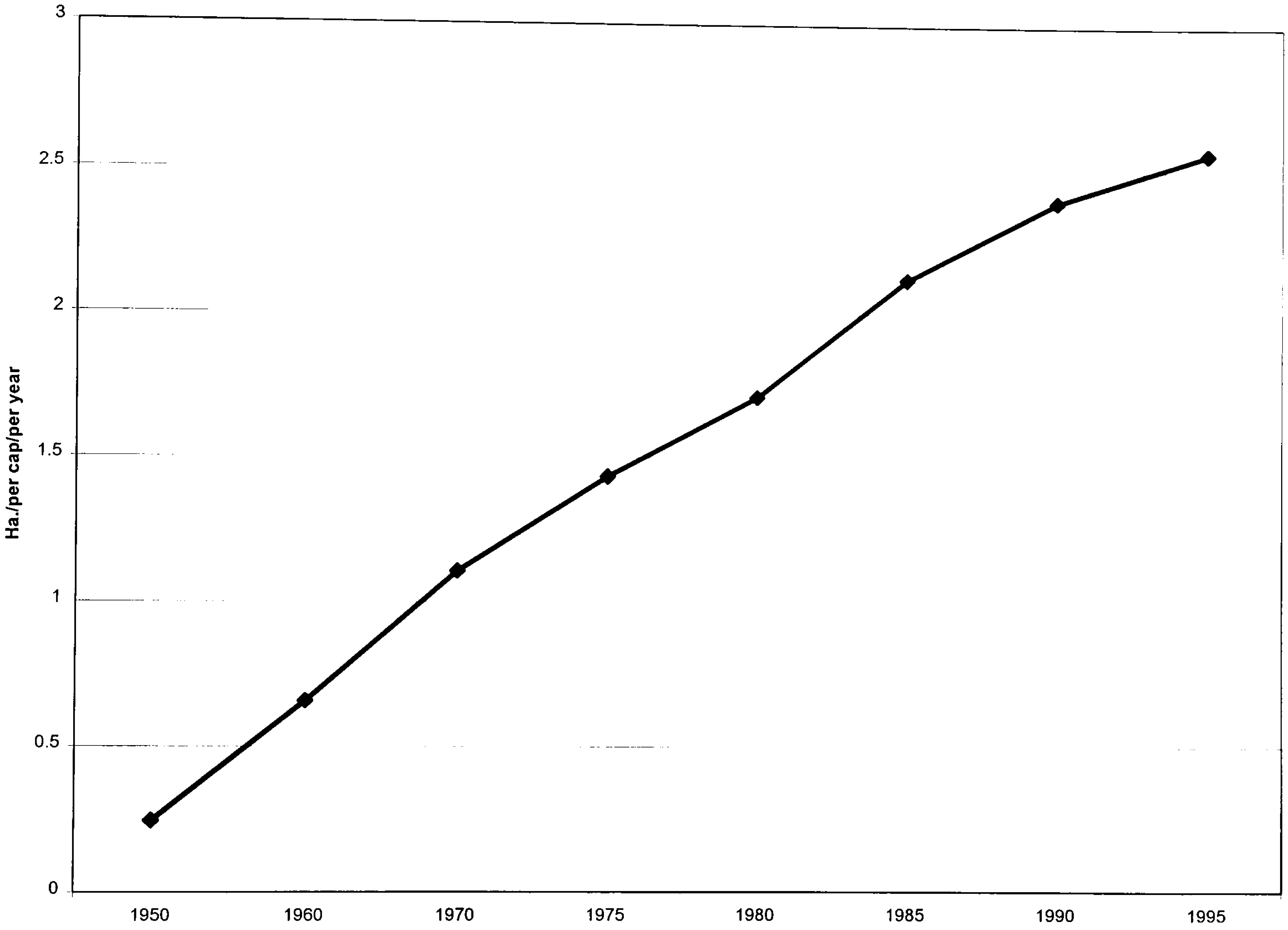


Figure 4.7: The per capita increase in the ecological footprint of road transport in Guernsey (1950-1996)
Source: Author

While population has increased the number of vehicles on the island, on a per capita level there are more cars that travel further in 1995 then at any other time in Guernsey's history. There are now more cars registered in Guernsey than there are people to drive them. A clear sign of prosperity is high car ownership and this time series analysis providing a warning to Guernsey as to what the potential increases in the ecological footprint of road transport may be. The application of a time series could help to establish targets for future policy objectives, similar to the targets set in global carbon policy. i.e. to reduce the ecological footprint of road transport to 1990 levels by 2005. This does not mean that other meaningful indicators could not be employed as well, such as reducing congestion and pollution. The ecological footprint does only provide an indicator for reducing carbon dioxide emissions.

4.9.2 Waste

For the time series analysis of waste it is possible to test the effectiveness of past policy decisions. This was not possible for road transport, as no policy decisions were introduced to curb its increasing impact. In contrast, a recycling scheme has been in operation in Guernsey since 1991. Since 1991 the recycling diverts an average of 2380 tonnes of waste a year from landfill. The total domestic waste to landfill for 1998 was 19,000 tonnes, meaning that 11.1% of the total waste is recycled. Time series data was available from 1990.

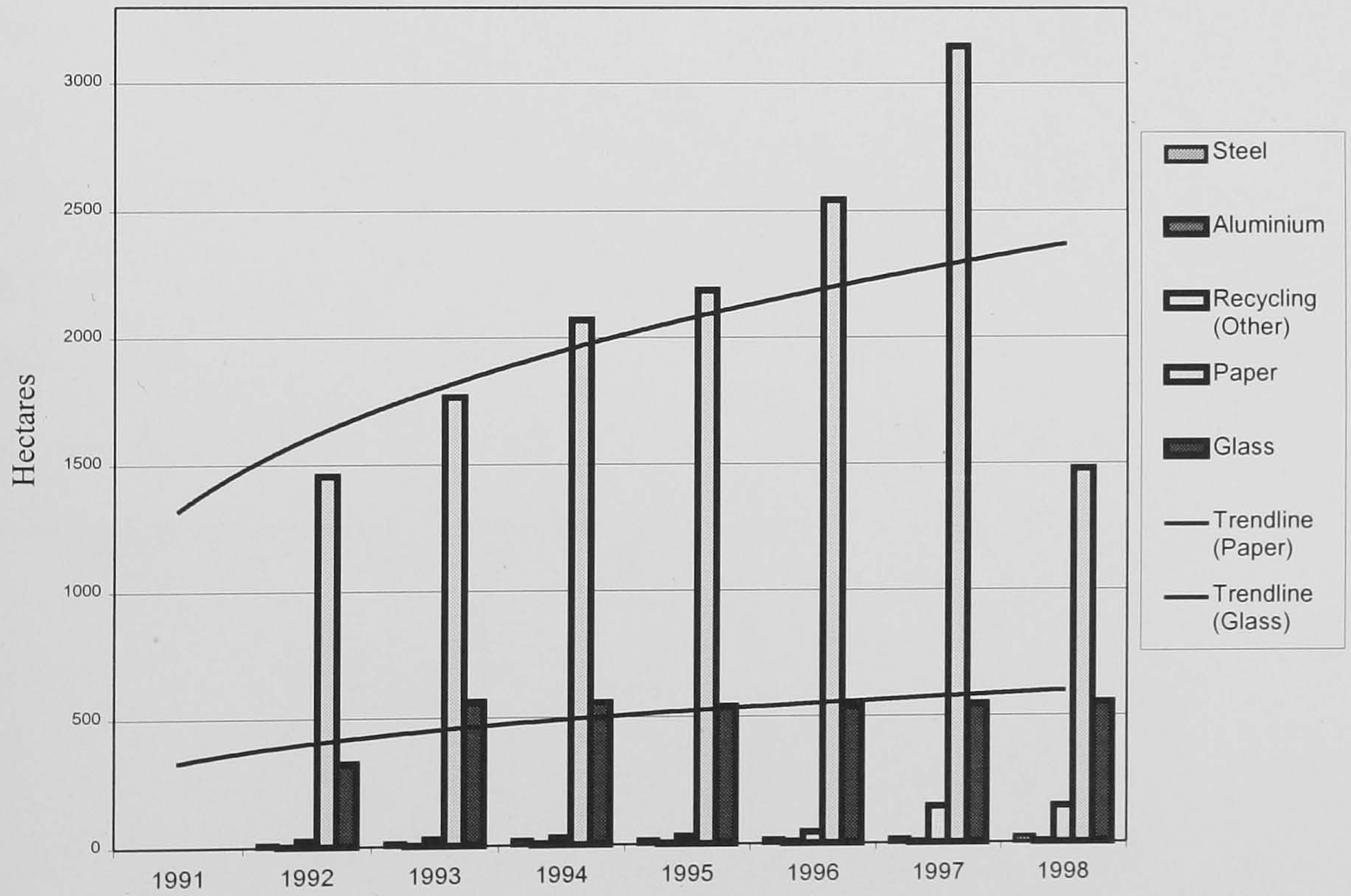


Figure 4.8: The Ecological Footprint of Recycling in Guernsey (1991-1997)
Source: Author

Figure 4.8 provides a time series analysis of the ecological footprint for recycled items in Guernsey. Although the recycling scheme started in 1990 it did not really take off until 1992. The overall recycling rate peaked in 1996 and has been declining ever since. Glass recycling has remained stable along with the recycling of steel. A worrying figure is that the recycling rate is declining. The trendlines for both paper and glass demonstrate this movement. While an increased recycling rate from since 1990 has occurred there has not been a reduction in the ecological footprint of waste. This is because of a growth in the overall volume of waste. The increase in recycling has helped curb the growth the ecological footprint of waste, but has not stabilised the ecological impact in the growth of domestic waste. Figure 4.9 demonstrates the reduction in the ecological footprint that has occurred due to Guernsey establishing a recycling scheme. This helps assess the overall success of the recycling project.

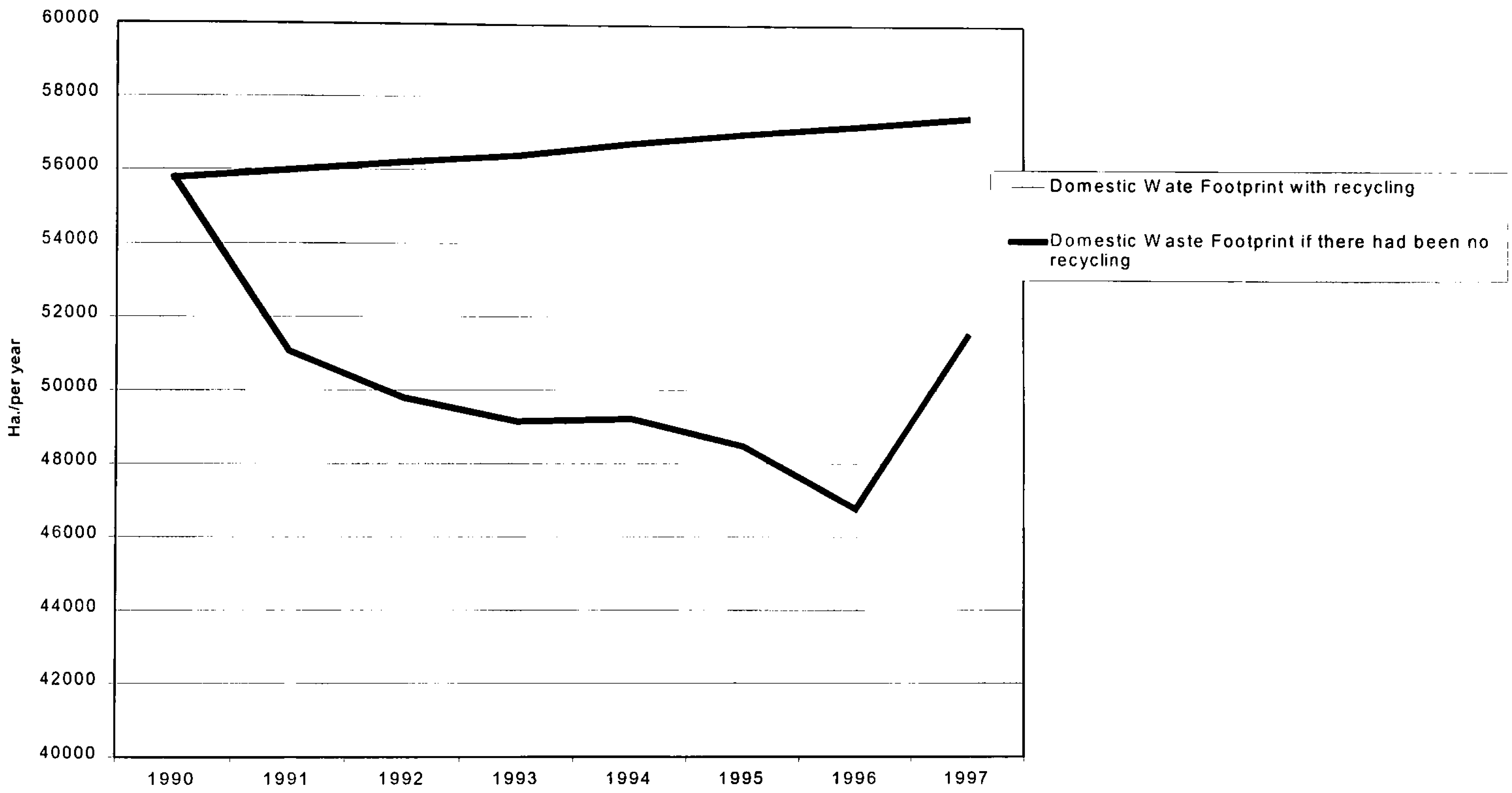


Figure 4.9: The Effect on the Ecological Footprint of Domestic Waste with the introduction of the recycling scheme (1991-1997)
Source: Author

The reduction of the ecological footprint with the introduction of the recycling scheme is a saving of 6000 hectares and a per capita saving 0.1 hectares. This figure equates to a 1.2% reduction in the overall ecological footprint of the island. While this may seem small the reduction in the ecological footprint is nearly the same size as the total area of the island (6310 hectares).

The total waste and materials footprint for Guernsey is currently 1.54 ha./per capita. Therefore, the ecological footprint of waste if no recycling scheme had been introduced would have been 1.64 ha./per capita. While any reduction in the ecological footprint is positive, figure 4.9 indicates the enormity of the problem. Guernsey's ecological footprint, concerning waste is at such a high level that the effect of recycling has been minimal. This does not mean that recycling should not be encouraged within Guernsey. What it does mean is that other more radical approaches must be introduced with a strong emphasis on waste minimisation.

4.10 Responses to the ecological footprint as a decision-making tool from practitioners and politicians

4.10.1 A Decision-Makers Response to the Ecological Footprint

To strengthen the appraisal of the ecological footprint a questionnaire survey was conducted with Guernsey politicians and Local Agenda 21 Officers in an attempt to gauge their opinion on the ecological footprint as a decision making tool. A copy of the questionnaire can be found in appendix 4 along with a pamphlet that accompanied the questionnaire on the ecological footprint.

4.10.2 The Methodological Approach

The type of survey to be conducted depends largely on the conceptual and structural nature of the research problem. If the intention is to test theory deductively by accounting for cause and effect relationships among a set of phenomena, the approach will be analytical. If, on the other hand, the aim is to assess the attributes of a population, a descriptive approach will be more appropriate (Gill & Johnson, 1991).

A descriptive survey is concerned with addressing the characteristics of participants. As such, they do not share the emphasis in analytical questionnaires upon control but do share a concern to secure a representative sample of the relevant population. This is to ensure that the findings can be generalised through repetition - that they have population validity (Gill & Johnson, 1991). However, a prior review of the theory and literature is still important in determining what types of questions need to be asked.

Usually, both analytical and descriptive questionnaire surveys have, as a major concern, the identification of the 'research population' which will provide the information necessary for resolving the initial research problem. Due to nature of this questionnaire survey this was not a factor. Every Guernsey politician was sent a questionnaire, therefore the sample size was 57.

4.10.2.1 Selecting a Research Strategy

In selecting a strategy for research of a social nature, one is confronted with a philosophical choice regarding the nature of human action and its explanation, which has direct methodological implications. The differences between the various methods are perceived as being ones of trade-off between reliability, internal and external validity and appropriateness to the research. Alternatively, methodological pluralism can be based on the notion of acquiring different kinds of complimentary data about a research problem using various techniques in the same study. This 'methodological triangulation' is thought to overcome the bias inherent in any single-method approach (Smith, 1981).

Overlaying the philosophical debate are issues of practicality. Put simply, it is a matter of which methods are accessible and which are likely to be successful in enabling the 'testing-out' of the theory. These issues are a function of resources and the nature of the research.

Resources include the time considerations, manpower and financial limits that form and constrain the environment for actually carrying out the research. Where resources are great, many people can carry out a number of different validation techniques independently and bring their findings together to develop a deep and rich but reliable and valid understanding of the social phenomena under consideration. However, the reality of research is that such resources are rarely available and, consequently, a single researcher will be constrained in available options and forced into philosophical decisions about which technique(s) to select and what structure they will take.

In many respects, it would have been beneficial to conduct in-depth, semi-qualitative interviews with all 57 Guernsey politicians. As highlighted above, for practical reasons of time constraints, manpower, and finances this was not possible. Instead a questionnaire approach was decided upon.

4.10.2.2 The Questionnaire Approach

The questionnaire has been designed to assess the political opinions of politicians in Guernsey. It has very much evolved out of the research concerning public perceptions of sustainable development, using focus groups (see Chapter 6). Each section of the questionnaire attempts to gain a particular opinion in assessing whether the political will is present in Guernsey for moving towards a sustainable society.

Control questions have been placed within the different sections in an attempt to highlight any inconsistencies displayed by the participant. The 'social desirability effect' has also been considered and attempts to reduce this have been made. This issue is discussed more with reference to particular questions.

The questionnaire follows a qualitative approach in an attempt to give the participants freedom of expression and ideas. This will hopefully articulate more rich and varied answers and correspond to the overall chosen methodology of the thesis. The participants are also required to answer, yes or no, to each question. This is not an attempt to introduce any statistical data into the questionnaire, but will provide data that can be displayed effectively with the use of graphs and charts.

The research objective of the questionnaire is listed above as: -

"...To assess the opinions of politicians in Guernsey concerning the ecological footprint."

From this the following questions outline the structure of the questionnaire.

Do the politician's opinions correspond with their "Policy and Resource Planning Report[12]

Do the politicians understand the importance of introducing indicators to guide policy decisions?

Is the opinion of the politicians similar to the people of Guernsey?

Do the politicians have any vision of a sustainable future for Guernsey?

These questions can clearly be seen in the structure of the questionnaire. The details of this are given below.

4.10.3 Establishing the Questions

4.10.3.1 Section 1: Sustainability

The main purpose of this section is to introduce key ideas of sustainable development and assess the past knowledge and ideas of the participants. Questions 1.2 to 1.5 are all concerned with this notion, with questions concerning carrying capacity, the rationality of sustainability and inter-generational equity.

Question 1.1 has been selected for a different purpose. Sustainable development is very much about balancing economic, social and environmental issues, giving them equal priority on the political scale. The participants are required to grade the importance of a number of social, economical and environmental issues. There is an equal amount of all three. The question gives a valuable insight into the prioritising of issues by the politicians. This also gives the opportunity to compare political opinion with current Guernsey policy. The Strategic Policy Statement (1997:78) on the Environment suggests that,

[12] The Policy and Resource Planning Report is the yearly document that is voted for by the States of Guernsey and is meant to guide all policy decisions over the next year.

"The aspirations of the community can best be met if, in development of policies and programmes, immediate and longer term environmental factors are given equal consideration alongside economic and social factors."

The question will test the reality of such a bold statement.

4.10.3.2 Section 2: Measuring Our Impact

One of the major objectives behind the research in the Ph.D. has been to assess the understanding of the ecological footprint as a tool for policy decision-making, planning and public awareness. The questionnaire is designed to compare the views of politicians and the public of Guernsey. Within the focus groups there proved to be large disparities between these two groups on this opinion.

Question 2.4 assesses the perceived usefulness of the ecological footprint in the areas of understanding sustainable development as a planning tool.

4.10.3.3 Environmental Policy in Guernsey

Particular issues related to the topics of transport, waste, energy and holidays were raised in the focus groups. The participants had specific concerns and expressed strong views within these topics. The most frequently expressed views within the focus groups have been translated into questions below. Each topic area has been limited to two questions in an attempt to understand the most important issues to the people of Guernsey and not to make the questionnaire too lengthy for the participant. This provides the possibility for comparison between political and public opinion.

4.10.3.4 The People of Guernsey

The last section has established the views of the politicians within the various policy areas, which has provided the opportunity for comparison with public opinion. This section questions the politicians about whether they think they understand the views of the public.

All the questions in the final section were asked in the focus groups. Comparative data can be generated. The final question (5.4) assesses whether the participants have the ability to link their own lifestyle choices with global environmental damage.

4.10.4 Analysis of the Questionnaire Results

The questionnaire follows a qualitative approach throughout; therefore a qualitative form of analysis is to be used. Nudist (Qualitative Software, explained in-depth in Chapter 6) will be used to gather information on the same topics, compare various answers from the questionnaire and for cross-analysis with the focus groups. Some of the answers will be presented with graphs and charts, but no statistical analysis is intended.

4.11 Analysing the Results from the questionnaire

4.11.1 The Guernsey Study

The questionnaire had a 30% response rate, suggesting that 70% believed that environmental issues were low on the political agenda. While this is a slightly disappointing return rate it still offers an insight into the opinion of nearly one third of the Guernsey politicians. The politicians were asked first whether Guernsey should measure its impact on the local environment. The response was positive with 81% of the politicians believing that this was important. There was also the opportunity for the participants to comment on measuring Guernsey's impact on the environment. Comments include,

"To achieve sustainability we need to audit our current and future environmental impact."

"We need to know our impact and then, if necessary, reduce it."

"We must continually monitor the use of our resources, i.e. land, population, water, clean air etc."

When asked whether it is important for Guernsey to measure its impact on the global environment the response was quite different; only 56% believed this to be important.

Comments by the politicians that felt it was not important suggested the idea of Guernsey being inconsequential in the context of the global environment.

"We are too small and insignificant."

"We are too small. Why should we when countries like the USA are the most wasteful and largest consumers of natural resources."

In contrast, the politicians who believed it was important to measure Guernsey's impact on the global environment saw the island as a small part of the larger picture contributing to global problems.

"Guernsey is part of the globe, even if only a small bit!"

"We do not live in isolation so we need to monitor the pollution we create and the pollution we receive from our global neighbours."

Finally, the politicians were questioned as to how effective the ecological footprint is for:

1. Planning departments and municipalities as a planning tool;
2. Political decision-making as a sustainable indicator.

Both the questions had exactly the same response and have been displayed in figure 4.10.

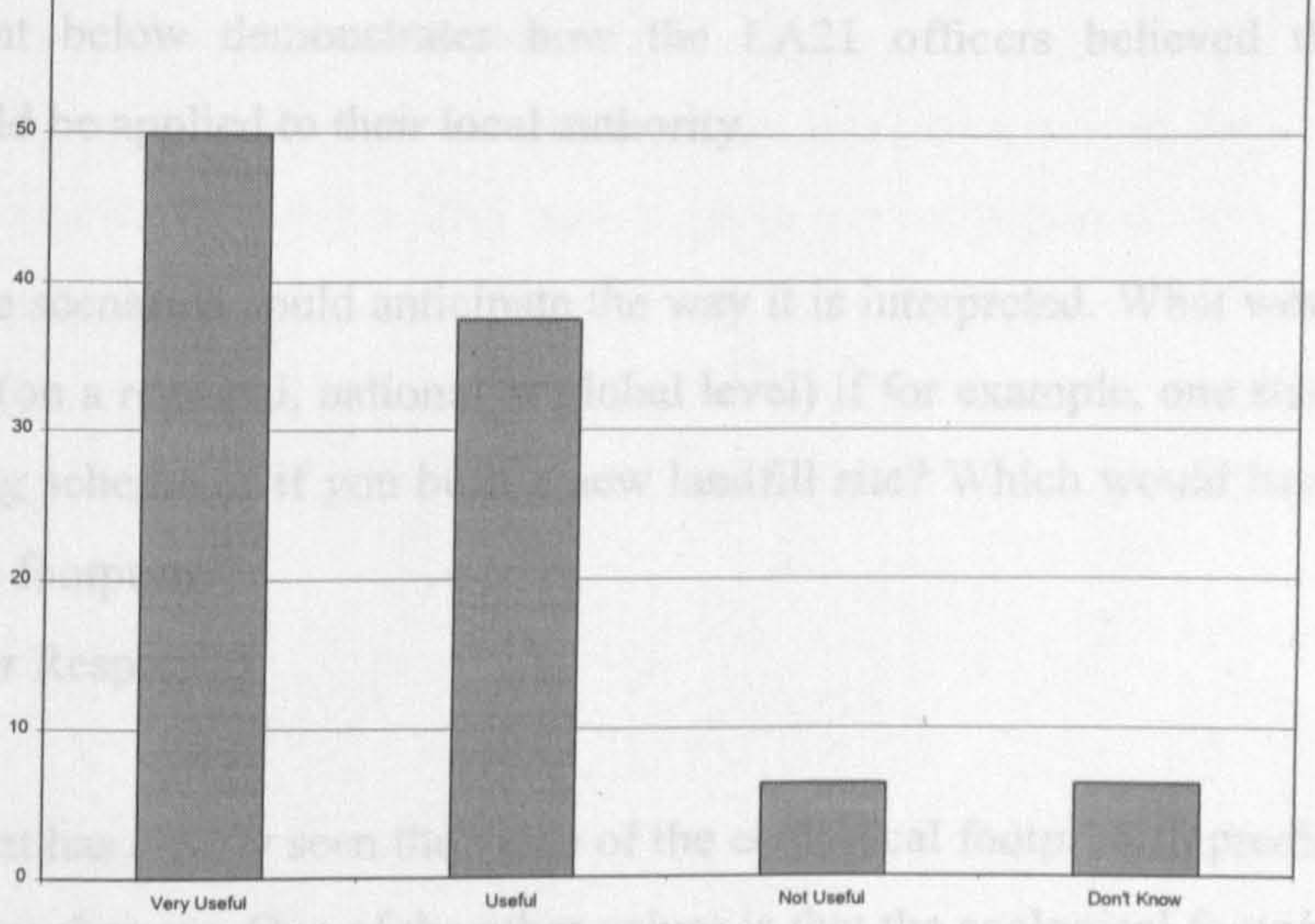


Figure 4.10: Guernsey politicians' views on whether the ecological footprint is a useful planning tool and sustainable indicator

Source: Author

Over 70% of the politicians believed that the ecological footprint was either useful or very useful as a decision-making tool. This is a very positive response and suggests that the ecological footprint could be used as a sustainable indicator within Guernsey.

4.11.2 The Local Agenda 21 Study

In November 1999 a UK-wide conference was held for Local Agenda 21 (LA21) Officers to establish how useful they believed the ecological footprint was as a decision-making tool[13]. The LA 21 Officers were provided with a short questionnaire concerning their views on the ecological footprint and how it might be of use to them. The general response from the LA21 Officers was that ecological footprint is a useful indicator for guiding regional policy, a point made by one of the officers.

"The concept is very interesting and relevant to local authorities' push towards sustainability."

(LA21 Officer Response)

[13] Speakers included John Barrett, Nicky Chambers and Craig Simmons. Information about the conference can be found at www.bestfootforward.com/

The comment below demonstrates how the LA21 officers believed the ecological footprint could be applied to their local authority.

"Maybe some scenarios could anticipate the way it is interpreted. What would happen to the footprint (on a regional, national or global level) if for example, one started a door to door recycling scheme or if you built a new landfill site? Which would have the biggest impact on the footprint."
(LA21 Officer Response)

The participant has clearly seen the value of the ecological footprint to predict the impact of future policy changes. One of the other values is that the ecological footprint can act as a benchmark to assess what will happen over a certain timescale.
"It can be used to benchmark with other regions and use a competitive approach to get local authorities to improve their footprint."
(LA21 Officer Response)

A general response by most of the LA21 officers was that with the UK Government having introduced the idea of 'Best Value' the ecological footprint can act as a measurement to compare city by city and understand why one city has a lower footprint than another does. It is important to introduce such an approach into the field of policy decision-making.

In conclusion, both the Guernsey politicians and the LA21 officers were able to visualise the strengths of the ecological footprint and believed that it has real practical use for helping local sustainability.

4.12 Conclusions

The component approach to the ecological footprint is a valuable means of measuring and monitoring the environmental dimension of sustainable development over time. The component approach has also proven valuable in determining the success of projects (for example of recycling in Guernsey). Again, the component approach suffers from the same problems as the compound approach; data availability. However, the component approach is still a robust scientific approach that has more relevance to local sustainable development issues. The component approach has also partly solved the problem of data collection. While there is still a long way to go in the collection of data, it is a simpler and more transparent approach.

CHAPTER 5: DEVELOPING A SUSTAINABLE SCENARIO FOR GUERNSEY

5.1 Introduction

This chapter explores whether the ecological footprint can offer an insight into what a sustainable society could look like, developing sustainable scenarios for Guernsey in the areas of waste, energy and transport.

For the ecological footprint to become a useful tool for sustainable development it must fulfil the following criteria: -

- The ecological footprint must be responsive to change. Therefore, if Guernsey can reduce its amount of waste that is going to landfill there is a subsequent decline in the ecological footprint of waste.
- The ecological footprint must be able to predict the effectiveness of future policies. It must offer an insight into which policies are the most effective in achieving ecological sustainability.

5.2 A Sustainable Model for Guernsey

To understand whether it is possible for Guernsey to live within its fair earthshare a model has been proposed (under the four categories used in figure 4.4). This is by no means a definitive model of how Guernsey can achieve sustainability, but more of an example of the potential reductions that can be highlighted through the eyes of the ecological footprint.

Figure 5.1 provides the current ecological footprint of Guernsey along with the sustainable model. It is assumed that the four categories (utilities, waste, bio resources and transport) will remain the same. The sustainable model situation for Guernsey displays an equal reduction in these four categories.

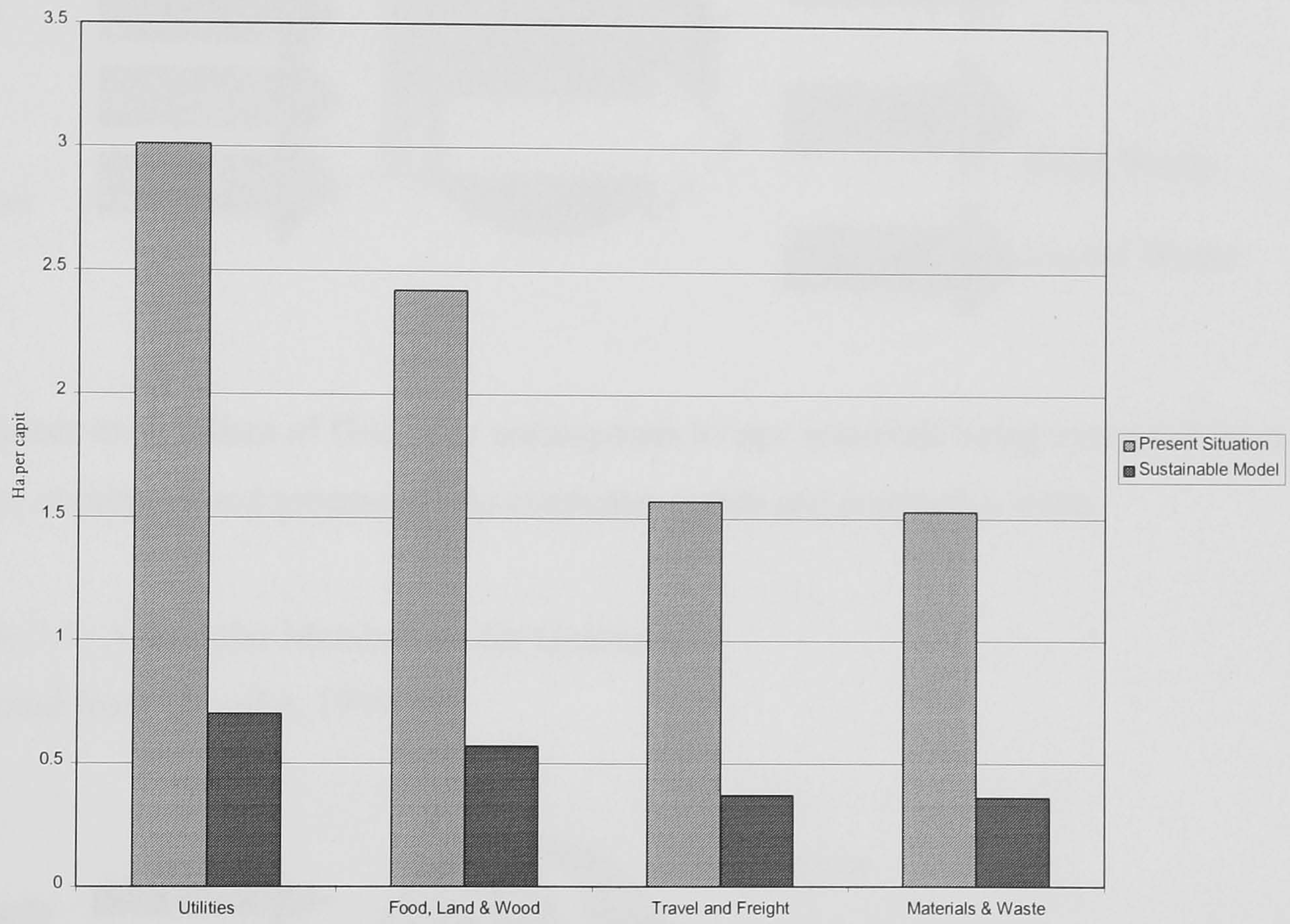
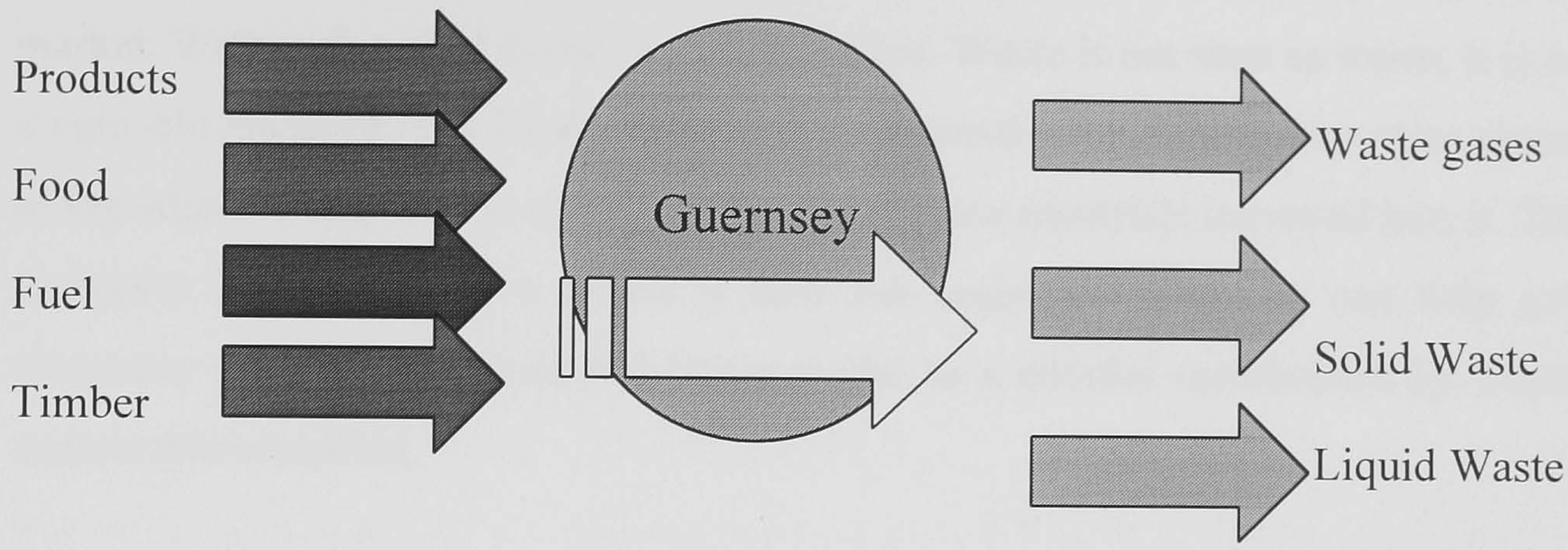


Figure 5.1: A Comparison of the Present Situation and the Sustainable Model for Guernsey

Source: Author

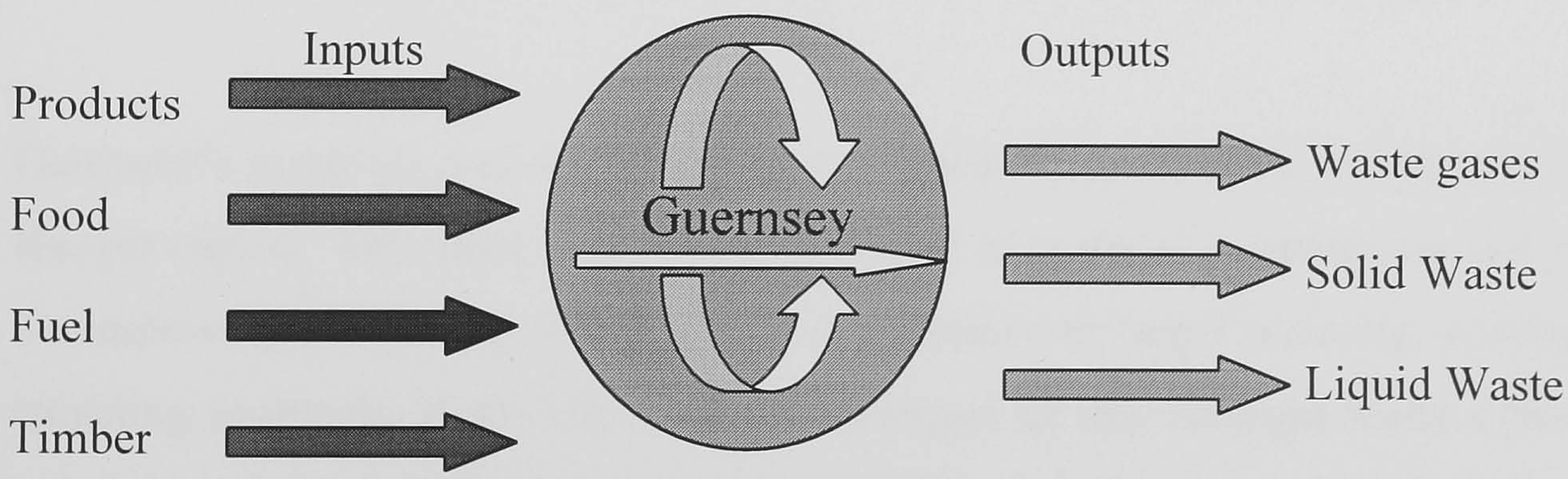
The sustainable model exemplifies the need for a change in the metabolism of the island. The metabolism of Guernsey is the 'flow of resources and products through the island for the benefit of the population' (Girardet, 1999). Natural ecosystems have an intrinsically circular metabolism of which the output from one organism becomes the input for another. For Guernsey, and many settlements of the developed world, the metabolism is linear. Materials and energy flow through the island for the benefit of one organism, without much concern about its origin, the destination of waste products or the energy requirements. There is very little connection between the outputs of the island and the inputs. The two models have been presented below to provide a clearer understanding of the different metabolisms.

Figure 5.2: The Linear Metabolism of Guernsey
(Adapted from Girardet, 1999:36)



The linear metabolism of Guernsey corresponds to raw materials being extracted from nature, combined and processed into consumer goods and producing waste.

Figure 5.3: A Circular Metabolism for Guernsey
(Adapted from Girardet, 1999:36)



In contrast, the circular metabolism is a cycle of energy and resources through a system as opposed to a flow of raw materials. To reduce the ecological footprint of Guernsey, the application of ecological system thinking needs to become prominent in the island's agenda (Girardet, 1999).

The linear model of production, consumption and disposal is unsustainable and undermines the overall ecological viability of urban systems (Girardet, 1999). For Guernsey to move towards a sustainable model it must understand the importance of changing from a linear to a circular metabolism.

When the decision is made to shift from a linear metabolism to a circular one, it opens up a whole spectrum of innovative ideas and concepts. New economic opportunities become available, which could help add diversity into the Guernsey employment market. With such a shift comes a shift in values. Waste is not seen as waste, it is now a valuable resource. The local economy is considered to be a more important element of the island as opposed to merely relying on the raw materials imported into it. Three examples have been given below it how the ecological footprint can help guide Guernsey from the unsustainable linear model to a circular metabolism by creating sustainable scenarios.

The three scenarios are:

- Materials and Waste - minimisation and recycling scenario
- Energy - Efficiency and renewable supply scenario
- Transport – the modal shift scenario

5.3 Materials and Waste - Minimisation and Recycling Scenario

Guernsey's materials and waste have an ecological footprint of 92,313 hectares (1.54 Ha./per capita). This value indicates a high level of material consumption and waste. To improve performance in this area it is necessary to target reducing, reusing and recycling materials. Recycling must be envisaged as one amongst many options to reduce the ecological footprint of waste. At present, in Guernsey, this is seen as the only option in dealing with the waste issue.

Some encouraging news for Guernsey is that their waste ecological footprint is lower than the UK on a per capita basis (UK waste EF: 2 Ha./per capita) (Best |Foot Forward, 2000). This could be attributed to the following reasons: -

- Guernsey has managed to implement a relatively successful recycling scheme for paper, glass and metal (2% higher than the UK average) (DETR, 2000)

- As an island the whole waste issue is more real in that the waste needs to be dealt with on the island and is not dumped in a landfill site miles away (out of site, out of mind philosophy). This makes landfill a less practical option.

This does not mean that Guernsey does not need to reduce its footprint for waste. In the sustainable model for Guernsey proposed above it is suggested that the ecological footprint for waste should be 0.36 Ha./per capita[1] (21,600 hectares). Therefore, Guernsey should be looking to reduce it's footprint of waste by 70,713 hectares. The following scenario does not suggest that this can be done in a year but with careful and innovative planning of a certain timescale this should be an achievable reduction.

[1] This figure is based on the assumption that all the components considered within the component ecological footprint of Guernsey would reduce at an equal rate. While this is not necessarily true it does provide a useful target for the scenario.

5.3.1 Community composting schemes

At present, there is no scheme for composting waste in Guernsey. In Guernsey 18% of domestic waste was deposited in landfill that was suitable for composting. This figure has been derived from the States of Guernsey, Department of Engineering (1997). However, a UK Government publication (HM Government, 1991) reporting research results from the Warren Spring Laboratory (Pearce, 1993) suggests the normal content of organic material in domestic waste can be as high as 45%. Other research suggests that the organic composition of domestic waste could be as high as 56% (Mitcham LGA, 1997). If adopting the Guernsey statistic for the amount of food waste disposed of by landfill, it is the equivalent of 3,420 tonnes, which has a footprint of 8,653 hectares (0.144 ha. /per capita). This represents 9.2% of Guernsey's footprint for waste.

The amount of land required for even a central composting site is minimal compared to landfill. Best Foot Forward has calculated the footprint of composting as 0.98 hectares per tonne[2] of composting waste. Therefore, Guernsey has a key opportunity to reduce the ecological footprint of domestic waste.

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[2] Personal correspondence with Best Foot Forward Ltd.

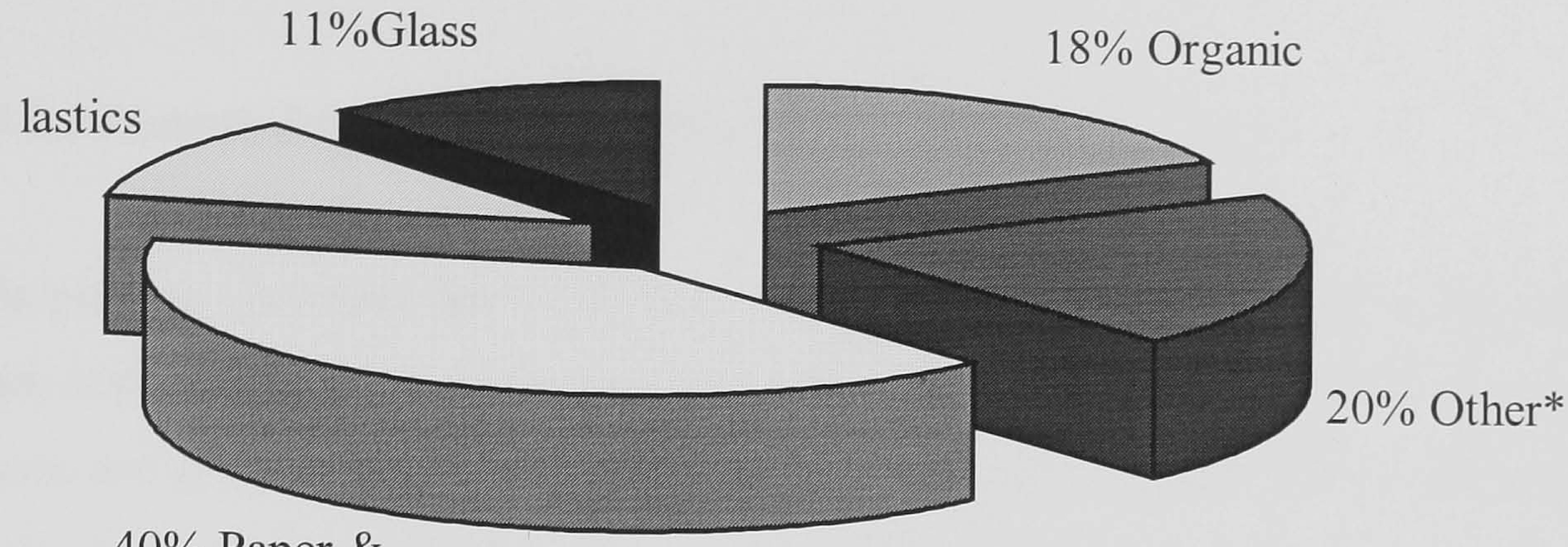

Figure 5.4: Household Waste Constituents in Guernsey

Source: Waste Strategy Assessment (1998)

*Other consists of: Ferrous metals 2.7%, Non-ferrous metals 1%, Textiles 3.6%, Miscellaneous combustibles 4%, Miscellaneous non-combustibles 9%

Even though 18% of domestic waste could be composted it is unrealistic to expect that Guernsey could compost all of it. Of the potential waste suitable for composting (3,420 tonnes) it is important to set a year on year target. For example, in the first year achieve a target of 10%, next year 20% and so on. It is realistic to assume that over a period of 10 years over 70% of organic waste could be composted. This would equate to 2,394 tonnes of household waste being diverted from landfill. In footprint terms this would mean a reduction from 0.144 Ha. /per capita to 0.08 Ha. /per capita. This is based on the following calculation: -

Disposal Method	Current EF (Hectares)	Sustainable Model EF (Hectares)
Landfill of Organic Waste	8,653	2595.78
Composting	0	0.057
Total	**8,653**	**2595.83**

Table 5.1: Reduction in the ecological footprint of waste with the introduction of a composting scheme.

Source: Author

This is a substantial reduction of 3811.1 hectares to the ecological footprint of Guernsey.

5.3.2 Door-to-door recycling collections

At present, Guernsey has a successful 'Bin Recycling Scheme'. This means that bins are strategically positioned around the island and residents are asked to deposit paper, cans and glass products in these bins. The bin scheme consists of 80 sites around the island. A small number of commercial operators provide a service for scrap metals, paper and board, tyres and oil. Recycling reduces waste volumes delivered to landfill by 7% annually (Whalley & Polson, 1999). A 7% recycling rate is considered to be an average figure across the UK with such a scheme (DETR, 1997). The Waste Strategy Assessment suggests that a source segregation of household wastes for collection would provide a marginal increase in collection of recyclables and that this could not justify changing the present system. However, in other local authorities in the UK a door-to-door collection scheme has proven to increase the rate of recycling by at least 55%. In Oxford, for example, in the areas where a door-to-door collection is operating a 62.5% rate of recycling has been achieved[3]. Assuming that Guernsey could achieve a similar figure in a specified timescale, a large and significant reduction in the EF of waste on the island could be accomplished. At present, there is no facility for the recycling of plastics on the island.

It is assumed that 51% of household waste is suitable for recycling (DETR, 2000). This includes paper and glass. This 51% of household waste is the equivalent of 9,690 tonnes/per annum, with a footprint of 24,516 hectares (0.41 Ha./per cap).

Table 5.2 provides the changes in the footprint of waste if a 62.5% could be achieved through the introduction of waste segregation at source scheme for glass and paper. Therefore, Guernsey has the potential of diverting 6057 tonnes/per annum of waste going to landfill, assuming a success rate of 62.5% (Whalley & Polson, 1999). Figure 5.5 provides a diagrammatic interpretation of these figures.

[3] Conversion with Paul Caray (Oxford City Council), Waste Department

	Landfill EF Hectares	Glass EF Hectares	Paper EF Hectares	Total EF Hectares
Present Situation	48,015	3,627	11,629	63,271
Sustainable Model	32,746	4,294	18,230	55,270

Table 5.2: Potential Reduction in the ecological footprint with the introduction of a door-to-door recycling scheme.

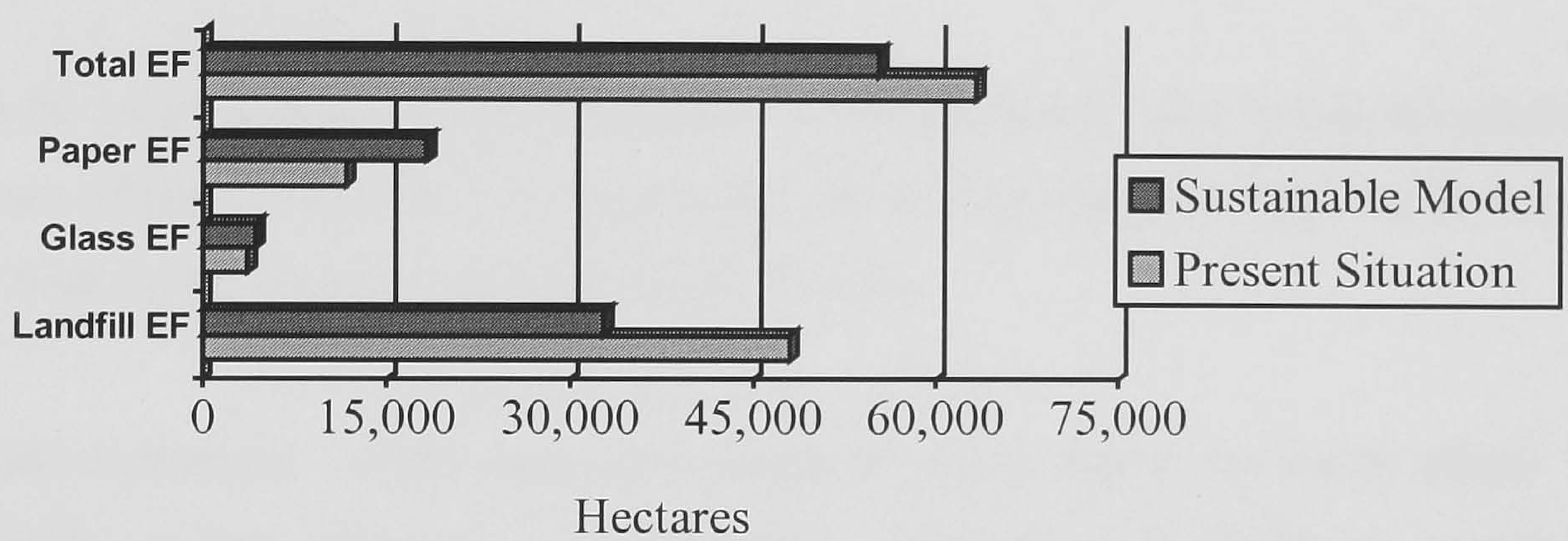

Figure 5.5: Diagrammatic Representation of the Potential Reduction in the ecological footprint with the introduction of a door-to-door recycling scheme.

This demonstrates one of the most powerful elements of the component ecological footprint. The potential gains in different schemes can be assessed. Not only is the impact of landfill considered but the potential increase of the impact of increasing recycling.

5.3.3 Recycling of Commercial Waste

Guernsey disposes of 12,500 tonnes of commercial waste in landfill each year. Of this, 2,500 tonnes is paper[4] (20% of commercial waste) while the remainder represents mixed waste (made up of computer equipment, wood, plaster board, etc). The re-use of the mixed waste is discussed below. This particular scenario concentrates on the recycling of commercial paper waste.

[4] Conversion with Simon Furclough, Department of Engineering, States of Guernsey

The 2,500 tonnes of paper from commercial waste has a footprint of 6,325 hectares (0.1 Ha./per capita). Successful recycling of office paper is easy to introduce into offices. It is suggested that 90% of this waste could be recycled. There is a potential reduction in the footprint of commercial waste paper from 5,693 hectares to 3,128 hectares, a saving of 2,565 hectares.

5.3.4 Encouraging 'green' businesses that use materials that would otherwise be wasted.

Within the waste hierarchy recycling is not the best approach. The re-use of materials is a more effective method. Two approaches have been suggested that could reduce the EF both in the commercial and household sector:

1. Waste exchanges – where organisations can advertise 'waste' for use by others
2. Specific re-use schemes – for example, targeted at furniture or computer equipment combined with a waste transfer plant.

It is important to understand what the remainder of commercial mixed waste consists of. A detailed assessment must highlight areas where resources can be initially re-used and then recycled. Once this has been completed it is possible to assess the possible reduction in the EF of waste.

5.3.5 Waste Minimisation

What is most interesting about the waste scenarios is that for every decrease in the ecological footprint of landfill there is an increase in the proposed method of waste disposal (even though these alternative methods are more ecologically sound). These scenarios do reduce the total ecological footprint through improved recycling and compost schemes, but there is still the same amount of waste. What this highlights most clearly is that waste minimisation has to be the most important dimension of any policy for waste. It is better not to produce the waste in the first place than have to even recycle or compost it. Guernsey does produce a substantial amount of waste on a per capita basis. Guernsey produces nearly 2-tonnes/per capita/per year compared to the Isle of Wight (1.2 tonnes/per capita/per year) (Best Foot Forward, unpublished).

What is important is for Guernsey to realise the significance of a year on year reduction in waste (both in the commercial and household sector). Guernsey is in the unique position that it can control imports to the island, making it possible to restrict the import of highly packaged products. This could be used as a method to achieve a year-on-year reduction. This scenario suggests that a 5% reduction should be possible in one year.

With all the other schemes suggested above, such a policy would help the transition to a sustainable model for waste. Figure 5.6, demonstrates the reduction in the footprint if such a policy is adopted combined with all the other suggestions.

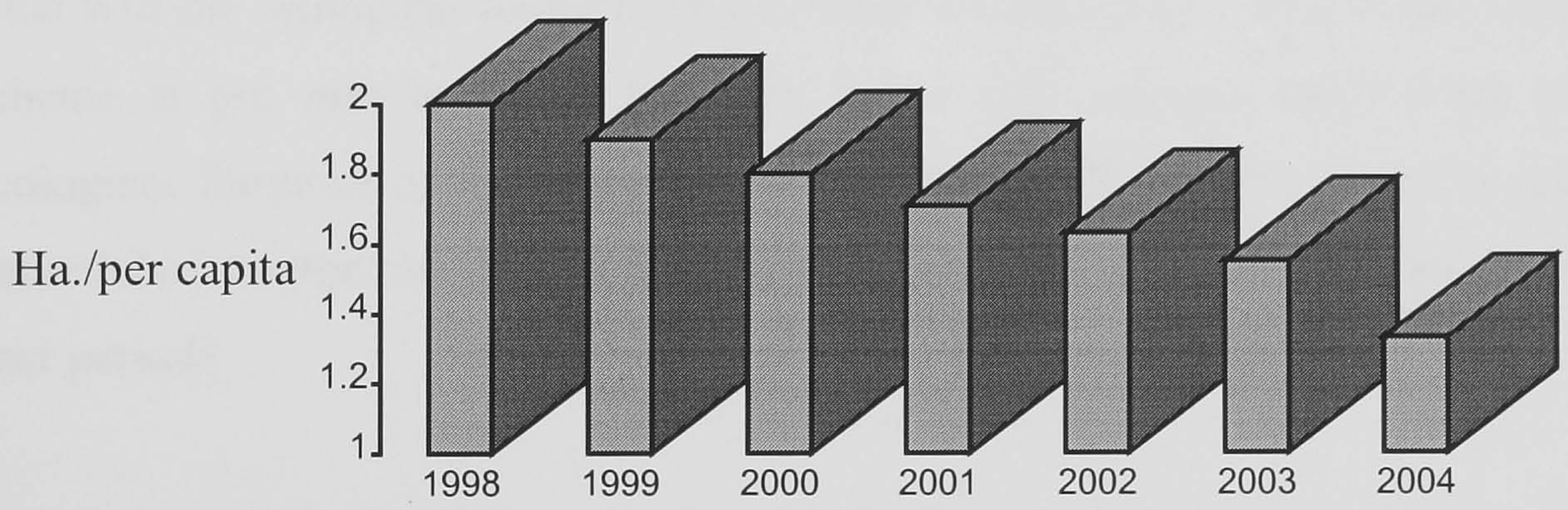

Figure 5.6: Proposed Reduction of the Waste EF in Guernsey over a 7-year timescale.

Even with all the proposed schemes of door-to-door collections, re-use of materials, recycling of commercial waste and waste reduction the ecological footprint of Guernsey's waste would still be 1.3 Ha/per capita after a 7-year reduction strategy. A projection of the scenario above suggests that Guernsey could achieve this by 2024 if the strong sustainability policies that have been suggested are employed. Of course, this scenario cannot predict future advances in technology, but as they are produced it may be possible to reduce the ecological footprint of waste at a more rapid pace.

If decision-makers believe this to be an unrealistic model setting impossible targets, the example of India demonstrates a successful sustainable waste model in action.

	Vegetables	Paper	Glass	Plastic	Cans
Burn it	15	11	1	5	2
Sell it	2	72	64	70	68
Domestic reuse	2	4	13	14	20
Compost it	70	9	12	5	4
Total	**89**	**96**	**90**	**94**	**93**

Table 5.3: Recycling of household waste: percentage of total in India

Source: Global Environmental Change Programme Briefing, 1997:2

What is particularly useful about the model explained above is that it demonstrates where the most effective gains can be made from the different options. For example, what will the ecological footprint of Guernsey's waste be if a door-to-door recycling scheme is put into operation but only has a 50% success rate? What will the ecological footprint of Guernsey's waste be if they choose to ignore the recycling potential of commercial paper waste but push for a 10% reduction in waste over a ten-year period?

The ecological footprint is very adaptable in that it can predict the impact of many different scenarios. With the ecological footprint placed into a computer model it would be an accessible tool for planners and decision-makers to assess the outcome of a variety of projects.

5.4 Energy – Efficiency and Renewable Supply Scenario

This category includes the direct supply of energy to businesses and households in Guernsey. To improve performance in this area it is necessary to improve energy conservation and move towards more renewable energy supplies. A switch to renewable energy sources is essential if we are to avoid climate change with the associated problems of sea-level rises, flooding and the subsequent damage to human health.

5.4.1 Guernsey's Energy Situation

In Guernsey nearly all energy supplied is derived from an oil-fired power station situated on the island. All the necessary oil is shipped into Guernsey. The situation is soon to change as an energy cable link is currently being built to connect Guernsey to the 'European Electricity Grid'. This will cost Guernsey over half a billion pounds. The alternative possibilities with a budget of this size are both boundless and exciting. Large-scale projects were the only ones considered as alternatives (such as renewables and gas-fired powered stations). Small-scale energy generation was unfortunately not given any consideration. There was also very little thought given to reducing the energy requirements on the island.

The justification for building the cable link was based on a risk analysis and not a problem with demand and supply. A risk analysis of the present situation indicated that there are a number of occurrences, such as a major fire, affecting the main distribution switchroom which in the worst case could lead to the island being without electricity for a considerable period (Billet D'Etat XIX, 1996). However, the cable link is to become the sole supply of energy to the island and the existing power station will be viewed as a back up. In 1995 the amount of time in which customers were without electricity due to generation faults was 12 minutes.

The following calculations have considered the environmental impact of the two scenarios: -

1. Business as usual approach – What will the ecological footprint be of Guernsey's energy supply when the cable link is in full operation?
2. What the ecological footprint of Guernsey would be if large and small renewable energy schemes were adopted, energy conservation and efficiency measures were adopted?

Initiatives/ideas resulting from the second scenario are:

- Promotion of renewable energy suppliers
- Promotion of energy conservation such as fridge 'energy savers', low energy lightbulbs, loft insulation, hot water tank jackets and so on.
- Solar clubs – to encourage installation of solar water heating systems

5.4.2 Business as usual Approach

The States Electricity Board has shown no interest in reducing the amount of energy required by the island. They have estimated that between 2000 and 2005 energy demand is set to increase by 17% as it did between 1990 and 1995. In 1997, Guernsey required 234 GWh of energy derived from mainly oil, but also gas, which has an ecological footprint of 19,709 hectares.

If Guernsey were to maintain the island's sole power station, the above estimate of energy demand would result in an increase in the ecological footprint for energy to 20,694.5 hectares by 2005.

However, it is not the intention of Guernsey to rely on this energy supply. The European grid uses a variety of fuels of which nuclear power is the most prominent source. The ecological footprint calculation for the European grid has been given below based on Guernsey's current energy demand (1998) and projected demand for 2005.

Energy Type	European Energy Mix	EF based on current demand (Hectares) (1998)	EF based on projected demand for 2005 (Hectares)
Gas	6.4%	2,070.88	2,174.43
Coal	29%	9,383.68	9,852.87
Oil	7.3%	2,362.1	2,480.2
Nuclear	34.8%	11,210.42	11,823.44
Hydro	20.7%	6,698	7,032.91
Renewables	1.8%	582.44	611.56
Total	100%	32357.52	33975.4
Total EF per capita		0.55	0.58

Table 5.4: The ecological footprint of supplying Guernsey with electricity from the European grid
Source: Author

The projection of 0.58 Ha./per capita in 2005 compares to an ecological footprint of 0.35 Ha./per capita with the existing power station, is a substantial increase. This increase would be solely due to the higher ecological footprint of the European energy mix, per unit produced. This demonstrates the lack of importance placed on environmental concerns when considering the new cable link development. The development is also in contradiction with Guernsey's Policy and Resource Planning Report (a document that is intended to guide future policy in Guernsey).

"The aspirations of the community can best be met if environmental conditions are such that in the development of policies and programmes, immediate long term environmental factors are given equal consideration alongside economic and social factors."
(Source: 1997 Policy and Resource Planning Report)

However, it is not even possible to state that economic considerations were the main driving force for such a decision as this was the most expensive option proposed by

Guernsey Electricity Board. It is difficult to find any justification for the project on environmental, economic or social grounds.

5.4.3 The Sustainable Model

This scenario is based on the two principles of energy conservation and renewable energy supply. The energy conservation scenario is based on information from the Association for Environment Conscious Building. They have considered the energy consumption of five different uses within the home and have emphasised their contribution to the total energy demand (Figure 5.7).

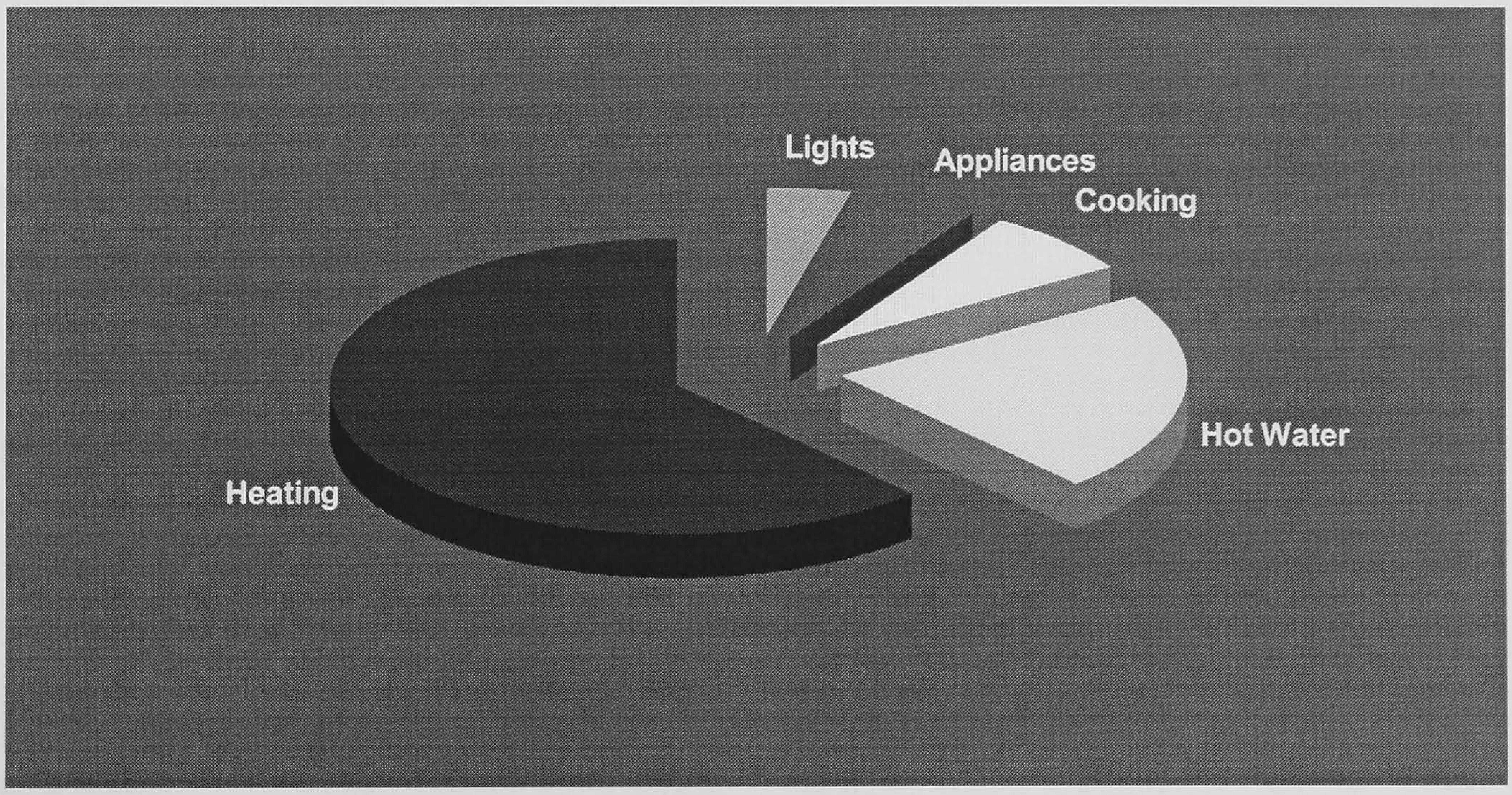

Figure 5.7: Domestic Energy Consumption of Different Uses
Source: AECD

Heating is by far the highest use of energy (68%) within the household and should therefore offer the greatest savings. The Building Research Establishment has highlighted the potential savings concerning insulation, double glazing and more efficient household appliances, suggesting that insulation is the most effective method by which to reduce energy demand. The savings that can be made in the new housing required on the island (see graph 1.5) are substantial. With encouragement from the Island Development Committee new homes could potentially be energy efficient, highly insulated units. The building of new houses without any consideration for energy efficiency is an unacceptable wasted opportunity. The negative effects of building new homes would be reduced if they were highly efficient users of energy.

5.4.4 Reducing Energy Demand in Domestic Housing

Table 5.5 below provides a simple analysis of the potential savings that can be made in three different types of housing (detached house or bungalow, semi-detached, terrace).

Measure	Detached House			Semi-Detached House			Terrace		
	Saving (£/yr.)	Payback time (yr.)	Energy saving (kWh)	Saving (£/yr.)	Payback time (yr.)	Energy saving (kWh)	Saving (£/yr.)	Payback time (yr.)	Energy saving (kWh)
Cavity wall Insulation	112	3-4	1417	112	4	1418	50	7	633
Solid wall Insulation (external)	150	9-10	1899	102	12-13	1291	55	13-14	696
Solid wall insulation (internal)	136	6-7	1722	136	6-7	1722	50	8	633
Roof Insulation	55	5	696	40	4-5	506	37	4-5	468
Floor Insulation	30	7-8	380	22	8	278	15	16-17	190
Replacement condensing boiler	150	2	1899	110	2-3	1392	82	3	1038
Hot water insulation package	20	2	253	10	3-4	127	10	3-4	127
Full heating control package	90	3	1139	70	4-5	886	57	4-5	722
Draughtstripping	22	6-7	278	20	6	253	17	7-8	215
Double glazing	37	4	468	22	5-6	279	25	4	316
Lighting	40		506	35		443	25		316

Table 5.5: Potential Reduction in Energy Requirements in Domestic Houses
Source: DETR: Good Practice Guide

The costs and savings figures will vary according to the size of the house, its location, fuel, heating system and material used. These figures are average savings and an independent survey of each house would be required to truly understand the actual saving made by introducing these measures. The figures are based on December 1996 prices.

It is unrealistic and probably unnecessary to implement all these energy saving measures in all the houses in Guernsey. The financial commitment to such a project would be enormous. However, it is possible to suggest some realistic scenarios adopting a different selection of energy saving measures. These have been included below along with the reduction in the ecological footprint if the schemes are adopted.

This approach considers the reduction in the ecological footprint if Guernsey attempts to introduce most of the energy saving initiatives listed above and nearly all of them in the construction of new houses.

At present there are 22,216 houses in Guernsey (Economics & Statistics Review, 1997). Guernsey is responsible for importing oil that generates 1515 GWh of electricity in 1997 (the equivalent of 1515,000,000 kWh). The ecological footprint of providing Guernsey's energy is 180,887 hectares of forest to absorb the carbon dioxide produced. Not all of this electricity is consumed by the domestic market. The domestic market is responsible for 41% of electricity consumption in Guernsey. Therefore, total domestic energy use in Guernsey, for 1997, was 591.20 GWh. Both consumption of electricity and the number of houses are set to increase. Table 5.6 demonstrates the decrease in persons per household and increase in the number of houses year on year.

	1971	1976	1981	1986	1991	1996
Persons per Household	2.96	2.88	2.76	2.70	2.61	2.55
Number of Houses	15,952	17,527	19,237	20,381	21,253	22,216

Table 5.6: Increase in houses within Guernsey from 1971 to 1996.
Source: Economic and Statistics Review, 1997.

The latest data from Guernsey Electricity is that they now have 22,265 domestic customers. Of these 22,265 customers the following split in houses is: -

- 10,000 Semi-Detached
- 7,000 Detached
- 3,000 Terrace
- 2,000 Flats

(These figures are approximations made by the Island Development Committee)

From these figures, taking the average energy use of different houses, it has been possible to determine what the GWh's used by the different house types were: -

- Average consumption of detached house in Guernsey = 42,996 kWh, per year. Therefore, detached houses are responsible for 301 GWh of electricity per year (States of Guernsey, 1998).
- Average consumption of semi-detached house in Guernsey = 32,247 kWh, per year. Therefore, semi-detached houses are responsible for 322 GWh of electricity per year. (States of Guernsey, 1998)
- Average consumption of a terrace house in Guernsey = 21,498 kWh, per year. Therefore, terrace houses are responsible for 64 GWh of electricity per year (States of Guernsey, 1998).

5.4.4.1 Policy Initiatives for Domestic Household Energy Reduction

Eight different suggestions for reducing household energy have been given below, along with the subsequent change in the ecological footprint of energy. None of the scenarios below assume that there will be a 100% success rate. Some households on Guernsey will have carried out some of the ideas suggested. There is no data available concerning the number of houses with double-glazing and other energy efficient measures. The energy efficient measures have been divided into external and internal measures.

5.4.4.2 External Measures

These include cavity wall insulation, loft insulation, double-glazing and draughtproofing[5].

Cavity wall insulation offers one of the largest gains in energy efficiency. Not all houses are suitable for insulation, but most houses built after 1930 are. The aim is to reduce the loss of heat through the walls. For the average household cavity wall insulation will reduce fuel bills by 35%.

Double-glazing can reduce heat loss through windows by up to 50%. Heating represents 68% of household energy consumption (see figure 5.6) and the insulation of double-glazing offers a 7% reduction in the energy bill of the average household.

Heat loss through draughty doors and windows is responsible for 20% of heat loss in an average domestic home. Through the installation of draughtproofing this can be reduced to 5%.

For Guernsey to reduce its domestic energy consumption it is important to establish a target for each year. It is proposed that Guernsey should have 5% a year of houses installed with the 3 suggestions above. This means that 1,000 houses a year would be fitted with the insulation, double-glazing and draughtproofing. To start with this

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[5] All the figures listed below were found on the government website for Energy Efficiency (www.est.gov.uk)

would be an easily achievable target, as some houses will already have a combination of the energy saving measures. Over a period of 20 years almost every house on the island would be well insulated having a substantial effect on the energy footprint for Guernsey. This has been calculated below for the three different house types (detached, semi-detached and terrace). Even if Guernsey perceive this to be an unrealistic target, whatever they feel is achievable can be seen though the eyes of the footprint. For example, in figure 5.8, the figure for 2010 represents 50% of all houses being fitted with the three suggestions measures. It is also possible to understand a different success rate within these three categories. For example, 30% of houses fitted with double-glazing, 20% with wall-cavity insulation and 50% with draughtproofing. The footprint offers a flexible tool by which to measure the effectiveness of a change in policy.

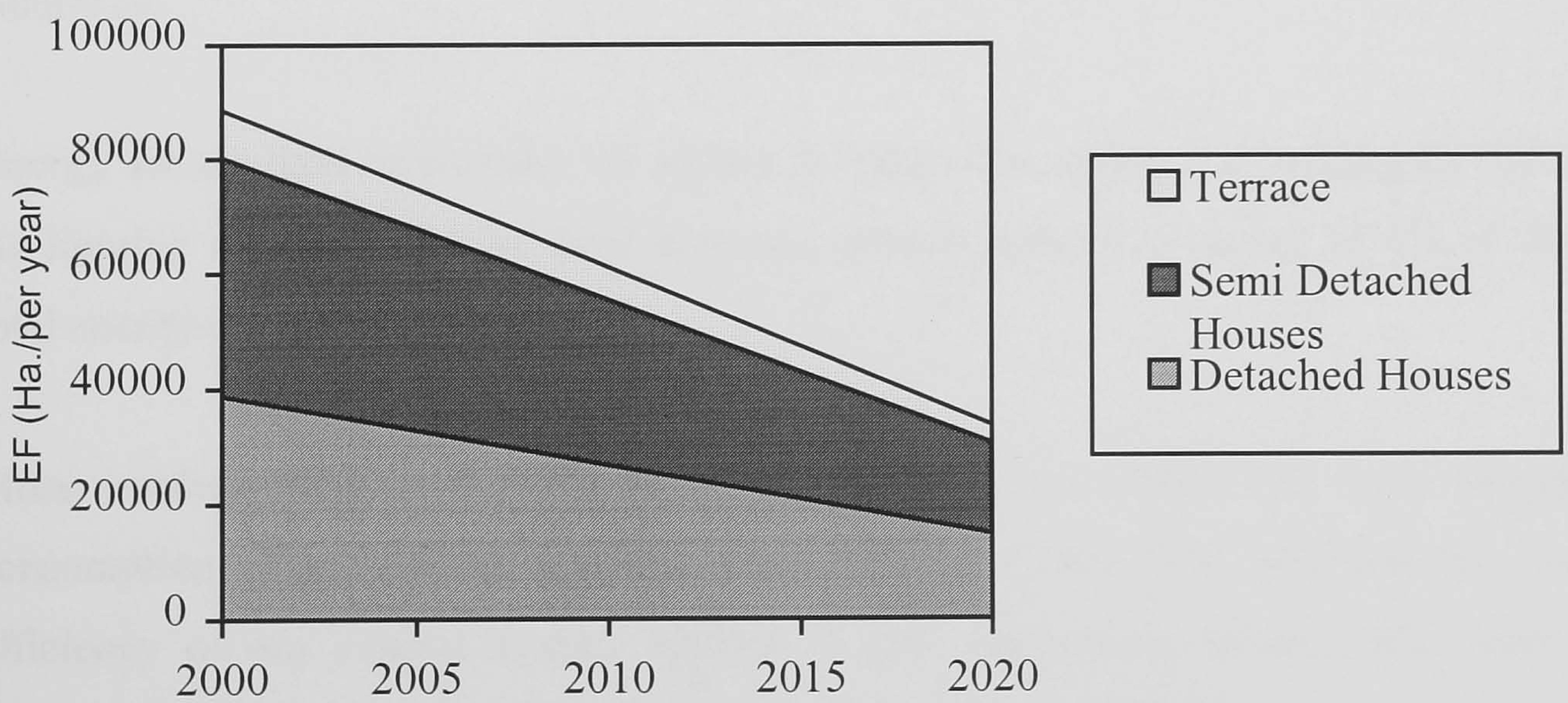


Figure 5.8: Reduction in the ecological footprint of domestic energy with the implementation of external energy saving measures.
Source: Author

Figure 5.8 only includes the external energy efficiency measures and these have achieved a 62% reduction in the domestic energy footprint over a 20-year period. As stated, if this is perceived as being too adventurous then a 50% success rate would mean a 31% reduction. Without any other measures the domestic energy footprint would reduce from 1.27 Ha./per capita to 0.48 Ha./per capita. With a 50% success rate in the scheme the domestic footprint would reduce to 0.88 Ha./per capita.

5.4.4.3 Internal Measures for Domestic Energy Conservation

Three internal measures have been suggested below concerning the reduction of domestic energy use.

The European Community has introduced a labelling scheme for fridges, freezers, washing machines and tumble dryers. The 'Eco-label' scheme provides a clear indication of the more energy efficient machines that are on average 50% more efficient than conventional machines. For example a washing machine with a 'classification B' requires 1kWh per wash while the popular classification 'E' requires 2.2 kWh per wash (Natural Collections, 1999). Appliances represent 5% of the electricity consumption in an average household (see figure 5.6). The associated policy is to allow only the most energy efficient appliances to be imported into Guernsey.

Energy saving light bulbs have the ability to reduce the energy for lighting by 75%. As lighting represents 4% of total domestic energy demand a saving of 3% on the total energy consumption is possible.

More modern heating controls have the potential to reduce the total energy consumption of an average domestic household by 13.6%. This will improve the efficiency of any central heating system. A new condensing boiler could reduce energy demand by 7%, depending if the house is insulated properly.

With the introduction of all these measures and using the same model as above (1,000 houses each year adopting all the measures) a 28% reduction in the total energy demand is possible. Figure 5.9 provides an understanding of what would happen if both external and internal energy efficient measures were taken.

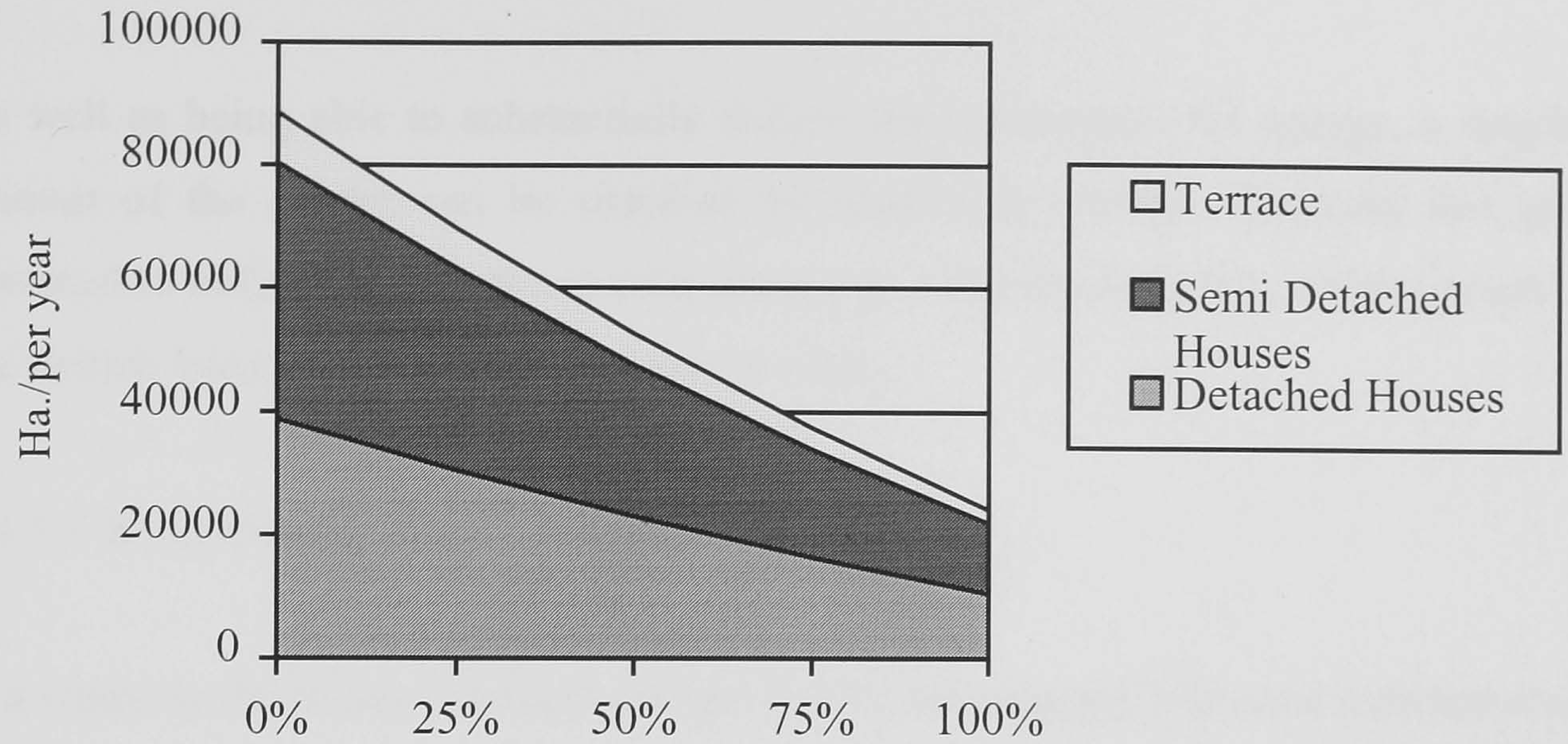


Figure 5.9: Reduction in the ecological footprint of domestic energy with the introduction of internal and external measures.

Figure 5.9 and other similar footprint graphs can be used very easily as a tool for quick calculations. It is possible to look at the graph and establish how much the footprint would decrease if the domestic energy use were reduced by 25%. Therefore, practitioners and decision-makers are able to set incremental targets and visualise the outcome in terms of ecological impact.

The overall gain from implementing all these suggestions is a 73% reduction in the domestic energy footprint. This would mean a domestic energy footprint of 0.34 Ha./per capita.

A substantial number of the measures listed above can also apply to the commercial sector. Ignoring industrial and horticultural energy requirement for the moment, offices could benefit enormously from the suggestions above. Even if offices were only able to achieve a 50% reduction this would have a substantial effect on the total footprint of Guernsey. The commercial energy footprint of 0.62 Ha./per capita could be reduced to 0.31 Ha./per capita.

5.4.5 Renewable Energy

As well as being able to substantially reduce the requirement for energy, a tangible amount of the energy can be supplied by renewable sources. Guernsey has great potential to utilise both wind and solar energy as it has the longest 'sunshine hours' in the British Isles as well as strong offshore winds.

5.4.5.1 Wind Energy

In a study by the States Electricity Board (SEB) they suggest that wind turbines could meet 9% of Guernsey's energy demand. There are three possibilities that SEB have failed to take into consideration: -

- SEB have not considered energy conservation techniques that would reduce overall energy demand on the island;
- SEB did not consider the benefits of an offshore wind farm;
- SEB were only looking at big projects, not addressing small-scale energy production.

By taking these key points into consideration wind energy becomes more of a viable option for Guernsey. With a 38% reduction in the energy requirement of the island, wind power, using SEB's estimate, could provide 15%. This is without including offshore wind energy or the introduction of small-scale projects.

5.4.5.2 Photovoltaics and Passive Solar Systems

The large unused area available on buildings in urban locations offers the potential for significant point-of-source electricity generation (Pearsall, 1995). The use of PV roofing becomes particularly attractive when considering commercial building, as their main energy requirement is during the day and that is when the energy source is available, i.e. the sun. The main environmental impact of PV is the embodied energy within the production. This is why PV has a higher ecological footprint than other forms of renewable energy.

While one of the reasons for rejecting PV, as a viable energy use is the cost, this is something that is set to improve. There are encouraging forecasts that suggest that PV cladding systems could reach cost competitiveness in the UK by 2008 (Orrock et al, 1995). This would result in a five-year pay back in Guernsey. Considering that the current lifetime of PV panels is about 30 years, the energy pay-back is at least four times the embodied energy (Orrock et al, 1995).

The Centre for Alternative Technology (CAT) has established the gains that can be made with the use of solar heating and photovoltaics for houses in the UK. Guernsey could potentially benefit even more with the longer sunshine hours. Provided below is an example developed by CAT of a detached house and the energy requirements of that house. The house is already well insulated with double-glazing and other energy efficient measures.

Heating Sources	kWh (per year)
Casual gains	2508
Solar gains	1890
Heating system	1855
Water heating	3900
Total	10,153

(Source: Borer & Harris, 1998:205)

The house is fitted with passive solar measures such as the windows are south facing, tiled floor, dense wall finishes and masonry partitions. It also has a solar water heating system. When comparing this house with the average detached house in Guernsey the energy savings are substantial. The low energy house requires a total of 10,153 kWh per year while the average Guernsey house requires an average of 42,996 kWh; a saving of 32,483 kWh. Not only is there a reduction in energy use but the energy is produced with the use of solar energy. The gains are represented using the ecological footprint below.

The ecological footprint of the existing detached house in Guernsey 3.58 ha.

The ecological footprint of the solar house 0.178 ha.

The potential saving in terms of the ecological footprint is substantial at a ratio of 1:20.

The policy that is required to make PV a realistic energy source is viable. An example of solar energy in Saarbrucken in Germany[6] provides an insight into the required policies for Guernsey. Saarbrucken is a city with 190,000 occupants that invested in a programme of solar energy. Since 1986, over one million pounds has been spent on solar heating, PV systems or other forms of renewable energy. There is a 50% subsidy available for technical assistance and local banks offer favourable lending terms for installation. The local energy company owns the PV array, but the inhabitants benefit from the solar electricity supply. From Saarbrucken being a former coal-mining centre, it has now become a centre for the development of solar energy systems.

5.4.6 Ecological Footprint for the Sustainable Energy Scenario

The energy scenario has revealed that some of the largest savings on the ecological footprint can be gained in this area. The scenario is based on the assumption that for both external and internal energy efficiency measures there is a 50% success rate. Considering all forms of energy savings, it is possible for Guernsey to reduce its energy consumption by 38%. This reduces the ecological footprint of energy demand from 3ha./per capita to 1.86 ha./per capita.

The scenario also considers different methods by which to produce the energy with 15% of Guernsey's energy demand being produced by wind turbines. Solar energy was also contemplated. Assuming 15% of the houses in Guernsey were fitted with solar energy the following calculations apply: -

1. The ecological footprint of wind energy (15%) 610.6 ha.
2. The ecological footprint of solar power (15%) 2474.1 ha.
3. The ecological footprint of the oil power station (70%) 57855.3 ha.

[6] This example was taken from Girardet, 1999, page 45

In per capita terms the overall ecological footprint for energy production in Guernsey, when applying the sustainable energy scenario is 0.96 ha./per capita.

5.5 Transport - The Modal Shift Scenario

This scenario includes all forms of transport, with car travel having the most significant impact (the second highest impact of all the components, see figure 4.5). The ecological footprint of the passenger transport in total is due to an extremely high reliance on the car for all activities. To understand the ecological footprint of passenger transport for different activities, UK Government statistics have been applied. This provides an insight into the effect of commuting, shopping and school trips.

Purpose for Trip	Percentage of Journeys	Consumption (passenger km)	Ecological Footprint of Journeys (Ha.)	Ecological Footprint per capita
Commute[7]	28	604,800	25,681.99	0.428
School Trips	19	410,400	17,426.99	0.290
Leisure[8]	16	345,600	14675.36	0.245
Shopping	22	475,200	20178.15	0.336
Social	15	324,000	13758.15	0.229

Table 5.7: Journey per person per year by main mode and purpose combined with the corresponding ecological footprint of mode for Guernsey.
Source: Column 1 & 2 – Transport Statistics Great Britain (1997); Columns 3 to 5 – Author.

5.5.2. Changing the Daily Commute

To understand the change in transport behaviour and the subsequent reduction in the ecological footprint it is important to have some knowledge of the current modal split. Without a travel survey to provide an accurate estimate of current modal split it is

[7] Commute includes; personal business (8%), course of work (3%), and commute (17%).
[8] Leisure includes; eating and drinking (3%), entertainment (4%), holidays (1%), day trips (6%), and sports (2%)

difficult to formulate a modal shift strategy with sufficient confidence to propose detailed courses of action. For the purpose of this scenario it is possible to make a reasoned assessment, based on the available information[9].

- The use of the car with the driver being the only occupant = 78%
- The use of the car with more than one occupant = 7%
- Walking to work = 6%
- Cycling to work = 6%
- The use of the bus to travel to work = 3%

These figures represent the modal split for the daily commute into St Peter Port. Most of the commuters are employed within the finance industry (some 80%) while the other 20% is made up of the hotel industry, tourist industry and a small proportion of other industries. Therefore, it is reasonable to assume that most commuters will be arriving in St Peter Port between 08:00-08:45 and leaving between 17:00 and 17:45. This is reflected in the congestion of traffic arriving and leaving St Peter Port at these times.

This scenario is based on a three-year transport scheme to change the modal split. It is not possible to predict the exact percentage change in the modal split. However, it is suggested that if implemented a change a modal shift in the 20-30% target range can be achieved. Details of the scheme have been given below.

5.5.2.1 Car Sharing

Car sharing is often one of the most successful areas of modal shifting, because it involves a less drastic change from the culture of car-borne travel behaviour. At present, it is estimated that only 7% of the commuters are car sharing. The predominant car sharing is estimated to be between couples travelling to St Peter Port. Previous studies in the UK, conducted by Whitelegg (1998 & 1999) indicate that 47% of the total commuters are prepared to consider car sharing. There appears

[9] The available information includes: information from participants within the focus group study, the number of car parking spaces provided in St Peter Port, discussions with staff at the States Traffic Committee and discussion with the transport officer for Friends of the Earth (Guernsey).

to be scope for expanding car sharing within Guernsey. Car sharing is perceived to work best when hours are fixed, a situation that does occur in St Peter Port in many of the offices.

Measures to improve the attractiveness of car sharing (discussed later) could increase its use, but the extent of this effect is difficult to judge. Existing low levels of sharing could indicate a high potential for further growth. The following calculation is the potential car share for the scenario.

Assumption 1: A shift of 47% of the single car drivers to car sharing meaning a 37% shift of the total commuter population. Therefore, the total commuter population involved within car sharing is 44%.

Assumption 2: The average occupancy for a shared car is 2.5 occupants.

78% of commuters travel in a car with only the driver. Therefore, with a shift of 47% towards car sharing, this signifies a decrease in passenger-km travelled by 88,687.9 km reducing the commuter passenger/km to 383056.1 km. This represents a reduction of 14.66% in passenger/km for commuting.

The reduction in the ecological footprint for commuting is therefore 13,446.3 Ha./per year, which on a per capita basis means an ecological footprint for passenger car transport of 1.3 Ha./per capita, a reduction of 0.22 Ha./per capita.

To help inaugurate a car-sharing scheme several incentives can be put in place to assist this process: -

1. Guaranteed ride home: this was introduced by Boots, to overcome the fear of the lift failing by guaranteeing a taxi ride home in such an eventuality.
2. Car share advice scheme: this would provide commuters with all the necessary information on car sharing, including a computerised database to put people in touch with other commuters living in the same area.
3. Preferential parking facilities: car sharers can be allocated the best parking places closest to the offices, and be offered free parking where charging will be put in place.

5.5.2.2 Car parking

Levying a charge for workplace parking is a potential tool in encouraging modal shifts in travel behaviour, by increasing the cost of travel by car thereby decreasing the car's financial attractiveness relative to other modes. At present, in Guernsey there are no car parking charges for any of the car parks. This has proven to be a controversial topic and there have been major objections to plans by the States Traffic Committee to introduce car-parking charges on the three main car parks in St Peter Port. Because of the controversial nature of car-parking charges in St Peter Port the States Traffic Committee (STC) commissioned a report on how much people would be willing to pay before shifting to another mode of transport, or car sharing. The results from the publication were that if a £2 per day parking charge was introduced, a 12% modal shift would occur (STC, 1996). Unfortunately, the study did not attempt to predict what this modal shift may be (i.e. cycling, the bus or walking). However, this does offer an insight into the potential modal shift with the introduction of car parking charges.

Taking the figure of a 12% modal shift, the reduction in the ecological footprint of passenger transport would be 11,007 Ha./per year, which signifies a reduction of 0.18 Ha./per capita.

5.5.2.3 An Improved Bus Service

Guernsey's existing bus service is unpopular and often accused of being unreliable and infrequent. In an effort to reduce the ecological footprint of commuting, a bus service that caters for the busiest times is essential. At present there is no such system. Attempting to calculate what the reduction in car use may be with the introduction of a more popular bus service may be difficult. However, an assumption has been calculated below based on passenger numbers.

Guernsey buses are small, in that they can only hold an average of 26 people. Therefore, if we assume the bus is half full for all its journeys, it has the ability to remove 16 cars from the road with one bus journey (assuming the average occupancy of a car is 1.6). Therefore, a 10% reduction in car passenger/kms, only signifies an increase of 1.6% in bus passenger/kms. Figure 5.10 demonstrates the reduction in the ecological footprint with a modal shift from cars to bus.

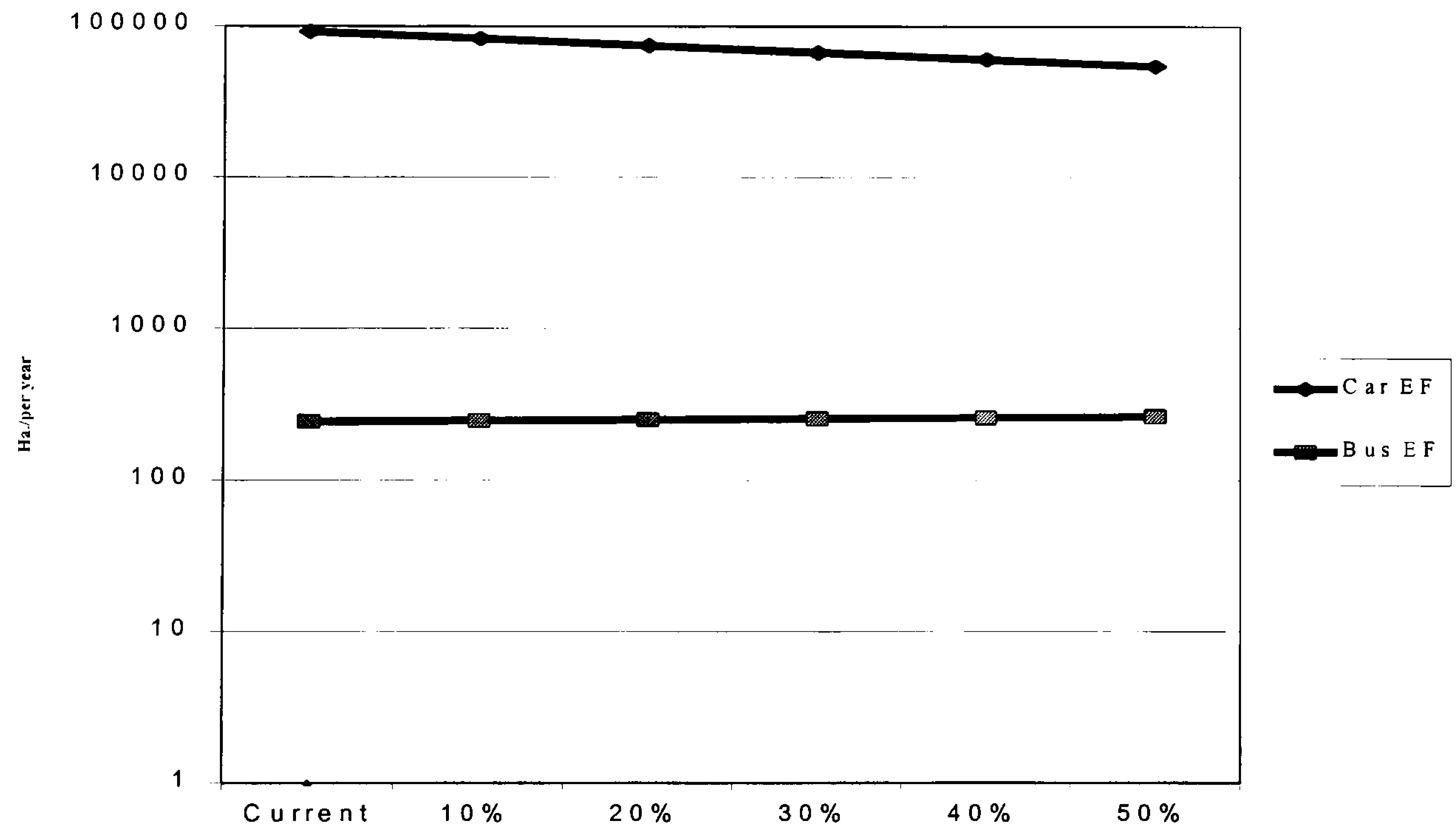


Figure 5.10: The subsequent increase in the ecological footprint of bus travel with a reduction in car use.

Source: Author

(N.B. The scale for figure 5.10 is logarithmic to make it possible to see the increase in the ecological footprint of buses in comparison with the reduction in the ecological footprint of car travel.)

What is most noticeable about figure 5.10 is the substantial reduction in the ecological footprint with a modal shift from the car to the bus. If the assumption that a 10% modal shift towards buses can be achieved the reduction in the ecological footprint is 0.15 Ha./per capita.

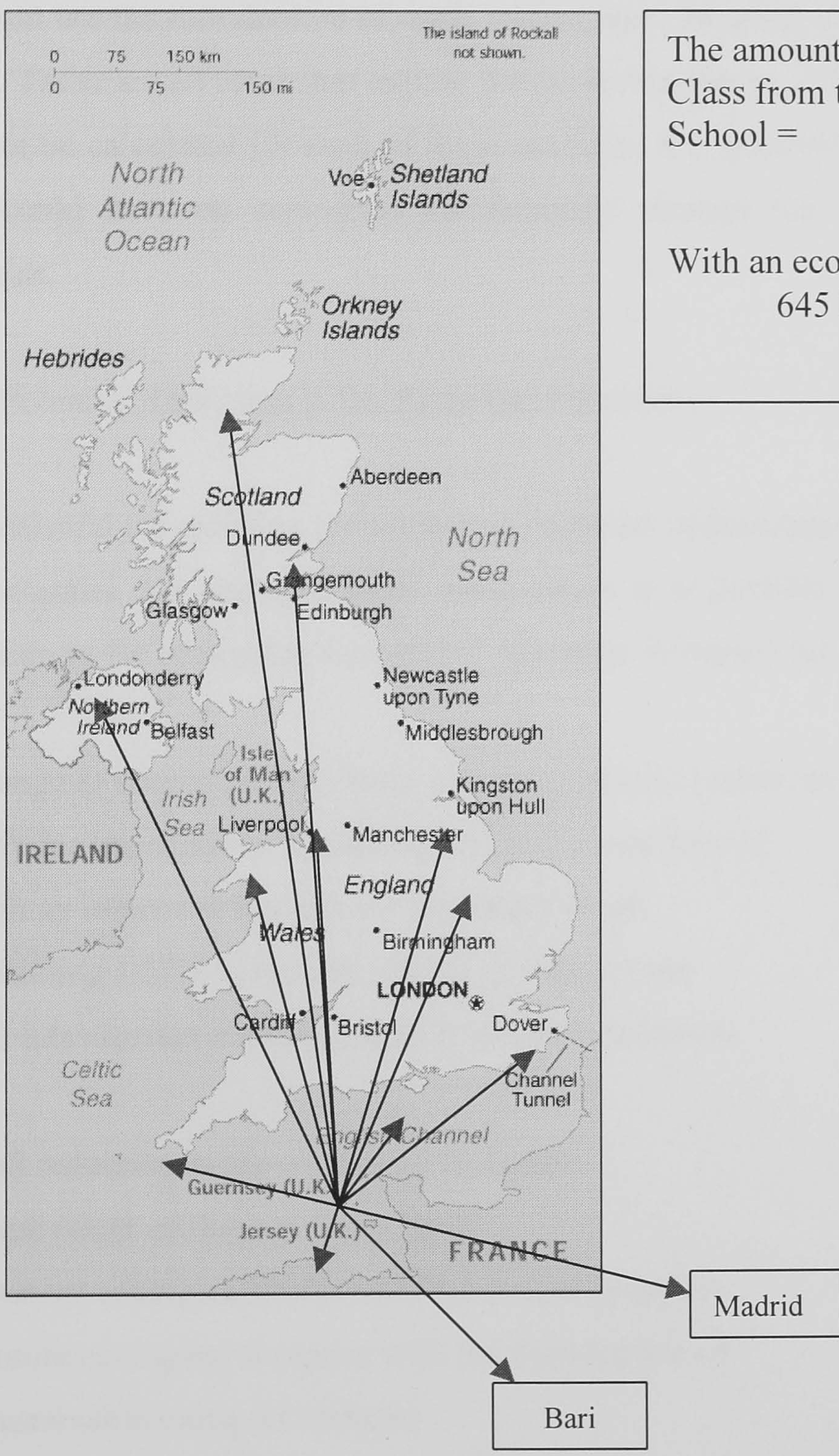
5.5.2.4 The School Trip

In Guernsey nearly 80% of all school trips are carried out by car. This offers an opportunity to reduce the ecological footprint of the school run substantially with the introduction of 'walk to school schemes', school bus services, and cycle-friendly routes for school children. Only a small percentage of school children would not be able to benefit from one of these three schemes. There is no reason, other than apathy, why an integrated transport system could not accommodate all the schools.

Figure 5.11 introduces a scheme where each class from every school in Guernsey could understand the ecological footprint of travelling to school by car. It documents an example taken from class 3.B from the Grammar School in Guernsey. The whole class of 18 pupils was asked to find out how far it was for them to travel to school each day and how they travelled to school. Figure 5.11 demonstrates how far each pupil would have travelled each year and the ecological footprint of the class. In a very visual depiction of their journeys figure 5.11 highlights that some pupils have travelled as far as the north of Scotland in one year.

Figure 5.11 provides an educational tool by which each class can compare their ecological footprint for commuting to school and understand the importance and the methods by which to change this. There can also be comparisons between schools, on a per capita basis, even a school competition for the lowest footprint. With money made available to schools there will be a greater emphasis on providing buses for school trips, encouraging the use of the bike and walking for pupils that live close to the school.

Figure 5.11 demonstrates that out of the whole class only 5 pupils out of the 18 walk to school, none use the bus or cycle and the rest travel by car. There is enormous scope for improvement.



The amount of CO2 produced by one Class from the Guernsey Grammar School = 144.5 kg

With an ecological footprint of 645 hectares

Figure 5.11: The Equivalent Distance travelled in one year by one class of 18 pupils
Source: Author

5.5.2.5 Other Possible Car Travel Reduction Schemes

Other schemes that could potentially reduce ecological footprint of passenger transport are the introduction of cycle routes, more localised shops and working from home. These are all ideas that require further investigation. When the reduction in car use can be calculated for each of these activities it is possible to establish the effect they could have on ecological sustainability through the use of the ecological footprint.

5.5.3 Potential Reduction in the Passenger Footprint

The potential for reducing the ecological footprint of passenger transport in Guernsey is substantial. By applying some assumptions it is possible to estimate an overall reduction in the ecological footprint of passenger transport for Guernsey.

1. Change in commuter behaviour will bring about a reduction of	0.22 Ha./per capita
2. With the introduction of parking charges a reduction of	0.18 Ha./per capita
3. With an improved bus service the reduction of	0.15 Ha./per capita
4. Assuming a 50% behaviour change in school trips	0.15 Ha./per capita
5. The introduction of other possible transport solutions	0.10 Ha./per capita

Overall reduction in the ecological footprint	0.8 Ha./per capita
The equivalent ecological footprint of	48,000 Hectares
The current ecological footprint of passenger transport	1.53 Ha./per year
The future ecological footprint with the introduction of	
The sustainable transport scenario	0.73 Ha./per capita

Although assumptions have been made in order to reach this final figure, the ecological footprint has offered an insight into the benefits of changing commuter behaviour, offering an empirical response to a subjective subject. The one caveat to this conclusion is that there is a degree of overlap in the target populations for the various modes. Therefore, the reduction in the ecological footprint could be lower than calculated.

5.6 Freight Transport Scenario

An effective way in which Guernsey can reduce its ecological footprint for freight transport is to reduce the amount of supplies that are exported to the island. The other method is a more efficient use of freight transport for the importation of goods such as working with local businesses to reduce empty lorry trips.

5.6.1 Local farmers markets to reduce 'food miles'

Boge (1993) with her analysis of local and imported strawberry yoghurt demonstrated the real costs of freight transport. More saving could come from decentralised dairies. Low transport intensity production means the production of more locally sourced goods. As consumers are becoming interested in the transport issue and are developing preferences for locally produced goods, markets for local food are being created. This is something that is not happening at any noticeable rate in Guernsey. As well as the transport requirements to bring foreign produce to England, Guernsey has the extra burden of shipping the produce to the island. There are potentially substantial benefits for Guernsey to recognise the value of local production. While, as demonstrated in section 4.2, it would be impossible for Guernsey to produce all its own food, it is possible to produce some. Research by Jones (2000) demonstrates the value of locally grown food over imported items in a study of sourcing, distribution and marketing of apples. Table 5.8 displays the results for Denbigh and Brixton.

		Energy Consumption (MJ/kg apples)	
	Retail Outlook	Imported	British
Denbigh	Supermarket	2.610	0.245
	Greengrocer	2.601	0.253
Brixton	Supermarket	2.695	0.091
	Greengrocer	2.689	0.129

Table 5.8: The energy consumption of imported and British grown produce

Source: Jones (2000:20)

Table 5.8 provides a useful analysis of the benefits that Guernsey could gain from local production. It is now necessary to calculate the amount of produce that Guernsey could produce.

With the introduction of global equivalence factors (see section 3.5.3) Guernsey has 11,200 hectares suitable for agriculture. Assuming that the crops produced are varied, are all vegetables, and are organically grown it is estimated that 18,000 kg/ha./per year (taken from table 3.7) is the yield factor. Therefore, Guernsey could potentially produce 20,160 tonnes of food each year. At present, Guernsey imports over 60,000 tonnes meaning that they could reduce import of food to 39,840 tonnes.

5.7 Bioregionalism in Guernsey – Footprinting the local against the global

Guernsey produces very little of its food locally, with milk being the only real exception. The two models in section 5.2 (linear and circular metabolism) look at the issue of what the ecological footprint can inform us about local sustainability. Chapter 2 stressed the significance of local sustainability believing it to be where most positive change has occurred, and will occur in the future. Moreover, while monitoring the ecological footprint of Guernsey and devising methods to reduce it, many of these approaches rely on Guernsey adopting a more bioregional approach.

With the implementation of all the ideas within the scenarios, the ecological footprint of Guernsey would be 4.77 ha./per capita. This, although not considered a sustainable footprint, is a substantial reduction for Guernsey. When considering the direction in which the scenarios would take Guernsey it is a more bioregional approach. For waste, the scenario is about a better circular use of waste, for energy it is about local supply and a reduction in demand and finally for transport it is about reducing the car need to import goods by producing them locally and relying on sustainable transport schemes. The ecological footprint has demonstrated that today's fossil fuel, auto-centric, throwaway economy cannot be sustainable. The future lies in a solar/hydrogen-powered, bicycle/bus centred, re-use-recycle, local economy. The less reliance that Guernsey places on external forces the smaller the ecological footprint and an improvement in the economic security of the island.

The solutions to reducing the footprint in Guernsey rely on a diverse economy and innovative thought. The footprint cannot bring about change but it can guide policy if the desire for change is present. Less reliance on the global economy and the development of a local identity for Guernsey are all part of the shift to a sustainable society.

A bioregional approach also has the advantage of linking our demand with nature's supply. The ways in which we conceptualise environmental problems have a great deal of influence on how we try to address them. Lipschutz (1999:102) suggest that,

"The complexity of such sociospheric and biospheric connections produces a confusion of causes, consequences and linkages that are difficult to parse."

Most importantly, the complex linking of local and global means is dissolved when a society no longer has a relationship with the ecosystems that provide them with their materials, food and life-support systems. The bioregionalism approach offers a solution; it offers Guernsey the opportunity to understand the relationship between human demand and nature's supply.

5.8 Conclusions

However complex the calculations may be in the footprint, it is simplistic in its message. It is clearly possible to see the consequences or success of a policy decision. It ignores the idiosyncrasy of politics and merely provides the facts. The footprint by-passes the slow process of what can and can't be done and shows us the true consequences of consumption. The footprint goes some way to answering the question,

"Can humans be compatible with the integrity of the biosphere?"

The scenarios for Guernsey, although sometimes crude because of lack of available data, tell us that it is possible to come closer to achieving the ecological dimension of sustainability is possible. Some adjustments on subsidies and encouraging particular investment along with education and local democracy provide a solid foundation for sustainability.

CHAPTER 6: THE ECOLOGICAL FOOTPRINT: AN AWARNESS RAISING TOOL?

6.1 Wider uses for the ecological footprint

A growing awareness of environmental issues and the ideas encompassed within sustainability should lead to increasing public concern. There is still, as yet, little consensus about how the environment can best be protected while allowing for further social and economic development at national and local scales. As Axelrod & Lehman (1993) have suggested, the importance of investigating the psychological antecedents of individuals' reactions to environmental concerns is vital, as we attempt to better understand the factors that guide individual choice regarding environmentally responsible behaviour.

One central problem is that the burden of environmental degradation does not always fall directly upon those who reap the benefits of the activities in question. The previous chapters have attempted to highlight this problem, but can the public take on such an issue? Furthermore, the isolated actions of particular individuals may not always be perceived by the actors as having a substantial damaging effect. This can possibly be attributed to a poor understanding of sustainability due to its abstract nature, or does the problem have deeper roots of cultural and psychological significance?

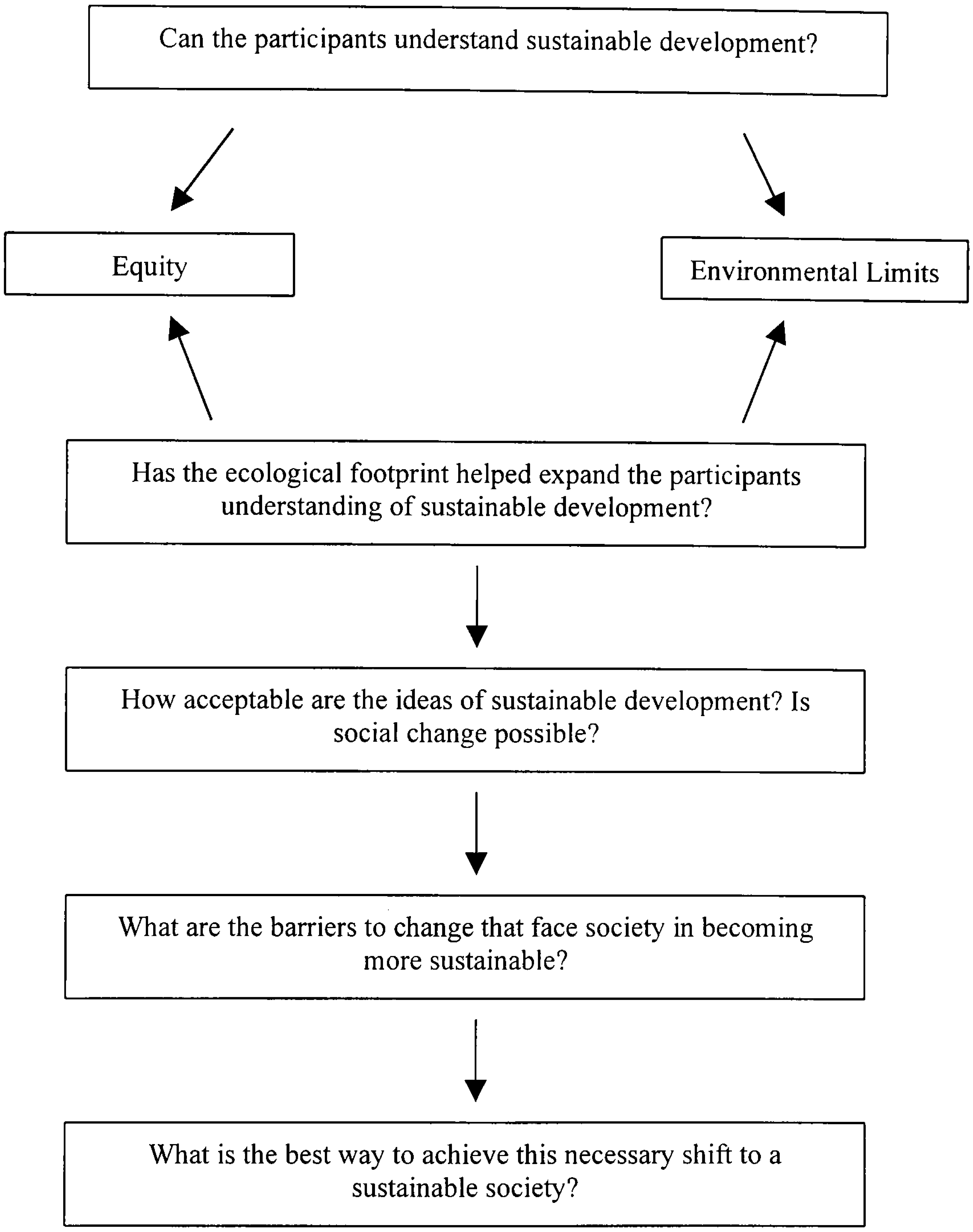
As a principle, sustainability does not come with its own rules of implementation and action. Deliberation and thought are required taking into consideration the needs of a specific location. According to Barry (1996), the collective analogue to this process of deliberation is public discourse and debate. The issues involved in the translation of sustainability from an abstract, academic concept to a regulative social principle requires the consideration as well as the consent and action of those whose lives will be affected by the transition.

There is the general acknowledgement that a continuation of the present levels of resource consumption and waste assimilation is likely to lead to environmental deterioration on a large scale. First, a model is required to assess the environmental degradation caused by the people in a specific geographical area. Second, it is important to assess the public understanding of sustainability with the use of this model. The first stage of this process has been completed. This chapter is concerned with the public perceptions of sustainability through the informative analysis provided by the ecological footprint.

Under this remit certain questions can be proposed.

- Part of the criteria for establishing a comprehensive set of indicators of sustainability lies in its ability to be understood by the public. Can the indicators provide a clear and comprehensive tool for people to understand their environmental impact?
- Will the ecological footprint help to contribute to environmentally benign behaviour?
- Do environmentally destructive lifestyles exist due to an uninformed public?
- Do individuals fail to adopt a more environmentally benign lifestyle due to a lack of sustainable choices within society?

The questions above have been born out of the detailed model below. The model attempts to form a logical and rational journey through the important issues embedded within the topic of public perceptions of sustainable development.



Source: Author

6.2 The Methodological Selection

Section 1.9 has explained the overall approach to the research from a methodological viewpoint. From the overall research strategy different research techniques have been chosen to collect the data for different parts of the thesis. To establish the answer to the questions posed within this section, focus groups were conducted for which the ecological footprint was made a crucial component. The design of the focus group was of extreme importance, as it was required to answer the demanding and thought provoking questions above. This methodological selection corresponds to the overall strategy of a qualitative approach.

6.2.1 Qualitative Research Techniques

There is an emerging recognition that quantitative research techniques fail to deal adequately with people's ambivalence (Macnaghten et al, 1995). They have largely failed to question the wider social and political significance of environmental concern in western industrialised society. With these issues in mind there have been a number of attempts to examine relevant public perceptions, using 'qualitative' methodologies (Waterton and Grove-White, 1993).

Recent examples of such research, within the framework of sustainability issues, include reports for the Countryside Commission using a combination of focus group discussions and quantitative tests to explore the attitudes of the public towards sustainable development (HPI, 1994). A consultant's study for Hertfordshire County Council (LUC and CAG, 1994), designed to explore the views of residents towards issues of sustainable development through focus groups, provides another example of the use of qualitative research techniques. Such qualitative focus group studies provide arguably richer accounts than previous studies of public perceptions of sustainability issues.

6.2.2 The Focus Group Approach

6.2.2.1 An Introduction to Focus Groups

In the focus group approach group interaction is employed to generate the data for analysis. Group forces or dynamics become an integral part of the procedure with participants engaged in discussion with each other rather than directing their comments solely to the moderator (Catterall and Maclaran, 1997). It is assumed that group interaction will be productive in widening the range of responses, activating forgotten details of experience, and releasing inhibitions that may otherwise discourage participants from disclosing information (Merton et al, 1956).

Catterall and Maclaran (1997) described the benefits from participant interaction as synergism, snowballing, stimulation and spontaneity. Also, Kruegar (1994) argues that focus groups produce data that are rich in detail and difficult to achieve with other research methods.

Focus groups are dissimilar from other group interviews, as Frey and Fontana (1993) have attempted to show. A distinguishing feature of the focus group is namely that the discussion is focused on one particular topic. There are also a variety of focus groups ranging from exploratory, clinical and phenomenological groups, which are selected on the basis of the research purpose and the underlying research approach or philosophy involved. As well as addressing a particular topic, the focus group technique is flexible enough not to be precise about the discussion. To a certain extent the focus group is free to discuss issues which may be of particular concern or interest.

To reiterate the introduction to focus groups, table 6.1 outlines the main advantages and disadvantages with the use of focus groups.

Advantages of Focus Groups	Disadvantages of Focus Groups
For practical reasons they are easy to undertake, it is efficient to interview a number of people at the same time, and results can often be obtained in a reasonably short time span.	The skill of the moderator can have a tremendous impact on the success of the group, i.e. whether discussion flows freely.
Social interaction with a group yields freer and more complex answers, due to interactive synergy, snowballing, spontaneity, and security of participants within the group.	Groups can be difficult to assemble, and considerable care must be taken to provide a setting conducive to the discussion.
The researcher can probe for clarification or greater detail, and unanticipated but potentially fruitful lines of discussion can be pursued.	Individual responses are not independent of one another. The evaluator has less control than in an individual interview.
Responses have high face validity due to the clarity of the context and detail of the discussion.	There is a great deal of specific information, some of it tangential to the topic, making analysis and summarisation of results challenging.
Focus groups can work well with any particular population.	Because participants are not randomly sampled from the population, the evaluator cannot freely generalise from the results.

Table 6.1: The advantages and limitations of focus groups
Source: Author

It can be surmised from table 6.1 that the approach is flexible, allows subjective thought and is not limited by a hard, fixed response to research. The goal of the focus group method is to gather as much information as possible. Open discussion is encouraged under conditions of complete confidentiality. The moderator, only when necessary, stimulates the discussion and keeps it on course. Both concrete information and opinions are considered relevant. Every response is considered valid. There is no attempt to support or criticise any response, resolve any issue, address any individual problem or concern, or reach a conclusion. The goal is only to gather as much information from as many different viewpoints as possible. The focus group technique explores an issue more then attempting to establish concrete conclusions on the topic.

6.2.2.2 The validity of focus groups

The essence of qualitative research lies in the intense involvement between the researcher and their participants. The moderator can challenge and probe for the most truthful responses. Qualitative research can yield a more in-depth analysis than that produced by formal quantitative methods (Mariampolski, 1984).

Focus groups are very much like other social science measurement procedures in which validity depends not only on the procedures used but also on context (Krueger, 1994:37). A definition of validity is as follows,

> "Validity is the degree to which the procedure really measures what it proposes to measure."

For example, within focus group research the question must be considered; did the focus group procedure really provide perceptions on this programme or were the results artificially developed by the interactions of group participants? Measurements or assessments of the human condition can be distorted intentionally or unintentionally. People are not always truthful, and sometimes they give answers that seem best for the situation. Maxwell (1996) describes this as the 'social desirability effect'. People are aware of right and wrong answers. A person's stated attitudes may not represent the way they will behave in a real life situation. All research must acknowledge that the results are the consequence of the means by which they were researched.

People may hold back important information because of apprehensions or social pressure. Kruegar (1994) suggests that experts who work with small groups testify about the unpredictable nature of groups, and that the moderator can cleverly lead groups into decisions or consensus. The procedure to counteract such a problem is to develop a protocol to administer the test, and at times build in questions that check on the truthfulness of the respondent. Kruegar suggests adopting the 'middle ground'; have some faith in all procedures but also retain scepticism. Indeed, all data should be regarded with some scepticism whether they are obtained from official documents, personal interviews, questionnaires, standardised tests, opinion polls, or focused interviews.

Validity can be assessed in many ways. The most basic level is described as face validity, meaning do the results look valid? The other types of validity, which must be addressed, are predictive and convergent validity. This is the degree to which the results are confirmed by future behaviours, experiences, or events. Typically, focus groups have high face validity, which is due largely to the believability of comments from participants. People often open up in focus groups and share insights that may not be available from individual interviews, questionnaires, or other data sources.

The research questions pose views and beliefs which people will not contemplate everyday. Interestingly when investigating people's relationship with their environment most will have a strong view on the subject.

6.2.2.3 Why have focus groups been selected?

The researcher's opportunity to concentrate on key issues is one of the main reasons for selecting focus groups. The strength of relying on the researcher's focus is the ability to produce concentrated amounts of data precisely on the topic of interest (Morgan, 1997). This necessary strength is clear in comparison with participant observation as focus groups not only give access to reports on a wide range of topics that may not be observable but also ensure that the data will be directly targeted to the researcher's interests. It is not possible to observe people's attitudes for a model such as the ecological footprint. People will be unaware of such information and an explanation will have to be given before any discussion can be conducted.

Interviews would also be less desirable. The process of group interaction involved within the focus groups will help participants to understand the issues at a higher level. If one person does not fully understand the topic the process of group interaction will provide a forum for expanding knowledge on the subject. The active sharing and comparison of information between participants provides a valuable insight into their complex behaviour and motivations (Morgan and Krueger, 1993).

One of the problems arising from the use of focus groups is whether the topic is appropriate. In other words, would the participants discuss the topic with interest? The issue of environmental concerns and ecological footprint analysis could possibly warrant fears of this nature. If there are barriers to active and easy interaction, these may be overcome by some of the discussion techniques highlighted later. This is also the reason for the use of pilot studies. They will highlight the difficulty or ease of discussion among participants giving the opportunity to change the emphasis of the questions or presentation conducted by the moderator. The research does not totally rely on focus groups for the collection of all the data. Other methodological selections will also be made.

6.2.2.4 Desirable Characteristics of Groups

The membership of each group should be homogeneous, representing a particular segment of the population (Morgan and Krueger, 1993). The aim is to create conditions that promote both comfort and independence of thought, in order to maximise discussion and self-disclosure. Focus groups can consist of 4 to 12 members, in addition to the moderator and the recorder. Seven or eight has been shown to be a good number for many types of group interactions, yielding both variety of viewpoints and good participation (Krueger, 1994).

In selecting participants for a focus group project, it is often more useful to think in terms of minimising sample bias than achieving generalisability. Focus groups are frequently conducted with purposively selected samples in which the participants are recruited from a limited number of sources. The shift away from an emphasis on generalisability also means a shift from random sampling techniques toward theoretically motivated sampling. There are two main reasons why the use of random sampling has been rejected: -

- The small number of participants involved within the focus groups make it extremely unlikely that the sample will be adequate enough to represent a larger population.
- A randomly sampled group is unlikely to hold a shared perspective on the research topic.

The decision to control the group composition is known as segmentation and homogeneity. The homogeneity created allows for a more free-flowing conversation among the participants and also facilitates analyses that examine differences in perspective between groups (Morgan, 1997). For example, within this research, the use of different socio-economic groups provides some useful comparisons. Participants must feel able to talk to one another, and wide gaps in social background or lifestyle could defeat this requirement. The focus groups are not meant to be an argument between people of different perspectives and opinions. Although there will be some disagreement between participants, they should not feel uncomfortable with their opinions. Older and younger participants may also have difficulty communicating with each other either because they have different experiences with a topic or because similar experiences are filtered through different generational perspectives.

Using groups that are segmented by background or socio-economic differences has the cost of requiring more groups because it takes a certain minimum number of groups within each category to observe the category's range of responses to a topic. The general strategy is to create a variety of internally homogeneous groups that capture a wide range of potentially distinct perspectives (Kitzinger, 1994).

A final decision in determining the group composition involves the debate between seeking strangers or acquaintances for each group. Generally, the use of strangers is favoured because, although acquaintances can converse more readily, this is often their ability to rely on the kind of taken-for-granted assumptions that are exactly what the researcher is trying to investigate (Agar & Macdonald, 1995). The use of strangers is not compulsory and there can be reasons for selecting acquaintances. For example, some focus group research is conducted within organisations where acquaintanceship is unavoidable (Morgan, 1997).

Practical considerations may govern the choice between strangers and acquaintances. This is the case within this research. For these circumstances, decisions should rely on the criterion of whether a particular group of participants can comfortably discuss the topic in ways that are useful to the researcher. The reason for this is the small amount of participants that are available. With about 120 participants from Guernsey it is not possible to distinguish strangers from acquaintances.

6.2.2.5 The structure of the focus groups

When determining the structure of the focus groups a balance must be achieved between the need to gain useful information and the need to allow free expression of ideas. More structured approaches to focus groups are useful when there is a strong agenda within the research (Morgan, 1997). Less structured approaches are useful when the research is of an exploratory nature. In addition, with low involvement from the moderator the participants will have more opportunity to explore what interests them. A major disadvantage with such an approach may occur when it is time to analyse the data. It may be difficult to compare results from group to group.

It is also possible to reach a compromise between the two ideas explained above. Within this compromise, each group begins with a less structured approach that emphasises free discussion and then moves toward a more structured discussion of specific questions (Morgan, 1997). This method creates a focus group with a broad, open beginning and a narrower, more tightly controlled ending. This selection will make it possible to listen to the participants' own perspectives at the beginning of the discussion as well as their responses to more specific questions put forward by the researcher.

6.2.2.5 Selection of focus groups

Fifteen focus groups, from the population of Guernsey, have been selected in an attempt to reflect a broad range of viewpoints. Two separate classifications for the focus groups have been established. The first, (socio-economic classification) establishes attitudes and perceptions from a broad range of society. The second classification (Opinion Related) concentrates on particular opinions that are of value when considering the specific subject of sustainability. The selected groups have been listed below: -

Socio-Economic Classifications

1. Six form students (Grammar School) – Age 16-18.
2. Teachers (Grammar School) – Mixed group, with a range of ages, socio-economic class B.
3. Non-working women, aged between 30-50, socio-economic classes C1/C2.
4. Young professionals working in the finance industry, aged between 25-35, socio-economic classes A/B.
5. Retired People – aged between 65-75, socio-economic class B/C1.
6. Young mothers group – aged between 20-30, socio-economic class C1/C2.
7. Students from the College of Further Education, aged 17-20, socio-economic class, C2/D.
8. Working professional men, aged 40-55, and socio-economic class, A/B.
9. Young professionals (civil servants), mixed, aged between 20-35, socio-economic classes B/C1.
10. Trades people. Mixed group, socio-economic classes C1/C2

Opinion related groups

1. Politicians
2. Environmentalists
3. Guernsey Tenants Housing Association
4. Environmental Strategy Working Group
5. Guernsey Hotel and Tourism Association

6.2.2.8 Focus Group Question Design

All the questions within the focus group were designed around the ecological footprint. A copy of the topic guide for the focus group can be found in appendix 5. The focus group contained two main sections: -

- The Global Steps Game and discussion;
- The Ecological Footprint Presentation and discussion.

6.2.3 The Global Steps Game

The focus groups opened with a simple exercise that introduced the participants to a number of environmental concerns, entitled the Global Steps Game. Everyone is provided with a set of cards (eight). Each card requires the participant to make a choice. They needed to decide which description on the alternate sides of the card best described their lifestyle with regard to that activity (cards relate to waste, paper use, travel, holidays etc.). The best descriptor is put face up. The points on the face up sides of the card are counted to determine a rough personal footprint. The scoring works as follows: -

- Transport: 'You travel mostly by car' (80 points)
  'You travel mostly by public transport, cycling and walking' (20 points)
- Waste: 'You recycle little or none of your waste' (30 points)
  'You reduce waste where possible, and recycle most of the rest' (10 points)
- Electricity: 'You use standard appliances, often left on standby, and have high bills.' (40 points)
  'You use low energy appliances, always turn them off and have low bills.' (15 points)

- Paper: 'You regularly buy newspaper and books.' (20 points)
  'You share newspapers and usually borrow books rather than buy them.' (5 points)
- Food: 'You pay little attention to how far your food has been transported.' (10 points)
  'You make a particular effort to buy mostly fresh and locally grown food.' (5 points)
- Heating: 'You keep your home warm, have poor insulation and high heating bills.' (50 points)
  'You use your heating sparingly, have good insulation and low bills.' (30 points)
- Water: 'You take lots of baths, have a dishwasher, hosepipe, etc.' (15 points)
  'You take mostly showers, and don't have a dishwasher or hosepipe.' (5 points)
- Holiday: 'You take at least one long haul flight per year, e.g. to the USA or Asia,' (55 points)
  'You usually take short flights (e.g. Europe) or overland trips.' (10 points)

The final score that the participant received was not used for any statistical analysis. It merely acted as an introduction to the issues and the choices that were available to them. The focus group moves on to assess the participants' understanding of the term 'sustainable development'. A presentation about sustainable development and the ecological footprint was given, providing the participants with an explanation of their score. (A copy of this presentation can be found in appendix 7)

When the presentation is completed the participants were questioned on their reaction to the speech. Their trust into such data was questioned and the idea of equity and ecological limits was introduced. The general perception on whether this is an important issue was investigated.

After the participants have been made aware of what is required to be sustainable the focus group returned to the issue of behavioural change and whether they were willing to change their behaviour.

Most importantly, 'barriers to change' are highlighted. The willingness of participants to change may be present, but whether it is possible or not is another issue. These barriers to change clearly indicate the requirements of governments in changing the value system of society.

6.2.4 Analysing the Results from the Focus Groups

To help analyse the data from the focus groups a qualitative software package was used entitled QSR NUD*IST (Non numerical Unstructured Data Indexing searching and Theory-building). NUD*IST is a tool kit to assist and support individuals and groups who are engaged in qualitative research processes. As a tool kit, it does not displace the researcher or the process but rather supports the processes or activities that are engaged with doing qualitative research (Gahan & Hannibal, 1998).

NUD*IST invites extremely fine-grained indexing. It will store information in tree-structured indexes. The index system is effectively unlimited not just in the number of categories but also in complexity of index structure (Fielding & Lee, 1993).

Figure 6.1 provides a screen-shot of NUD*IST and explains how it was used for this particular project. The main reasons for using NUD*IST for the data analysis were:-

1. It helped to see the whole story as the data gained were both complicated and extensive (over 100,000 words of text)
2. It helped to sort the data into theme areas and assess whether particular views were collective or individual perceptions;
3. It did the data justice, not just summarising it but really exploring it;
4. It helped to associate key linkages between categories and ideas.

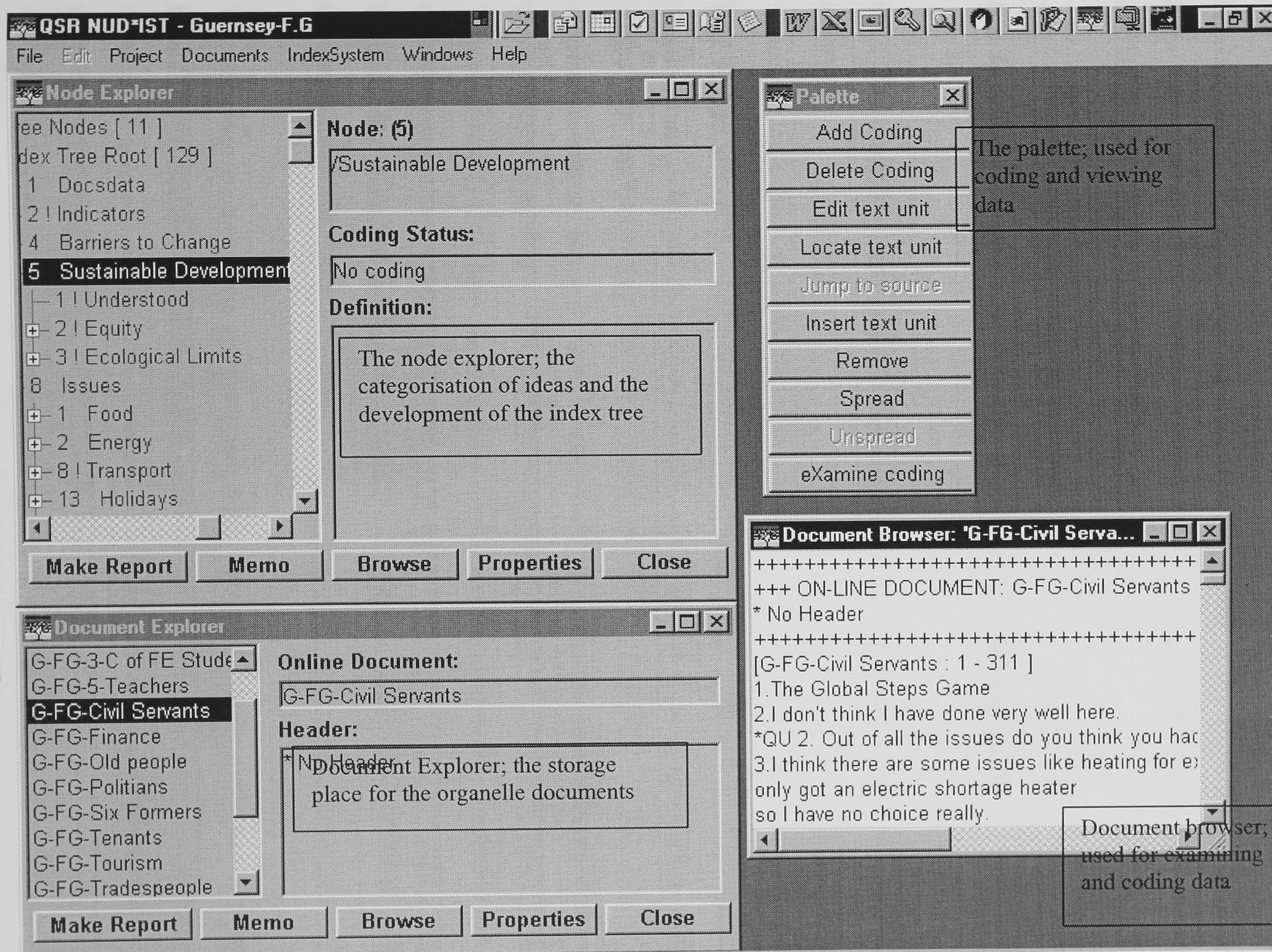


Figure 6.1: NUD*IST Screen Shot

Figure 6.1: NUD*IST Screen Shot

The first stage of the analysis involved importing the transcriptions of the focus groups into the document explorer. From here it is possible to browse the document (using the document browser). When a particular comment of interest appears it is possible to code the information and place it into a category within the node explorer. The categories are not pre-prepared but form in an organic sense. From the document browser (using the palette) it is possible to form nodes as the ideas appear within the text. The research is data driven and not lead by preconceptions as to what the data might be.

6.3 The Sustainability Discourse within the Public Domain

6.3.1 The Analysis - will people participate in the progression towards a sustainable society?

Part of the discourse of sustainable development is its approach in embracing the people. Such attempts to involve people in the transition to a sustainable society reflect the understanding that the general public's acceptance of the concept is required to initiate genuine social change. A result of the Rio Conference (1992) was the introduction of a new language within the environmental field with words such as 'empowerment', 'citizen participation' and 'multi-stakeholder partnership', all included under the framework of Local Agenda 21 (Macnaghten & Urry, 1998). It has become an excepted process to conduct a public consultation exercise before developing a Local Agenda 21 plan.

The structure of the focus groups encouraged the participants to discuss individual issues (transport, water, waste, energy, etc). Before developing models of behaviour, apathy and political will, it is important to perceive whether the participants felt there is an environmental problem. This has obvious implications for policy. If people do not believe society faces environmental problems that need to be solved the whole sustainable development agenda becomes politically impossible, purely for the reason of political popularity. The crucial question is whether people will participate in the progression toward a sustainable society. Acceptance of pro-environmental policy requires an acceptance that there is a problem that needs to be solved. As well as establishing whether a perceived environmental problem exists it is also important to establish the participant's ability to understand sustainable development. This is one of the key factors highlighted in the construction of the focus group questions; can sustainable development be understood? Section 4.33 breaks this question down into a more detailed analysis.

Past research, mainly opinion polls (e.g. Gallup & Newport, 1990), suggests that the public is 'highly concerned' about the environmental problems society faces today, with over 90% of the survey 'worried about the environment'. However, key indicators of sustainability, such as the ecological footprint, highlight the continuing and increasing damage to the environment due to environmentally destructive lifestyle choices.

There was a remarkable degree of consensus between the 15 focus groups in Guernsey. This clearly corresponds with other studies in Lancashire (Macnaghten et al, 1996), Nottingham and Eindhoven (Burgess, 1995) and Jersey (Collins, 1997). Significant similarities were observed across all groups, irrelevant of socio-economic status, with one exception, the politicians.

The remainder of the chapter has been structured under four main topics: -

- Information Barriers to Sustainability
- Physical Barriers to Sustainability
- Personal Barriers to Sustainability
- Political Barriers to Sustainability

This is followed by an analysis of the separate issues and conclusions.

The four topics have evolved from the focus groups and were not pre-fixed ideas about what are barriers to achieving a sustainable society. This demonstrates the organic nature of the focus group design. The findings control the research as opposed to enforcing pre-conditioned assumptions about the issues. The model below demonstrates the findings from the focus groups under these topics. This model (figure 6.2) illustrates and summarises the findings from all the focus group research and research into political will.

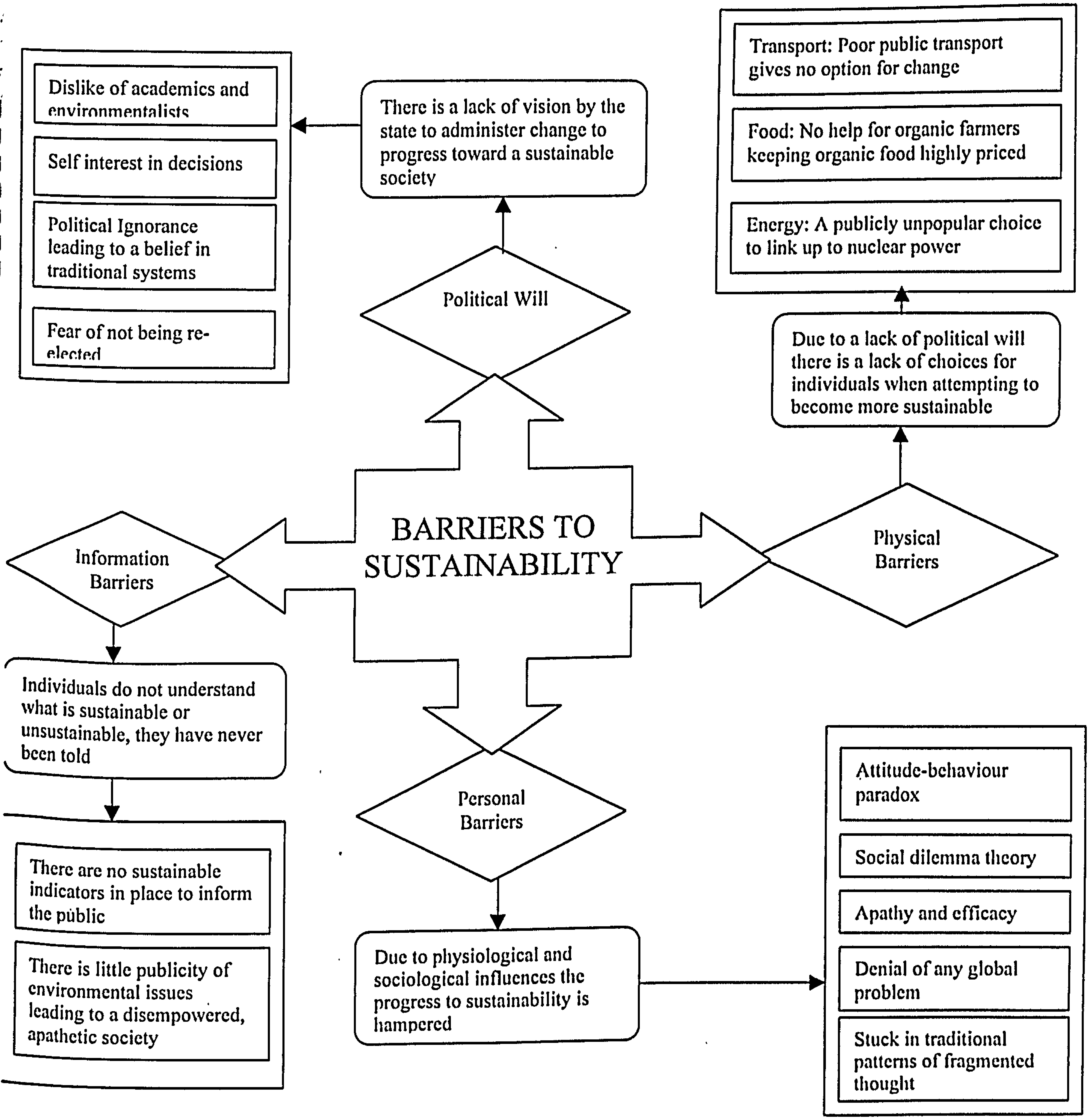


Figure 6.2: Barriers to Sustainability Model
Source: Author

The model above does not assume that each variable exists independently. Moreover, each variable has interconnecting features with the others in a complex web of issues.

6.4 Information Barriers to Sustainability

One of the main purposes of the focus group was to assess the ecological footprint as an awareness-raising tool for sustainability. This section outlines the research findings related to this topic. Initially, the section addresses whether the participants perceived there to be an environmental problem, proceeding to assess their understanding of sustainable development and finally considering the influence of the ecological footprint within the focus groups.

6.4.1 Is there an environmental problem?

With the growth in the interest of environmental problems, through the media, the initial thought would be that most people would perceive that society faces environmental problems. The level of importance attributed to the problem will always vary from individual to individual, but generally the expected view would be that environmental problems exist.

Indeed, most groups shared the perception that we do live in a world of ecological limits and that, as a society, we face the problems associated with finite resources. The majority of groups accept the view that there are currently very serious environmental problems of a global and local nature that are potentially catastrophic. This view can be seen within the finance industry group, discussing the problem of global warming and its effect on Guernsey.

P1[1]: Without any protection on, after 15 minutes you could really feel it burning you and that's in March. It is quite clear that the climate change is kicking in. We have heard reports that in 20 years time in Guernsey the climate is going to be that of the south of France. God knows what we are going to do for water in 20 years time, where are we going to get that from?
(Reference: Young Finance Industry: 244-247)

There was a generally high awareness of environmental issues and a perception that the problem is worsening.

6.4.2 Understanding Sustainable Development

To understand sustainable development is to truly understand the interconnected nature of environmental problems. The discussion in chapter 2 highlighted the fact that sustainable development must be based on the two central tenets of environmental limits and quality of life. This section will discuss the ability of the participants to fully understand the concept of sustainable development.

Out of the 120 participants involved within the focus groups, 16% had previously heard of sustainable development. This figure is not surprising as there has been little talk of sustainable development within the media of Guernsey and it still remains new on the political agenda. However, when asked what they felt it meant there was a reluctance to answer. Most of their suggestions made in an attempt to define sustainable development were based on the idea of environmental capacity as opposed to a combination of issues (e.g. social, environmental and economic). In contrast, the environmentalist group demonstrated a holistic understanding of the concept.

P1: Broadly it is keeping within ecological limits.
M: Is it mainly an environmental concern?
P2: It's environmental, social and economic. There are definitely three dimensions to it.
(Reference: Environmentalists: 29-31)

Very few felt that the world is endless and represents a continual supply of resources, although the politicians expressed this opinion.

6.4.3 Does sustainable development mean a better life?

There was a mixed response from the different groups as to whether sustainable development would lead to a 'better life'. Within the focus group the moderator did not define the ambiguous term 'better life', but left it to the individual to define what

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[1] P = Participant in the focus group

they felt a 'better life' would entail. Within the civil servant group they felt that it was not just possible to achieve sustainable development, but it would be beneficial to all.

Moderator: Do you think we could reduce our footprint and still have a good quality of life?
P1: Yes
P2: Yes, I think so.
P3: Yes, it would actually improve quality of life, with a decent transport system, for example.
(Reference: Civil Servants: 51-54)

In contrast, some groups viewed sustainable development as a threat to their high standard of living. There was almost a fear that they would personally have to reduce their standard of living to the same standard as a third world existence.

Moderator: Would you like everyone to have equal footprints?
P1: No, I don't want to live like an Ethiopian.
(Reference: Professional Men (45+): 87-88)

This comment follows the presentation that advocates sustainability to be a multi-faceted concept concerned with ecological limits and equity. However, most groups endorsed the assumption that sustainability improves lifestyle.

6.4.4 Public Perceptions of Indicators: The Ecological Footprint

A key aim of the focus group was to explore the role of indicators, particularly the ecological footprint, in bringing about a positive social change.

The first major observation from the focus groups was that it is not possible to change in-built attitudes by informing a group of people only once, however well constructed the indicator and presentation may be. This can clearly be seen within the tourism group.

M. Do you believe in information like that?

P1.Yes, I think your presentation gets the message over, but how many of us will walk away at this stage of your presentation and say we are going to change our lifestyles because we see that we are doing wrong. I mean the first one is holidays. I should give myself no points because I haven't had a holiday for 4 years, but if I had a holiday it would be a long haul one. I'm not going to stop taking long haul holidays to save the world. If I want to go to Australia, I'm not going to go to Paris instead just to get a few less points.

P2.Equally, it is the attitude that I won't stop it if you don't stop it. You won't stop it unless someone else stops it.

P3.I'm not going to give up my car. I might one day get a bike and use the car less but it is very difficult to give up your car, whatever you do with public transport or anything else.

(Reference: Tourism: 63-72)

This very honest comment highlights the limitations of any form of education. It is not possible for education alone to change attitudes in a short time scale. It is possible to introduce issues that may develop into a constructive change in individual behaviour but not to see a society transformed over night.

The general consensus by all the groups was information must be followed by action. It is almost pointless to know the environmental impact without the policy to support a positive change.

M: How important do you think information like this is?

P: It depends on how it is going to be used really. I mean, if it is going to be acted upon then it is very important. If no one is interested then it is irrelevant.

(Reference: Farmers: 63-65)

The 'tourism' group who believed that indicators were only helpful if 'they' listen to them held the same opinion. When questioned who 'they' are the answer was the politicians.

When asked whether they felt the information was useful most groups believed there to be an educational value in the ecological footprint. Many groups found the ecological footprint to be a useful exercise to demonstrate the link between individual lifestyle choices and a collective environmental responsibility:

P1: I think it is useful as a way of tying down the general principle of not wasting electricity to something where you can prove the principle, not just with waste of electricity but the whole approach to how much resources you can consume as an individual. You do need to argue it out and that simplistic technique is quite powerful I think.
(Reference: Environmentalists: 46-48)

Not only does this claim the footprint to be a 'simplistic technique', but it highlights a major achievement of the indicator. The discussion, particularly within the environmentalist group, was able to go beyond merely topical local environmental concerns, to encompass a holistic response. This issue is discussed in more depth in section 6.6.

While scepticism existed of data in general, there was still a great deal of trust in the information. This can be seen within the comments below.

M: Do you believe in data like this? (Referring to the ecological footprint presentation)
P1: I believe data like that?
P2: Yes, I do.
P3: I think it is difficult to take it at face value. It is a simple conclusion but includes many wider issues.
(Reference: Civil Servants: 21-24)

The only group that displayed an adamant disbelief in the data was the politicians. They failed to accept the data, which limited the conversation from moving on to discuss more complex issues. Some members of the group even went as far as to say that they believed no monitoring was necessary. This was not the opinion of the whole group and caused a heated discussion about our methods of monitoring our impact on the environment.

The actual reaction to the size of the Guernsey's ecological footprint was reasonably consistent. While some groups were shocked at the high impact of Guernsey, others could understand why the ecological footprint was so high. During the presentation there is a reference to the size of the average American's footprint. Comparing America's footprint of 8.5 ha/per capita with that of Guernsey's (8.28 ha/per capita) came as a shock to most groups and there was a strong reaction towards these figures.

M: Do you believe in information like this?
P1: It seems right to me.
P2: Why is Guernsey so high then, because we have so much money?
M: Do you find this information shocking?
P2: It is when you see how high we are.
P3: It is embarrassing really.
P2: We are the same as the United States.
P4: I went to America for a year and a half and I didn't hardly notice any difference when I came back to here. I was in LA, which is a full on place and everybody just consumes like nobody's business and then you come over here and everyone has a brand new car and they are doing the same thing, basically. You can see in another few years we will be up there as well.
(Reference: Tradespeople: 67-77)

A similar reaction came from the women's group, aged 40+. Not only did they compare the footprint of America and Guernsey, but clearly stated they were embarrassed by this and did not wish to be regarded on the same level as America. America was very much seen as an over-consuming, environmental disaster.

P1: It is quite horrifying. I was shocked. We are up there with the States.
P2: We don't want to be up there with the States, do we?
P3: Definitely not.
(Reference: Woman 45+: 19-21)

This clearly highlights one of the useful components of the ecological footprint: the ability to compare country-by-country, region-by-region etc. It is even possible to compare different regions with the countries' figures to understand areas responsible for higher and lower environmental damage. This ability, to place the figures on a per capita basis had a distinctive effect on the focus groups. Some groups were able to go beyond the theory that it is 'someone else's problem' to an acceptance of individual global responsibility. When the participants understood that their individual impact was the same as someone in the United States they were not happy with the situation, as can be seen from the comments above.

6.4.5 Indicators and Empowerment

One of the roles of indicators is to empower people through the dissemination of information. Indicators are not just for decision-makers and 'experts' but must be available and understood by the public, encouraging participation and achieving a greater public understanding of policy decisions. The comment below illustrates the dis-empowered nature of Guernsey society.

M: Do you think it is important for Guernsey to monitor its impact on the environment?
P1: Yes, it is. We should know what we are doing, or the powers that be should know.
(Reference: Civil Servants: 125-126)

The civil servant's group highlights the fact that information is predominately for 'experts'. There is little interest in obtaining the information for public use and interest. This sentiment devolves from a lack of political action concerning sustainable development, progressing downwards to an apathetic society. Without the political will for change the public will often hold the same predilection. The issue of political will is discussed in more depth later.

Every group, apart from some of the politicians, felt it was important for Guernsey to adopt sustainable indicators such as the ecological footprint. The groups believed the ecological footprint to be a powerful tool in explaining sustainability and guiding policy.

The footprint has started the process of thought within individuals. It has provided a powerful tool that advanced the discussion in the focus groups beyond localised issues. The participants discussed global issues, within a localised context and for the first time, they were given some understanding of the far-reaching environmental impact of Guernsey. It would be naïve to believe that the footprint could change opinion immediately, but it did raise the complex interconnections of environmental problems. With a more educated public, pro-environmental policy becomes more accepted by the community at large.

The participants viewed the ecological footprint as something that can be used by experts, as well as understood by 'everyday people'.

6.5 Personal Barriers to Sustainability

This section is concerned with the psychological barriers to behavioural change. From the focus groups this proved to be one of the most important obstacles to sustainability.

According to Hans Mosler (1993) environmental issues are not actually problems between people and the environment, but are problems among members of a social system. In many respects this is correct; our behaviour towards the environment is always social behaviour. Each individual use of property has an effect on the property and thus the potential use of the property by others (Mosler, 1992). It is the development of this understanding that leads to environmentally responsible behaviour.

6.5.1 The Attitude – Behaviour Paradox

Within the focus groups, participants clearly shared and discussed their attitudes to environmental and social problems. Due to the free and flexible nature of the focus groups, attitudes could be explored in depth, sometimes discovering disagreement with the other participants and sometimes reaching an overall consensus on a particular issue. For example, during discussions on transport issues, not only did nearly every member of individual groups agree, but also a general pattern of opinion occurred in all the groups.

As well as an exploration into participants' attitudes, the focus groups investigated behaviour and the interrelationship between these two variables. According to Johnson and Pattie (1999) attitudes and behaviour are mutually interdependent. This raises the question; can attitudes predict behaviour?

Within a chapter entitled, 'Implications for Social Psychology', Hummelweit (1984: 183) identifies four main opinions concerning the connection between attitude and behaviour:

- Attitudes can be used to predict behaviour, as predisposing factors.
- Behaviour influences attitudes, because we think and feel on the basis of our observations, rather than act on the basis of our thoughts and feeling.
- There is no link between attitude and behaviour, so the former cannot predict the latter.
- Attitudes and behaviour are jointly conditional.

This is supported by Axelrod & Lehman's (1993:52) theory of 'three domains of attitude', represented by the following statements: -

- I believe, therefore I act;
- I can therefore I act; and
- I desire, therefore I act.

The first statement denotes the notion that attitudes guide behaviour. The second statement implies that personal control is the most dominant influence on behaviour. The third statement suggests a motivational force provided by the desire to attain certain outcomes from one's actions.

Within this study the relationship between attitude and behaviour was modest. This can be seen with the examples from the focus groups below.

If you talk to most of the people in Guernsey about the use of their cars, most people in Guernsey are concerned about the environment and the island. Then ask them, 'do you believe it would be beneficial for your own health sake and the environment's sake that you use the car as little as often. Then say you actually cycle to work or use public transport and very quickly they would all find one reason why it is impossible to do that in their particular circumstances.
(Reference: Farmers: 147-150)

Within this example the participant has highlighted the clear gap between attitude and behaviour. The attitude maintains the desire for a better environment and improvement in health. Whereas, the behaviour is very different: the continual use of the car and a failure to adopt sustainable transport options. This extract also highlights another interesting observation. The participant has failed to talk about the issue on a personal level. Throughout the focus groups the participants were also encouraged to express their opinions from their own personal experiences. When talking about attitudinal and behavioural connections none of the participants discussed the issue on a personal level. It always takes the form of what the rest of Guernsey society would or in this case, would not do. Therefore, it is accepted that they are actually talking about their own personal experience and are influenced by the 'social desirability effect' (Maxwell, 1996).

Below is another, even more apparent example of the lack of connection between attitude and behaviour.

If we are all really honest with ourselves, I don't want to get rid of my car; it is as simple as that. I agree with the fact that I should do and I agree if there was a better public transport system then I would. It is environmentally unfriendly but it offers the freedom to do things that we want to do and things that we can afford to do. So long as we are tied to someone else's timetable psychologically that is going to create a problem. We do have control over our lives.
(Reference: Civil Servants: 57-61)

According to Scott and Willits (1994) one explanation for a weak relationship between attitude and behaviour is that the researcher may have erroneously assumed that specific behaviours are valid indexes of a given attitude, or that a cluster of attitudes leads to or implies the expression of a particular behaviour. Within the example above this is clearly not the case. The focus group approach allows for probing and verification of comments made by the participants. This may be the situation in the example below. Two quotes have been extracted from the same focus group to highlight this fact.

M. Do you think we should try and reduce our footprint?
P1.The simple answer is most clearly, yes.
(Politicians: 84-85)

M. Do you think we have global responsibility as individuals?
P1.I have no argument with that at all.
P2.Everyone has to.
P3.Yes, everyone.
P4.Nobody can argue against that.
P5.You can't argue against the principle.
(Reference: Politicians: 364-367)

The politicians have shown a commitment to environmental responsibility. These are attitudes toward the environment and not their behaviour. The quote below provides an example of behaviour concerning the environment.

What I don't understand, with transport for example, 5 years ago we were told that it was petrol that was the pollutant, now we are told it is diesel that is the pollutant. We are told that two drops of petrol on a forecourt causes more pollution than driving from London to Liverpool. So no sooner do you start, it is a bit like the one I'm always carrying on about, recycled paper, which creates more pollution than cutting down a few more softwood trees, of which there are far more in Europe than there used to be, and decaffeinated coffee. It is the same scenario because you were told that caffeine was not bad for you and then we find out 10 years later that it is the worse thing you can do.
5.You have to work out who is talking sense and who is talking nonsense.
3.Well they don't seem capable of doing that.

5.They, who's this they you keep talking about.

3.A. Environmentalists, B. these scholars who do it, who work it out.

(Reference: Politicians: 183-193)

The comment demonstrates a total denial of any environmental responsibility. It displays a lack of commitment to sustainable transport, quality of life and a deep fear of anyone attempting to provide answers to the problems. When comparing this to the other comments made the politicians there appears to be great disparity of ideas.

In all the examples concerning the attitude-behaviour paradox discovering the orgin is difficult. Below are a number of detailed suggestions. Eden (1993) suggests that this inconsistency has arisen because researchers in the same context are measuring values operating in different contexts. Cotgrove and Duff (1981) highlight the fact that public goods and individual goals may be in conflict. For example, public goods that an individual may feel are good for society (for example, the use of public transport) may not be the same as those that they feel are good for themselves and their families (the convenience of car use). This results in the highlighted discrepancy between individual and behaviour. It is almost a situation where the individual is struggling between individual self-gratification and the collective responsibility of society. When the individual is consulted about attitude they will usually translate the answer into the best possible attitude that an individual could have for society (social desirability effect) (Maxwell, 1996). This does not necessarily mean that the individual is not willing to change behaviour. It means that a large shift in society is required so that pro-environmental behaviour is considered the social norm. Behaviour relates to the social and material constraints, which transfers responsibility onto some other agent rather than the individual or prevent action on perceived and self-ascribed responsibility. This is one of the major factors, but not all, which has influenced the result within the focus groups.

This finding is consistent with research within this field over the last two decades (Dunlop, 1989, Macnaghten, 1996, Burgess and Harrison, 1998). Given the amount of environmental coverage within the media another suggestion is that people have learnt the language of environmentalism without developing a simultaneous behavioural commitment (Scott and Willits, 1994).

Another suggestion is that participants are unaware of how their personal behaviour contributes to environmental degradation and thus may believe it is the problem of 'someone else'. They also may lack information as to what specific things they can do to contribute to a sustainable society. Many of these issues are solvable. What is more difficult to understand is when all these barriers to change have been removed why the rational ideology of sustainability is still ignored.

Within this text there has been many suggestions as to why this phenomenon occurs. The list below draws the main propositions together.

- People have learnt the language of environmentalism without developing a simultaneous behavioural commitment.
- Participants are unaware of how their personal behaviour contributes to environmental degradation.
- The participants may believe it is the problem of 'someone else'.
- The participants may have a lack of information as to what specific things they can do to contribute to a sustainable society.
- The choices necessary for individual people to become more sustainable are not present.

6.5.2 Social Dilemma Theory

The social dilemma theory (SDT) (van Lange et al, 1992) is useful in describing some of the findings from the focus group. It helps to explain one of the propositions already suggested: a conflict between personal gain and collective responsibility. The example below puts this argument into context and explores what many of the participants expressed within the focus groups.

It can be easy not to see the real need to recycle newspapers. On a personal level, we each read such an infinitesimal amount of the total newspapers printed. Individually it can be difficult to see the bigger picture of forest depletion leading to problems of climate change and loss of biodiversity, plus many more. Van Lange, Liebrand, Messick and Wicke (1992:26) describe this situation as a social dilemma, defined as: -

"A situation in which private interests are at odds with the collective interests."

The dilemma arises when all or most members of a group act in accordance with their private interests and do worse for themselves than had they ignored their own interests. There are numerous examples of this occurrence during the focus groups.

P1: When you are taking half an hour to do a journey of two to three kilometres, which you can definitely do, there is definitely a problem. It is just taking me longer and longer to get to work each morning and I only live two kilometres away from town.
(Reference: Young professionals: 82-87)

Within the quote above it demonstrates that their own private interest leads to driving a car to work everyday for increased comfort and mobility. However, because 78% of people in Guernsey drive to work there is major traffic congestion, the roads are gridlocked causing numerous health problems. Not at any point does the participant perceive that they are part of the problem. We have here a social dilemma.

Social dilemmas can be defined as situations in which each decision maker is best off acting in there own self-interest, regardless of what the other persons do. Each self-interest decision, however, creates a negative outcome or cost for the other people who are involved. What is interesting is that individuals don't like the situation of other individuals conducting the same behaviour as them. This is particularly relevant when considering transport issues.

When a large number of people make the self-interested choice, the costs of negative outcomes accumulate, creating a situation in which everybody would have been better off deciding not to act in their own private interest. Environmental problems then arise from this social conflict of interests. It is in the interest of each individual to gain the greatest possible use of a resource that causes of accumulation of the larger problem. Within the focus groups most of the participants had difficulty in connecting their individual behaviour to global environmental problems. They merely perceived themselves as too small to cause any real marked effect on the global environment.

Why does this occur? The focus group research highlights that the visibility, time-scale and proximity of the positive individual benefit and the negative outcome are separated. It is possible, particularly on an island like Guernsey, to remove the negative outcomes to far away places and only receive the positive benefits. The social nature of decisions in social dilemmas is obvious because people have influence on each other's welfare (Van Lange, 1992). The decision problem underlying social dilemmas can be explained by two conflicting definitions of rationality.

6.6 Physical Barriers to Sustainability

One of the valuable aspects of the Global Steps Game was for the participants to distinguish between environmentally sound and environmentally damaging behaviour. By comparing the two distinctive lifestyle choices on each card the participants should be able to link the issues of their individual choices and environmental damage. This raised one of the most interesting points of discussion within the focus groups. Many of the participants almost felt they were being criticised for their environmentally damaging behaviour. The participants were very keen to highlight the point that they did not always have the sustainability option made available to them. Within this section the lack of sustainable choices within Guernsey will be discussed under the different issues of the Global Steps Cards.

The lack of sustainable choices is described as physical barriers to change. If an individual wishes to be live life sustainably, it should be easy for them to do so. They should have the choices in front of them to be able to make the ethical decision of whether they feel it is important to adopt the most sustainable choice of the two. This is an issue that the people of Guernsey felt very strongly about. They gave many examples that have been discussed below. Finally, the section inter-connects the issue of physical and physiological barriers to sustainability.

6.6.1 Barriers Related to Transport

The transport issue was the most discussed and controversial issue for the participants of the focus groups. The effect of transport is both visual and immediate. The negative outcome occurs at the same time as the positive individual benefit. The reason it is becoming more and more controversial is due to everyone exercising his or her right to the positive benefit of using the car the immediate negative effect is becoming unbearable (congestion, pollution etc).

This has created a conflict of interest for each individual driver. The major problem is that the necessary structure to allow for a behavioural change is not in place. This is the physical barrier to change related to transport. The model below illustrates the consensus of opinion concerning transport on the island.

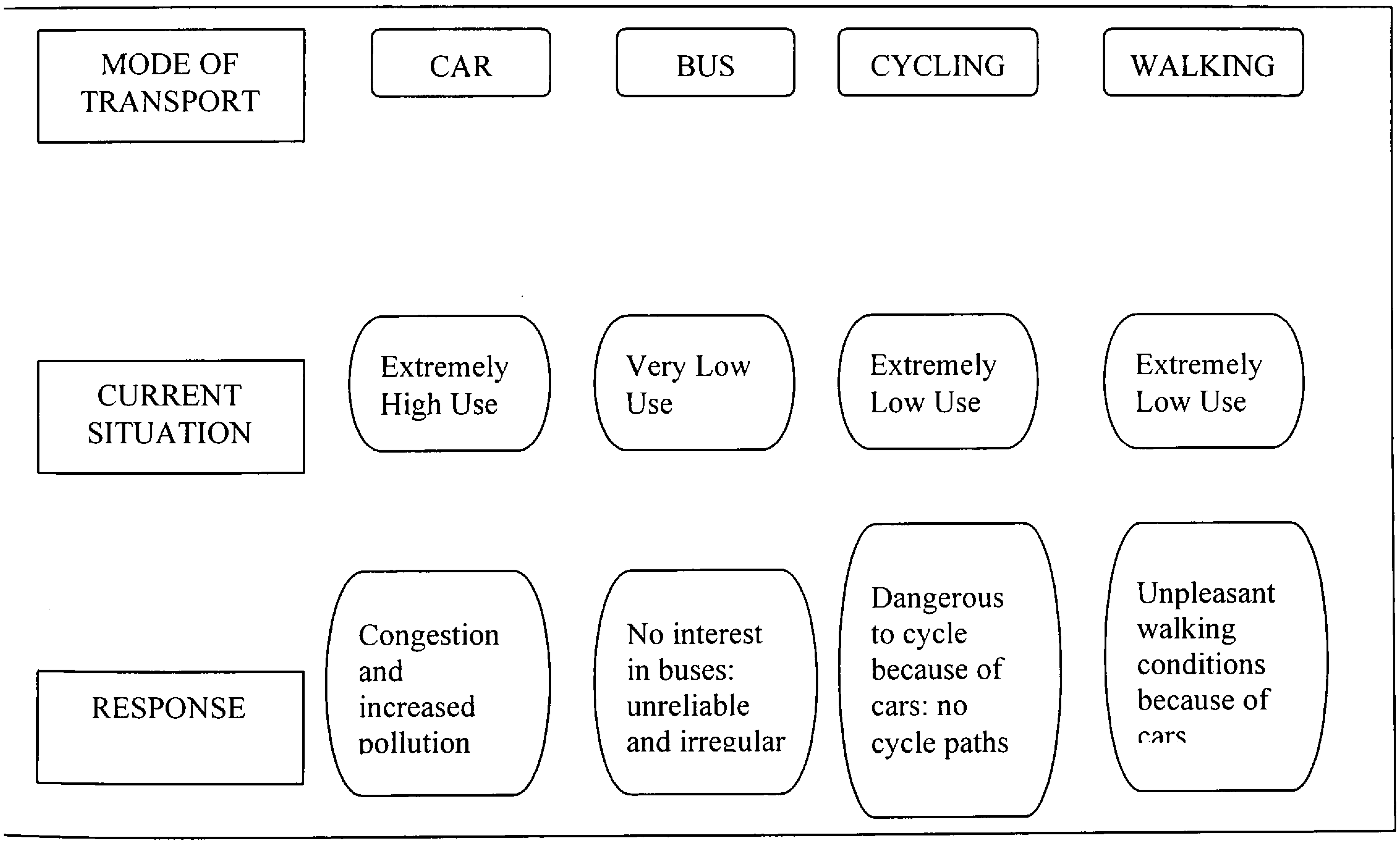

Figure 6.3: Guernsey Transport Situation

Source: Author

Figure 6.3 shows that Guernsey has the worse case scenario concerning every form of transport. All the focus groups felt that this situation must change. However, there was a wide range of possible solutions to the transport problem. High car use is the precursor to poor planning for buses, cycling and walking.

Being such a small island one of the transport options that should be feasible is cycling. Five of the focus groups felt that cycling was a real option, as a form of transport for them, but with such a large amount of traffic on the roads did not feel safe. The Farmers group expressed this: -

P.1 I would cycle.
P.2 I used to cycle everywhere but nowadays it is blinking lethal being on the road because of all the cars.
(Reference: Farmers: 459-460)

The teacher group also believed that the more cars there are on the road, the more unpleasant cycling becomes. The finance group felt that safety was a major issue.

P.1 Because it is not safe parents don't feel happy that their children are cycling because it is not safe because there are too many cars. For me, if they had a series of cycle roads then I would know I would be safe.
(Reference: Teachers: 88-89)

This example of transport is similar for other issues, such as the supply of local food and the choice of different forms of energy. Adopting a sustainable lifestyle has become a difficult task for any individual in Guernsey.

6.7 Political Barriers to Sustainability

Within the 15 focus groups the participants felt very strongly about the lack of political will concerning environmental issues. Most of the focus groups were very critical of the Guernsey politicians suggesting they were too traditional in their approach, out-dated and failed to consider the views of Guernsey people. One of the focus groups was conducted with local politicians and proved to be extremely insightful.

The initial reaction to this focus group was that it was extremely different from all the other groups with Guernsey people. There was a distinct divide within the group between politicians who believed in the acceptance of environmental problems and those who denied the existence of any environmental problems. An analysis of this focus group has been given below, followed by a comparison with the other focus groups.

The issue of political will was of such importance to the Guernsey people that it was decided to investigate the issue further. A questionnaire was constructed (see section 3.4) that was sent to every politician on the island concerning the issues of environment, political will, sustainable indicators and the views of the Guernsey people. The methodology and analysis of this questionnaire has also been included in this section.

6.7.1 What the people said about the Politicians

It is fair to state that there was a general consensus of opinion across most of the focus groups concerning their attitude towards politicians. The only group that believed politicians were 'doing a good job' was the retired group: -

M: Do you think the politicians are doing a good job concerning the environment?
P1: I think the States are doing quite well.
(The whole group agrees that they are doing a good job)
P2: Some are better than others.
M: Would you like to have more say in decisions?
P3: I'm quite happy with the situation at the moment because I don't know anything different.
(Reference: Old People: 56-61)

The College of Further Education group appeared ambivalent and displayed no real strong opinions on the subject. The remaining 11 focus groups all displayed a dislike and mistrust of Guernsey politicians of varying degrees displays the following feelings towards the politicians.

- Self interest

- Incompetent
- Lack of political will
- Slow to change, lacking vision
- Fail to listen to the people

6.7.2 Politician Opinion and Public Opinion – Any Common Ground?

As well as considering what the politicians have had to say about the issues, from the focus group and the questionnaires, and what the Guernsey people had to say about the politicians, it is possible compare both opinions by looking at particular issues. The aim of this section is to compare and contrast the views of politicians with those of the Guernsey public. The energy cable link to France provides an excellent example.

6.7.4.1 The Cable Link to France

The ecological footprint to supply Guernsey with all its energy requirements is substantial. Even though it was not recognised by the Guernsey people as the most important issue effecting the environment in Guernsey, one particular issue within the energy debate proved very controversial, the cable link to France. It was possible to compare what the politicians thought about the cable link and what was the impression of the Guernsey people. Figure 6.4 diagrammatically displays the difference in opinion between the two groups.

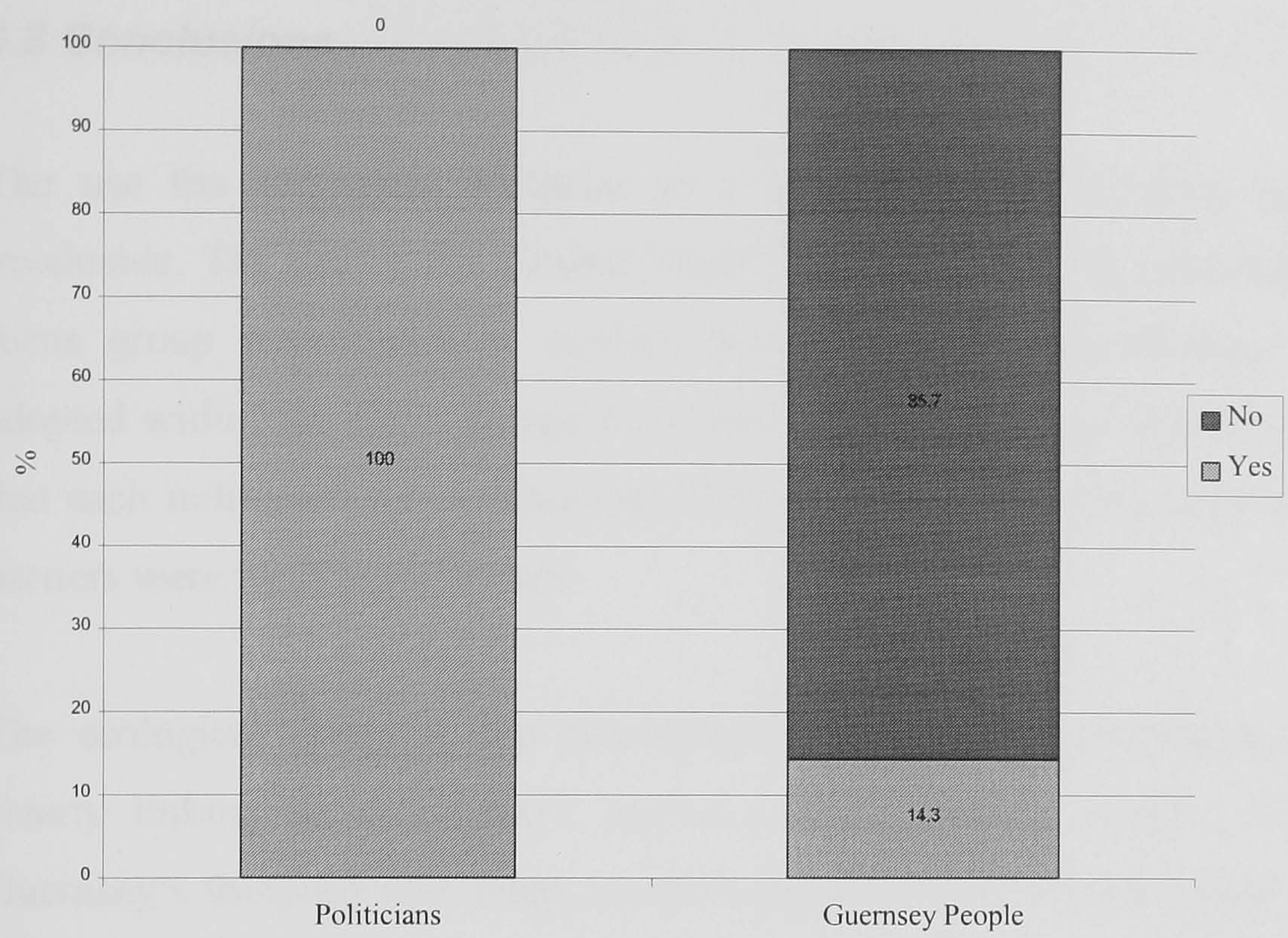

Figure 6.4: Question: - Are you pleased with the cable link to France?

The first, and most obvious, observation from figure 6.6 is the vast difference of opinion between the politicians and the people of Guernsey. The issue of treating sewage on the island had a similar response. While the Guernsey people thought it was important to stop pumping raw sewage into the sea, the Guernsey politicians had no problems with this. Also, many of the groups believed that a door-to-door recycling collection should be introduced. Again, the politicians felt this was an unnecessary waste of public money.

6.8 Conclusions

The use the ecological footprint as a tool for communicating sustainability is invaluable. The use of the 'Global Steps Game' provided an opportunity for all the focus group participants to explore the barriers to sustainability. The approach adopted within the focus groups provided a rich response concerning the difficulties that each individual faces concerning sustainability, where the physical and political barriers were most predominant.

The ecological footprint also demonstrated the need for collective responsibility, clearly linking an individual's impact within a global context. Comparisons of Guernsey's footprint with other countries demonstrated that the island's impact (on a per capita level) was unacceptable in global terms. This was an issue that many of the participants did understand. The ecological footprint also demonstrated that, while complex calculations are required, the final figures are transparent and can be easily understood by the general public.

The research highlighted that there was a gap between attitude and behaviour. While the ecological footprint provided a logical communicative tool for the participants to understand their impact, it did not change behaviour to a noticeable degree. However, it was not excepted that the participants would leave the focus group, converted to environmentalism. What the ecological footprint did do is raise important lifestyle issues that many of the participants had not thought about before. The Ecological footprint can assist policy decision-makers in persuading the general public to adopt more sustainable lifestyles.

CHAPTER 7: 'DEVELOPING' A SUSTAINABLE FUTURE

The purpose of this thesis was to assess the ecological footprint as a tool for both communicating sustainable development to the general public and its use as a planning tool. The final research question of the thesis was set to discover whether the ecological footprint offers new insights into the ecological crisis.

In this concluding chapter, the original research questions that can be found in the introduction (section 1.2) will be used to frame the final discussions.

7.1 Question 1: Does the ecological footprint adequately measure ecological sustainability?

In order to begin exploring this question it was described how the various competing uses of nature can be translated into a calculated land area through the eyes of the ecological footprint. To make the calculation procedure more applicable it was illustrated with the example of Guernsey using the compound approach and then comparing this with other studies. A detailed critique of the ecological footprint approach was also undertaken.

7.1.1 Measuring Ecological Sustainability

The research has demonstrated that the ecological footprint is a robust and scientific tool that offers a clear understanding of ecological sustainability. It is robust in that it confirms the findings of many other indicators, believing that one of the major reasons for unsustainability is over-consumption. It is scientific in that the ecological footprint relies on concrete scientific data from range of organisations (FAO, IPCC, IEA). The methodology is also replicable and follows a simplistic chain of calculations (see appendices 7-10 for calculations). One of the most important aspects of the ecological footprint is that it is only a tool for measuring one of the dimensions of sustainability.

It was highlighted how the ecological footprint is able to translate biophysical limits down to the local scale and thus demonstrate the need for appropriate local socio-economic adjustment. The ecological footprint shows that the carrying capacity appropriated by one person or group diminishes the carrying capacity that can be appropriated by other people. In summary, human uses of nature compete against each other. It links the issues of social equity with ecological concerns, as it illustrates how competing uses of nature can translate into social conflicts through resource distribution. Chapter 3 demonstrated that there is a limited amount of resources that countries are competing for creating a situation of conflict.

It has been shown that a major strength of the ecological footprint is that it incorporates several defining qualities of ecological economics and resonates with the ideas of various other authors concerned with human carrying capacity. (Rees, 2000) The ecological footprint recognises that humans are not separate from nature and that the economy is a fully contained, growing, dependent, sub-system of the non-growing ecosphere. The research recognises the idea put forward by Odum in 1972, that 'Great cities are planned and grow without any regard for the fact that they are parasites on the countryside which must somehow supply food, water, air and degrade huge quantities of wastes'. The ecological footprint recognises this by providing an understanding of land appropriation by a city, an island or an individual. It is broad enough to consider the effect on sustainability that occurs through the consumption of food, wood, manufactured items and fossil fuels.

From a scientific perspective the ecological footprint recognises the importance of the second law of thermodynamics to human affairs (explained in Chapter 3). Indeed, the area represented by the ecological footprint can be conceived as the photosynthetic surface needed to replace the free energy or negentropy dissipated by humans and their industrial metabolisms.

7.1.2 Limitations and Improvements of the ecological footprint

The research also demonstrated that there is room for improving the methodology of the ecological footprint. The existing ecological footprint assessment would gain from a more comprehensive treatment of consumer goods (section 3.7.2). Such research would involve the development of more reliable data sets and would require:

- Clarifying forest productivity as the reported yields are still scattered over a wide range (section 3.5.3);
- A greater understanding of the amount of land required for biodiversity protection (section 3.5.4);
- Improving existing data collection.

Even though the ecological footprint has proven itself as a useful indicator for sustainability, it does have certain limitations. The most important limitation to recognise is that the ecological footprint cannot stand alone as a sustainability indicator (section 3.10.3). The ecological footprint does not produce a complete picture of the ecological dimension of sustainability. A necessary ecological indicator to accompany the ecological footprint is the quality of agricultural land. The footprint does not address the issue of mixed land use sufficiently. If land is classified as arable the footprint does not inform us about the quality of that land. Is the arable land farmed in a way that protects bio-diversity?

The ecological footprint does not consider the issue of social justice. Therefore, it is also necessary to include indicators to address this issue. Indicators concerning education, poverty, crime and housing conditions are essential tools necessary for the sustainable transition.

Finally, indicators to protect wildlife are required. Indicators concerning biodiversity and protection of specific ecosystems that are invaluable for protecting the other 350 million species that we share the planet with.

In conclusion, modern society weighs heavily on nature; its metabolism has reached a volume and a velocity that threatens to throw into disorder the very ecosystems it depends upon. In that secular predicament, what matters less is the fact that nature is utilised, but how much is used in what way and, above all, at what speed. The ecological footprint is able to address such a question sufficiently, making it an invaluable measure of ecological sustainability.

7.2 Question 2: Can the ecological footprint be used as an effective planning tool to guide humanity towards sustainability?

This question was addressed by introducing the component approach and demonstrating its value to local sustainability. The ecological footprint was tested as a tool for planning through the analysis of time series data and the development of detailed scenarios for Guernsey (Chapters 4 & 5). This provided an understanding into what a sustainable society might resemble. An analysis of the attitudes of politicians and Local Agenda 21 Officers was conducted obtaining their views on the ecological footprint as a decision-making tool.

7.2.1. The effectiveness of the ecological footprint as a planning tool

The ecological footprint facilitates political decision-making as it offers a simple, transparent approach for comparing sustainability impacts of human activities. The research suggests that it is a useful tool, but that it is only a tool. It can only guide policy, not make the decisions. It presents an heuristic tool that builds on present knowledge and stimulates future orientated thinking. Even though the ecological footprint is a scientifically based tool, it can deal with generalities rather than getting lost in specificity. It helps to sharpen the debate between conflicting assumptions and beliefs around such issues as ecological efficiency, growth management and impact assessment.

While poor countries are limited in resource consumption, the industrialised countries are able to take more than their fair share of the Earth's resources. The ecological footprint graphically underscores global ecological constraints and provides a warning about the reliance on economic expansion. In fact, the ecological footprint's conceptualisation of the global ecological challenges whilst linking them to local decision-making (Chapter 4) is an aspect of the tool that is invaluable. The evolution of the component approach to footprinting has demonstrated, more clearly than the compound approach, the necessity for local and regional policies to adopt sustainable ideals. Through the component approach the ecological footprint concept can be taken a step further by linking these global constraints to local action. Its various applications to; technology assessment, local and regional decision-making, national and international decision making, inter and intra-national social equity, and education and behavioural analysis provide venues for pertinent policy responses (Wackernagel, 1994). Even though there remains much scope to improve the technical aspects of the component ecological footprint (particularly in the area of nuclear power, incineration and the transport of waste), the tool's potential to translate global ecological constraints down to the individual and institutional decisions is second to none.

7.2.2 The need for the ecological footprint as a decision-making tool

There is a common confusion between cleanliness and sustainability. Over the last 25 years environmental policy has largely focused on cleaning and protecting air, water and soils. The issue of justice acquires a different and probably more fundamental relevance to the environmental crisis. This is defined in terms of excessive resource use. Such a shift in attention from the tail end to the front end of the economic cycle is overdue for ecological reasons. What really matters is the sheer volume of material input, not so much the pollutants in the output (Schmidt-Bleeck, 1994).

The issue of justice does not in the first place concern the social distribution of pollution but rather involves the social distribution of resource consumption. 'Who takes how much?' acquires the utmost political importance. This question, however, does not arise in a pollution perspective that moves developing areas into the focus of attention, since pollution tends to be more intense in such areas. It is only in a resource perspective where over consumption is defined as the critical problem that industrialised countries are put on the spot. Rich countries may be relatively clean, but they remain consumers, in the present state of affairs. Guernsey fits neatly into this example with 95% of all its resources imported. One way to conceptualise the resource perspective in a context of finiteness is the notion of ecological footprint. A society can be called sustainable when its demands on nature do not exceed the ecological footprint it is entitled to. This poses the question; are the rich countries capable of living without the surplus space they appropriate today?

7.3 Question 3: Can the ecological footprint help communicate the ideas of sustainability to the general public?

This question was addressed through a series of focus groups and questionnaires. They assessed the usefulness of the ecological footprint in explaining sustainable development to the general public and politicians.

The ecological footprint enables people to visualise the cumulative effect of incrementalism and illustrates its potential destructiveness. The ecological footprint provides the 'bigger picture' about the impact of people's individual decisions without alienating the individual. The ecological footprint gives an indication for socio-economic development that may not be present in individual preference-based valuations (Deutsch et al, 2000). It provides a clear and unambiguous message often in an easily digested form (Moffat, 2000).

A strength of the ecological footprint metaphor is conceptual simplicity. It personalises sustainability by focusing on consumption (we are all consumers).

There is no doubt and very little argument as to the use of the ecological footprint as a communication tool for sustainable development. An indicator that can be understood by the general public and links individual's lifestyle choices to global environmental problems is invaluable. Not only does it do this but also it provides comparative data so that people can see where they stand compared to people in India and America, for example.

Combined with the focus group design the research was able to identify four key barriers to sustainable development within Guernsey. With the inclusion of the global steps game personal, physical, political and information barriers were identified. The ecological footprint has helped remove the information barrier to sustainability (Chapter 6).

7.4 Question 4: Can the ecological footprint offer new insights into what a sustainable society consists of?

This question can be answered by using all of the research that has been conducted. It is the variety of research methods used and the range of the data collected that make it possible to fully consider the new insights the ecological footprint can offer.

The footprint is sufficient to suggest approximately by how much we must reduce our consumption, improve our technology, redistribute wealth, or change behaviour to achieve sustainability. Most importantly, the ecological footprint shows how conventional economic development strategies are at odds with preserving ecological integrity, thereby compromising future well-being. It becomes a tool to visualise these conflicts and provides a framework for alternative approaches to economic development through the use of scenarios (Chapter 5).

7.4.1 New insights into sustainability

The ecological footprint has the ability to question economic expansion. As demonstrated with the Brundtland Report (1987), the problems of bio-physical limits and social injustice have been addressed by facilitating economic expansion. There is increasing evidence, not just with the ecological footprint, that the world may already be effectively 'full' (Goodland 1991, Daly, 1991) due to the constant reliance on economic development. Chapter 3 demonstrated that human appropriation exceeds nature's supply by 35%. In other words, we would need at least a 35% larger Earth to accommodate the present material flows through the economy, sustainably. This indicates that the ecological crisis and social injustice are caused by the quantity of resources consumed. This questions the philosophy of the economic system that is responsible for the promotion of ever more consumption. Even when solely looking at the consumption of the richest 20% of the world population, this translates to an ecological footprint larger than global carrying capacity.

By providing such a clear understanding of the various competing uses of nature, the ecological footprint provides a framework to visualise and communicate overshoot as applied to human activity. It demonstrates that the concept portrayed in 'Limits to Growth' of a sudden crash is not a reality. What actually occurs is a depletion of natural capital, that can for a short time provide a continuous supply of resources to maintain human appropriation. Social injustice also helps sustain this situation.

Chapter 5 demonstrated that a sustainable society will have to adopt a bioregional approach, however, the current picture contradicts this. The current situation is a world where economic expansion through globalisation is at the forefront. This ideology is responsible for the high level of consumption in industrialised countries and the current situation of unsustainability. Therefore, the ecological footprint scenarios, which offer new insights into what a sustainable society consists of, lead us to question the direction in which society as a whole is moving. With the removal of trade barriers, the global economy opens access to new resource stocks and feeds rising consumer expectations.

The scenarios (particularly the waste scenario, section 5.4) also give an insight into the fact that sustainability will not be achieved through the efficiency perspective. Optimisation of resources will not reduce consumption as this section will go on to justify.

7.4.2 The direction of economic growth and globalisation

The following quote exemplifies the extent to which the economic ideology has and continues to create the need for incessant consumption. The ecological footprint has verified that over consumption can be inextricably linked with unsustainability.

'The economy overshadows every other reality ; the laws of economy dominate society and not the rules of society the economy.' (Sachs, 1999 :17)

Not to lose ground in the economic arena has become a fixation that dominates politics all the way down to the local level. The politicians in Guernsey were preoccupied with Guernsey being a formidable competitor in the global economic market (Chapter 4). This overruling imperative drives developing countries further into exploitation of their environment, for the sake of boosting exports and protecting their markets. Diversity becomes an obstacle to be removed. There is scarcely a country left today that seems able to control its own destiny.

Chapter 2 demonstrated that the government's language when discussing sustainable devlopment concentrates around phrases such as progress, growth, market integration, all notions that are part of the problem, not the solution. The example of Guernsey acts as a constant reminder of conflicting policies. Guernsey incorparates ideas of environmentalism in policy statements, while pursing ecologically disastrous free-trade policies.

The gap between the rich and the poor had never been wider, to the extent that it has become inconceivable that it could ever be closed (Sachs, 1999). People in the South live in greater hardship and misery than at the time of decolonialisation.

The most compelling fact of all is, as the ecological footprint demonstrates, that the world economy has outgrown the planet. After all, the world economy increases every two years by the size it had reached by 1900, after centuries of growth. The situation has arisen that economic expansion has already come up against bio-physical limits.

The establishment of global markets has facilitated the appropriation of carrying capacity from all over the globe and has accelerated its destruction. If industrialised countries continue to promote a lifestyle that requires three more planets (Wackernagel & Rees, 1996) they are, in effect, blindly planning for their own collapse. If the industrialised countries want to make a contribution to sustainability may should massively reduce their resource consumption. Industrial countries should promote living simply, so others can simply live.

The ecological footprint provides direction for an ecologically more sensitive and therefore more humane and future orientated development path. There are numerous innovative ideas for local communities. Society lacks the intellectual and emotional acceptance of the fact that humanity is materially dependent on nature, and that nature is limited in its biological productivity.

In fact, the OECD countries surpass their average earthshare by a magnitude of about 75-85% as measured by the ecological footprint, while only 9 out of the 52 analysed countries remain below this permissible average altogether (Chapter 3). The example in chapter 3 illustrates this where 95.2% of the world's population has an ecological footprint lower than Guernsey's. Guernsey would need to reduce their resource consumption by 78% to achieve ecological sustainability.

In a closed space with finite resources the under consumption of one party is the necessary condition for the over consumption of the other party. The consumer classes have succeeded in passing on environmental burdens to less advantaged groups, leaving the noise, dirt and the ugliness for the new industrial areas of the world. This is why an analysis, such as the ecological footprint, demonstrates who is responsible for consumption and the subsequent resource depletion.

However, with the emergence of bio-physical limits to growth, classical notions of justice, which were devised in a perspective of finitude and not in a perspective of infinity, acquire new relevance; justice is about changing the rich and not about changing the poor. The North is required to shape its patterns of production and consumption in such a way that Southern countries are not deprived of what they are entitled to use. A systematic retreat from using other people's land and share of the global commons is the most important step to take in the spirit of global responsibility. The principle of equal rights of all people to the world's resources is a yardstick to make one's own society sustainable.

Therefore, if privileged communities, like Guernsey, intend to take sustainability seriously, it will have to reduce its resource weight by 80-90%. It will amount to both an efficiency revolution giving a new shape to technical progress and a sufficiency revolution giving rise to a certain lack of interest in monetary and material growth. Sufficiency was the hallmark of justice before the concept of infinite growth took over; sufficiency in resource consumption is now bound to become the axis around which the post-developmentalist notion of justice will revolve (Sachs, 1999). Whoever calls for equity will have to speak about sufficiency. A more comprehensive strategy will avoid pollution from the outset, rather than cleaning up at the end of the pipe.

Making wealth creation less dependent on resources requires a broad-range and long-term de-materialisation of the economy that lies on the Utopian horizon of the sustainability idea. The notion of resource productivity merges the two ambitions contained in the sustainability idea into a formula; it calls for a considerable reduction in resource use while suggesting an accomplished economic life at the same time.

By restricting, for example, the types of materials that can be used for housing more innovative and creative uses can be found for the existing materials. Therefore, durability of products becomes essential. Chapter 4 demonstrated many innovative options for the subsequent reduction of the ecological footprint. Resourceful ideas concerning transport, waste and domestic energy included schemes for zero energy housing and alternatives to the use of the car. The idea of a circular metabolism becomes a reality, as it is the only opportunity.

A post-fossil fuel society is required to satisfy society through means that require fewer resources. The productivity of a sustainable society will be measured not by the eco-efficiency of an ever expanding number of technologies, but by the quality of the civilisation it creates out of limited means (Sachs, 1999).

It is overwhelmingly clear that the search for sustainability implies a drastic reduction in absolute levels of resource consumption, be it for fossil fuel, water or timber. For this reason, any statement about relative efficiency on the micro level remains of little relevance as long as it is not combined with the assumption about the development of absolute volumes on the macro level.

7.4.3 Facing up to biophysical limits – The Optimisation Fallacy

The efficiency perspective, if it is to become meaningful, must be embedded in a broader sufficiency perspective. The transition towards sustainability can be achieved only through a twin-track strategy: an intelligent reinvention of means as well as a prudent moderation of ends (Sachs, 1999). Chapter 5 indicates that if this dual approach is not taken, the expansive dynamics, remaining unexamined and eventually unchecked, will undermine all successes achieved from boosting resource efficiency. Moreover, the twin-track approach makes the transition to sustainability easier because the pressure of high efficiency of means is softened when certain levels of sufficiency in goals are socially accepted.

The scenarios within Chapter 5 also provide a clear example that efficiency is not enough. Within the waste scenario for Guernsey, the introduction of more recycling schemes (both domestic and commercial) as well as composting schemes, while reducing the ecological footprint, still demonstrated that Guernsey is simply producing to much rubbish. The 'Sustainable Model' for Guernsey suggested that waste should be reduced to an ecological footprint of 0.36 Ha./per capita from 1.55 Ha./per capita. The potential saving by introducing the efficiency measures (including domectic recycling, composting and commercial recycling) created a saving of 0.18 Ha./per capita reducing the ecological footprint of Guernsey's waste to 1.37 Ha./per capita. Only a reduction in the amount of waste Guernsey produces, combined with efficiency measures, will be adequate.

There is no doubt that an efficiency revolution would have an effect on global energy and resource use. The efficiency gains are indigenous to the North and play into the North's hands ; they can again offer the South a new selection of tools for economic progress. As well as the waste example, cars act as a another example. While they have become more and more efficient the pollution from cars has increased due to the increased number of miles driven.

Herman Daly provides an insightful example of this.

'Even if a cargo on a boat is distributed efficicently, the boat will inevitably sink under too much weight, even though it may sink optimally.' (Daly, 1990 :35)

The proposed policies for change continue to ignore the option of intelligent self-limitation and reduce ecology to a higher form of efficiency. Such reductionism implicitly affirms the universal validity of the economic world view. This will eventually spread further the Westernisation of minds and habits, a cultural fall-out that in the long run also endangers the overall goal of sustainability (Sachs, 1999).

7.4.4 The responsibility for change

Although there are many interpretations of sustainable development, there is one underlying message; keep the volume of human extraction/emission in balance with the regenerative capacities of nature. It also provides an opportunity to consider the important factor of social justice.

Western aspirations are taken for granted, not only by the West but worldwide, and societies that choose not to put all their energy into production and deliberately accept a lower throughput of commodities become unthinkable.

Responsibility can be repressed, with the South expected to take the initative for urgent action. Logically, the population question figures prominently on the global agenda of the contest perspective. After all, no issue lends itself so easily to taking the South to task, no issue grants the status of innocence so clearly to the North as this one does. Environmental problems in the South are framed as the result of insufficient capital, out-dated technology, lack of expertise and slackening economic growth (Sachs, 1999). Again, the ecological footprint offers a different perspective.

One of the key findings of the ecological footprint is that there are insufficient resources for the South to emulate the North's lifestyle. What links the efforts of Southern groups with dissidents in rich countries is the fact that both expect the North to retreat from utlising other people's nature and to reduce the footprint it occupies. After all, all the Northern countries leave an 'ecological footprint' on the world that is considerably larger than their territories. They occupy foreign soils to provide themselves with meat and vegatables; they utilise the global commons – such as the oceans and the atmosphere – far beyond their fair earthshare. The North must be called upon to reduce the environmental burden it places on other countries and to repay the ecological debt accumulated from the excessive use of the biosphere over decades and centuries. The principal arena for ecological adjustment is thus neither the Southern hemisphere nor the entire globe, but the North itself. It is the reduction of the global effects of the North to the reach of domestic responsibility that is at the centre of attention. It is necessary to make room for others by means of an orderly retreat; it proposes a new kind of rationality, which could be called 'the rationaility of shortened chains of effect' for meeting the crises of justice and of nature.

7.5 Final Conclusions

Sustainability promises nothing less than to square the circle : to identify a type of development that promotes both ecological sustainability and international justice.

Local planning offers significant leverages for action toward sustainability. Innovative changes in transportation and land-use patterns can significantly reduce resource consumption and improve quality of life. The ecological footprint has proven that it can assist in analysing policies for their global ecological impact. People should focus on living locally, rather than consuming globally.

The ecological footprint is a tool that can facilitate the comparison of policy choices that society inevitably must face. As a decision-making tool the analysis was given a distinct local flavour. On this local level as suggested, the ecological footprint is a valuable part of the sustainable indicator tool kit. It provides an insight into distinctly local issues of transport and energy consumption. It helps provide a larger picture while providing the detail required to guide policy in specialised areas. Again, it is important to acknowledge that the ecological footprint takes nothing away from the democratic process. It is important to remember that the ecological footprint is merely an accounting tool. It is now the decision of politicians and the residents of a given population as to whether they wish to pursue sustainable development. The ecological footprint has provided some of the important information but not all of it. As an indicator for sustainability it forms part of a range of tools that can promote sustainability.

Intelligent rationalisation of means and prudent moderation of ends is the only solution. In other words, an 'efficiency revolution' remains without direction if it is not accompanied by a 'sufficiency revolution' (Sachs, 1999). Nothing is ultimately as irrational as rushing with maximum efficiency in the wrong direction. A 'sufficiency revolution', however, can neither be programmed nor engineered ; it involves a mixture of subtle and rapid changes in the cultural outlook and institutional set-up of society. Asking the North to be sustainable, therefore, questions the most fundamental beliefs embedded in society. This sustainability discourse tends to focus more on values and institutional patterns, in short, on the symbolic universe of society (Sachs, 1999).

As a consequence, the ideal of lean consumption becomes more attractive, because a wealth of goods is at odds with the wealth of time. What would things look like if they were designed with a view to quality, durability and uniqueness ?

Both the crisis of justice and the crisis of nature necessitate looking for forms of prosperity that would not require permanent growth, for the problem of poverty lies not in poverty but in wealth. It implies instead that each country puts its own house in order in such a way that no economic or environmental burden is pushed onto others that would constrain them in choosing their own path.

Nevertheless, the emergence of the globe as an economic arena where capital, goods and services are able to move without much consideration for local and national communities has delivered the most serious blow to the idea of a polity built on reciprocal rights and duties among citizens. The challenge of the sufficiency debate is to contribute to society's reflection about its own well-being and to determine whether a reduced emphasis on economic expansion can enhance the quality of civilisation.

Economic integration entails transport and ever more transport. The distances between producer and consumer, suppliers and manufacturers are increasing everywhere. Production and lifestyle based on high volumes of long-distance transportation carry an unsustainable load of energy and raw materials.

Forging more business links in the region can create locally intensified economies, which is also desirable for reasons of economic security and enhanced political autonomy in the places where people live. Because of both ecology and community well-being, strategies of regional sourcing and regional marketing are particularly important for food, furniture, construction, repair and maintenance services, as well as for human services. In terms of jobs, quality of services, and regional linkages in the economy, medium-scale actors in business and public administration are often superior to centralised institutions (Morris, 1996). In addition, a regionalist economy appears to offer the appropriate scale for the development of core sectors of a restorative economy. Recycling and repairing, both sectors of high importance for an economy of low throughput, require proximity to the consumer and are therefore most efficient at a medium scale of operation (Blau and Weib, 1997). Moreover, solar power, which relies on the widespread but diffuse resource of sunlight, is best developed when many operators harvest small amounts of energy, transforming and consuming them at close distance.

Confusion about what sustainability is can no longer be an excuse for slowing down progress. Now we must move beyond the Brundtland definition and assess sustainability in concrete terms. Only clear and measurable objectives help us manage for sustainability. Simple benchmark yardsticks, such as the ecological footprint that compare human consumption with nature's limited supply help refocus public attention on the sustainability challenge. They clarify ecological boundary conditions and make way for meaningful debates on development. By providing common ground, such assessments build bridges between different world views, they amplify the resonance between all disciplines working on sustainability. From here we can build shared visions for a sustainable future.

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CONTENTS OF THE APPENDIX

Appendix 1: Expert Interview Guide: Mathis Wackernagel

Before entering into the topic of the methodology of the footprint, I would like to congratulate you on designing an extremely valuable tool for advancing sustainable development. I would like your general impression on how you feel it has advanced since you started developing the tool.

When do you feel the greatest advancement in the development of the footprint was made?

Do you feel the footprint has come a long way since the first idea of the footprinting?

Has it become a more complex and scientifically advanced tool?

Section 1: The methodology of the ecological footprint

Section 1.1 The Footprint and Pollution

Inclusion of other pollutants: How does the footprint deal with the amount of land that is being destroyed by different pollutants. Should there be a category for "pollutants" in the footprint measurement? Levett gives the example of ozone depletion and including these footprint calculations?

For footprinting to provide a universally comparable 'currency' of environmental impacts, it would be necessary for each unit of each 'footprintable' impact to have the same effects on bioproductivity wherever it occurred.

Many pollutants have a non-linear effect. For example, at a low level a pollutant can actually be beneficial (heavy metals within soil promote plant growth).

The use of standard figures poses a major problem. The effect of pollution can vary from one location to the next. Does this mean that standard international figures for the footprint have no use and only when local statistics are gained can the footprint be put into use?

Section 1.2 The Footprint and Energy

Many believe that nuclear power is inherently unsustainable. The main argument being that by producing waste that lasts for millions of years this is not a step that preserves the environment for future generations. Therefore, it is extremely important that it is included within a footprint measurement.

Footprint and Global Warming: Which method does Best Foot Forward use to establish this pat of the footprint?

How does the embodied energy link up with the Eco-index?

Can you explain how you establish the ecological footprint of nuclear energy?

Is the nuclear energy figure a value judgement on behalf of the designer of the footprint?

Should the footprint aim to be as objective as possible?

How accurate is the embodied energy figure within the footprint?

1.3 Footprint and Utilitarian Biases

The footprint assumes that all productive land is available for human appropriation? It does not consider views of aesthetics, recreation or other qualitative values.

The factor of human health

Footprint and public services

Section 2: The Application of Ecological Footprint

What do you feel is the most valuable application for the ecological footprint?

Do you feel that the use of the footprint as a decision-making tool for policy is the most difficult bridge to get over?

Why do you feel it has be meet with such scepticism?

In your latest questionnaire (designing a simple footprint measurement) I noticed you have taken a step out BBF idea, placing footprinting into simple questions concerning issues.

Section 1: Fitting the ecological footprint into a framework of indicators for decision-making. For the footprint to truly make an advancement as a tool for sustainability, it must advance into the field of policy decision making. There are many issues concerning this advancement that needs to be addressed.

Considering the value of the footprint to guide policy.

Is the footprint anti-rural?

Is the footprint attempting, from your opinion, to become the only required indices for policy decision making?

The potential of the footprint relies on the availability of data, that is not always easily to obtain. Is this one of the major problems of the footprint?

Is there a problem with relying on prorating data, something that is often required with the ecological footprint?

Section 2: Various others use for the ecological footprint

With the issue of a fair 'earthshare' for everyone, could equal shares impose unequal privations? Equality of outcome requires unequal inputs.

Developed countries have already had more than their fair share and should now rein back to let others have their turn?

Is it right to reduce the footprint measurement to an individual person. Does this remove any ideas of collective responsibility?

How do we deal with the issue of children within footprinting?

Scenarios that would increase the footprint

The footprint in the use of time series data?

The use of footprints as an education tool?

I see the footprint as a headline indicator, feeding down to group of more specific indicators, such as indicators concerning pollution, a factor that the footprint has trouble dealing with. The footprint should not be viewed as answering all the requirements for indicators, of which I'm sure the inventors of the footprint had not intended. (Establish structure of indicators).

Appendix 1: Interview Guide: Roger Levett

Thank you for agreeing to spend the time for an interview. I have listed the questions below under three sections. Some questions may seem similar but this is an attempt to make sure that all areas covered. It is not essential to stick to this interview guide. I'm hoping for a semi-structured approach to the interview.

Section 1: Introductory Footprint Issues

1. Please explain your involvement of uses of the ecological footprint?

2. "Footprinting is the best tool we yet have for measuring and comparing the ecological impacts of different activities, places, people or lifestyles." (Levett, 1998)

Has you opinion changed since you made this comment and if not why do you think footprinting is the best tool for measuring ecological impacts?

3. "Rather than being over precise, we make sure that footprints do not exaggerate the severity of the ecological situation." Wackernagel

Is this the right approach for an indicator of sustainability?

Section 2: The Methodology of the Ecological Footprint

1.Many believe that nuclear power is inherently unsustainable. The main argument being that by producing waste that lasts for millions of years this is not a step that preserves the environment for future generations. Therefore, it is extremely important that it is included within a footprint measurement.

How do you believe the issue of nuclear power should be dealt with in the footprint?

2. Is the nuclear energy figure a value judgement on behalf of the designer of the footprint?

3. Should the footprint aim to be as objective as possible?

4. The objectivity of the EF has been questioned concerning a number of key issues. Do you believe an indicator of sustainability should be as objective as possible?

5. van den Bergh & Verbruggen suggest that conversions for land area is necessarily incomplete, while no account is taken of regional and local features of land types and land use. Do you believe this to be a major problem of the EF?

6. The 'carbon sink land' for the EF has proven to be the most controversial issue. The fact that CO2 assimilation by forests is one of many options to compensate for CO2 emissions weakens the footprint.

Do you agree with this statement?

7. Van den Bergh suggests that the EF would be more useful as a "modelling rather than an accounting approach should be followed to realise economically feasible outcomes?"

Do you agree with this statement?

8. The footprint assumes that all productive land is available for human appropriation? Do you feel the footprint is too utilitarian in its approach?

9. One of the problems with footprinting is the lack of available data on consumption. Mathis would say that this is not a footprint problem but a problem with data availability. Would you agree with this comment?

10. Prorating data can lead to a footprint figure that is less responsive to local change. Again, is this a data issue and not a footprint issue?

11. What is your opinion on the use of global equivalence factors that adjust the final footprint calculation?

12. You have raised the valuable point about who to assign the footprint too (example of buses). Do you feel that this type of problem weakens the footprint methodology?

13. Many of the criticisms surrounding the EF are based on issues that it has never claimed to do. Do you believe this to be fair?

Section 3: The Application of Ecological Footprint

1. What do you feel is the most valuable application for the ecological footprint?

2. I feel there is no doubt that the ecological footprint has provided a powerful educational tool. The results are shocking to most people and can act as a catalyst for individual behavioural change. I feel this has been demonstrated with my extensive analysis of Guernsey and Liverpool (using focus groups).

However, the use of the ecological footprint as a policy decision-making tool is more questionable. Do you agree with this comment?

3. Do you feel that the BFF approach to footprinting provides a clearer understanding of how to reduce an areas ecological footprint?

4. Is the footprint a robust enough tool to be used to guide policy at a local level (a city for example)?

5. "The footprint is not a substitute but a complement to other kinds of (more management orientated) measurement approaches."

Would you agree with this statement?

6. Why do you feel it has been meet with such scepticism?

7. Is it right to reduce the footprint measurement to an individual person. Does this remove any ideas of collective responsibility?

8. How do we deal with the issue of children within footprinting?

9. Do you believe the footprint can be used as time series data for monitoring improvements over time?

Is the footprint really this innocent, surely implying what is good or bad gives the footprint a bias response to the answer?

10. Do you believe, the continuing development of the ecological footprint that it is a 'step in the direction' regarding its use as a policy tool?

Appendix 1: Interview Guide for Ferguson

Section 1: The methodology of the ecological footprint

Section 1.1 The Footprint and Pollution

Footprint and Global Warming: Which method does Best Foot Forward use to establish this pat of the footprint?

Inclusion of other pollutants: How does the footprint deal with the amount of land that is being destroyed by different pollutants. Should there be a category for "pollutants" in the footprint measurement? Levett gives the example of ozone depletion and including these footprint calculations?

For footprinting to provide a universally comparable 'currency' of environmental impacts, it would be necessary for each unit of each 'footprintable' impact to have the same effects on bioproductivity wherever it occurred.

Many pollutants have a non-linear effect. For example, at a low level a pollutant can actually be beneficial (heavy metals within soil promote plant growth).

The use of standard figures poses a major problem. The effect of pollution can vary from one location to the next. Does this mean that standard international figures for the footprint have no use and only when local statistics are gained can the footprint be put into use?

Section 1.2 The Footprint and Energy

Many believe that nuclear power is inherently unsustainable. The main argument being that by producing waste that lasts for millions of years this is not a step that preserves the environment for future generations. Therefore, it is extremely important that it is included within a footprint measurement.

Can you explain how you establish the ecological footprint of nuclear energy?

Is the nuclear energy figure a value judgement on behalf of the designer of the footprint?

Should the footprint aim to be as objective as possible?

How accurate is the embodied energy figure within the footprint?

Section 1: Fitting the ecological footprint into a framework of indicators for decision-making

Is the footprint attempting, from your opinion, to become the only required indices for policy decision making?

1.3 Footprint and Utilitarian Biases

The footprint assumes that all productive land is available for human appropriation? It does not consider views of aesthetics, recreation or other qualitative values.

The factor of human health

Footprint and public services

Section 2: Present environmental policy and the ecological footprint

Considering the value of the footprint to guide policy.

Is the footprint anti-rural?

The potential of the footprint relies on the availability of data, that is not always easily to obtain. Is this one of the major problems of the footprint?

Is there a problem with relying on prorating data?

Section 2: Various others use for the ecological footprint

With the issue of a fair 'earthshare' for everyone, could equal shares impose unequal privations. Equality of outcome requires unequal inputs.

Developed countries have already had more than their fair share and should now rein back to let others have their turn?

Is it right to reduce the footprint measurement to an individual person. Does this remove any ideas of collective responsibility?

Appendix 1: Interview Guide for Simmons and Chambers

Section 1: The methodology of the ecological footprint

Section 1.1 The Footprint and Pollution

Footprint and Global Warming: Which method does Best Foot Forward use to establish this pat of the footprint?

Inclusion of other pollutants: How does the footprint deal with the amount of land that is being destroyed by different pollutants. Should there be a category for "pollutants" in the footprint measurement? Levett gives the example of ozone depletion and including these footprint calculations?

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How accurate is the embodied energy figure within the footprint?

Section 1: Fitting the ecological footprint into a framework of indicators for decision-making

Is the footprint attempting, from your opinion, to become the only required indices for policy decision making?

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The footprint assumes that all productive land is available for human appropriation? It does not consider views of aesthetics, recreation or other qualitative values.

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Footprint and public services

Section 2: Present environmental policy and the ecological footprint

Considering the value of the footprint to guide policy.

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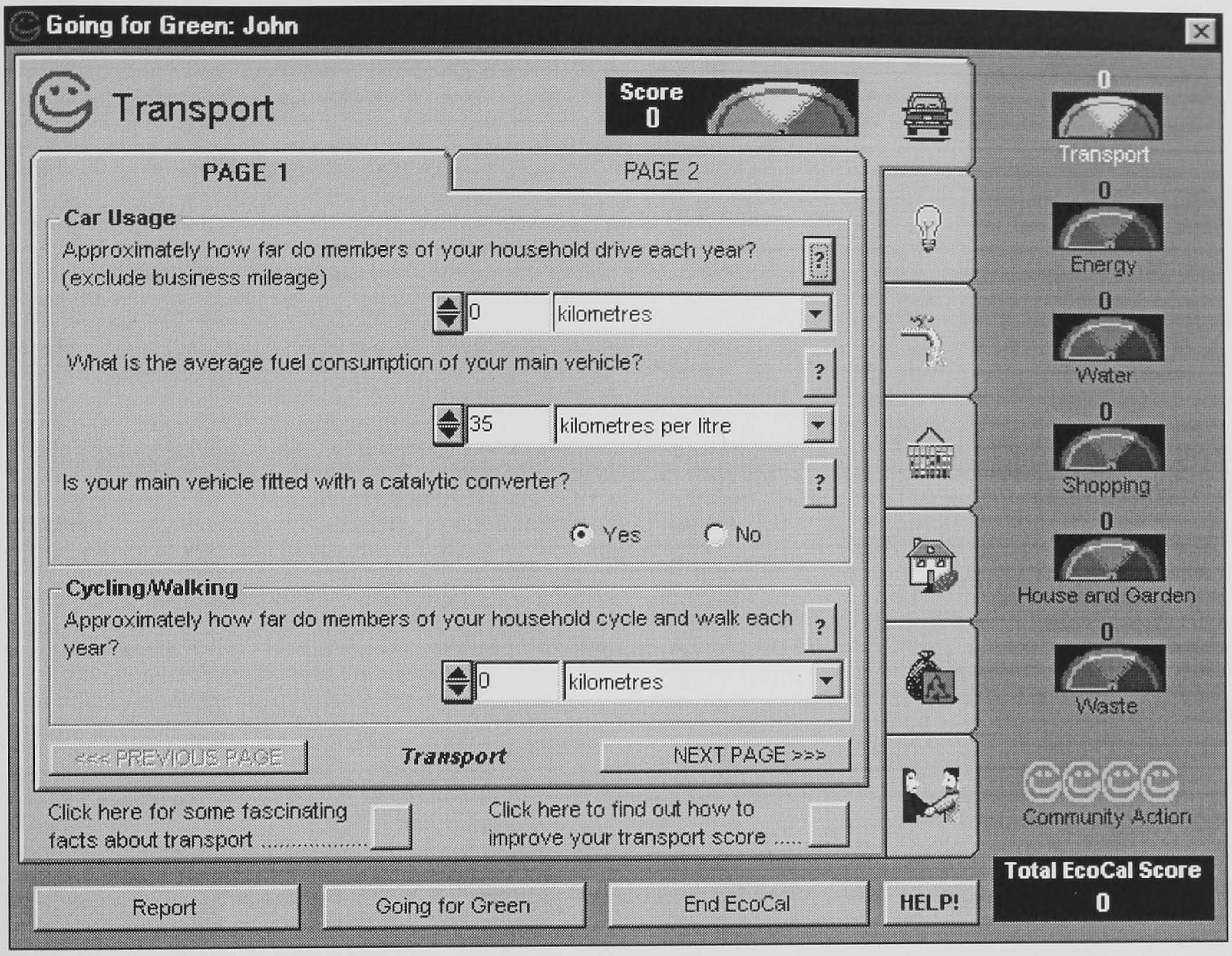
Section 2: Various others use for the ecological footprint

With the issue of a fair 'earthshare' for everyone, could equal shares impose unequal privations. Equality of outcome requires unequal inputs.

Developed countries have already had more than their fair share and should now rein back to let others have their turn?

Is it right to reduce the footprint measurement to an individual person. Does this remove any ideas of collective responsibility?

Appendix 2: Screen shot of EcoCal designed by Best Foot Forward Ltd



TOTAL NUMBER OF MOTOR VEHICLES "IN USE" EACH YEAR
IN THE ISLAND OF GUERNSEY

	MOTOR VEHICLES				MOTOR CYCLES		COMBINED TOTAL	
Year	Private	Commercial	Total	Plus or Minus	Total	Plus or Minus	Total	Plus or Minus
1950	3,670	1,767	5,437	-	1,385	-	6,822	-
1951	3,587	1,933	5,520	+ 83	1,536	+ 151	7,056	+ 234
1952	3,699	1,929	5,628	+ 108	1,683	+ 147	7,311	+ 255
1953	4,075	2,014	6,089	+ 461	1,821	+ 138	7,910	+ 599
1954	4,173	1,956	6,129	+ 40	1,871	+ 50	8,000	+ 90
1955	4,485	2,051	6,536	+ 407	2,137	+ 266	8,673	+ 673
1956	4,912	2,239	7,151	+ 615	2,442	+ 305	9,593	+ 920
1957	5,173	2,370	7,543	+ 392	2,656	+ 214	10,199	+ 606
1958	5,732	2,491	8,223	+ 680	2,968	+ 312	11,191	+ 992
1959	6,249	2,542	8,791	+ 568	3,338	+ 370	12,129	+ 938
1960	7,252	2,619	9,871	+1,080	3,674	+ 336	13,545	+1,416
1961	7,977	2,735	10,712	+ 841	3,964	+ 290	14,676	+1,131
1962	9,036	2,757	11,793	+1,081	4,111	+ 147	15,904	+1,228
1963	10,107	2,830	12,937	+1,144	4,202	+ 91	17,139	+1,235
1964	11,152	2,933	14,085	+1,148	3,846	- 356	17,931	+ 792
1965	12,030	2,962	14,992	+ 907	3,499	- 347	18,491	+ 560
1966	12,924	2,966	15,890	+ 898	3,263	- 236	19,153	+ 662
1967	14,255	3,054	17,309	+1,419	3,206	- 57	20,515	+1,362
1968	15,539	3,236	18,775	+1,466	2,995	- 211	21,770	+1,255
1969	16,772	3,418	20,190	+1,415	2,774	- 221	22,964	+1,194
1970	17,416	3,440	20,856	+ 666	2,632	- 142	23,488	+ 524
1971	17,549	3,386	20,935	+ 79	2,487	- 145	23,422	- 66
1972	18,607	3,490	22,097	+1,162	2,607	+ 120	24,704	+1,282
1973	19,606	3,676	23,282	+1,185	2,444	- 163	25,726	+1,022
1974	20,400	3,884	24,284	+1,002	2,452	+ 8	26,736	+1,010
1975	21,105	3,912	25,017	+ 733	2,543	+ 91	27,560	+ 824
1976	21,147	4,125	25,272	+ 255	2,679	+ 136	27,951	+ 391
1977	21,791	3,944	25,735	+ 463	3,008	+ 329	28,743	+ 792
1978	22,699	4,105	26,804	+1,069	3,170	+ 162	29,974	+1,231
1979	23,500	4,162	27,662	+ 858	3,314	+ 144	30,976	+1,002
1980	23,938	4,258	28,196	+ 534	3,505	+ 191	31,701	+ 725
1981	24,151	4,255	28,406	+ 210	3,661	+ 156	32,067	+ 366
1982	24,850	4,245	29,095	+ 689	3,758	+ 97	32,853	+ 786
1983	25,899	4,362	30,262	+1,167	3,805	+ 47	34,067	+1,214
1984	26,748	4,580	31,328	+1,066	3,850	+ 45	35,178	+1,111
1985	28,064	4,816	32,880	+1,552	3,953	+ 103	36,833	+1,655
1986	29,632	5,041	34,673	+1,793	3,900	- 53	38,573	+1,740
1987	31,167	5,433	36,600	+1,927	3,776	- 124	40,376	+1,803
1988	32,362	5,819	38,181	+1,581	3,690	- 86	41,871	+1,495
1989	33,626	6,021	39,647	+1,466	3,642	- 48	43,289	+1,418
1990	34,918	6,143	41,061	+1,414	3,591	- 51	44,652	+1,363
1991	33,545	6,302	39,847	-1,214	3,435	- 156	43,282	-1,370
1992	32,612	6,358	38,970	- 876	3,227	- 208	42,197	-1,085
1993	32,691	6,466	39,157	+ 187	3,035	- 192	42,192	- 5
1994	33,037	6,614	39,651	+ 494	3,013	- 22	42,664	+ 472
1995	33,997	6,756	40,753	+1,102	3,124	+ 111	43,877	+1,213
1996	34,271	6,821	41,092	+ 339	3,342	+ 218	44,434	+ 557

Appendix 3: Total Number of Vehicles 'in use' in Guernsey

ANSTAT1

Appendix 4: Questionnaire and pamphlet

QUESTIONNAIRE SURVEY

Sustainability and Ecological Footprints

John Barrett, M.Sc., B.Sc.
Environmental Planning Research Unit
Liverpool John Moores University
School of the Built Environment
Clarence Street, Liverpool
L3 5UG

The following research has been commissioned by the States of Guernsey in an attempt to investigate the development of sustainable indicators (explained in the text) for the island of Guernsey. Liverpool John Moores University has already conducted a series of focus groups in Guernsey investigating the views of the Guernsey people. To further this research the following questionnaire has been devised.

The information within this pack includes: -

- A pamphlet explaining sustainable development and indicators, which can be used in conjunction with the questionnaire.
- A questionnaire concerning your opinions on environmental issues.
- A self-addressed envelope to return the questionnaire.

I understand that you have already received this questionnaire and would be most grateful if you could find the time to complete it. I appreciate the high demands on your time, however this research will be beneficial for Guernsey regarding the development of environmental issues.

The questionnaire will help to establish the acceptability of sustainable development on the island. All the responses remain confidential and are protected under the 'Data Protection Act. I will provide you with a summarised report of the findings, if you wish. Your opinion is very valuable and the research gives you the opportunity to express your concerns about the island.

It is important to read the pamphlet before completing the questionnaire, as this will guide you through the issues concerning sustainable indicators.

Thank you for your time.

Yours faithfully,

Identification

Name____

Contact address for questionnaire summary

____

____

Section 1: Sustainability

1.1 Please rate the importance of each of the following issues?
(3 = very important, 2 = important, 1 = marginally important, 0 = not important at all)

( ) Providing child day care
( ) Slowing down resource depletion
( ) Reducing waste
( ) Supporting the finance industry
( ) Preserving the countryside
( ) Reducing income disparity
( ) Providing the best possible health care
( ) Controlling health care costs
( ) Abating pollution
( ) Economic growth
( ) Reducing crime
( ) Reducing income taxation
( ) Supporting art and culture
( ) Improving public transport
( ) Supporting the horticultural and farming

1.2 Before reading the pamphlet had you heard of sustainable development?

( ) Yes ( ) Barely ( ) No

1.3 Do we overuse nature to supply us with our resources?

( ) Yes ( ) No

(Please explain, if necessary)

____

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____

1.4 Do you believe sustainable development to be about a sensible approach to using resources?

( ) Yes ( ) No

(Please explain, if necessary)

____

____

____

1.5 Is it important that future generations should have the ability to achieve a decent life and this depends on how we use with our resources today?

( ) Yes ( ) No

(Please explain, if necessary)

____

____

____

Section 2: Measuring Our Impact

2.1 Should Guernsey measure its impact on the local environment?

( ) Yes ( ) No

Please explain your answer:

____

____

____

2.2 Should Guernsey measure its impact on the global environmental?

( ) Yes ( ) No

Please explain your answer:

____

____

____

2.3 How effective do you feel the ecological footprint is for: -
(Please circle the appropriate number for each statement)

- The general public to understand what sustainable development is about.
  1: Very Useful 2: Useful 3: Not Useful 4: Don't Know
- Individuals to reconsider the effect of their lifestyle choices.
  1: Very Useful 2: Useful 3: Not Useful 4: Don't Know
- Planning departments and municipalities as a planning tool.
  1: Very Useful 2: Useful 3: Not Useful 4: Don't Know
- Political decision-making as a sustainable indicator.
  1: Very Useful 2: Useful 3: Not Useful 4: Don't Know
- Students and scholars to generate positive choices for sustainable development.
  1: Very Useful 2: Useful 3: Not Useful 4: Don't Know

Section 3: Environmental Policy in Guernsey

3.1 Energy - Are you pleased with the forthcoming cable link to France?

( ) Yes ( ) No

(Please explain, if necessary)

____

____

____

3.2 Energy - Do you think alternative forms of energy (wind, solar, tidal, wave) are a valid option for Guernsey?

( ) Yes ( ) No

(Please explain, if necessary)

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3.3 Waste - Would you like to see a door-to-door collection of recyclable products?

( ) Yes ( ) No

(Please explain, if necessary)

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____

3.4 Waste - Do you consider a sewage treatment plant to be important for Guernsey?

( ) Yes ( ) No

(Please explain, if necessary)

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____

3.5 Transport - Do you think car-parking charges should be introduced within the centre of St Peter Port?

( ) Yes ( ) No

(Please explain, if necessary)

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____

3.6 Transport - Do you think a well subsidised, reliable public transport system is needed for the island?

( ) Yes ( ) No

(Please explain, if necessary)

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____

3.7 Holidays - Do you consider flying to be a major environmental problem?

( ) Yes ( ) No

(Please explain, if necessary)

____

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____

3.8 Holidays - Would you like to see Guernsey tackle the issue of pollution caused by aircraft?

( ) Yes ( ) No

(Please explain, if necessary)

____

____

____

Section 4: The People of Guernsey

4.1 Do you think your opinions, concerning the environment, are similar to the residents of Guernsey?

( ) Yes ( ) No

(Please explain, if necessary)

____

____

____

4.2 Do you think the people of Guernsey understand the environmental problems facing the island?

( ) Yes ( ) No

(Please explain, if necessary)

____

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4.3 Are environmental problems important to the people of Guernsey?

( ) Yes ( ) No

(Please explain, if necessary)

____

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____

Section 5: The Future of Guernsey

5.1 Could Guernsey be a model island for sustainable development?

( ) Yes ( ) No

Please explain your answer:

___

___

___

5.2 Do you think we should attempt to reduce our ecological footprint in Guernsey?

( ) Yes ( ) No

Please explain your answer:

___

___

___

5.3 Do industrialised countries need to massively reduce their resource consumption?

( ) Yes ( ) No

Please explain you answer:

___

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___

5.4 By Guernsey reducing its environmental impact, do you think it will make a difference to global environmental problems?

( ) Yes ( ) No

Please explain your answer:

___

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___

If you have any other comments concerning environmental issues on Guernsey they are most welcome below.

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Thank you for taking the time to complete the questionnaire. Your assistance is most appreciated.

Appendix 4: The Pamphlet

ENVIRONMENTAL PLANNING RESEARCH UNIT

HELPING TO DEVELOP SUSTAINABLE COMMUNITES

SUSTAINABLE DEVELOPMENT IN GUERNSEY

DEVELOPING SUSTAINABLE INDICATORS

Section 1: Sustainability

Everyone depends on nature to provide the basic requirements for life. We need energy for heating, wood for paper and of course food for basic nutrition. Without nature, nobody could survive. Nature also absorbs all our waste (see diagram 1).

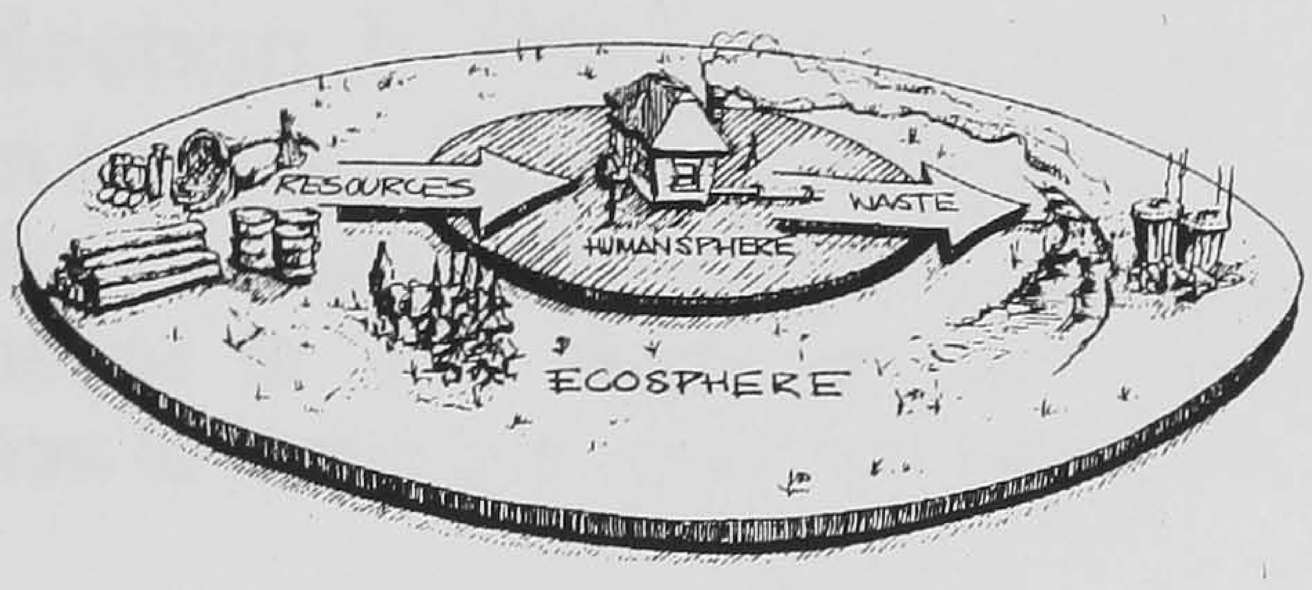


Diagram 1: Human Life Interwoven with nature.

If we are to continue to have good living conditions, we must ensure that we do not use up nature's resources faster than they can be renewed. This is one of the main ideas of sustainable development, a sensible approach to using resources. In its simplest form we can define sustainable development as,

"Achieving a good quality of life for all within the means of nature"

Most people would agree that it is important that future generations should have the ability to achieve a decent quality of life and this very much depends on how we deal with our resources today.

Section 2: Measuring Our Impact

Developing sustainably, however, is hard and needs the co-operation of all. Sustainability begins with accepting our dependence on nature, and acknowledging the problems posed by our unsustainable lifestyles. The next step is to take up the challenge of making them sustainable.

Diagram 2: How much damage are we doing?

The problem is that we don't always know how much damage we are doing. We need to start monitoring whether we live within our ecological means and at what rate humanity is depleting our natural resources. We must ask, "How much nature does humanity use to sustain itself?"

Without monitoring and measuring, we cannot plan for sustainability. To make sustainability a reality, we must know where we are now, and how far we to need go. The good news is that such essential tools for measuring progress have made substantial headway.

Section 3: The Ecological Footprint

In fact, any human economy, city or household is an ecological system much like the cow on the pasture (diagram 3). To maintain itself, the economy needs to "eat" resources, and eventually, all this intake becomes waste and has to leave the organism again.

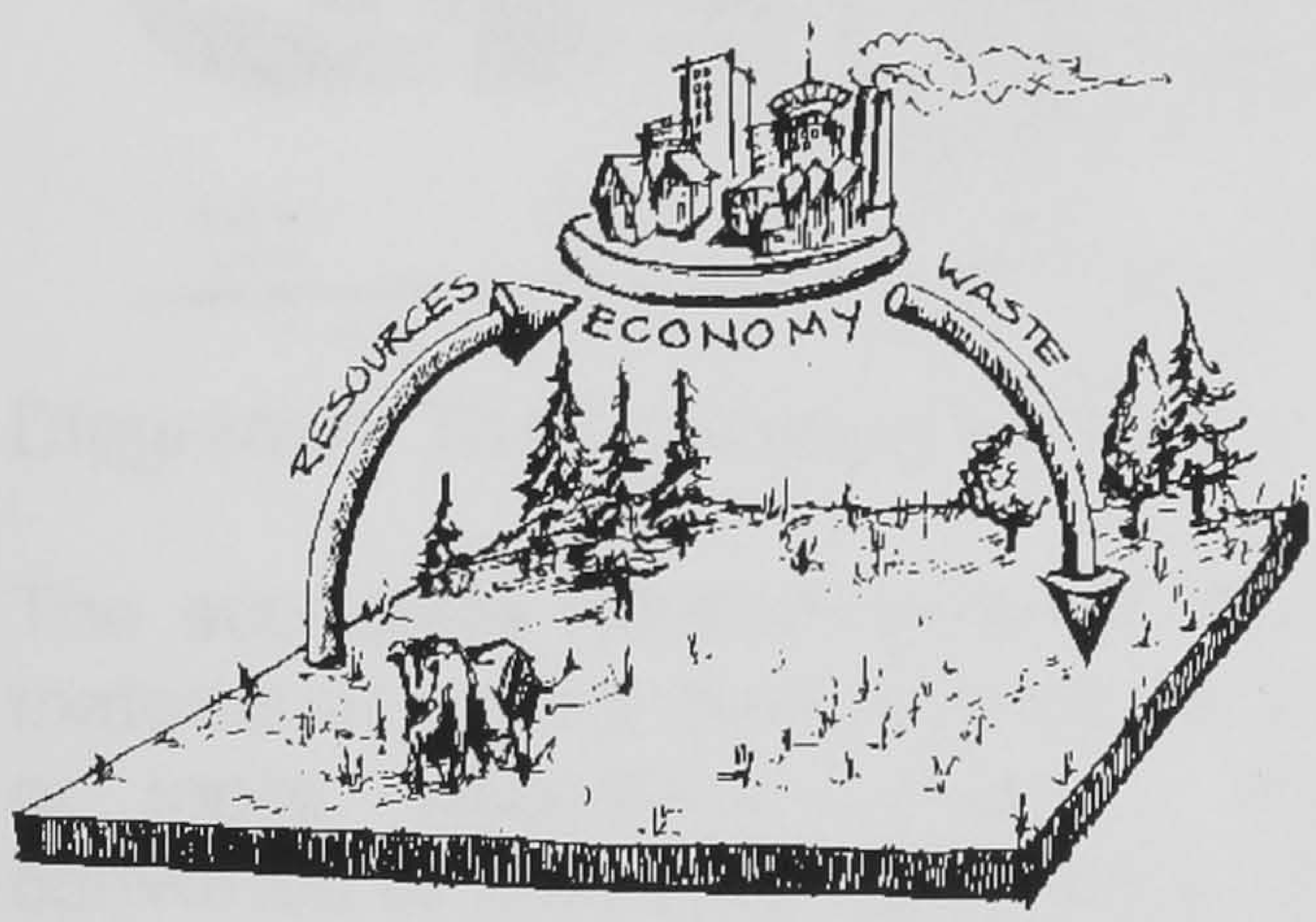


Diagram 3: Cow in the pasture

So the questions is,

"How big a pasture is necessary to support that economy, to produce all its feed and absorb all its waste?"

This human use of nature can be measured with the ecological footprint. We define it as the area necessary to continuously provide the resource supplies of a given population and absorb their waste. Now we can compare human demand with nature's supply (diagram 4).

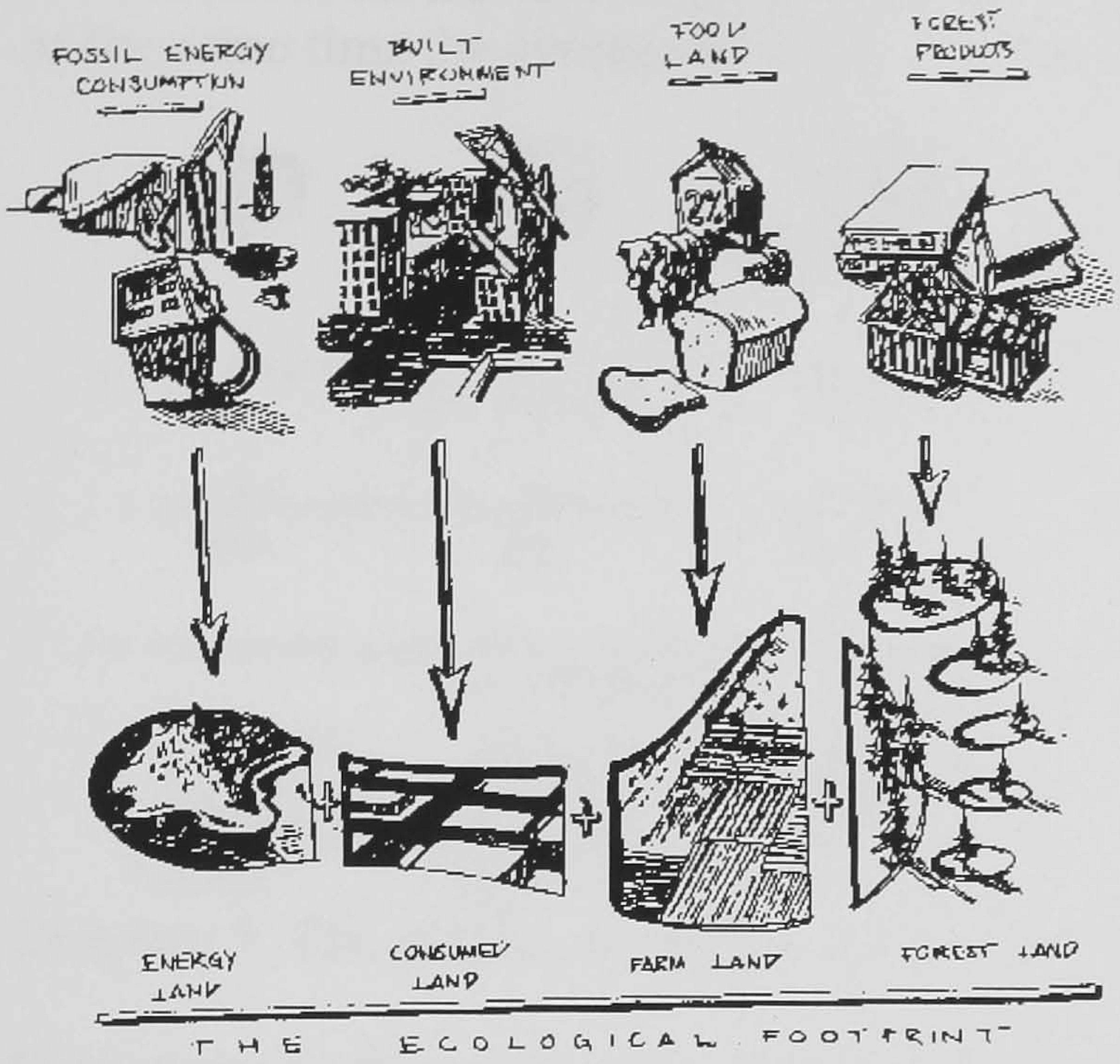


Diagram 4: The Ecological Footprint

The ecological footprint concept is based on the idea that for every item of material or energy consumption, a certain amount of land is required from one or more ecosystem category. These ecological productivities can be converted to land-area equivalents. Summing the land requirements for all the significant categories of consumption and waste estimates the ecological footprint for the reference population.

For a more refined analysis, these categories can be subdivided as required. For example, the food component of the footprint is divided into other 60 different food types, while transportation into walking, cycling, using the bus, boat, car and aeroplane.

First, we estimate the average person's consumption of particular items by dividing total consumption by the population size. The next step is to estimate the land appropriated per person for the production of each major consumption item. Finally, we then compute the total ecological footprint of the average person. This has been calculated for Guernsey.

Section 4: Footprints Over Time

Before we work out how much land we require, lets look at how much land is available on our planet. The earth has a surface area of 51 billion hectares, 71% of this area is ocean only leaving 29% land. However, only half of this land is productive for human use.

If this area were divided equally by all the people on the earth, each person would have 2 hectares each. Therefore, it is possible to say that if every person had an ecological footprint of 2 hectares that they are sustainable.

To better understand the current situation, let's look first at the historical trends of our ecological footprint over this century (diagram 5). Since the beginning of this century the amount of land available per person has decreased from 5 hectares to 1.5 hectares. At the same time the average footprint has grown from 1 to between 3 and 8 hectares.

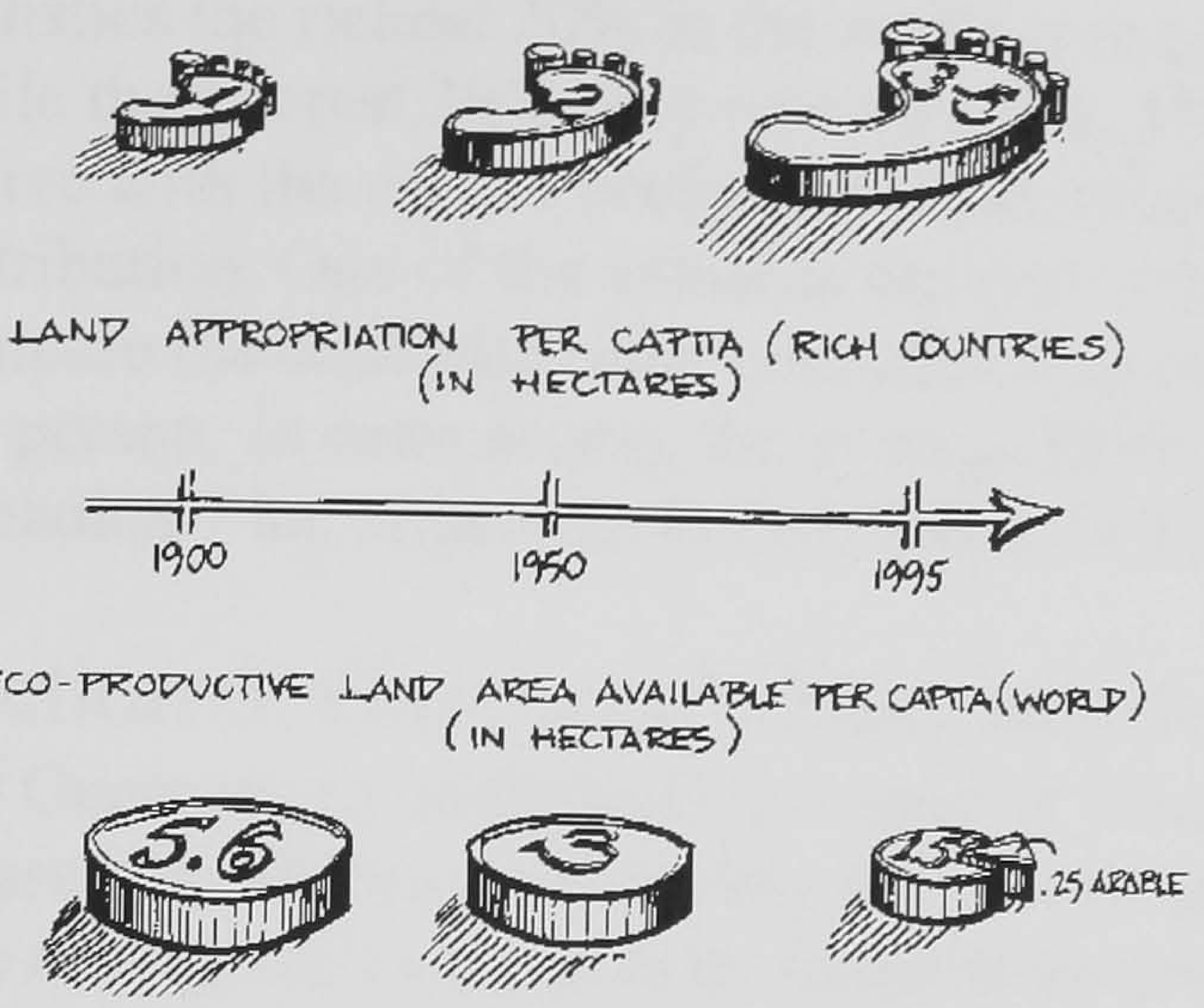


Diagram 5: The ecological footprint over this century

If everyone in the world today lived like Guernsey residents, it would take at least three additional planet Earth's to produce the resources and absorb the waste (diagram 6).

Diagram 6: Three additional planet Earth's wanted.

Section 5: Guernsey's Footprint

We can now look at the ecological footprint of Guernsey. The ecological footprint of Guernsey is 8.3 hectares per person. The footprint of Guernsey informs us about the amount of ecological capacity appropriated by the island to sustain its functions. Guernsey's demand of global ecological capacity is substantial on a per/capita basis. The island requires over half a million hectares to supply all its residents with the resources they use. A hectare is approximately the size of one football pitch. If accepting the previously discussed figure of 2.0 ha per person as the ecological benchmark for sustainability, Guernsey's global deficit is 6 ha per capita. Therefore, for one Guernsey resident to be sustainable four other people in the world must be willing to consume no more than 0.26 ha of the available bio-capacity per capita for all five people to live within the means of nature. Guernsey's inability to support itself means a strong reliance on imports for survival. While Guernsey enjoys this enormous resource consumption other countries are not so fortunate. According to United Statistics the richest 20% in the world consume over 83% of the world's resources, while the poorest 20% only receive 1.4%. This leaves Guernsey with two challenges: to live with the earth's ecological capacity and to address the problem of resource distribution. One of the valuable aspects of the ecological footprint is the ability to compare the data with other countries. Guernsey's ecological footprint totals 8.3 ha per person. In comparison, the average British footprint is 5 ha; Hong Kong 6 ha; Canadian 7 ha; American 8.5 ha, while the footprint of an average Ethiopian is 1.0 ha

Section 6: Guernsey's Sustainable Future?

For Guernsey to understand its impact it is important to start monitoring and measuring. Without monitoring and measuring it is difficult to manage for the future. The ecological footprint is an essential tool for the island. It can help the island address problems of transport, energy use and waste. Ecological Footprinting is an ideal tool for sustainability reporting. It can compare countries and regions, analyse the ecological implications of trends and issues, or evaluate progress toward sustainability (diagram 7).

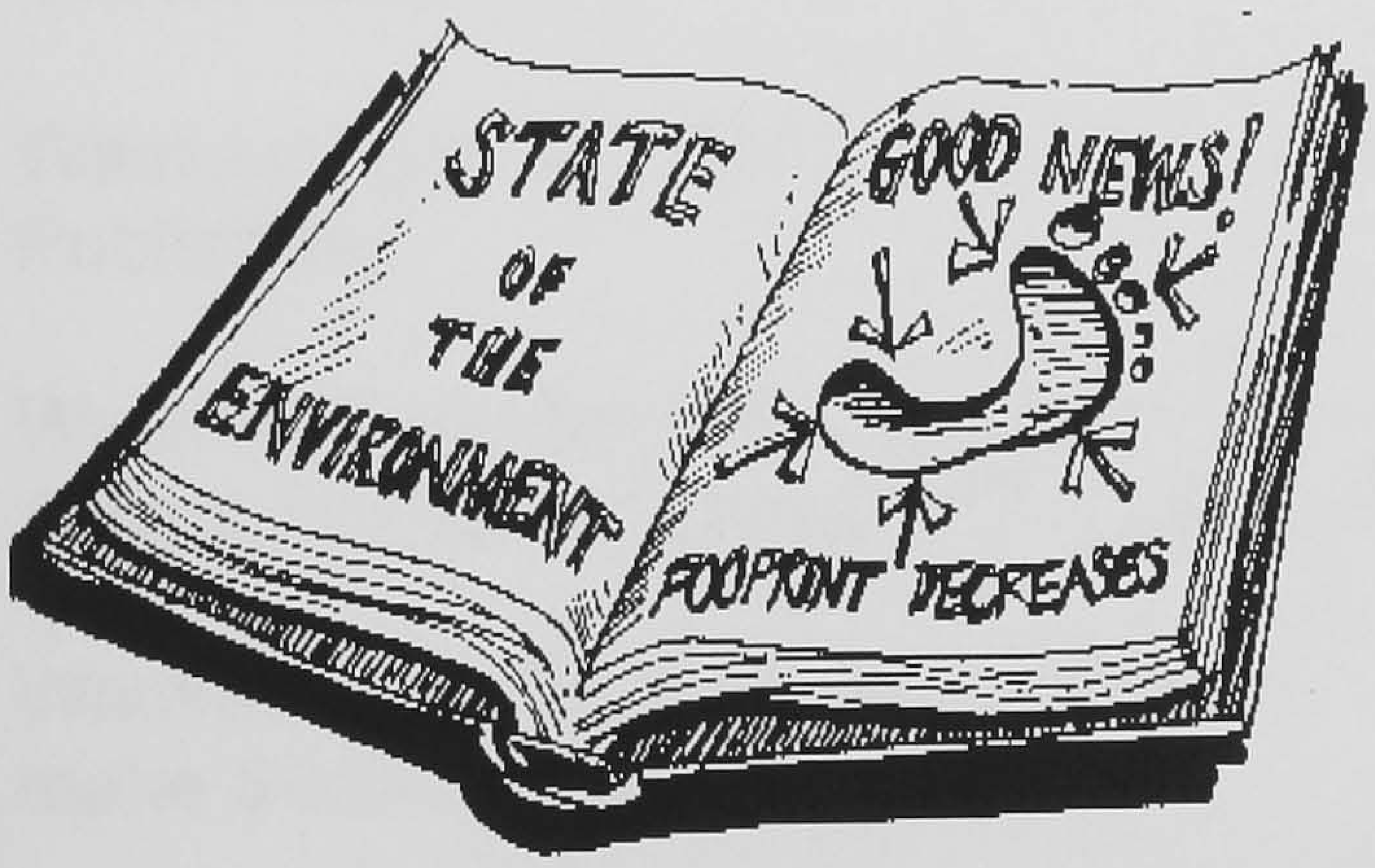
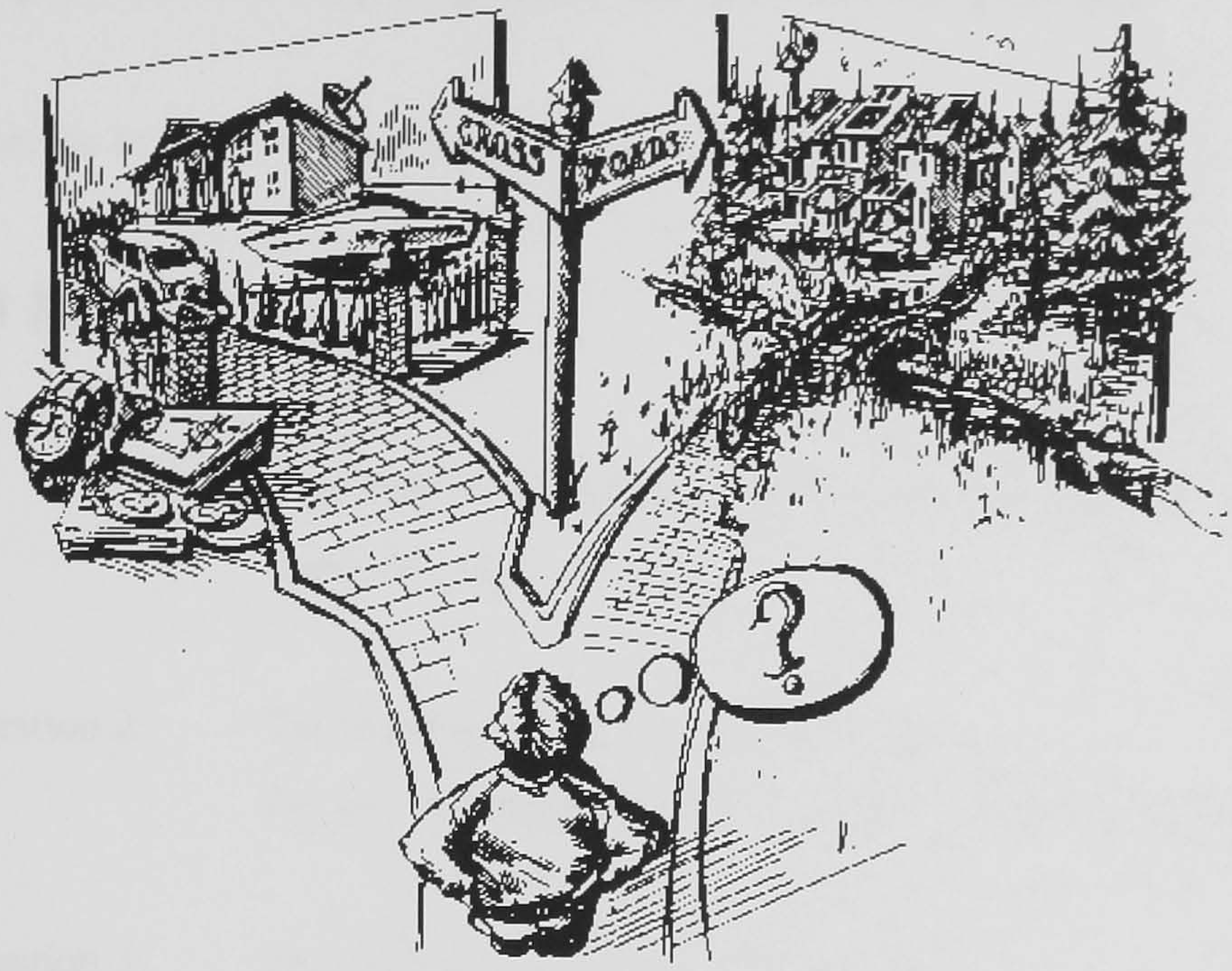


Diagram 7: State of the Environment Reporting

Guernsey has the ability to become a model island for sustainable development because it has the ability to control its own future. At the same time, if it continues in its present fashion, it will add to the problems of global warming, forest destruction, the polluting of the atmosphere and water. It is now decision time for the island. Will Guernsey embrace its global responsibility?



References:

Wackernagel & Rees (1996) Our Ecological Footprint, New Society Publishers.

Wackernagel (1994) Ecological Footprint and Appropriated Carrying Capacity: A Tool for Planning toward Sustainability, University of British Columbia.

Wackernagel, Pamanes & Testemale (1997) Ecological Footprints: A Tool to make Sustainability Happen, Centre of Sustainability Studies

For further information on the issues addressed within this pamphlet please contact:

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Appendix 5: 'Topic guide' for the focus groups

Exercise 1: 'Global Steps Game'

10 Minutes

The next few questions will be partly contingent upon the answers obtained from question one.

Question 2: Do you think your performance is good?
Do you consider yourself to be above or below average?

Question 3: Do you have control over these issues?

Move the conversion on to introduce sustainable development.

Question 4: Would you please tell me what you consider sustainable development to be?

Question 5: Could you tell me where, if you have heard of sustainable development
Did everyone hear about sustainable development from...?

Question 6: Is sustainable development about environmental issues?
Does it include any other issues?

Question 7: At what level should sustainable development being implemented?
Prompt: Global, National, Local or Individual

Question 8: Who is most likely to use this term?

10 Minutes

THE ECOLOGICAL FOOTPRINT PRESENTATION

7 Minutes

Question 11:

- Do you believe the information you have been given?
  (I.e. does the ecological footprint convince you?)
- Do you care about what has been said?

- Do you see the importance of studying this?
- Do you think we should all have equal footprints in England?
- Do you think we should all have equal footprints in the world?
- You should (if any) be held responsible for environmental damage?

15 Minutes

Moderator moves the conversion onto behavioural patterns after final footprint question. We now what we are doing so lets see how we can reduce our impact.

Statement 12: "I will give up my car."
"I will drive my car less."
"I will continue to drive as much as possible."

Statement 13: "I will continue to eat vegetables that have travelled a long distance."
"I will start eating organic locally grown vegetables."

Statement 14: "When I travel abroad I will continue to fly."
"When I travel abroad I will use the boat."
"I will reduce my travelling as much as possible."

Statement 15: "I will throw away all my rubbish into one single bin for refuse collection."
"I will recycle as much as I possibly can."
"I will not buy items with packaging in an effort to reduce consumption."

Statement 16: "I will use as many households appliances within the house."
"I will only use the items that I consider essential."
"I will attempt to have nearly no electrical appliances in the house."

Statement 17: "Energy conservation in the home"
Would you pay for energy conservation appliances such as insulation and lighting?

Question 18: Which one of these issues to be the most importance issue concerning sustainability?

Question 19: Which of these problems concerns Guernsey most?

Question 20: Do you think local action is important?

Question 21: Do you think this is where we should start trying to be sustainable?

Question 21: Do you think there are issues that have not been addressed today that are important to sustainability?

Question 22: Can you see a pattern between your lifestyle and environmental problems?

18 Minutes

Appendix 6: Forest Sequestration Rate

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	CALCULATION OF FOREST TIMBER PRODUCTIVITY AND FOREST CARBON ABSORPTION (1990 data)									by Mathis Wackernagel					
2															
3					area	area	yield 1-20 yr	yield 20-100 yr	aver yield	production		standing biomass			
4					[10E6 ha]	[10E6 ha]	[t-dm/ha/yr]	[t-dm/ha/yr]	[t-dm/ha/yr]	[10E6 t-dm/yr]		[t-dm/ha]	[10E6 t-dm]		
5	Tropical wet forest				715,00										
6	Africa					86,60	10,00	2,50	6,25	541,27		300,00	25 980,90		
7	Asia continental					63,33	11,00	3,00	7,00	443,34		225,00	14 250,08		
8	Asia insular					114,51	13,00	3,40	8,20	938,95		275,00	31 489,23		
9	America					451,26	10,00	2,60	6,30	2 842,94		295,00	133 121,70		
10	Tropical moist w short dry season				838,00										
11	Africa					119,46	5,30	1,30	3,30	394,22		140,00	16 724,40		
12	Asia continental					0,00	9,00	2,00	5,50	0,00		185,00	0,00		
13	Asia insular					4,30	11,00	3,00	7,00	30,10		175,00	752,50		
14	America					129,06	7,15	1,65	4,40	567,86		140,00	18 068,40		
15	Tropical moist w long dry season														
16	Africa					131,69	2,40	1,80	2,10	276,55		75,00	9 876,75		
17	Asia continental					31,80	6,00	1,50	3,75	119,26		100,00	3 180,32		
18	Asia insular					5,91	13,00	3,40	8,20	48,44		100,00	590,68		
19	America					168,50	4,00	1,00	2,50	421,25		90,00	15 165,00		
20	Tropical dry				238,00										
21	Africa					92,50	1,15	0,90	1,03	94,81		37,50	3 468,75		
22	Asia continental					41,03	5,00	1,30	3,15	129,24		75,00	3 077,03		
23	Asia insular					0,07	5,00	1,30	3,15	0,23		75,00	5,47		
24	America					44,94	4,00	1,00	2,50	112,35		105,00	4 718,70		
25	Montaine Moist														
26	Africa					32,73	5,00	1,00	3,00	98,18		105,00	3 436,34		
27	Asia continental					30,18	5,00	1,00	3,00	90,55		190,00	5 734,83		
28	Asia insular					15,35	12,00	3,00	7,50	115,10		255,00	3 913,41		
29	America					98,95	5,00	1,40	3,20	316,64		150,00	14 842,50		
30	Montane dry														
31	Africa					2,50	2,00	0,50	1,25	3,13		40,00	100,00		
32	Asia continental					0,95	2,00	0,50	1,25	1,19		45,00	42,75		
33	Asia insular					0,00	2,00	0,50	1,25	0,00			0,00		
34	America					22,72	1,80	0,40	1,10	24,99		50,00	1 136,00		
35	*TOTAL TROPICAL*					*1 688,34*				*7 610,58*			*309 675,74*	*297 197,00*	
36															
37	***Summary for tropical, temperate and boreal forest***														
38	Tropical forest					1792,03				7 610,58			309 675,74		
39	Temperate forest South (evergreen/coniferous and deciduous)					217,88	2,50	2,50	2,50	544,71		112,86	24 590,39		
40	Temperate forest North (evergreen/conif. and deciduous)				731,00	512,46	4,95	4,95	4,95	2 536,22		112,86	57 835,90		
41	Boreal forest				920,00	920,00	1,00	1,00	1,00	920,00		60,00	55 200,00		
42	Tropical woody area					935,97									
43	Temperate and boreal woody area				1 678,00	741,89									
44															
45										[10E6 t-dm/yr]			[10E6 t-dm]		
46	**Total w/ woody**				5 120,00	5 120,23				11 612			447 302		
47	**Total w/o woody**				3 442,00	3 442,37									
48															
49				**40,00**	**year horizon for maturation of forest (corresponds to harvest cycle)**										
50															
51															
52	**Footprints for fossil energy consumption (through CO2 absorption)**							**CO2 absorption and biomass accumulation**							
53	carbon emission factors														
54	[t of carbon/TJ]		[Gj/ha/yr]					2,27	dry matter in [t/ha/yr] or		2268	[kg/ha/yr]			
55	28	coal	55				2,18	2,15	dry matter in [t/ha/yr] calculated from total forest biomass in the world						
56	20	oil	71					2,83	dry matter in [t/ha/yr] including roots						
57	15,3	gas	93					1,42	carbon absorption in [t/ha/yr] including roots						
58								1,99	corresponding roundwood production [m3/ha/yr]						
59															
60	**Total bio-productive area in the world in [1000 ha] (for 1993)**								**Equivalency Factors (calculated in ef-swe94.xls)**						
61															
62	1 447 509	arable land (FAO 3#1:3)							fossil energy		1,14				
63		1 342 826,00	of which arable land (FAO 3#1:3)						arable land		2,82				
64		104 683,00	of which permanent crops (FAO 3#1:3)						pasture		0,54				
65	3 361 733	permanent pasture (FAO 3#1:3)							forest		1,14				
66	5 120 227	forest and other wooded areas (FAO.1995. State of the World's Forests p 38)							built-up area		2,82				
67	332 000	built-up area (Costanza et al.)							sea		0,22				
68	4 638 531	other areas such as wetlands, ice, rocks, desert, tundra, lakes and rivers													
69	**14 900 000**	**TOTAL land area on the planet (Kalusche:12)**													
70	36 100 000	TOTAL sea area (Kalusche:12)													
71	51 000 000	TOTAL surface of planet (Kalusche:9, 12)													
72															
73	**reference:**	Kalusche, Dietmar, 1996. Ökologie in Zahlen. Gustav Fischer, Stuttgart													
74		Intergovernmental Panel on Climate Change, 1997. Greenhouse Gas Inventory: Workbook. Revised 1996 IPCC Guidelines. Volume 2. IPCC, OECD and IEA.													
75		Intergovernmental Panel on Climate Change, 1997. Greenhouse Gas Inventory: Reference Manual Revised 1996 IPCC Guidelines. Volume 3. IPCC, OECD and IEA.													
76		Costanza, R., R d'Arge, R de Groot, S. Faber, M.Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton and M. van den Belt, 1997. The value of the world's eco													

Cell: E3
Anteckning: Reference: FAO, 1995. State of the World's Forests.

Cell: F3
Anteckning: Reference: For the tropical areas: IPCC Workbook; for the rest: FAO, 1995 State of the World's Forests.

Cell: G3
Anteckning: From IPCC Workbook Table 5-8 p5 22

Cell: N35
Anteckning: From FAO, 1995. State of the World's Forests, p35-38.

Cell: F38
Anteckning: These forest areas are taken from FAO,1995. The State of the World's Forests.

Cell: G39
Anteckning: IPCC lists a lower temperate forest productivity than that calculated for Europe as shown in (FAO, 1995 State of the World's Forests. p.41)

Temperate forests in hotter countries seem to be limited by the water (see e g , productivity in Spain, Turkey etc). Therefore, for temperate forests in the South, we take the IPCC average value of 2.5 [m3/ha/yr]

Cell: G40
Anteckning: IPPC says 2.5 for decidiuous and 3.5 for coniferous temperate forests Here, we calculated the productivity by taking an estimate from the European FAO estimates of net increments. The estimated boreal areas (23,000,000 hectares) are only counted as 1/3 of thier area as their productivity is probabbly only 1/3 of temperate forests.

Cell: A53
Anteckning: From IPCC Worksheet p 1.6

Cell: G55
Anteckning: Estimated from calculated forest biomass divided by harvest cycle.

Cell: H55
Anteckning: Calculated from FAO, 1995. State of the World's Forests. p38

Cell: H57
Anteckning: IPCC assumes a carbon density of 0 5 t of carbon per t of dry mattern (IPCC Reference Manual p5 18). Here we include the root biomass

Cell: H58
Anteckning: In the IPCC Workbook, they assume an average (or default) roundwood denisty of 500 kg/m3 (IPCC Workbook p5 6) However, FAO (5 xvii) assumes an average density of 750 kg/m3. At 15 percent humidity, this would still be 637.5 kg/m3. Here we use, we believe still as a conservative average, a default value of 600 kg/m3.

Also, IPCC assumes an expansion ratio of 1.9 for logged forests (IPCC Workbook p5 6, or IPCC Reference Manual p5 22) This accounts for the non-commercial biomass (limbs, small trees, etc.)

The roots, however, are not included in the dry biomass accounts yet They may add another 1/4 according to the IPCC Reference Manual (p5 54) This would increase the CO2 absorption rate by 25 percent.

Appendix 7: The Focus Group Presentation

Hello, my name is John and I'm from Liverpool John Moores University. Thank you for coming today. What we are going to do is have an informal discussion about some issues that I'm going to raise. There are no right or wrong answers. You should address your answer to the group and not to me. I'd appreciate it if only one person would speak at a time and that everything that is said is said to the group. It is important that everyone has his or her say. This should be an enjoyable experience so please relax and there will be some refreshments available at the end.

Since 1970, one report after the other has warned about the dangers of human expansion. Since 1950, human activities have grown over five fold because there are more people and we are also consuming more. We are told that we live in a riskier world each year with more consumption, more waste, more people, more poverty, but less forest area, less fresh water and less ozone.

According to the United Nations, the richest 20% receive over 83% of the world's income, while the poorest 20% receive 1.4%.
In essence we are left with two challenges. On the one hand humanity as a whole is running out of resources, while on the other hand a growing group of people still needs more to satisfy its basic requirements.

To solve these problems they idea of sustainable development was introduced in 1987 even though the idea was developed much earlier. In its simplest form we can say that sustainability means,

> "To secure people's well-being within the means of nature"

Developing sustainably, however, is hard and needs the co-operation of all. Sustainability begins with accepting our dependence on nature, and acknowledging the problems posed by our unsustainable lifestyles. The next step is to take up the challenge of making them sustainable.

The problem is that we don't always know how much damage we are doing and what we actually need to do. We need to start monitoring whether we live within our ecological means and at what rate humanity is depleting our natural resources. We must ask,

"How much nature does humanity use to sustain itself?"

Without monitoring and measuring, we cannot plan for sustainability. To make sustainability a reality, we must know where we are now, and how far we to go. The good news is that such essential tools have made substantial headway.

In fact, any human economy, city or household is an ecological system much like the cow on the pasture. To maintain itself, the economy needs to "eat" resources, and eventually, all this intake becomes waste and has to leave the organism again. So the questions is,

"How big a pasture is necessary to support that economy, to produce all its feed and absorb all its waste?"

This human use of nature is measured with the ecological footprint. We define it as the area necessary to continuously provide the resource supplies of a given population and absorb their wastes. Now we can compare human demand with nature's supply.

Before we work out how much land we require, lets look at how much land is available on our planet. The earth has a surface area of 51 billion hectares. 71% of this area is ocean only leaving 29% land. However, only half of this land is productive for human use.

If this area were divided equally by all the people on the earth, each person would have 2 hectares each. Therefore, it is possible to say that if every person had an ecological footprint of 2 hectares that they are sustainable.

To better understand the current situation, let's look first at the historical trends of our ecological footprint over this century. Since the beginning of this century the amount of land available per person has decreased from 5 hectares to 1.5 hectares. At the same time the average footprint has grown from 3 to 8 hectares.

If everyone lived like today's North Americans, it would take at least three additional planet Earth to produce the resources and absorb the waste.

Here is a list to show how big the footprints of nations really are. Iceland, New Zealand and the United States are leading the race with footprints between 8 and 10 hectares.

This slide shows the nations with the smallest footprints. As you can see there is a real contrast between these figures and the last slide. Bangladesh have the smallest footprint on this list of 0.6 hectares per person. It is clear enough to see that sustainability is not taking place due the massive amount of resources required by the industrial countries. One of the valuable aspects of the ecological footprint is the ability to compare the data with other countries. In comparison, the average British footprint is 5 ha; Hong Kong 6 ha; Canadian 7 ha; American 8.5 ha, while the footprint of an average Ethiopian is 1.0 ha.

We can now look at the ecological footprint of Guernsey. The ecological footprint of Guernsey is 8.3 hectares per person. The footprint of Guernsey informs us about the amount of ecological capacity appropriated by the island to sustain its functions. Guernsey's demand of global ecological capacity is substantial on a per/capita basis. If accepting the previously discussed figure of 2.0 ha per person as the ecological benchmark for sustainability, Guernsey's global deficit is 6 ha per capita. Therefore, for one Guernsey resident to be sustainable four other people must be willing to consume no more than 0.26 ha of the available bio-capacity per capita for the five people to live within the means of nature. Guernsey's inability to support itself means a strong reliance on imports for survival.

Without knowing it, you used a simple method to work out you ecological footprint by using the 'global steps' cards.

If you scored 100, Well done. You are treading lightly on the Earth. If everyone lived more like you then we could live sustainably with our current technology and population.

If you scored between 100-200 your footprint is below the national average, but you are still using more than 2 hectares. If everyone on the planet lived like you then we would need at least two Earths to live sustainably.

If you scored between 200-300 your footprint is equal to or above the national average. If everyone on the planet lived like you we would need about three Earths to support us.

To live well tomorrow, sustainability is required today. We now know what we have got to do within Guernsey. We know the amount by which we have to reduce our consumption so that everyone over the world will be able to live a decent life. We know how much we have to reduce our consumption so that future generations will be able to live. Ecological footprint analysis has helped us link the global problems with the local so each person can change.

Appendix 8: Further Examples of Compound Ecological Footprint Calculations

An example of the calculation used in the compound footprint approach has been given below for rice. It includes many of the different elements that are generic to most of the ecological footprint calculations.

Calculation 1: The Ecological Footprint of Rice Consumption

By calculating the total amount of imports in Guernsey, it was possible to calculate that Guernsey consumes 246 tonnes of rice a year. The following calculation was undertaken to understand the ecological footprint of rice consumption in Guernsey.

Stage 1: Divide consumption by yield factor

246 tonnes of rice / 3747 kg/ha./yr. = 65.65 hectares

The yield factor is a global average taken from the UNFAO: Production Manuel (page 64). By dividing consumption by the amount of rice that can produced per hectare, the amount of land required to provide Guernsey's rice demand can be calculated.

Stage 2: The Energy Intensity of the Product

The ecological footprint of rice is not merely the amount of arable land required to grow it. There is also the energy requirement to package, transport and manufacture the final product. After an extensive review of available data two sources were used that gave some detail of the 'embodied energy' within different products. The IVEM calculated that 10 Gj/t was required to conduct these functions (IVEM, 1999).

246 tonnes x 10 Gj = 2460 Gj

Stage 3: Converting the Energy Figure into an ecological footprint

The total energy requirement of producing and transporting the rice was 2460 Gj. This can be converted into an ecological footprint calculation by considering the amount of land required to sequester the carbon dioxide released by producing the necessary energy. It is assumed that the burning of coal produces the energy used in production. This assumption is based on the fact that coal is the largest provider of energy is OECD countries (over 35%) (IVEM, 1999).

Earlier we assumed that an average hectare of forest in the world could absorb 1.8 [t] of C per year (see section 3.5). Thanks to IPCC data (Intergovernmental Panel on Climate Change, 1997. Greenhouse Gas Inventory: Workbook. Revised 1996 IPCC Guidelines. Volume 2. IPCC, OECD and IEA.) we could get a good estimate for forest productivity, including carbon absorption.

Using a very optimistic forest maturation time (or harvest cycle) of only 40 years, we estimated an average carbon absorption of 1.42 [t/ha/yr]. Solid fossil fuel has a carbon emission factor of 15.3 [t C/Tj]. Hence the energy to land ratio is 55 [Gj/ha/yr] for solid fossil fuel.

Therefore,

2460 Gj / 55 Gj/ha.yr. = 44.7 hectares

Stage 4: Aggregation and Equivalence Factors

The final stage of calculation is to apply equivalence factors to the different land types (in this case arable and energy land) (see section 3.5 for more information on equivalence factors).

65.65 hectares of arable land x equivalence factor of 2.83 = 185.79 hectares

44.7 hectares of energy land x equivalence factor of 1.17 = 32.3 hectares

Therefore, the total ecological footprint for Guernsey's rice consumption is 218.09 hectares. This is an ecological footprint of 0.0036 ha./per capita.

Appendix 9: Further Examples of Component Ecological Footprint Calculations

To provide a more detailed explanation of the methodology of component footprinting the example of waste has been given below. The table below (page 355-356) provides the details of the data used in the footprint calculation. The waste footprint is primarily an investigation into the energy requirements of producing waste of which most can be classed as packaging or food waste (within the domestic sector). Therefore, to conduct an ecological footprint of waste it is important to know the energy required in making the product. This information was gained from a range of sources that can be seen in column 3 and 6 in the table below and in the references (pages 303 to 315).

If the packaging is disposed of by landfill, the embodied energy is lost. Therefore, the ecological footprint of a waste item disposed of to landfill is the embodied energy lost from its production. An example of PET plastic has been given below.

To produce 1 kg of PET takes 29.94 kWh. Guernsey is responsible for disposing of 3,610 tonnes of PET a year (11% of the total amount of domestic waste, see figure 5.4).

3610 tonnes x 29.94 = 109.08 GWh

The amount of land required in sequestering the carbon dioxide released by producing 109.08 GWh is calculated. It is assumed that the electricity used in producing the packaging comes from the UK. The footprint conversion factor for UK electricity is 84.47 hectares per GWh (Chambers, Simmons and Wackernagel, 2000). This is based on the fact that 0.44 kg of carbon dioxide is produced for every kWh of electricity in the UK (DETR, 2000).

Therefore,

109.08 GWh x 84.47 ha./per GWh = 9,213.99 hectares

An ecological footprint of 0.15 hectares/ per capita

The Ecological Footprint of a Recycled Product

There is a significant difference in the method behind calculating the ecological footprint of an item that has been recycled. The ecological footprint of a recycled product is the energy required within the recycling process. The table below gives the figures for domestic household products, gained from a number of sources. As PET was given as the example above, the same material is considered below.

According to research conducted by the Tellus Institute, to recycle 1 kg of PET requires 8.62 kWh. Guernsey does not recycle any PET. However, to demonstrate the methodology employed it is assumed that a 1,000 tonnes of PET is recycled every year.

Total energy requirement for PET recycling would be 8620 kWh. Using the same footprint conversion factor as above (84.47 hectares per GWh) means an ecological footprint of 0.73 hectares.

By looking at the table below it is clear to see that the benefits of recycling PET are 3.5 times greater than landfill. The calculation does not assume that the item being disposed of has been recycled (in the case of PET bottles it has probably not). What is does assume is that one less PET bottle is required from raw materials due the recycling process.

Waste Stream Material	KWh/kg Production	Sources	Year	Energy Recycling Requirement (kWh/kg)	Source	Year
Paper						
...Newspaper	10.17	Tellus Institute	1999	6.05	Tellus Institute	1999
...Corrugated Cardboard	9.72	Tellus Institute	1999	8.39	Tellus Institute	1999
...Office paper	10.67	Tellus Institute	1999	6.64	Tellus Institute	1999
...Tissue paper	10.09	Tellus Institute	1999	0.28	Tellus Institute	1999
Plastic						
...PET	29.94[1]	Boustead	1999	8.62	Tellus Institute	1999
...HDPE	21.58[2]	Boustead	1999	5.48	Tellus Institute	1999
...LDPE	27.22	Tellus Institute	1999	7.28	Tellus Institute	1999
Glass						
...Bottle	12.46	Grant et al	1999	3.24	Swiss Agency for the Environment	1999
...Sheet	6.11	Building Research Establishment	1999	3.24	Swiss Agency for the Environment	
Metal						
...Aluminium can	16.83[3]	Swiss Agency for the Environment	1999	1.12[4]	Swiss Agency for the Environment	1999
...Tin can	12.6	Tellus Institute	1999	5.23	Tellus Institute	1999

[1] This figure has been derived from the database supplied by APME. The total figure can be broken down as follows: a) Fuel production and delivery energy 6.52 kWh/kg; b) Energy constant of delivered fuel 12.26 kWh/kg; c) Energy use in transport 0.124 kWh/kg; d) Feedstock energy 11.03 kWh/kg.

[2] This figure has be derived from the database supplied by APME. The total figure can be broken down as follows: a) Fuel production and delivery energy 2.29 kWh/kg; b) Energy constant of delivered fuel 6.1 kWh/kg; c) Energy use in transport 0.09 kWh/kg; d) Feedstock energy 13.1 kWh/kg.

[3] This figure includes two different processes. 1) The energy requirement for the production of aluminum can (16.80 kWh/kg), 2) The transport requirement of the aluminum can (0.026 kWh/kg)

[4] This figure includes two different processes. 1) The energy requirement for the recycling of aluminum can (1.1 kWh/kg), 2) the transport requirement of the aluminum can (0.014 kWh/kg)

Organics						
…Food waste	2.7	Friends of the Earth	1991	0.185	Juniper Consultancy Services Ltd	1998
…Garden waste	2.7	Friends of the Earth	1991	0.185	Juniper Consultancy Services Ltd	1998

Appendix 10: Details of Scenario Calculations (from Chapter 5)

- Waste Scenario

The scenario provides information on how the ecological footprint of waste would be reduced by composting household food waste as opposed to disposing of it in landfill (see table 5.1). From the Waste Strategy Assessment it was possible to calculate that 3,420 tonnes was suitable for composting (i.e. green waste). The ecological footprint of domestic is that is disposed by landfill is 2.53 ha./per tonne. This calculation takes into account the make-up of the waste (i.e. percentage of waste that is plastic, organic, paper etc.) and applies the methodology explained in appendix 9.

The ecological footprint of composting is calculated by considering the energy requirement to compost the material. The energy required to compost green waste is 0.185 kWh/per tonne (Juniper Consultancy Services Ltd, 1998, see appendix 9). As the composting site would be in Guernsey the local electricity mix can be applied (Guernsey's electricity is currently supplied by oil). The ecological footprint calculation for oil is 128.8 hectares/per GWh (Chambers, Simmons and Wackernagel, 2000).

Within the scenario it suggests that 2,394 tonnes of green waste can be composted by 2010. The calculation converting this figure into an ecological footprint has been given below.

2,394 tonnes of composting material x 0.185 kWh/ tonne = 442.89 kWh

Therefore, 442.89 kWh x 128.8 ha./per GWh = 0.057 hectares

- Transport

The calculations have been given below for the scenario concerned with increasing car sharing.

The scenario assumes a 47% shift from one passenger cars to an average of 2.5 passengers per car. This figure was taken from research conducted by Whitelegg (1998 & 1999). Table 5.7 provides the total passenger-km for commuting, this being 604,800 km a year. Of this figure, 78% of the passenger-km is conducted by car with only the driver (States of Guernsey, 1998). Therefore, cars are responsible for 471,744 passenger-km. Table 4.2 provided a detailed explanation of how the ecological footprint of car travel was calculated. As can be seen from table 4.2, car occupancy is built into the calculation (with the average car occupancy being 1.6 passengers). If 47% of commuters started car sharing (average occupancy rate of 2.5), a 14.66 % reduction in passenger-km would occur. If the average car occupancy increase from 1 to 2.5, 40% less journeys are required. This is calculated as follows:

Car occupancy 1 / Car occupancy 2.5 x 100 = 40% reduction

Therefore, 47% of the total commuter passenger km of 471,744 km is 221719.68km. A 40% in this distance travelled is 88687.9 km. The scenario demonstrates that Guernsey could reduce the commuter passenger-km to 383056.1 km. This can then be converted to an ecological footprint figure using the calculation given in table 4.2.