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Sustainable Mobility - the Concept and its Implications

Ph.d. thesis

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Preface

This Ph.d. thesis is about a concept and its implications. The concept is *sustainable mobility*. The superior objective of the thesis is to develop an understanding of this concept. Both theoretical and empirical research approaches and material are used.

The thesis is based on contributions from several research projects. They cover a period of almost 10 years, all of them with a prime focus on relations between transport and environment. In most of the projects I have had a combined function as performing researcher and project leader with the main scientific responsibility. This implies that there are several contributors to the research material which forms the basis. Some of them are employed in the research group I am heading at Western Norway Research Institute. I am grateful for their contributions. No one mentioned, no one forgotten. Others however, belong to other institutions, notably the Norwegian Institute for Urban and Regional Research (NIBR) and Eastern Norway Research Institute (ØF). I am in particular indepted to former Head of research Petter Næss (NIBR), now Professor at Aalborg University, and Professor Tor Selstad (ØF and Lillehammer Regional College). However, without several years of fruitful discussions with and critical comments from my teaching supervisor at Roskilde University Centre, university lecturer Bo Elling, this thesis would not have become a reality.

The thesis consists of 6 main chapters. Each is a separate article already printed either in a book or a journal. They are exactly in the form they have been printed. Due to differences in editoral requirements they differ both in language form and in some other minor components (e.g. editing of references). Some of the articles are printed in the American form of English and others in pure English form. Most of the translations from the Norwegian originales have been made by college teacher Jan Talsethagen in Sogndal.

Each chapter consists in addition of a separate set of notes which has not been printed before. The texts in these notes were included in the original manuscripts delivered for reviewing by the book and journal editors. Mostly due to restrictions regarding the length of the articles they were, however, not printed. They are included here in order to give a more complete presentation both of the theoretical and empirical material the articles are based on.

A few years ago I had an accident while - as a paradox - I was moving in a sustainable way by bicycling to work. Since then my abilities to process words through computers have been severely restricted. Much of this part of the work has been carried out by Anne Lise Skaar at Western Norway Research Institute. Without her patience through several years and her outstanding ability to read my awkward handwriting, the whole process of producing this thesis would not have been completed.

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CONTENTS

SUMMARY

This Ph.d. thesis is about a concept and its implications. The concept is *sustainable mobility*. The superior objective of the thesis is to develop an understanding of this concept, its origin, development and content. Both theoretical and empirical research approaches and material are used. Theoretically through analysing the two conceptual brickstones *sustainable development* and *mobility* and the issues raised by combining the two into one concept. Empirically among other through analysing the development of transport systems, the environmental problems caused by such systems and their relations to the development within various societal sectors. The implications of sustainable mobility are analysed both on a superior societal level and on the sectorial levels.

Besides an introduction and a chapter with conclusions the thesis consists of six main articles. They are all given separate chapters. Five of the articles have been printed in scientific books, published both internationally and in Norway. The last article is accepted for publication in an international scientific journal.

The Introduction (Ch.1) presents the issues addressed and the main theoretical framework and methodological approaches needed to respond to these issues. It also gives a review of relevant international litterature and a first introduction both to the concept of sustainable mobility and the two basic concepts *sustainable development* and *mobility*.

The first article (Ch.2) gives a principal analysis of how the environmental problems, included our understanding of the problems, have changed character during a period of more than twenty years. It covers a presentation and definition of concepts fundamental to an understanding of *environmental* and *sustainability* issues. These are concepts used in the other parts of the thesis.

The second article (Ch.3) is printed in a book which evaluates Norway's follow up of the UN-Summit on environment and development in Rio in 1992. Based on an evaluation model, usually termed "ideal-reality tradition" in Norwegian evaluation research, the article analyses what the Brundtland Commission and Agenda 21 say about transportation. Another set of basic text-analytical material is the content in crucial official Norwegian policy documents developed in response to these international documents. They are applied as two sets of background criteria for an assessment of the actual development of mobility and transportation in Norway and to what extent new actions and measures presented will give changes to this development.

The third article (Ch.4) gives a theoretical and empirical analysis of the limits of "technical fix"-solutions. Recycling of natural resources are used as "case"-issues. Recycling is placed within the framework of the concept *industrial ecology* which is also made subject to a theoretical presentation and critical inquiry. In the empirical part of the article mobility and the private automobile are used to elucidate the limits of recycling.

The fourth article(Ch.5) is printed in a book which sums up the results from a Norwegian research programme on rural development. It presents elements of a physical theory of resources and a theoretical foundation for energy analyses of the transformation of natural resources. The concept *ecological sustainability* is further defined together with a discussion on the implications of *sustainable development* for utilization of biological resources. Empirical "cases" are energy analyses of Norwegian fisheries and aquaculture, where the results are discussed in relation to a concept of *goods mobility*.

The fifth article (Ch.6) gives a critical discussion of the internationally prevailing understanding of the concept *sustainable tourism*. This concept is analysed theoretically in relation to both of the basic concepts *sustainable development* and *tourism*. Results from an empirical analysis of environmental impacts of all tourism travels - within and to and from Norway - are related to the development of a concept of *sustainable tourism*.

In the sixth and last article (Ch.7) the theoretical foundation for a concept of *sustainable development* is analysed in a context of environmental history and different

approaches within environmental philosophy and –ethics. A form of operationalization is presented through an identification of extra prima and prima characteristics. To elucidate the implications of such an operationalization “emissions of CO_2” and “automobililty” are used as empirical “cases”. This is again related to a concept of *sustainable mobility.*

The Conclusion chapter (Ch.8) is quite comprehensive. It presents some main characteristics of transport systems and transport which are in accordance with sustainable mobility requirements. However most importantly, by connecting material from the six articles together it summarizes the thesis’ main contribution to a critical discourse on sustainable mobility. Besides development of characteristics this covers problematization, alternative conceptual constructions and identification of values.

SAMMENDRAG

Denne Ph.d. avhandlingen er om et begrep og dets implikasjoner. Begrepet er *bærekraftig mobilitet*. Det overordnete formålet er å utvikle en forståelse av dette begrepet, dets opprinnelse, utvikling og innhold. Såvel teoretiske som empiriske forskningsmessige tilnærminger og materiale er brukt. Teoretisk ved å analysere de to grunnleggende begrepene *bærekraftig utvikling* og *mobilitet* og de problemstillinger som reises ved å kombinere de to i ett felles begrep. Empirisk blant annet ved å analysere utviklingen av transportsystemer, miljømessige problemer forårsaket av slike systemer og deres relasjoner til utviklingen innenfor forskjellige sektorer i samfunnet. Implikasjonene av bærekraftig mobilitet er analysert både på et overordnet samfunnsmessig nivå og på de sektorielle nivåene.

Ved siden av en innledning og et kapittel med konklusjoner består avhandlingen av seks hovedartikler. De er alle gitt hvert sitt kapittel. Fem av artiklene er trykket i vitenskaplige bøker, utgitt både internasjonalt og i Norge. Den siste artikkelen er akseptert for publisering i et internasjonalt vitenskaplig tidsskrift.

I innledningen (kap.1) presenteres avhandlingens hovedproblemstillinger og det teoretiske rammeverket som er lagt for belysningen av disse. Den gir også en gjennomgang av relevant internasjonal litteratur og en første introduksjon til begrepet om bærekraftig mobilitet og de to grunnleggende begrepene *bærekraftig utvikling* og *mobilitet*.

Den første artikkelen (kap.2) gir en prinsipiell analyse av hvorledes miljømessige problemer, inkludert vår forståelse av slike problemer, har endret karakter over en periode på mer enn 20 år. Det omfatter en presentasjon og definisjon av begreper som er grunnleggende for forståelsen av problemstillinger knyttet til *miljø* og *bærekraft*. Dette er begreper som brukes i andre deler av avhandlingen.

Den andre artikkelen (kap.3) er trykket i en bok som evaluerer hvorledes Norge har fulgt opp anbefalingene fra FN-konferansen om miljø og utvikling i Rio i 1992. Basert på en evaluerings-modell, vanligvis betegnet som del av ”ideal-realitet tradisjonen” innenfor norsk evalueringsforskning, analyserer artikkelen hva Brundtland kommisjonen og Agenda 21 sier om transport. Et annet grunnleggende sett av tekst-analyse materiale er innholdet i viktige offentlige norske politiske dokumenter utviklet i respons til disse internasjonale dokumentene. De anvendes som to sett av bakgrunnskriterier for å vurdere den faktiske utviklingen i mobilitet og transport i Norge og i hvilken utstrekning nye tiltak og virkemidler kan tenkes å gi endringer i denne utviklingen.

I den tredje artikkelen (kap.4) gis det en teoretisk og empirisk analyse av begrensningene ved ”teknisk-fix” løsninger. Resirkulering og gjenvinning av naturressurser er brukt som ”case”. Disse plasseres innenfor rammen av begrepet *industriell økologi* som også gjøres til gjenstand for teoretisk presentasjon og kritisk drøfting. I artikkelens empiriske del brukes mobilitet og privatbilen spesielt til å belyse resirkuleringens begrensninger.

Den fjerde artikkelen (kap.5) er trykket i en bok som summerer opp resultatene fra et norsk forskningsprogram om bygdeutvikling (rural utvikling). Det presenteres elementer til en fysisk teori om naturressurser og et teoretisk grunnlag for energianalyse av transformeringen av slike ressurser. Videre defineres begrepet *økologisk bærekraft* i sammenheng med en diskusjon om implikasjonene av *bærekraftig utvikling* for utnyttingen av biologiske ressurser. Empiriske ”case” er energianalyse av norsk fiskeri og akvakultur, hvor resultatene diskuteres i relasjon til et begrep om *varemobilitet*.

I den femte artikkelen (kap.6) gis det en kritisk diskusjon av den forståelsen av begrepet *bærekraftig turisme* som dominerer internasjonalt. Dette begrepet analyseres teoretisk i forhold til de to grunnleggende begrepene *bærekraftig utvikling* og *turisme*. Resultatene fra en empirisk analyse av alle turismereisers miljømessige problemer brukes som grunnlag for en utvikling av begrepet *bærekraftig turisme*.

I den sjette og siste artikkelen (kap.7) blir det teoretiske grunnlaget for begrepet *bærekraftig utvikling* analysert i en kontekst av miljøhistorie og forskjellige tilnærminger

innenfor miljøfilosofi og –etikk. En form for operasjonalisering blir presentert gjennom identifisering av extra prima og prima karakteristika. For å belyse implikasjonene av denne operasjonaliseringen brukes ”utslipp av CO2” og ”automobilitet” som empiriske ”case”. Dette blir igjen relatert til et begrep om *bærekraftig mobilitet*.

Konklusjonskapitlet (Kap.8) er gjort forholdsvis omfattende. Det presenterer noen hovedkarakteristika for transportsystemer og transport som er i samsvar med kravene til bærekraftig mobilitet. Men den største vekten legges likevel på en oppsummering av avhandlingens viktigste bidrag til en kritisk diskurs om bærekraftig mobilitet. Denne oppsummeringen bygger på en sammenknytning av materiale fra de seks artiklene. Ved siden av utviklingen av karakteristika for bærekraftig mobilitet omfatter dette problematisering, alternative begrepsdannelser og identifisering av verdier.

1. Introduction

In a 1992 “Green Paper” the Commission of the European Union launched the concept *sustainable mobility* (EUCOM, 1992). It evoked considerable interest, both in politics and science.

This Ph.d thesis is elucidating the following *superior issue*:

- How can we understand the concept of sustainable mobility?

The implications of the term *understand* are to analyse the historical background, the origin, the development and the meaning of the concept. A critical perspective is applied. An objective is to contribute to a *critical discourse* on sustainable mobility. Such discources cover problematization, alternative conceptual constructions, identification of values and development of characteristics. All these elements are included. A critical discourse should be understood as the first step in a four-step process of *normative intentionality*. The other three are planning, implementation and evaluation/reflection. The term *normative* emphasizes that sustainable mobility – as sustainable development – is a normative concept. A necessary task is to analyse what this normativity is about.

Three *leading issues* define in a more operational sense the scope and content of the various parts of the thesis. They are:

- How can we understand the concept of sustainable development, in particular in a context of environmental problems?
- How can we understand the concept of and focus on mobility in such a context?
- What are the implications of sustainable mobility in relation to the requirements of modern transportation systems?

Sustainable mobility is a mobility in accordance with the principles and requirements of sustainable development. This introduces the two concepts: *mobility* and *sustainable development*. In order to understand the concept of sustainable mobility it is necessary to understand both of these basic concepts. With the objective of contributing to a critical discourse the overall perspective has again to be critical. Both concepts are complex and subject to large differences in understanding. Such differences can originate in perspectives and traditions given by various scientific disciplines. However, they can also have a more fundamental basis through variances in value systems and preferences. The complexity only increases when the two are combined into one: sustainable mobility.

My empirical research has mostly been confined to the transport sector, or more precisely relations between *transport and environment*. This is expressed in the third leading issue above. In particular I thus wish to use this research to elucidate and discuss the implications of a concept of sustainable mobility in relation to the requirements of our modern transport systems. This is not the least important as the concept itself originated in policy documents discussing implications of the serious environmental problems caused by the development in transport and transport systems.

The original EU Commission green paper on sustainable mobility does not elaborate on the concept sustainable development. However, an implicit understanding is conveyed. With reference to the socalled *Bergen Declaration* from an ECE-conference in Bergen (Miljøverndepartementet, 1990) the paper emphasizes that the attainment of sustainable development requires fundamental changes in human values towards the environment and in patterns of behavior and consumption. Also with reference to the Bergen Declaration the need to encourage low transport demand is emphasized.

The paper outlines a "Community" strategy for sustainable mobility. This is presented as a global approach and implies integration of transport into an overall pattern of sustainable development. Such a strategy cannot solely rely on technological progress and technical measures and it is recognized that environment-friendly vehicles only would bring some relief. Existing strategies and measures are thereby considered insufficient and the following demands should form parts of a future strategy:

> "In order to reinforce (these) initiatives public and private investment should be guided towards collective transport, whereas urban, industrial and commercial as well as regional development planning should be geared towards reducing the need for mobility. At the same time infrastructure planning should be made subject to restrictions on land intrusion as well as to strict environmental impact assessment procedures at both the strategic and project stages, including evaluation of alternative options".
> (p. 51)

Similarly as for sustainable development the paper does not elaborate on the concept of mobility. However, an implicit understanding is again conveyed. It is expressed in the above quotation; the implications of integrating transport into an overall pattern of sustainable development are reduced levels of mobility, which in this context refers to the volume of actual movements of persons as well as goods. This is at the same time a reason for using the concept *mobility* instead of *transport*. The challenges ahead are deemed to be more fundamental than just adjustments within and between different modes of transport. It is consistent with the understanding that attainment of sustainable development requires fundamental changes in patterns of behavior and consumption.

1.1. A limited scope

The EU Commission published in 1993 a new document on the future development of the Common transport policy. It was still titled: "A global approach to contruction of a community framework for sustainable mobility" (EU COM, 1993). However, the changes in perspectives and understanding are substantial, and it is emphasized that the purpose of the former “Green Paper” was to institute a public debate on the issue of transport and the environment.

There is a change in understanding of both concepts: sustainable development and mobility. In both cases the scope has become more limited. The implications of sustainable development are described as a matter of taking environmental costs fully into account, requiring the pursuit of efficient policies in the field of prizing, including internalization of external costs, infrastructure and the removal of market barriers. One of the key objectives of the future common transport policy is therefore to correct environmental inefficiencies and to improve the environmental performance of the transport sector. It is no mentioning of the need for fundamental changes in patterns of behavior and consumption. No distinction is made between mobility and transport. To the extent that reduced levels of mobility are prescribed this is only limited to urban areas and other local, pressure points. This is to alleviate problems caused by congestion and too high consentrations of local pollution. These are really *traffic*-problems, caused by consentration of transport in time and space. The issue is thereby defined as a matter of local *intensity*, implying much less fundamental changes than the understanding of societal *volume* problems expressed in the Green Paper.

Several scientific works have later been performed under the heading “Sustainable Transport”. In the book “Transport, the Environment and Sustainable Development” *Banister & Button* (1993) put sustainable development synonymous with solving regional and global environmental problems. The focus is on the contributions from social sciences in developing methods for internalizing the external environmental costs which do not fit into the common market regimes, and on how environmental issues can be handled more effectively in decisional processes about transport.

Levels of mobility are not at stake, and the concept of mobility is neither addressed. The approach is global in the sense that global environmental problems are included. However, more fundamental global inter- and intra-generational issues are not part of the analysis. Internalizing environmental cost into todays market regimes in the world’s rich countries is one thing. Taking account for the large inequalities in levels of mobility between rich and poor and the connected differences in the degrees of instrusion into the global commons of resources and ecosystems, is something else.

In a research project on “Sustainable Transportation” *Schipper & al* (1994) also limits the issue to the question of internalizing the total social costs of transport. A major claim is that unless the marginal costs of using cars are increased in order to close the gap between private and social costs, it will become more and more difficult to atone for the environmentally “deadly sins” of the private car.

Sustainable development is defined as a matter of increasing the wealth of todays generation without future generations to get worse off; and sustainable transportation as a matter of providing transport services as long as those using the system pay the full social costs of their access, without leaving unpaid costs for others (including future generations) to bear.

Issues related to intra-generational inequalities are not included. Implications on levels of mobility are solely addressed within a context of local intensity problems; measures should be geared at reduced use of infrastructure at peak times and a reduced *growth* in total transport demand within the urban space.

A similar delimitation of the sustainable development concept is expressed by *Nijkamp* in the article “Roads Toward Environmentally Sustainable Transport” (1994). Global inter- and intra-generational issues are not included in his analysis, and the discussion on implications for transportation is confined to the situation in rich countries of the world.

However, Nijkamp recognizes that the core problem is the total *mobility* level and pattern. A lasting alleviation therefore implies both reduced levels and changed patterns of mobility. Only limited contributions can be expected from such measures as making more effective use of transport modes or developing more environmentally benign vehicles. The concept of mobility is understood as the volume of actual movements of persons as well as goods in the society.

Mobility is used in the same sense by *Hart* (1994) in the article “Transport Choices and Sustainability: A Review of Changing Trends and Policies”. He also considers sustainable development basically to be a global concept with substantial ethical, political and even spiritual overtones. However, he finds it a difficult concept to give a meaningful operational definition and claims that promising progress can be made by distinguishing between “absolute ecological sustainability” and “subjective sustainability”. The last is placed within a context where increased purchasing power, adjusted market conditions and changes in consumer behavior work together to moderate input of natural resources while GNP (Gross National Product) continues to increase.

Hart concludes that much could be won through addressing “subjective sustainability”, as most people worry about levels of road traffic and local pollution, congestion, parking problems, quality of urban life and deterioration of the countryside. More so than about issues related to global “absolute ecological sustainability”. A consequence is that the concept of sustainability is not related to his concept of mobility. Subjective sustainability only implies changes in situations characterized by local problems of intensity.

1.2. Equity, globality and mobility

Much more fundamental changes are prescribed by *Whitelegg* (1993) in his book “Transport for a Sustainable Future”. He emphasizes that dimensions of equity and globality are crucial in an understanding of the concept sustainable development. This implies including the third world in all discussions about transport policy and environmental impacts of transportation. Transport policy in the rich north must within such a context comprise reductions in the number of vehicles as well as in travel lengths and the number of travels. Sustainable development means thereby changes in life styles and structures in order to attain reductions in levels of consumption in north and increases in the south. According to Whitelegg transport is at the core of this process, because it defines the limits of production and consumption in time and space. It has in addition a large potential for accelerating depletion of natural resources and environmental deterioration, in north as well as in south. The private car and the lorry are both symbols of the problems of “unsustainability”. He accentuates the fact that they represent consumption in a large scale and that this consumption is embedded in social structures, in structures of land use and in ideological structures which are necessary but still hard to break through.

Whitelegg expresses an ambigious relation to the concept sustainable development. On the one hand he uses it in the meaning presented above. On the other he warns against it as a convenient concept which allows us to defer a confrontation with the unthinkable: that we should consume less and at the same time give priority to an increase in consumption and wealth in the countries of the third world. In this context he further claims that sustainable development has at its centre the notion that it is possible to avoid a global catastrophe through a controlled growth based on careful management of ecological conditions, and that it in this way justifies a “business-as-usual” strategy.

An ambiguity is also expressed in his relation to the concept of mobility. On the one hand he uses it to express the levels of movement of persons and goods in a society. On the other he connects continued growth in the levels of movement to the actual use of the concept. He claims that traditional transport policies raise *mobility* above *accessibility*, and that the opposite should be the case in policies for sustainable development. According to this view a major challenge is to attain better accessibility through changes in land use planning. Such changes imply shorter and less dependence on motorized transport. In particular are changes in urban structures focused to facilitate a transport system based on walking, bicycling and high quality public transport.

Whitelegg assigns crucial importance to the application of the *time* concept. He even uses *time pollution* as an illustration of our current relation to this concept. Giving time economic value, as in existing transport analyses, according to Whitelegg pushes the system towards even higher mobility, faster speeds and larger investments in transport infrastructure. He emphasizes that sustainable transport policies cannot be based on economical principles that include time as a monetarized unity.

In two papers *Zeitler* (1995a, 1995b) discusses basic theoretical aspects of the concept *sustainable mobility*. His main focus is on the *environmental ethics* foundation of sustainable mobility. Zeitler claims that the Brundtland Commission (WCED, 1987) demand for a *sustainable development* at the very beginning included an ethical requirement of global justice within and between human generations. Accordingly he considers that this concept in particular should focus on 3 problem areas (1995b):

1. Problems related to satisfaction of basis human needs;
2. Problems related to equity and social justice;
3. Problems regarding human relations to nature

All these areas raise some fundamental ethical issues.

Human actions in our context are generally not ethically neutral. Neither are they generally environmentally neutral. This also applies to actions in the form of transport, which then from an ethical point of view always have a problematic nature, that is they have a potentially harmful effect on fellow beings and the environment. Zeitler stresses the point that this must imply a general *principle of caution*, which he places at the core in a definition of sustainable development (1995b):

> "A sustainable devleopment is a development which renders possible that we, as moral subjects, display a maximum sensitivity towards the other forms of existence which are our company (other human beings, animals, plants, landscapes, ecosystems, minerals, etc)."

Sensitivity implies "to guarantee our greatest possible attentiveness to negative and positive signals from the social and natural environment" (1995a). A *precautionary principle* of action follows from such a definition. He considers this to be a fundamental ethical principle with the meaning: "we (human beings) must exercise maximum possible concern towards other forms of existence" (1995a). The precautionary content is that such a norm for action is necessary as long as we lack decisive criteria for what and how other forms of existence deserve our moral concern.

In the area of transport this has the following two major implications:

1. Largest possible reduction in transport activities;
2. Development of the most considerate modes of transport.

Zeitler hence emphasizes that a *sustainable mobility* without reservation implies lower mobility in western, affluent societies. Mobility he defines as "the ability of an individual to move about" (1995a), while at the same time recognizing that it is an incredibly complex concept, and closely connected to concepts as "liberty", "equity", "risk", "need", "accessibility" and "movement". He disputes the common understanding that reduced mobility seriously will increase the amount of social restrictions and regulations. It will first of all clear the ground for alternative actions that formerly were not possible, and in this way serve as a reallocation of options for human action. In such a context car driving is not only expressing freedom, it also covers a lot of restrictions, both environmentally and socially. This, according to Zeitler, at least makes it improbable that restrictions in "automobility" necessarily increase the total volumes of restrictions.

1.3. Sustainable mobility and social change

In their works on sustainable mobility both *Tengstrøm* (1995, 1999) and *Steen & al* (1997) express a similar understanding of the implications. In the report "Sustainable Mobility in Europe and the Role of the Automobile" (1995) *Tengstrøm* focuses mainly on the bodies and organizations that are the relevant actors in transforming the transport systems in Europe. However, it includes a critical survey of the recent scientific debate on transport and sustainability.

He concludes this survey by emphasizing that other scientific studies on the topic in general do *not* recommend only simplified solutions of the type "technical fixes" or overemphasize the importance of economic policy instruments. They do, however, have other limitations. Most of them accommodate the concept of "sustainable development" to conventional thinking in transportation studies. Tengstrøm stresses that it instead should be regarded as a trigger of new ways of thinking.

Another critical observation by Tengstrøm (1995) is the absence of a global perspective in most of the studies. Global in this context refers to globalization of "automobility" as a driving force in conflicts over natural resources and ecological sustainability. The implications of sustainable mobility are in a global perspective outlined as severe restrictions on “automobility” and reduced levels of mobility in the rich world.

Tengstrøm attaches to traditions within *human geography* in defining mobility - or more precisely “domestic mobility” - as the trips and travels individuals carry out during the day. It includes non-motorized forms of transport, as walking and bicycling. In methodological perspectives he further attaches to Swedish *time geography*. It implies an understanding that humans have to be mobile in order to overcome structural barriers in space and that this mobility is carried out under strict restrictions in time. Through methods developed in time geography it is possible to study the time-space related restrictions that humans are subject to.

In his report “On The Road Towards Environmental Sustainability” (1999) Tengstrøm emphasizes that a sharp distinction should be made between “a sustainable transport system” and “sustainable mobility”, while they sometimes are taken as synonyms in the litterature. Through the last concept it is expressed that the levels of mobility are challenged. These levels have to be adapted to the carrying capacity of an environmentally sustainable transport system.

Tengstrøm mostly focuses on mobility of human beings. In another Swedish report *Steen & al* (1997) however include the movements of commodities. They define mobility both as the possibility (or ability) to *and* the realized physical movements, of human beings *and* commodities (Steen & al uses the Swedish term “rørlighet” and not “mobility”). Common expressions are the actual movements measured in numbers of personkilometers or tonnekilometers. However, there is a limitation in their definition in claiming that it is common only to include motorized forms of movement, that is to exclude walking and bicycling.

Steen & al title their study “Transportation in a Sustainable Society” and their main objective is to describe how a transport system might look like if sustainable development is accepted as a superior societal aim. It is meant to give a contribution to the current debate on the future development of transportation. While limited to Sweden, it covers all transports of persons and commodities both within and to and fro the country. That is, also travels made by Swedes or Swedish products in other parts of the world are included.

Steen & al emphasize that a transition to a sustainable transport system implies large societal changes. First of all is sustainable development a global concept. The challenges raised by this “globality” represent the main reason why it is a matter of such extensive changes. Their definition of the concept covers four main subjects:

1. Conservation of a viable environment;
2. Fair distribution between present and future generations;
3. Increased or maintained quality of life;
4. Fair distribution within generations (implying to solve the poverty problems of the world).

The issue of distributive justice is considered to have a major importance in an operationalization of the concept, not the least in establishing the boundaries for future transportation. In this context they apply the concept *environmental space* and presuppose that all people (pr capita) - present and future - have a right to an equal share of this space.

It implies that all human individuals should be guaranteed access to an equal volume of global ecosystem services (“sink”-capacity) and natural resources (“source”-capacity). They do however admit than an equal per capita “space” only can serve the function as a guideline. It should not be understood as a question of exact implementation. Neither does it imply an equal standard of living all over the world; the *intermediate connections* between the physical available environmental space and the actual societal structures vary largely in relation to cultural and social differences.

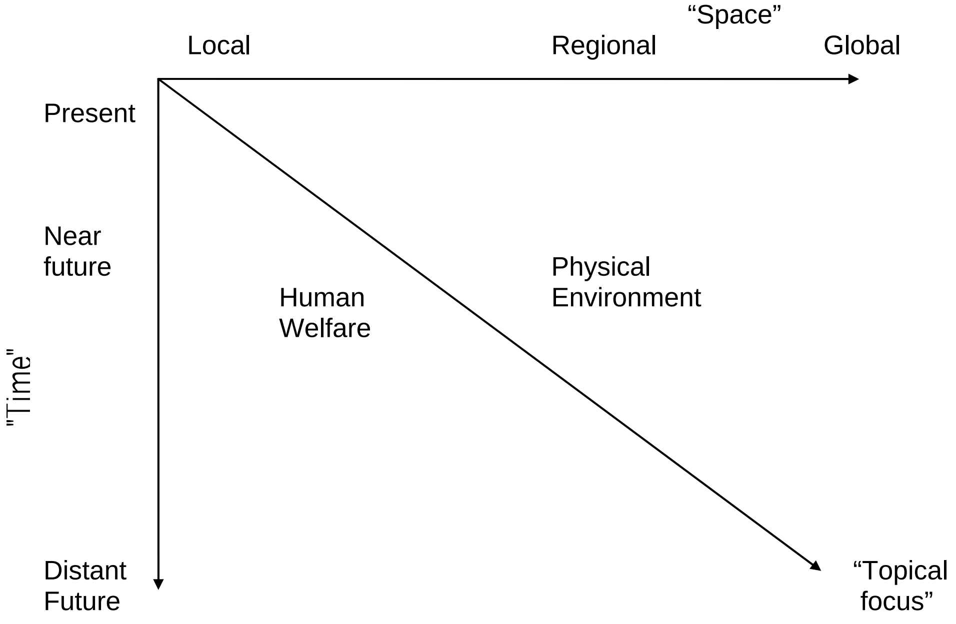
1.4. Sustainable development

So far I have presented how the concepts *sustainable development* and *mobility* are applied in scientific works addressing issues related to the combined concept “sustainable mobility”. However, this does not give full credit to differences in understandings and definitions. There are a lot of works about sustainable development without any explicit linkages to mobility or transport. Similarly has the mobility concept been addressed without linkages to a sustainable development.

There is a vast international literature on sustainable development. At least 40 different “definitions” have been registered, all of them intended for a role as useful working tools (Torgerson, 1994). I shall later in the thesis give a more thorough presentation of differences in perspectives and definitions. This includes an historical analysis of the development of the concept and its main brickstones.

In this context I shall confine the presentation to the major demarkation lines between different works on sustainable development. This is illustrated in *figure 1*.

Figure 1 Sustainable development according to time, space and topical focus



The figure identifies three major demarkation lines. They are the dimensions of *Space,Time* and *Topic*. Differences in the understanding of the concept are expressed through their way of addressing the "space" dimension. It is illustrated as a continuum, but with the main focal points local, national and global. Some works focus mostly on local issues. Others are confined to a national context, and others again have broader global issues as their main focal point. Similarly with the "Time" dimension. Some have their focus on the present situation. Others extend this to cover the near future, or this generation. Others again mostly focus on long term issues connected to a more distant future.

The third dimension is "Topic". Two main topics are identified; *physical environment* and *human welfare*. They should also be understood as extremes in a continuum. Some works, however focus only on issues related to the physical environment, while others combine the two or have their main focal point on human welfare issues.

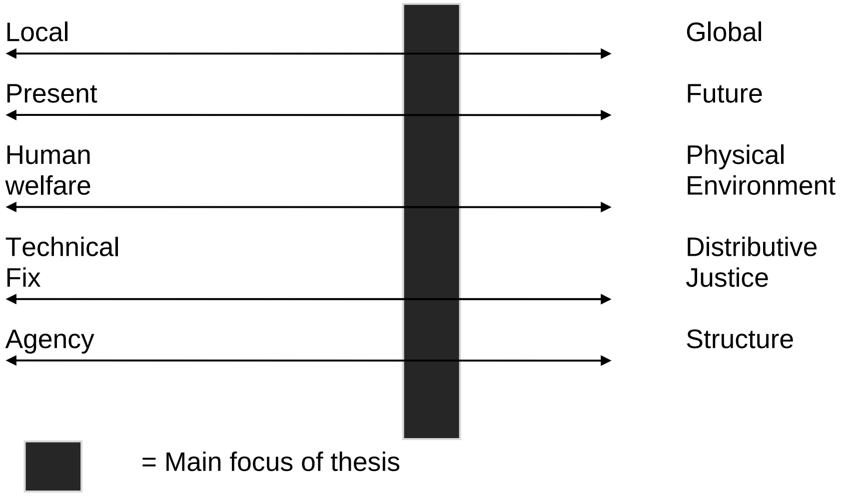
But, in order to make the demarkation more complete two more dimensions are needed. The *fourth* is related to the pair of concepts *technical fix* and *distributive justice*. They are in each end of a continuous scale. I shall later in the thesis elaborate on both. This dimension is meant to express what major types of solution principles different scientific works focus on. *Technical fix* is a term illustrating a focus on technical solutions. Within transportation they can be of the types catalysator technologies, new motor systems, alternative energy sources etc. They are considered to be valuefree, or at least value-neutral. This is not the case for the types of solutions that can be related to the term *distributive justice*. Ethical issues are involved, both regarding means and ends. Crucial questions are: Which ends are legitimate? Which means are we entitled to apply in order to attain the ends? In addition are these other types of ethical issues involved:

- What sort of responsibilities do we have towards human beings living in other parts of the world?
- What sort of responsibilities do we have towards human beings in the future?
- What sort of responsibilities do we have towards other parts of nature, now and in the future?

The *fifth* dimension is related to the pair of concepts *structure* and *agency*, a classical distinction within social sciences, - and a distinction subject to much dispute. In my context they are two extremes of a continuous scale. Agency-approaches put human conscious agency at the centre of analysis while structure - approaches focus on the social/environmental-structural conditions for, and constraints on, action. The work by *Tengstrøm* (1995) referred to earlier is an example of an agency approach. With a typical structuralist emphasis one focuses on the patterned contexts in which individuals or actors make choices. Individuals can then be understood to be "locked into" patterns of daily activity - such as the use of private cars - which they know to be environmentally harmful. Only if structural changes in space are enforced, in the form of changes in land use and localization of key functions, in addition to a provision of alternative modes of transport would individuals have a meaningful choice to make about transport options for themselves (Redclift & Benton, 1994).

Figure 2 illustrates the *main* focus of the thesis accordning to these five dimensions;

Figure 2 Main focus of thesis in relation to dimensions to the concept of sustainable development



The thesis focuses mostly on issues with a global character, and in relation to a distant future. That is: the lead issues are distant both in time and space. Topically the focus is on issues in relation to the physical environment, usually termed "environmental problems". This is a reflection of my own main scientific background in "environmental sciences" and "environmental planning". However, some links are drawn to human welfare issues, in particular how these are influenced by the environmental issues.

Regarding solution principles these are mostly analyzed and discussed on the level of “distributive justice”. “Technical fix” solutions are, however, also part of the analyses. Particularly in one of the chapters are they made subject to a fundamental critical inquiry. This analysis reflects my background in “engineering sciences”. Lastly the focus is mostly on “structural” issues. Only to a minor extent are “agency” issues included. This is again a reflection of my scientific background.

1.5. Mobility and movement

This is a concept with a longer history than “sustainable development”. It is complex. The complexity only increases as it - as sustainable development - is subject to a substantial metaphorical use. As a metaphor it usually links *movement* and *change* (Hägerstrand, 1993). We talk about population mobility, occupational mobility, educational mobility, but also about labour force mobility, removal mobility, travel mobility, and so on. They express societal changes as a matter of movements, but only sometimes in the form of actual physical movements. There is even often a *normative* element involved; increased mobility is something we want because it is an expression for progress and better standard of living. This is taken to apply to all forms of “mobility”, physical mobility just as much as occupational or labour force mobility.

One of the superior theoretical perspectives to this thesis is that movement and change are linked together, in principle just as in a metaphorical use of the concept. However, there are two major differences. First of all there is no normatively positive element involved. The focus is on the contrary on the negative aspects of mobility. Secondly there is a broader concept of change. It not only covers societal changes, but also changes in the physical environment.

Included in this perspective is the understanding that there is no social neutrality connected to movement. We can, then, not have any type of movement in combination with any type of society. The car society is quite different from a society based on walking and cycling, or from a society based on public transport means as buses, trams and trains. There is similarly no environmental neutrality. As physical movements presuppose mobilization and consumption of natural resources, this necessarily implies environmental change. We can, then, neither have any type of movement in combination with any type of environmental state.

However, the connections between movement and change can be understood in more ways than one. We can consider movement as a result of change, as a dependent variable in a process of change. Alternatively it is possible to understand movements as an independent variable, as an instrument for change. In either of these models a unidirectional causal connection between movement and change is presupposed. But, even a third conceptual model is possible. In this movement can be understood in a wider sense as a process with its own driving forces and mechanisms. The thesis is not limited to either of the three. An aim is to gain perspectives and understandings from all. This implies that the empirical material is not generated through a systematic choice of movement as a dependent or independent variable in relation to change. However, when this empirical material is limited to environmental issues, a direct causal link between movement and change is presupposed. On the one hand are environmental changes caused by movements. On the other hand will limits put to an acceptable environmental change cause limitations in the types and levels of movement.

In order to survive all species must move. This applies to man as well. Throughout mankind's history of development movement has been an important precondition for the survival not only of individuals, but for communities and societies, too. There are a number of cultures, among others our own Sami culture, where this has been the central precondition. The question, then, cannot be movements or no movements. A basic perspective is that this has to do with *the volume of movement.* Sustainable mobility is, above all, a question of a volume of movement which is in accordance with the principles of sustainable development. Man must still move in order to survive and develop societies which can give a satisfactory social and cultural quality of life. However, this cannot have a volume which both undermines the preconditions for future generations to be given corresponding opportunities and destroy the life conditions for other species.

The volume of movement is linked to the systems applied to carry out the movements. We call them *transport systems*, or more precisely transport modes and means. There is no neutrality in the relation between transport system and level of movement. When we mostly use shank's mare or bicycle as means of conveyance, we can only reach a certain level. Larger volumes can be attained with the addition of bus, train, and tram. Yet it is the car and the plane which can give the really substantial leaps in terms of volume. Americans use the term *automobility* to express this connection. It is a volume of movement which has the "automobile" as its basic precondition (Tengström, 1995).

1.6. Different forms of mobility

The concept is *mobility* and not "movement". Its complexity is emphasized. It is used differently in different disciplines of science. In economics reallocation of factors of production in general and of the labour force in particular is referred to as mobility. In other social sciences mobility is usually understood as the movement of individuals or groups of people between social positions and places of residence (migration). In physical planning and transport research it is a concept expressing locomotion and travel in society. Hägerstrand (1987) underlines that it is not possible to draw distinct border lines between these different meanings; they overlap and partly condition each other.

Similar positions are taken by Jones (1987), Nijkamp (1987) and Walzer (1990). In the article "Mobility and the Individual in Western Industrial Society" Jones (1987) stresses that mobility in its varying forms is an important characteristic of Western Societies which is reflected in its social, political and economical systems. Freedom of thought, freedom to act and freedom to move, all associated with "mobility", are considered to be fundamental rights in a democratic society. Jones refers to several other analytical works where the claim is that without the flexibility expressed in the concept of mobility, the modern technological society could not have developed so fast and with such a large diversification of products and services. He therefore emphasizes that any limitation in the use of the concept - for instance to "transportation" - should be understood only as a part of a broader concept of mobility. This encompasses residential and industrial relocalization, social mobility, etc - all of which are parts of a continuous process of development and adaption in modern industrial societies.

A similar line of argument is forwarded by Walzer (1990) in the article “The communitarian critique of liberalism”. As Jones he claims that the Western societies are both founded on and penetrated by mobility. He identifies four forms:

1. *Geographic mobility*.
(Changes of residence and mobility in the form of transportation);
2. *Social mobility*
(Changes in social positions);
3. *Marital mobility*
(Broken marriages, remarriage, dissolved families, etc);
4. *Political mobility*
(Floating voters, institutional instability, etc).

According to Walzer is “liberalism”, most simply, the theoretical endorsement and justification of the individual movement expressed through the four forms of mobility. He claims that any effort to curtail mobility in the four areas would require a massive and harsh application of state power. And the four mobilities are interlinked; serious curtailment in one would have substantial effects on the others.

The concept of mobility used in this thesis is found within the first form described above: “geographic mobility”. However, focus is not on changes of residence, but rather on the incessant movements of individuals (and commodities) in society at large. It is thereby linked to a concept of *transportation* and is within a tradition found in physical planning and transport research. However, the term is “mobility” and not “transport”. This serves amongst other as a reminder of that it only is a component of the broader concept of mobility. An analysis of the implications of sustainable mobility can then only be complete through including the other components in the scheme. This is, however, outside the scope of the thesis.

In this limited meaning mobility is still a complex concept. Within transport research it is common to distinguish between accessibility and mobility. *Accessibility* can be defined as the ability of persons to get access to or be reached by those functions that matter to them. This, however, does not only have to be limited to persons. With the same basic definition in mind, we can also talk about goods accessibility or resource accessibility. Studies of accessibility are frequently carried out on the basis of two different perspectives. The first one is based on place or region, focusing on the localization of functions and activities. The second has its basis in individuals, or in some goods or resource categories (Høyer, 1995).

In recent years, international transport research has focused much on the concept of accessibility. This has been perceived as the most fundamental concept. The question of *distance structure* within limited, spatial contexts has been looked upon as especially significant. The idea is that the crucial challenge lies in creating easy accessibility, and that this primarily deals with suitable localization and distances between functions. Consequently, a co-ordinated land and transport planning on the basis of these principles will be decisive for the actual transport volume and the need for transport infrastructure. It is primarily in cities and towns that this issue has been subjected to recent research approaches (Høyer & Selstad, 1993; Næss, 1995). Naturally, it is in these areas that the most obvious opportunities exist for creating proximity between the diversity of functions implied in modern life. Indeed, cities and other urbanised areas were actually built up around the idea of spatial proximity.

An understanding of accessibility as the most fundamental concept has many aspects. It implies that transport is looked upon as a means to obtain an end, within the framework of a classical and well-defined means-end hierarchy. It corroborates the perception of transport as needs *derived* from those conditions and development characteristics prevailing within and among the various target points. This is an interpretation open for discussion. The relations between end and means are not easily limited and defined. New infrastructure covers not only needs; it also generates new transport. An easily accessible mean of transport - such as the private car - creates its own ends. Thus, it is not only the ends which create means, but also means which create ends (Høyer, 1995).

This brings me back to the concept of mobility. In some contexts, the concept is exclusively explained as a *potential* for movement (Kasanen, 1994; Berge & al., 1992). A commodity may have high mobility, that is, a high potential for movement by possessing characteristics making it easy to move, and by the existence of easily accessible means of transport to carry out the movement. Correspondingly, persons may have different mobility depending on individual factors such as age, sex, health, occupation, and so on. In addition, there may be different time frames at one’s disposal, as well as different access to appropriate means of transport.

Such a limited definition is to a very little extent in line with the actual use of the concept. It applies in a more general context, but also in relation to the core of international transport research. In such a central study within more recent European travel patterns research as *A Billion Trips a Day* (Salomon & al., 1993a) it is, for example, applied as a wider concept. In terms of person travels, it especially expresses both actions of individuals as they manifest themselves in travels and the potential actions the individuals can think of carrying out, but are hindered from doing, either because of inadequate transport services or for personal reasons. In this way, what we can refer to as person mobility is the disclosed travel behaviour of individuals which is carried out as an answer to a set of needs and wishes in relation to work, service, care, and leisure activities (Salomon & al., 1993 b).

1.7. The mobility concept in the thesis

Consequently, mobility can be defined as a function of two variables. With person mobility still in mind, the *first one*, then, is the tangible realisation of travel needs in the form of actual movements. The *other one*, previously referred to as the potential for movement, is a personal and societal categorisation functioning as a limitation of the the first (Banister, 1985; Jones, 1987).

I then define mobility in the following way:

> “Mobility is an expression for both the potential for movement and the volume of the actual movement taking place. It can be linked to persons, goods, and resources. It can be applied at an individual level, that is, for a person or a commodity. However, it can also be applied within sectors, or at a superior societal level.”

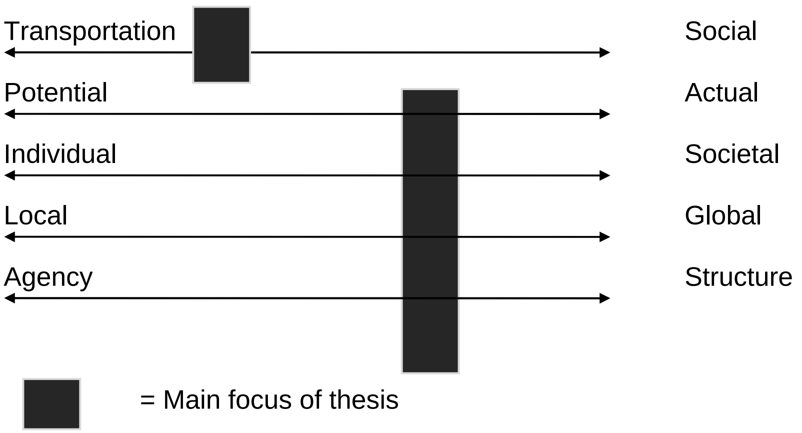
Based on such a definition, the concepts of *person mobility* and *goods mobility* are used as two basic categories. The goods mobility does not only refer to resources - raw materials and processed goods - when they are set in motion. It can also comprise the input in the very exploitation of resources. The fishing industry is an obvious case in point. In this industry there can be more or less mobility, depending upon how the harvesting of resources is carried out, that is, how much the fishing vessels have to move before and after the fishing. Sectors and industries can comprise both person and goods mobility. Tourism is a good example of an industry dominated by person mobility.

According to the definition, mobility can be analysed at various levels, and also by means of different types of indicators. By means of travel patterns surveys we can get knowledge of travel patterns at individual levels expressed in terms of indicators such as travel frequency, travel purposes, travel distance, travel time, itineraries put together in chains and networks, to mention a few. In principle, this type of surveys can also be carried out for the movement of individual commodities. At a superior societal level, such data can be aggregated and expressed in units such as *person kilometre* and *tonne kilometre*, with possible distributions on transport modes and means and various travel categories. These are units that can be applied to express the mobility in the society as a whole, which brings us back to the former concept of *movement volume.*

It is primarily the person mobility which has been subjected to more fundamental research approaches. However, there is no reason for not making goods mobility subject to a similar focus. The thesis gives some examples on how this form of mobility can be addressed. It covers both theoretical and empirical analyses.

Even the definition given above is pretty wide. The main focus in the thesis is more limited. This is expressed in *Figure 3* which presents a delimitation according to *five* pair of concepts or dimensions.

Figure 3 Main focus of thesis in relation to dimensions to the concept of mobility



All concepts are in each ends of continuous scales. The focus in relation to the first dimension has already been made explicit. It is mainly on *transportation mobility* and not on the more encompassing social mobility (covering all forms of mobility referred to before). The definition of mobility includes both *potential* and *actual* movements. The thesis focuses mostly on actual mobility expressed in physical terms. Whether the object is persons or commodities aspects of mobility can be analysed on *individual* or *societal* levels. The focus is mostly on the last. However, theoretical as well as empirical analyses on individual levels are included. Similarly regarding the distinction made between *local* and *global* mobility. The thesis focuses mostly on global aspects, that is the direct and indirect movements of persons and commodities made in the wider geographical space. This, of course, is linked to an understanding of *globalization* as an important part of the current phase of "late" – or "post"-modernity in the Western societies (Beck, 1992; Giddens, 1994). However the importance of the local context should not be underestimated and is included in some of the material. Finally – as for the concept of sustainable development – the thesis has its centre of gravity towards a *structuralist* approach (as distinct from an *agency* approach).

1.8. A foundation in research projects

The thesis is based on theoretical and empirical contributions from several research projects. They are projects I have been engaged in for a period of almost 10 years, all the time with a prime focus on relations between transport and environment. In most of the projects I have had a combined function as active researcher and as project leader with a main scientific responsibility. This implies that there have been several contributors to the research material which forms the basis. Some of them are employed in the research group I am heading at Western Norway Research Institute. Others, however, belong to other institutions, notably the Norwegian Institute for Urban and Regional Research and Eastern Norway Research Institute (Lillehammer).

Altogether it encompasses 8 separate *research projects*. They are in chronological order (with all titles translated from Norwegian originales):

1. 1988-1992. *NAMIT – Environmentally Sound Urban Development*. A research programme under Norway Research Council. Main aim was to develop principles for urban development and planning that were in accordance with sustainable development requirements. In particular focus was on relations between local transport, land use planning and sustainability.

2. 1990-93. *The ecological basis of regional policy*. A Nordic project under NordREFO, Nordic Institute for Regional Policy Research Main aim was to elaborate on relations between environmental challenges and regional policy and planning. This was done both historically and in a principal, theoretical context.

3. 1991-1993. *Public transport – impacts on environment, energy and land-use*. A project under the Norway Research Council research programme on public transport. Main aim was to develop methods for, on basis of life cycle analysis, and to perform actual analyses of energy, environment and land-use impacts of different means of public transport in comparison with the private automobile.

4. 1992-95. *Rural Areas and the Environment – local and global environmental challenges as conditions for rural development.* A project under the Norway Research Council research programme on rural development. Main aim was to give a thorough analysis of local and global environmental challenges that could affect

the future development of rural areas in Norway. Relationships between person and commodity mobility, environment and rural areas were given special emphasis.

5. 1994-97. *The large Nordic infrastructural projects in transportation – regional and environmental impacts*. A Nordic project under NordREFO, Nordic Institute for Regional Policy Research. Main aim has been to give an empirical analysis of major regional and environmental impacts of the last years investments in large transport infrastructure projects in the Nordic countries. The project covers in addition a comparison between two future scenarios, one based on "trend" and the other on "sustainable mobility" requirements.

6. 1995-97. *Directional Analyses for Sustainable Development in Municipal Planning and Politics*. A project under KS-Research, the research fund for the Norwegian Organzation of Local Municipalities. Main aim has been to develop a framework for applying directional analysis in relation to sustainable development requirements in municipal planning and politics. It further covers an analysis of local indicators for sustainable development, both in a historical and theoretical perspective.

7. 1995-97. *Environmentally Adapted Tourism*. A project under the Norway Research Council research programme on measures in environmental policy. Main aim has been to develop a framework for measures to attain an environmentally adapted tourism in Norway. It further covers a theoretical discussion of the implications of "Sustainable Tourism". An empirical part on relations between tourism, transport and environment has been financed by the Ministry on Industry and Energy.

8. 1995-98. *Mobility and Car dependence in Rural Areas – what are the implications of sustainable mobility for rural development?* A project under the Norway Research Council research programme on development in rural and coastal areas. Main aim has been to analyse the implications of sustainable mobility requirements on rural development conditions. This includes a theoretical analysis of the concept of sustainable, a historical analysis of the development of mobility and car use in rural areas, and an empirical survey of the current travel pattern of individuals and households in rural areas (in Norway). The project is limited to person mobility.

1.9. The chapters

Besides this introduction and a chapter with conclusions the thesis consists of *6 main chapters*. Each is a separate article already printed either in a book or a journal. They are exactly in the form they have been printed. However, each article in this thesis has a separate set of *notes* which has not been printed before. The texts in these notes were included in the original manuscripts delivered for reviewing by the book and journal editors. Mostly due to restrictions regarding the length of the articles they were, however, not printed. They are included here in order to give a more complete presentation both of the theoretical and empirical material the articles are based on.

In the order they are printed the articles are:

1. *World in Environmental Transition.*

Printed in: Brune, D., Chapman, D., Gwynne, M.O. Pacyna, J.M. (eds). (1997) *The Global Environment. Sciences, Technology and Management*. Vol. 1. Weinheim: VCH Publ.

The article has been reviewed by two anonymous referees and is printed as an introductory article to this two volume book work. It gives a principal analysis of how the environmental problems, included our understanding of the problems, have changed character during a period of more than twenty years. It covers a presentation and definition of concepts fundamental to an understanding of "environmental" and "sustainability" issues.

2. *Mobility, transport and sustainable development viewed in the light of Agenda 21*
   Printed in: Lafferty, W., Langhelle, O., Mugaas, P., Holmboe Ruge, M. (eds.) (1997): *Rio + 5. Norges oppfølging av FN-konferansen om miljø og utvikling*. (Rio + 5. The Norwegian follow up of the UN-Summit on environment and development). Oslo: Tano Aschehoug.

   The article is translated from Norwegian. It is printed in a book which evaluates Norway's follow up of the UN-Summit on environment and development in Rio in 1992. Based on an evaluation model, usually termed "ideal-reality tradition" in Norwegian evaluation research, the article analyses what the Brundtland-Commission and Agenda 21 say about transportation. Another set of basic analytical material is the content in crucial official Norwegian policy documents developed in response to these international documents. They are applied as two sets of background criteria for an assessment of the actual development of mobility and transportation in Norway and to what extent new actions and measures presented will give changes to this development.

3. *Recycling: Issues and Possibilities*
   Printed in: Brune, D., Chapman, D., Gwynne, M.O., Pacyna, J.M. (eds.) (1997). *The Global Environment. Science, Technology and Management*. Vol. 2. Weinheim: VCH Publ.

   The article has been reviewed by two anonymous referees. It gives a theoretical and empirical analysis of the limits of "technical fix"-solutions. Recycling of resources is used as "case"-issues. Recycling is placed within the framework of the concept "industrial ecology" which is also made subject to a theoretical presentation and critical inquiery. In the empirical part of the article mobility and the private automobile are used to elucidate the limits of recycling.

4. *Rural industries and the Environment. What is the state of affairs of sustainability?*
   Printed in: Aasbrenn, K. (ed.) (1996). *Rise up and stand, old Norway*. (Opp og stå, gamle Norge). Oslo: Landbruksforlaget (Agricultural publ.).

   The article is translated from Norwegian and printed in a book which sums up the results from a research programme on rural development (1990-95). It presents elements of a physical theory of resources and a theoretical foundation for energy analyses of the transformation of natural resources. The concept "ecological sustainability" is further defined together with a discussion on the implications of "sustainable development" for utilization of biological resources. Empirical "cases" are energy analyses of Norwegian fisheries and aquaculture, where the results are discussed in relation to a concept of “goods mobility”.

5. *Sustainable tourism - or sustainable mobility? The Norwegian Case*.
The article is accepted for publishing in the international referee-journal “Journal of Sustainable Tourism”, no. 1, 2000.

The article gives a critical discussion of the internationally prevailing understanding of the concept “sustainable tourism”. This concept is analysed theoretically in relation to both of the basic concepts “sustainable development” and “tourism”. Results from an empirical analysis of environmental impacts of all tourism travels - within and to and from Norway - are related to the development of a concept of “sustainable tourism”.

6. *Sustainable Development*
Printed in: Brune, D., Chapman, D., Gwynne, M.O., Pacyna, J.M. (eds.) (1997). *The Global Environment. Science, Technology and Management*. Vol. 2. Weinheim: VCH Publ.

The article has been reviewed by two anonymous referees. Both in relation to environmental history and different approaches within environmental philosophy and -ethics the theoretical foundation for a concept of “sustainable development” is analysed. A form of operationalization is presented through an indentification of extra prima and prima characteristics. To elucidate the implications of such an operationalization “emissions of CO_2” and “automobililty” are used as empirical “cases”. This is related to a concept of “sustainable mobility”.

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2. World in Environmental Transition

A distinction can be made between qualitative and quantitative environmental issues. The whole industrial production of environmentally alien substances (e.g. CFC gases), is primarily a qualitative issue. Once products containing new environmentally alien substances are set in circulation, the decisive foundation for irreversible environmental consequences is laid. International agreements on the phasing-out of the production of ozone-depleting CFC and halon gases provide an interesting example. The production of these gases has been vital to the development of the chemical industry in western industrialized countries since the late 1940s. Now a whole product spectrum is being phased out. It is not a matter of making production more environmentally friendly or limiting the extent of the use: it is a matter of getting rid off the problems themselves – in other words, there is a qualitative, and not a quantitative, limitation.

The environmental issues imply quantitative dimensions as well. The greenhouse effect linked to the emissions of CO_2 is a typical quantitative environmental impact. [1)] It has never been suggested that coal, oil and natural gas should not be used at all; it is more a question of the extent of their use. CO_2 exists in a natural cycle. The problems arise once the anthropogenic additions become too large. This is also the case with land area-linked impacts. Obviously, there is a need for transport infrastructure, but problems arise when its land area encroachment becomes too big.

2.1. Quantitative Limits

Goodland (1991) emphasizes the following four points as “proofs” that we are close to absolute quantitative limits:

- Human use of biomass;
- The greenhouse effect;
- Erosion of topsoil;
- Degradation of biological diversity.

In addition, he points out the proof “ozone depletion”.

Goodland refers to calculations showing that direct and indirect human activities use approximately 40% of the net production of all terrestrial photosynthesis (25% if all aquatic photosynthesis is included). This means that with just a doubling of the world’s population (within 25 years), 80% of available biomass will be used, increasing to 100% shortly afterwards. The latter figure is not only ecologically, but also socially, impossible.

The costs of refuting the greenhouse hypothesis, if it is correct, are substantially bigger than accepting the hypothesis if it proves to be wrong. By the time the proofs are irrevocable, it will be too late to avoid unacceptable costs. These costs could lie in millions of refugees from low-lying coastal areas (where 55% of the world's population lives), destruction of harbors and ports due to increased storm intensity and the destruction of agricultural areas (Goodland, 1991). Even if there is a phasing-out of the production of CFC and halon gases, the environmental impacts of ozone depletion will be accentuated in the coming decade, and will last far into the next century. Another point is that many of the substituted substances sustain the greenhouse effect.

Goodland underlines the fact that soil erosion is a major problem in most of the world's agricultural areas. It increases gradually as more marginal soil is cultivated. Globally, the rate of loss of topsoil is ten times higher than the rate of production of new soil. It is thus only a question of time before absolute quantitative limits are exceeded.

The impacts in terms of degradation of biological diversity emphasize how human activities occupy so much space that there will be progressively less space for other species. These species are at the same time necessary to sustain a reasonable balance in the ecosystems that humans depend upon.

Conservative estimates put the total global number of species at 5 million, whereas the upper estimate is 30 million. There are big variations in estimate of the extinction rate of species; the most conservative give an annual extinction rate of 5 000, but others give 150 000 species per annum (Goodland, 1991). Even under the most dramatic changes in the Permian and Cretaceous periods, there was only a slow replacement of species, taking million of years. Besides, problems run deeper than the very extinction of species. Furthermore, there are far-reaching ecosystem effects linked to the interaction of the various species and their variants. Even if a species as a whole does not become completely extinct, whole populations can be lost to an extent that fundamentally breaks down the genetic diversity. Thus there is a loss of ability and capacity to adapt to climatic changes and various types of environmental overload. The natural robustness and buffer characteristics of ecosystems are lost.

2.2. Environmental Problems in the 1970s and 1990s

In the early 1990s international attention was focused on environmental problems. There are many reasons for this. Firstly, there are a number of environmental problems of a more critical character than experienced previously, e.g. the global depletion of stratospheric ozone. Secondly, scientific documentation occurs to a much greater extent. This is a result of the environmental research which began in most industrialized countries about 20 years ago. The greenhouse effect is an example of an area in which increased awareness is primarily due to scientific documentation because there is no acute environmental impact today; it will become a problem in another 30-40 years.

Thirdly, the commitment of the United Nations and the presentation of the Brundtland Commission Report (WCED, 1987) have played important parts. The report itself and its treatment in regional and global follow-up conferences (e.g. the Rio Conference, 1992) have placed the environmental problems on the political agenda. It is a process which has laid down important premises for future environmental policy.

The focus on environmental issues is, however, by no means new. Something similar took place in the 1960s and 1970s. The publication of the book *Silent Spring* by American ecologist Rachel Carson (Carson, 1963) was a releasing force. The ensuing debate laid the foundation for environmental organizations all over the western world. New environmental organizations were founded and a significant new orientation of established natural conservation organizations took place. Attention was directed at fundamental aspects of industrial development.

Changes in public policy followed. Ambitious legislation for environmental impact analyses was passed in the USA in 1969. Simultaneously a development in the management of environmental protection occurred. For example, the Norwegian Ministry for the Environment was established in 1972. In the same year, the UN staged an environment conference in Stockholm. A report was prepared for the conference on the global climatic problems, including the greenhouse effect (SMIC, 1971).

Thus, two historical situations, approximately 20 years apart and both characterized by substantial attention directed at environmental problems, have occurred. The fist resulted in public policy in the form of new legislation and new institutions. It was built on “apprehension” of the environmental problems regarded as the most critical and on the prevalent environmental-political understanding of these problems. Today, this picture looks different. – the environmental problems have changed in character, reflected in a different understanding of which environmental problems should be given priority (Redclift and Benton, 1995)[2)] . The rest of this chapter deals with how the environmental problems have changed in character between the 1970s and today.

2.3. Resource and Recipient Limits

The changed character of environmental problems is examined according to five dimensions (Odum, 1989; Høyer, 1991; Holmberg, 1992). (Figure 1). Twenty years ago much attention was focused on resource limits, whereas now it is on recipient limits. This distinction is based on a two-way split of the functions provided by the natural base in relation to anthropogenic encroachments. On the one hand biological, material and energy resources are extracted. On the other hand, the natural base is the recipient of human wastes, thus fulfilling its function as recipient [3)] .

Three impact areas can be identified in connection with the exploitation of resources:

- Impacts linked to the quantity and quality of the resources;
- Impacts in the extraction of resources;
- Impacts in the use of resources.

Figure 1 *The changing character of environmental problems (After Odum, 1989; Høyer, 1991; Holmberg, 1992)*

1970	Post 1990
Resource limits	Recipient limits
Local recipients	Global recipients
Short feedback loops	Long feedback loops
Point sources	Diffuse sources
Production related impacts	Product related impacts

Essential to the environmental discussions that took place around 1970 were impacts related to the quantity of resources and in addition partly to extraction. The view was that absolute limits to anthropogenic activities would be determined by the limited quantity of the resources [4)] . These may be termed resource limits and they are not prominent today. Of far more importance are the limits determined by the recipients' limited capacity for dealing with the wastes caused by the use of resources. These are termed recipient limits. To put it concisely, the problem is not that there is too little coal, oil or natural gas, but rather that there is too much. The global recipients cannot deal with all the waste products. This implies far more severe restrictions than those caused by the limited quantities of resources [5)] .

2.4. Global Recipients

The next distinction can be made between local and global recipients. Compared with earlier situations, anthropogenic activities and encroachments today have become substantial in comparison with the global ecosystems. There are good grounds for maintaining that in this way the relationship between the human society and the global natural environment has changed in character in the last few decades.

Throughout history, local and regional recipient limits have been exceeded. However, such a comprehensive exceeding of local, regional and global recipient limits has never been seen before. It is at the least an indication that the volume of human activities constitutes a problem, independent of the qualitative technologies of which they are comprised. This is what is referred to as the quantitative problem, and here it is globally encompassing. There are indications that absolute limits are about to be breached.

A nitrogen cycle in serious imbalance may serve as an illustration (Unsworth and Wolfe, 1995). Today humans tie almost as much nitrogen as nature does, largely due to the production of fertilizers. This causes serious global and regional disturbances in the nitrogen cycle throughout ecosystems. Other important anthropogenic sources are emissions of NO_x from combustion processes, especially in the transport sector, but also from overfertilization and changes in land use in agriculture and forestry. The disturbances are intensified by the mobilization and release of substances which otherwise are naturally tied bio-geochemically. The effects come in the form of nitrate pollution transported over long distances in the air; acid rain; increased nitrogen content in the soil, and increased run-off of nitrogen and subsequent "overfertilization" of freshwater, including groundwater and oceans. There are many sources and they are not easily defined. The causual relations are also complicated. This is a problem area which is part of the issue of diffuse sources (as opposed to the more traditional pointsource issues) (Zwerver et al., 1995; IPCC, 1996).

The global carbon cycle has also been disturbed. The CO_2 content in the atmosphere has been increased by approximately 25% in the course of the last 130 years. At the moment, humans are putting 7 000 - 8 000 million metric tonnes of carbon per annum into the atmosphere. This amounts to approximately 7% of the total, immense natural carbon exchange between the atmosphere and the world's oceans.

The dynamics in this type of cycle are frequently insufficiently comprehended. Even an immediate and globally comprehensive halving of CO_2 emissions will merely result in a continued gradual increase in the atmosphere's CO_2 content, until it has increased by an additional 20% by the year 2010. An immediate reduction of around 80% is needed to achieve a relatively fast stabilization og the atmosphere's CO_2 content at the present level. Today's global growth rate of approximately 0,4% per annum will, if it continues, lead to a doubling of the preindustrial CO_2 level long before the year 2100 (Brinck et al., 1992; Selvig, 1992).

Twenty years ago, attention war primarily focused on local issues, but partly also on regional issues. Today there is marked attention to the global aspects [6] . Local overload has partly been solved by moving impacts to the regional level. Extensive technical "solutions" to local problems have, however, led to an overload of the regional recipients, simply because the sum load from many small, local sources becomes too big regionally. Similarly, the sum of many small, local sources causes too much load globally. Apparently many local environmental problems are solved, but in fact they are just moved from one level to another.

2.5. Long Feedback Loops

The distinction between short and long feedback loops comprises many dimensions [7] . Firstly, there is a spatial dimension. Consistent with the development from local to global recipients, feedback loops have become longer. They penetrate and make up a larger part of the global ecosystems (Commoner, 1990) Secondly, there is a time dimension. Long feedback loops mean that it takes a long time until the full effects in the ecosystems are felt. An encroachment today can in some cases give a full backlash only in a hundred years, even if, in the meantime, the extent of the encroachment is reduced. Classical examples are the greenhouse effect and the impacts of the depletion of the ozone layer in the stratosphere. Gases which may have a lifetime of several centuries are emitted into the atmosphere. Even if all emissions are stopped today, they will still have negative effects on future generations.

Furthermore, there is a dimension related to the question of clarity. There has been a development from clear to more diffuse feedbacks. The cause-effect chains are no longer so obvious. The effects, e.g. dying forests, can be obvious enough. The causes, however, are diffuse. It may be an interaction of many causes - some natural, others of human origin. This is the issue of diffuse sources. For example, the greenhouse effect comprises a number of feedback mechanisms.

The "precautionary principle" is formulated in order to take into consideration the problems emerging from the diffuse feedbacks [8)] . Diffuse, maybe conflicting and major delays in terms of feedback can be particularly disastrous in systems undergoing rapid change, particularly where the quantity of anthropogenic encroachments is substantial.

2.6. Diffuse Sources

Figure 1 makes a distinction between point sources and diffuse sources (Odum, 1989; Høyer and Selstad, 1991). Point sources are few, large and easily defined. A point may take the form of an industrial chimney or the end of a drain pipe. It can include the problem of originally small, dispersed sources being led to a point through technical measures. Drainage systems are a case in point.

Diffuse sources are many, small, dispersed and not easily defined. Each and every one of them is small, apparently without any significance. In addition, they are scattered over great distances. They may also be different types of sources; nevertheless, they cause the same environmental impact. The transport sector provides us with typical examples. Both the greenhouse effect and disturbances of the nitrogen cycle are definitely linked to the issue of diffuse sources. This is also the case with the degradation of biological diversity through area-linked encroachments: even if each point is small ,the sum loads on the ecosystems are substantial.

In the 1990s, the problems linked to diffuse sources have prevailed. Previously, point sources were dominent and people have become used to dealing with all environmental impacts as if they were of a point-source character [9)] . Thus technical solutions have dominated, taking the form of "end of pipe" solutions, such as waste gas purification in industrial chimneys or sewage purification at the end of municipal drainage systems.

Diffuse sources pose other challenges. There will be problems if they are dealt with as point sources. Diffuse sources demand source-oriented solutions and not conventional end-of-pipe solutions. This is frequently referred to as input solution or input control: it necessitates control of what goes in [10)] .

2.7. Products

Figure 1 distinguishes between the environmental issues of production and products. Environmental impacts arise during the manufacture of products: these are the traditional point source impacts. Today these impacts are of lesser significance. More attention is given to the environmental issues of the products, both when they are used and after use when they become waste.

This is a form of the issue of diffuse sources. The problems have been moved from the manufacturing company to the products. Each product constitutes a source of environmental problems. There are many products; they are dispersed, and they are not easily defined. The degree of diffusion has been increased by the fact that the composition of substances in each product have become more complicated. There are more substances, and more of them are environmentally alien substances.

This development has presented the paradoxial situation of environmentally friendly production of environmentally alien products. For example, the consumption-linked municipal drains may today be more complex and consist of far more environmentally alien substances than industrial waste pipes. Whereas the industrial effluents have been significantly reduced, other effluents increase [11)] .

Many future environmental impacts will arise from consumption. The modern household is a major consumer of environmentally harmful poisons. A household could be described as a medium-sized chemical firm. As for the environmental issues, this marks a shift from production to consumption. To a larger extent than before, the environmental impacts of the 1990s are found in the back yard.

There remains the situation where large quantities of environmental poisons are tied in products in use and, consequently, not yet discharged or released into the ecosystems. Swedish analyses, for example, show that just 4% of the heavy metal chromium has so far been released into soil and water. The rest is tied in shoes, leathers, dyes, kitchen utensils, car parts, bicycles etc. The analyses show that if the use of chromium remains at the present level, the biggest and most densely populated municipalities in Sweden will eventually experience as large a load in soil and water as the most affected areas around the ferro-chromium industry (SNV, 1993).

The solution to the environmental issues of products is not found in the traditional “technical fix”. Completely different approaches are needed. A real solution is only feasible through input control. In order to get control of what comes out of the products when they are consumed, it is necessary to put restrictions on what goes into them. In practice, this means greater application of biologically degradable substances and restrictions on the content of environmental poisons. There will be totally different demands on product design. Products need to be easy to dispose of or, alternatively, simple to recycle or reuse.

This type of solution will have profound effects on production. Even now, a shift to “cradle to grave” can be detected when it comes to the responsibility of manufacturers for their products. “Cradle to grave” implies following the environmental consequences at all stages from the extraction of raw materials (cradle), through production and use until the product becomes waste (grave). In principle, this is supposed to encompass all transportation between the various stages. This is the basis of socalled life cycle analyses (LCA) of products and technologies, a methodology under rapid development.

2.8. Precautionary Action

After the presentation of the Brundtland Commissions' Report in 1987 (WCED, 1987), the precautionary principle has been internationally endorsed. It can be defined in the following way: "In those cases where there is a danger of irreversible environmental consequences, the lack of full scientific proof should not be an argument for failing to implement actions and measures which reduce the environmental problems" [12)] .

Its fundamental dimension is the fact that the uncertainty must benefit the environment: uncertainty as to whether a product or technology will result in irreversible environmental impacts is sufficient basis for stopping its implementations. However, it cannot be any kind of uncertainty: it must have a scientific foundation and pertain to irreversible environmental impacts. Without such limitations, it would be impracticable because it could be used to stop any anthropogenic encroachment in the natural environment (Cameron and Wade-Gery, 1992).

The principle contains a time dimension. It does not give any basis for a final rejection, merely a postponement of the implementation of measures, products, and technologies implying new encroachments in the natural environment. For systems already established, it gives a basis for carrying out limited measures until it has been scientifically proved that there is no need for them. Final decisions must be made on the basis of reliable knowledge of the irreversible environmental impacts of the encroachments. The time dimension also allows for sufficient time for consideration.

The principle of "the reversed burden of proof" is included in the "precautionary principle" - whoever is responsible for the measure, product or technology must be able to prove its environmental harmlessness. Others do not have to produce proof that it is harmful. However, the evidence can be tested by others. Procedures must be etablished to provide the basis for others to assess the issues of scientific uncertainty. Above all, openness is needed. It must be possible to gain insight into all aspects of the products and technology, and the evidence put forward by the institutions in charge.

In all, the precautionary principle underlines a major change in the environmental policies for the 1990s compared with former policies. Uncertainty about possible serious environmental impacts is sufficient as a basis for halting future encroachments in ecosystems. The burden of proof lies with the institutions in charge.

2.9. Notes:

1) I use the term "environmental problem" as a collective term for all types of man-made encroachments and overloads causing "problems" in the natural ecosystems. Partly the term is linked to the very effects arising in the ecosystems. With such a wide term both emissions of carbon dioxide and the greenhouse effect become an environmental problem.

2) *M. Redclift and T. Benton* (1994) are covering this topic in their book "Social Theory and the Global Environment". They are both social scientists. One of their claims is that the global reach of environmental problems is paralleled by important changes in the way the environment is understood, and: without a radical re-think of the own inherited assumptions in social sciences they are not equipped to play a major role in addressing such issues. In this context there is need of a two-way process: "Environmental debate

stands to benefit greatly from the insights of the social sciences, but, equally, the social sciences themselves have much to learn from their attempt to rise to this challenge" (p.2).

Another outstanding social scientist writing with insight about the challenges of the changing character of environmental problems is *Anthony Giddens*. In his book "Beyond Left and Right" he puts the ecological crisis at the core. That crisis, "are expressions of a modernity which, as it becomes globalized and turned back against itself, comes up against its own limits" (p.11). He considers globalization and "manufactured risk" to be two fundamental aspects connected to the "new" ecological crisis. Manufactured risk implies that the human population is confronted with risks manufactured by itself, but which still is largely unpredictable. The classic concept of "externalities" can not be used to describe such a situation. The ecological crisis is already deeply integrated and "internalized" in the human society. Classic environmental "management", as it is based on a concept of "externalities", will neither be able to address the problems following from this understanding.

3) More popular terms for the same two-way split of ecosystem functions are "sources" (resources) and "sinks" (recipients).

4) The most important written contribution expressing such an understanding was the 1972-report "The Limits to Growth" from the socalled "Rome-Club" (Meadows et al., 1972). By advanced computer-models the research group outlined absolute physical limits for a continued growth in the extraction of crucial natural resources. It is interesting to note that the same research group 20 years later in their book "Beyond the Limits" (Meadows et al., 1992) very much has changed perspective and now is focusing on "recipient limits".

5) When it is only a matter of limited quantities of resources solving the problems through substitution appears a promising solution. It is not easy to exchange one recipient with another, at least when we are talking about global recipients. We can not exchange the CO_2-cycle with another, and we can neither exchange the whole global atmosphere with another.

The more fundamental importance of recipient limits is thereby emphasized in two contexts; the limits on our utilization of resources are stricter than before and the opportunities for problem solving through substitution are more limited (Høyer and Selstad, 1993).

6) Figure 2 below illustrates the historical development from local to global environmental impacts.

Figure 2 *The development of environmental impacts - from local to global*

After: Tiberg (1990)

7) Within ecosystem theory the concept of “feedback loops” is used. It is used to describe the complex cause/effect-chains in connection with human encroachments in ecosystems. The American Ecologist *Barry Commoner* has expressed this through 3 (of his 5) laws on ecology (Commoner, 1972; 1990; Høyer and Selstad, 1993):

- Everything is connected to everything else
- Everything has to end somewhere
- There is nothing like a free lunch

8) I shall elaborate further on the importance of the “precautionary principle” at the end of this article.

9) This happens frequently in the discussion of the greenhouse effect. The argument is raised that the emissions of greenhouse gases from the separate activities or sectors are so small in a global context that they can be disregarded. This is precisely the special

character of diffuse sources. Each and every one of the sourcees is small, and in extent quite insignificant to the relevant environmental impact. The problem is rather the sum load of all small sources. Solutions require attacks on all the sources, no matter how small they are or where they may be located.

10) The issues of diffuse sources have been described by several authors. Hägerstrand (1991) describes them as the “tyrrany of small decisions”. Odum (1989) uses the term “tyrrany of the small technologies”.

11) This is illustrated in *Figure 3* below showing the results from a Swedish analysis of the relation between production and consumption linked effects of a problematic heavy metal (Anderberg et al., 1989).

Figure 3 *The environmental issues of consumption*

After: Anderberg et al. (1989)

12) In the *Ministerial Declaration* from the *Bergen Conference,* the ECE region's follow-up conference of the Brundtland Commission report in Bergen, May 1990, we find the following formulation (point 1.7):

"In order to obtain sustainable development, policies and strategies must be based on the precautionary principle. Environmental measures must predict,prevent, and attack the causes of environmental deterioration. Where there is no risk of any serious or irreversible damage, the lack of full scientific proof should not be used as an excuse for failing to implement measures in order to avoid environmental deterioration." (The Ministry of the Environment, 1990).

According to this formulation, sustainable development presupposes the application of the precautionary principle. Such an explicit link did not exist before. For example, it is absent in the Brundtland Commission report, even if the report contains strong references to the necessity of a *preventive* environmental policy. In the precautionary principle *this* is but one of several elements. Actions with reference to the precautionary principle will always be of a preventive character, but not vice versa. This is a question I shall return to.

Another important aspect in the Ministerial Declaration is that it establishes the precautionary principle as a *general* environmental-political principle. It is general in two ways. In the first place, it comprises all decision levels, from political and programme levels to planning and project. In the second place, there is no limitation in types of cases, as long as there is any risk of serious or irreversible damage. Previous references to the precautionary principle in international declarations and agreements were limited to cases, primarily linked to emissions of toxic chemicals.

The history of the principle

Since the early 1970s, both national and international environmental organisations have put forward suggestions of this type of environmental-political principles. The first suggestions dealt with getting general recognition of the principle of *the reversed burden of proof.* This means that whoever is responsible for the activity, product or technology, must be able to prove its environmental "harmlessness." It is not up to others - the environmental organisations or nature itself through trial and error - to carry the burden of proving it is harmful. It requires a system of explicit permissions in each and every case in which everything that is not proved satisfactorily is banned, at least preliminary.

There is a parallel in the planning legislation. In the late 1970s, a draft for a new planning act in Norway was drawn up, based on the so-called *mirror principle.* This refers to the mirroring of the basic principle of former legislation, which, broadly speaking, meant that "anything that is not explicitly banned is allowed." The mirror principle would mean that "anything that is not allowed is banned." One reason for this new principle was the environmental problems caused by "unplanned" encroachments in land and nature. At the time this suggestion was put forward it was regarded as controversial, and it was not incorporated in the new act (the Act of 28 May, 1985). The suggestion of *environmental impact analyses* which had been under review since the mid seventies, was not included either. It was later to be incorporated in an amendment in 1989 (Høyer and Selstad, 1993).

The principle of "the reversed burden of proof" however does not contain the element of *uncertainty.* On the contrary, it is linked to an expectation of an unambiguous and certain proof of environmental harmlessness. The point is *who* is responsible for producing the proof. It gives no premises for how uncertainty is to be treated, except as a demand for producing *better* proof.

The history of environmental issues - at least after Rachel Carson's focusing on the effects of the application of pesticides in the early 1960s - underlines far more complex connections (Carson, 1963). Not only has there been revealed a wider range of *unintentional* effects than could be expected. When the effects have been tried analysed beforehand, substantial, *unexpected* effects and connections have been revealed. It can be expressed in the following way: the *causes* of the environmental problems are far more diffuse, complicated and mutually synergetic, and the *effects* more extensive, cumulative and partly synergetic than were anticipated beforehand.

The complexity has been further substantiated by the fact that "solutions" to certain environmental problems have caused new problems, in some cases more serious than those one wanted to solve originally. In another context I have linked the term *the ecology of environmental problems* to these connections; this means that the environmental problems cannot be understood or addressed as single phenomena. They form parts of complicated connections and are primarily expressions of basic imbalances in the relationship between the man-made society and the natural ecosystems. Thus the environmental problems are symptoms, and limited attempts at solutions easily result in falling into *the ecological traps of environmental problems* (Høyer and Selstad,1991).

The element of *uncertainty* has gradually become more prominent in the understanding of the problem than was the case in the early 1970s. In particular, this was strongly propounded by the environmental organisations. It formed the basis for promoting the principle *nature is to be given the benefit of the doubt*, not instead of, but as an additional dimension to the principle of *the reversed burden of proof.* A parallel was drawn to the legal principle of *the benefit of the doubt* with a basis in the conception that it is nature that is on trial.

Within environmental management, the precautionary principle was first established in West Germany. A so-called *Vorsorgeprinzip* (”care principle”) was incorporated as early as the early 1970s. Originally it was given a relatively trivial form as a principle for *precautionary* environmental policy in a general sense. Later this has been developed further. In 1986, the West-German government published its "Guidelines for an Environmental Precautionary Principle." They contained three superior principles:

1. Protection against manifest environmental threats.
2. The avoidance of risks for the environment even when they cannot be fully demonstrated.
3. Precautionary organisation and management both of the economy and the environment to sustain nature's integrity as a basis for future life.

(von Moltke, 1988; O'Riordan, 1992).

The precautionary principle in international agreements

The so-called *London Declaration* in connection with the North Sea Agreement is the first international agreement to include the precautionary principle. In the 1987 declaration, the ministers subscribe to the following:

> ".... in order to protect the North Sea against possible detrimental effects of the most dangerous materials it is necessary to apply a precautionary approach which can demand measures to control the supply of such materials, even before a causal connection is established, built on absolutely certain scientific proof." (The London Declaration, 1987).

At the North-Sea agreement ministerial meeting in the Hague, 1990, there was a strong focus on the precautionary principle. The following formulation from the so-called *The Hague Declaration* was endorsed:

> ".... will continue to apply the precautionary principle, that is, implement measures to avoid potentially harmful supplies of materials which are persistant, toxic, and probably accumulative,

> even when there is no scientific proof of a causal connection between emissions and effects." (The Hague Declaration, 1990).

A similar formulation is included in the declaration from 1990 concerning the *Baltic* (the Baltic Declaration, 1990).

Thus, in an international context, there was originally a rather strong limitation in the application area of the precautionary principle. It was constricted to problem areas such as *environmental poisons* and *heavy metals.* However, within this framework the development of the principle is interesting. A formulation to the effect that there is no need for *any* scientific proof as to causal connections is significantly more far-reaching than the fact that there must be scientific uncertainty concerning such connections.

It has been pointed out that the Ministerial Declaration from the Bergen Conference in 1990 resolved the precautionary principle as a general environmental-political principle, that is, without any limitation to certain types of environmental problems. This resolution was corroborated at the Rio Conference, the United Nations Conference on Environment and Development as a follow-up of the Brundtland Commission report.

In the *Rio Declaration* on environment and development, principles on general rights and obligations, we find the following *principle 15:*

> "In order to protect the environment the state must *to a large extent* apply the precautionary principle in accordance with *its possibilities.* Wherever there is a threat of serious or irreparable damage, lack of full scientific certainty must not be used as a pretext to put off *cost-efficient* measures to prevent environmental deterioration." (my italics).

In the Norwegian Parliamentary white paper on the Rio Conference it is underlined that this formulation of the precautionary principle is "significantly watered down and weaker than what is considered desirable from a Norwegian point of view." (The Ministry of the Environment, 1992). As Norway has put strong emphasis on incorporating the principle of *cost efficiency,* I assume that this is a reference to the reservation in the introductory sentence in terms of the countries' obligations to apply the principle.

The two conventions of the Rio Conference, the climate convention and *the convention on biological diversity,* both include the principle. The precautionary principle is stated in the preamble to the convention:

> "The contracting parties...., who note that when there is a threat of substantial reduction or loss of biological diversity, the lack of full scientific certainty should not be used as a reason for putting off measures to avoid or limit this threat." (The Ministry of the Environment, 1993).

This is a formulation in line with what is found in the Ministerial Declaration from the Bergen Conference. This forms the basis for my further discussion.

The conceptual core of the principle

The precautionary principle is subjected to various interpretations. There are, in particular, two relations that seem to cause some confusion. They are:

* the relation to *prevention*
* the relation to *uncertainty*

Both have been touched upon previously. Both in terms of its conceptual core and practical implications, the precautionary principle is a *preventive* environmental-political principle. It hinges on the fact that precaution implies the *prevention* of damage, rather than a reparation afterwards. However, this is not the same as saying that all types of preventive environmental policy and environmental standards are a precautionary principle, too. These can be *non*-precautionary principle or precautionary principle to a varying degree. On the other hand, a standard or an implemented measure based on a precautionary principle can never be non-preventive. There is a distinction which will be clarified through the discussion of the relation to uncertainty.

All the quoted formulations of the precautionary principle contain the element *uncertainty*; a lack of full scientific certainty should not be used as a reason for putting off measures with a view to avoiding environmental deterioration. The fact that such a lack exists - in this respect understood as uncertainty - is a *sufficient* basis for implementing preventive or regulative measures in those environmental cases where the principle can be applied. The precautionary principle *does not apply* when it is certain that environmental damage will occur. Nor does it apply when damage is likely to occur. In such cases, decisions must be taken on another basis, for example in the relation to standards established as a part of a precautionary environmental policy. In this context, cost-benefit analyses can be of help.

Calculation of probability may be used to a certain extent. I wrote that the principle does *not* apply when environmental damage is *likely* to occur. However, it does apply *when* environmental damage is not likely to occur, if there is a well-founded uncertainty linked to *this* calculation of probability.

The precautionary principle states implicitly that it is preferable to run the risk of overestimation than underestimation. It requires types of worst-case analyses. The advantages of the regulative measures are supposed to be high, and the disadvantages correspondingly low, precisely because "the worst" is assumed as for possible environmental consequences. This aspect of the principle has been discussed by the two British environment lawyers *James Cameron and Will Wade-Gery* (1992). They draw a parallel to *insurance*. The precautionary principle can be regarded as an environmental insurance policy. Those who pay their insurance premiums in other contexts rarely feel they do not get their money's worth simply because what they are insured against does not occur. The value is normally considered to lie in the fact of being insured. Similarly, regulative measures based on the precautionary principle are of value not only because of the actual avoidance of environmental damages, but because of the insurance value itself. The latter point is *not* influenced by the ensuing course of events (Cameron and Wade-Gery, 1992).

The relationship between the precautionary principle and the so-called *levels of tolerance requirements* is also subjected to misunderstandings. The term "level of tolerance" is complicated, to be sure, both in a natural-scientific and a social-scientific context. If we let this discussion rest, the question still remains whether critical-load requirements unreservedly are a type of environmental standard falling within the framework of the precautionary principle. My answer is no. Again, this is a question of *uncertainty.*

In some cases we have relatively certain knowledge of cause-effect chains for emissions of polluting materials and effects in certain types of ecosystems. A case in point is the connection between emissions of sulphuric gases, acid rain and the absence of fish in lakes and rivers. We can lay down demands on emission levels for sulphuric gases in relation to levels of tolerance in especially exposed water systems. This implies that the precautionary principle does *not* apply.

However, it *may* be applied. There may, for example, be a well-founded uncertainty in terms of serious effects of acid rain in other types of ecosystems. In order to be on the safe side, emission demands may then be stipulated which are stricter than those required to re-establish the fish stock in empty rivers and lakes. This falls within the framework of the precautionary principle. Similarly, this is the case with emissions of nitrogen oxides. Emission demands may be determined with a built-in safety margin, linked to the substantial uncertainties in the whole complexity of effect connections these emission gases form part of. This would clearly be within the bounds of the precautionary principle. On the other hand, this would not be the case if the demands are stipulated according to our present knowledge of limited acid-rain effects of the emissions.

Uncertainty

The term *uncertainty* has so far not been discussed thoroughly. *What kind of uncertainty* are we talking about? It has to do with our knowledge of connections between man-made encroachments and effects in the ecosystems. However, it comprises at least two different dimensions in terms og this knowledge. In the first place, it has to do with our knowledge of *cause-effect relations.* An important aspect of this uncertainty basis is linked to the fact that we are faced with cumulative causes as well as cumulative effects. In both cases they can be antagonistic, purely additive, or synergetic. In our modern history of environmental issues, such complex environmental connections have, in fact, received much attention. In the second place, it is a question as to what knowledge we have of *the extent of the effects.* Either form of uncertainty gives the basis for special forms of regulative measures.

However, this does not mean that the whole question of "what kind of uncertainty" has been answered. There are at least two more factors. It is not enough with *just any form* of uncertainty. It must be a case of potentially *significant* connections. All formulations of the precautionary principle refer to serious or irreversible environmental damage. This means that the uncertainty must be linked to the cause-effect relations which may produce new, even more serious or irreversible damage than what we already have knowledge of. There may be uncertainty of even more serious effects with a basis in the cause-effect relations we know of. In addition, there may naturally be a more fundamental lack of knowledge concerning the whole complex of cause-effect relations, but where the potential for serious or irreversible damage nevertheless is present. I would put the *greenhouse* issue in the latter category.

Another aspect has to do with what kind of demands on arguments that might be relevant. Or, to pinpoint the question: does the precautionary principle imply a free-for-all as to any kind of hypothesis of uncertainty, put forward by anybody? In other words, does this imply a stronger *non-scientification* of the decision basis in complex environmental cases?

The English professor in environmental sciences, *Timothy O'Riordan* (1992) argues towards such a standpoint. He maintains that the precautionary principle accepts a *non-scientific* basis for decision-making, requiring as many interest groups as possible to be involved in the decision process. This leads to a greater pressure on political institutions by forcing them to implement regulative measures both in the public and private sectors without having to refer to any formal-scientific authority. O'Riordan maintains that this gives a special basis for national and international pressure groups to aggressive participation in political decision-making processes. These groups can exploit the uncertainty and political decision problems that occur as a result of having to put more emphasis on such uncertainty. His argument is that the precautionary principle thus results in a *democratisation* of national and international environment regimes. According to O'Riordan, by explicitly underlining the limitations of scientific criteria, a stronger degree of political decision of these questions is legitimised.

Uncertainty and scientific views

These are viewpoints that I do not completely endorse. The precautionary principle must not be used in such a way that any hypotheses - forwarded by any individual or interest group – can automatically be included as a basis for decisions. Even though it gives accept for the relevant knowledge to be somewhere away from certain empirical proofs towards shere speculation, decisions can not automatically be based on all forms of speculative claims (NENT, 1997). Hypotheses on uncertainty must also have some sort of scientific foundation, and these foundations must be subjected to critical analyses just as with hypotheses and empirical evidence for so-called certain cause-effect connections. In a number of cases, there may even be solid empirical material substantiating hypotheses on uncertainty, while their theoretical basis is uncertain or strongly disputed. The environmental history is rife with cases where hypotheses on uncertainty have their very basis in empirical research findings produced by ”alternative” research groups outside the scientific establishment. It does not imply no demands on the way these findings have been produced, or how their significance to the relevant environmental case is founded. Uncertainty and lack of knowledge is not the same as lack of knowledge of everything. All hypotheses on uncertainty cannot be equally probable.

However, this raises more complex issues in relation to science. And it should be emphasized that the precautionary principle is the one principle in sustainable development having the most profound implications for scientific thinking and practise. I used the term ”some sort of scientific foundation”. The question is what ”sort” we are talking about. It is beyond the realm of *normal science*, when this is understood to be mainly positivistic inclined. Such normal science has a strong focus towards producing reliable empirical proofs, thus focusing on scientific *certainty* as an absolute condition before drawing conclusions or publicizing scientific findings. In normal science it is of utmost importance not to make claims that later are found to be wrong. The precautionary principle on the other hand requires scientific work to attach particular importance to *uncertainty* in the empirical material produced within the established theoretical boundaries, but also to possible uncertainties if these boundaries are extended or if alternative theoretical perspectives are accepted as basis. If such uncertainties are found scientists are obliged to make the results public so that they can form a basis for decisions in a societal context.

Just as the precautionary principle obliges the society to act for the benefit of nature if there are sufficient degrees of uncertainty in existing scientific knowledge, the scientists are obliged to make public this knowledge about such uncertainties. This is expressed in the *precautionary principle of science* endorsed at the formerly mentioned ECE-conference in Bergen in 1990 :

> ” When there is a threat of serious or irreversible damage to nature and environment, the lack of full scientific certainty should not be used as a reason for not informing the public about the possibilities for such damages.” (Høyer and Selstad, 1993)

These aspects (focus on uncertainty, base decisions on uncertain knowledge, accepting a low treshold for ”proofs”, publish about uncertain knowledge and accepting a high probability of making claims that later are found to be wrong) are parts of a concept of *post-normal science* (Teigland, 1997). Implications are a science with rather fundamental changes in criteria for control of validity and quality (NENT, 1997).

In their theories about *risk society* and *manufactured risk* the German sociologist *Ulrich Beck* (1992, 1997) and the British sociologist *Anthony Giddens* (1994) include such changes in scientific thinking and practise, but without explicitly refering to the concept post-normal science and to the precautionary principle. These changes are crucial in their concept of *late modernity*. Beck (1992, 1997) distinguishes between sceptisism in the internal and external aspects of scientific work. He claims that methodological *sceptisism* – at least as an ideal – is institutionalized in modern science, but that it is confined to the internal scientific work. It should be emphasized that I here have used the terms ”internal” and ”external” aspects of science differently from Beck. With late modernity – and in confrontation with the challenges of risk society – this sceptisism is extended to the very foundations for and the external risk implications of scientific work. This double sceptisism or *doubt* at the same time leads to a situation where science is demystified and made common. Normal science looses its monopoly of truth and has to accept that it is only one of many ways of generating knowledge about this ”truth”. In discussing how science should respond to a situation with extended sceptisism, Beck (1997) refers to the science theoretician *Imre Lakatos’* criteria for ”positive” (or ”negative”) *problemshift*. According to these decisive of a ”right” science is to what extent claims about facts, questions, problems, falsifications and developing perspectives so far having stayed in the shadow of dominating theories and controverses can be uncovered and made subject to interesting research and public debate. This is similar to the requirements of a science responding to the precautionary principle.

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3. Mobility, transport, and sustainable development viewed in the light of Agenda 21

In a global context, transport is both a substantial consumer of non-renewable energy resources as well as being an important source of emissions of greenhouse gases. It is *the* sector in the society having the strongest dependency on fossil energy.

Transport is also an important source of some of the most serious environmental problems we are confronted with both regionally and locally. This is especially the case in cities. The person transport in particular causes serious problems both for people and the natural environment, not only in the rich countries, but in the fast-growing big cities of the developing countries as well. This is the basis for focusing on transport when the question of sustainable development is on the agenda. In this chapter we shall take a closer look at the Norwegian transport development in the period after the Rio-Conference (in 1992). In line with the general evaluation model described earlier in this book we shall first analyze what the World Commission (Brundtland Commission) and Agenda 21 have to say about transport issues [1,2] . Thereafter we shall analyze the political documents and decisions that have formed a basis for Norweian transport policy during the period. The real development of Norwegian mobility and transport shall then be analyzed in relation to these two sets of criteria.

3.1. Transport in "Our Common Future"

The resource and environment problems of transport do not constitute a separate theme in the Brundtland Commission report [3] . Still, there are several references to them. One of these is found in the report's main chapter on energy. Transport is an important source of three of the four environment problems the commission highlights as implied in a high future consumption of energy. These are:

* The risk of climate changes because of increased emissions of CO_2 from the combustion of fossil fuels
* Air pollution in cities and industrial areas caused by the combustion of fossil fuels
* Acidification of the environment for the same reason

(WCED, 1987, p. 129)

The fourth is the environment problems linked to the commercial exploitation of atomic energy.

The commission outlines two major alternatives for the future development of the world's energy consumption, one high and one low. A common interpretation is that it is the low alternative which is recommended, which is corroborated by the following formulations in the conclusions of the energy chapter (pp. 148-149):

> «It is obvious that a low-energy strategy is the best way towards a sustainable future .... In the course of the next 50 years all nations will have the opportunity to offer the same energy services with as little as half the primary energy now used. This calls for profound structural changes in the socio-economic and institutional arrangements, and it constitutes a major challenge for the world community.
> Even more important is the fact that a low consumption will give us the time needed to implement large-scale programmes for sustainable types of renewable energy, and, consequently, start the transition to a safer, more justifiable energy era.»

Within the low-energy strategy the commission delineates possibilities for a reduction of the energy consumption per inhabitant in industrialised countries of 50% and an increase of 30% in developing countries. Transport is one of the areas which is explicitly linked to such targets for reductions of the primary energy consumption in the rich part of the world (p. 147).

A low-energy strategy is presented as a challenge for the entire world community. Energy resources are understood as global resources, and the environment problems caused by the consumption of energy are understood as loads on a global commons. Even the exploitation of renewable energy sources is defined as a global responsibility, as well as a question of fair distribution of scarce resources. Within such a framework, there is no basis for a policy implying that countries and regions with abundant energy resources should have a higher energy consumption than others. This applies regardless of whether we are talking about fossil energy, atomic energy, or renewable alternatives.

In this context, however, the Brundtland Commission is not consistent. A 50% reduction in industrialised countries and a 30% increase in developing countries will sustain big differences between the rich and the poor. This is one of the many compromises the commission was forced to make in order to escape a tricky balancing act between «justice» and «political realism». The low-energy alternative presupposes that the total global energy consumption is kept approximately on the present level (about 11TW). Based on a principle of global justice, this means that in the next century this will demand at least an *80% reduction* in the industrialised countries' average energy consumption per capita. In that case it will be much harder to prove that this can be obtained through increased energy conservation alone.

One point must be made absolutely clear. The Brundtland Commission seems to presuppose a stabilisation of the energy service level in the industrialised countries. An increase of *this* level from the late 1980s thus undermines the possibilities for realising the low-energy alternative, and it is in conflict with the commission's principles for sustainable development (Høyer, 1989).

We may describe this perspective in the Brundtland Commission report as a *volume perspective*. It expresses that the problems are linked to the total volume of the energy use; in our context, this means the volume of the transport energy. Sustainable solutions primarily demand volume reductions.

The report also includes another perspective. It may be described as the *intensity perspective* (Høyer & Simonsen, 1996). The attention is mainly directed towards the special accumulation of problems found in urban areas. This applies particularly to health problems. They may be caused by both stationary and mobile energy consumption, that is transport, but also by - or possibly the lack of - other types of infrastructure (water, drainage, and waste).

Characteristically enough, it is the problems caused by transport which are focused on when it comes to the big cities of the industrialised countries, whereas in the developing countries it applies to the other types of infrastructure as well.

3.2. Transport and Agenda 21

Some changes can be found in the process from 1987 (Brundtland Commission) to 1992 (A 21). The Brundtland Commission report emphasises the need to do something in both places; that is, develop solutions for the complex urban environment problems both in industrialised and developing countries (pp. 175-179). In *Agenda 21* it is to a larger degree the problems in the large cities of the developing countries which are referred to (Sitarz, 1994).

On the other hand, *Agenda 21* expresses a highly fundamental view of *land resources* with far-reaching consequences for the development of transport in a more superior context. Its significance is emphasised by the fact that these questions are given a special main chapter (chapter 10, «An integrated view of planning and husbandry of land resources»). It is pointed out that land is to be understood as an essential physical unit as well as a system of natural resources. Land resources include soil, minerals, water, plants and animals, with all its biological and genetic diversity. The interaction between these components make up a significant share of the global cycle and processes, and it is closely tied up with climatic and other atmospheric phenomena. Primarily, land must thus be looked upon as a set of basic terrestrial ecosystems, and only secondarily as a source of resources (Sitarz, 1994).

This complex system constitutes the foundation for human activity. Exploitation of most natural resources is linked to land. Besides, it gives room for human settlement and activities and covers the needs of other species. This limited global resource cannot without serious impacts on long-term sustainability cater for a fast growing population and an increasing intensity and extent of human activities.

In this way, Agenda 21 expresses an understanding of land which falls inside the concept of *land ethics*, a branch within the international environment ethics (Beatley, 1993). It is an understanding which implies far-reaching demands for an integrated land use planning and policy on the basis of a superior principle of *land efficiency.* It will have major impacts on the types of human activities which are genuine consumers of land. Development of urban areas and infrastructures belongs to such a category.

This is of interest in an *environmental-historical* perspective. In the environment legislation which has been built up in western countries in the past 20-30 years, there is an absolute distinction between *polluting emissions* and *land encroachments*. In line with the understanding embodied in Agenda 21 they could just as well be understood as two aspects of the same issue. It is two ways of doing something at a certain place in space which affect the presuppositions for attaining sustainability *elsewhere.* Whereas much attention has been directed towards the globalisation of emissions, the *globalisation of land encroachments* should actually be understood as the same type of basic problem.

This is, for example, expressed through the following connections between transport, land, and sustainability:

- Through the infrastructure and its use by the transport means, the complex land systems are subjected to a changed state. Degradation of biological and genetic diversity is an important factor in this context
- Certain types of human activities and values are tied to the quality and certain location of land. This applies to areas such as agriculture, landscape conservation, and recreational life. Transport and its infrastructure can in this respect represent substantial negative influence factors
- Certain types of land management for human activities can both lead to a huge transport volume and an especially high use of the environmental-damaging types of transport. This is particularly the case with the land-extensive urban sprawl which has been so closely attached to the history of the proliferation of cars
- The last point also has an inverse aspect: important preconditions for developing a type of transport which gives reduced environmental loads both on the natural environment and man lie precisely in changed land management based on a stringent land efficiency. Such types of transport are bicycling, walking, and land-based public transport.

3.3. Central Norwegian principles and decisions

The Bergen conference directed much attention to the relations between transport and sustainability [4)] . According to the joint action plan which was resolved, there should be a transition from road to rail traffic with emphasis on the development of freight-train networks as well as high-speed passenger trains. A lowering of maximum speed limits should be considered, as well as pedestrianised city zones, bicycle lanes, and a ban on idling car engines. According to the action plan, more balanced transport plans should be drawn up with more emphasis on bicycles and public transport as a way of reducing rush-hour problems in the cities, air pollution, and the use of fossil fuel (Miljøverndepartementet, 1990).

Similar suggestions but of a more radical character were put forward in the so-called *Oslo declaration* from the IULA World Congress in Oslo in 1991. IULA is the worldwide organisation for local authorities, and it includes Norwegian primary and county municipalities. On the basis of the debate on sustainable development, the theme for the 1991 congress was «environment, health, and lifestyle». In the Oslo declaration we find the following formulation under the section on agenda for action (IULA, 1991):

> «Strengthen mass transport in general, especially in cities, by improving the efficiency and accessibility of public transport, such as railways, trams, suburban undergound trains, and buses. Counteract the use of private cars in city areas with all available means. Design programmes for physical planning and traffic administration to promote city development, based on an overall, sound transport infrastructure and a low need for transport.»

At a more superior level, the need is highlighted for taking *land use planning* into use as a policy measure , both in rural and urban areas to preserve sound, natural, and human environments, and to halt uncontrolled urban growth. ("Such plans should promote the long-term principles behind sustainable development rather than short-term economic gains, and must be managed by the need for a reduction of the energy consumption" (IULA, 1991)).

In 1993, the board of directors of KS (the Norwegian Association of Local Authorities) appointed an ad hoc committee for environmental protection which was to put parts of the Oslo declaration into concrete terms for use in primary and county municipalities. Under the heading "think globally - act locally", the committee report was passed as the KS programme for locally prioritised target areas for environment. Of tasks that would be given special attention, the following point is of interest in our context (KS, 1993):

> «5.11. Transport
> Arrangements must be made for a best possible environmentally friendly and energy-efficient transport through increased investments in public transport where conditions are favourable. The least possible transport need must be a superior objective in all planning.»

It goes without saying that this is a strong management signal for primary and county municipalities that a least possible transport need *must be* a *superior* objective in *all* planning. These aims correspond with several principles expressed in A21 [5)] .

This type of principles is also embodied in a number of Norwegian parliamentary white papers. The first example is found in the white paper on the follow-up of the Brundtland Commission report (Miljøverndepartementet, 1989). The white paper highlights the following initiatives and policy measures:

- Suggestions will be put forward of national guidelines according to the Local Planning Act in order to arrive at a better co-ordination of land, road, and traffic planning
- Work must be started to make total transport plans for the 10 major city areas (TP10)
- Public transport will be strengthened and prioritised. An increased share of the transport funds will be spent on investments in the public transport system. The government will also draw the attention to the possibility of using funds for the construction of major roads and toll-road revenue on other infrastructure, for example the construction of suburban underground trains
- The role of the railway in the person traffic around and between the major urban areas will be strengthened. The transport authorities will consider various measures to increase the railway's share of freight transport over longer distances.

In the 1993 parliamentary white paper on regional planning and land policy the same department reiterates the significance of national guidelines for co-ordinated land and transport planning to limit the need for transport (Miljøverndepartementet, 1993). At the same time, some superior principles for the land policy are drawn up in line with the understanding embodied in A 21. In order to attain the target of a sustainable urban development, there are special references to an *environmental cities programme* as a central initiative. The following main feature is outlined:

- The environmental cities initiative is a targeted effort for a sustainable urban development along with other initiatives which are presupposed to give fast environment improvements for the inhabitants. Much emphasis is put on reducing the consumption of resources (especially land and energy), noise, pollution, and waste. It is of particular significance to highlight *the transport system*, the centre, and the residential areas.

In such a perspective, it appears to be somewhat of a paradox that the objectives of the report in terms of priorities of public transport have become much more subdued than what was previously the case.

The formulation of the concrete transport policy is most clearly expressed in a system of four-year plans. They are referred to as Norwegian Road and Road-traffic Plan (NVVP), Norwegian Railway Plan (NJP), and Norwegian Air-traffic Plan (NLP). It must be added that this system is currently under revision, amongst other things in the form of more long-term plans.

The corresponding objectives for the re-organisation of the transport policy outlined above, are expressed for the first time in NVVP for the period 1990-93. This re-organisation was suggested in a parliamentary white paper from 1989 (Samferdelsdepartementet, 1989). The following NVVP plan for the next period - 1994-97 - to a large extent keeps the same objectives. This report was put before the «Storting» in 1993 (Samferdselsdepartementet, 1993).

3.4. Norwegian Political Aims in relation to “Our Common Future”

One question is what agreement there is between objectives and the actual policy. We shall return to this question later on. Another question is what changes in priorities can be found by analysing the texts in the political documents. The most obvious point is how the objectives for *public transport* have changed. In the first period after the presentation of the Brundtland Commission report, these objectives are very dynamic, as expressed in one of the above points. Important elements in these objectives are to increase the share of public transport funds used for investments in public transport, and to assess such investments as alternatives to new road systems. In 1993, the ambitions are confined to facilitating public transport, especially in major urban areas.

The fact that we are faced with a systematic revision of objectives is corroborated by the co-ordinated transport white paper placed before the «Storting» in 1996 (Samferdselsdepartementet, 1996). When the «Storting» asked for such a report, it was especially emphasised that public transport should be assessed. In the white paper itself the ambitions - as expressed in the text - have merely been further lowered since 1993.

In his annual statements to the «Storting», the Minister for the Environment gives important signals in terms of environmental-political priorities. An analysis of these texts for the period 1988-96 reveals no similar systematic features when it comes to giving more or less priority within the transport sector. Admittedly, it got off to a dynamic start in 1988, with the following formulation (Miljøvernministeren, 1988):

> «In order to illustrate some of the choices we are faced with in the years ahead, I would also like to mention that it takes seven times as much energy to move one tonne of freight on the road than on the railway. A permanent, strong growth in the road traffic is thus in conflict with a sustainable development. We must literally change tracks.»

If we go to 1993, it is the «whole transport system» and «our lifestyle» which are challenged if we are to react quickly enough in the face of possible climate changes or the threat to the biological diversity. In 1994, transport and energy issues are «quite central in a policy for sustainable consumption», and it is underlined (Miljøvernministeren, 1994):

> «that the focusing on the policy measure implementation within the transport sector to a higher degree must move in the direction of a reduction of the need for transport, increased efforts on environmentally friendly transport, co-ordination between various types of transport means as well as co-ordinated transport and land use.»

In 1995, the vision of the *environment city* as a sustainable urban society takes precedence. In these cities «walking and environmentally friendly transport means such as bus, rail, and bicycle» are given priority, and «new development and local centres are linked to important public transport axes» (Miljøvernministeren, 1995).

To what extent the actual policy is in accordance with such a revision of the policy measure implementation and also forms the basis for the realisation of the vision of the environment city will be subjected to a closer analysis in the following part of the article.

3.5. The Norwegian development

In the following we shall analyze various aspects of the development of mobility in Norway[6)] . Focus is mainly on the period 1992-97. However, as the long term development in mobility is connected to short term investments, it is also of interest to analyze how political decisions made in this period will influence future development. A crucial issue is to what extent official Norwegian aims (as outlined above) correspond with the actual politics.

3.6. Person mobility

Table 1 shows the development within the domestic person mobility since 1855. In this case we use travel distance as an indicator expressed in the number of kilometres each inhabitant on average covers each day. The table only includes the mobility linked to the use of transport means. Walking is, consequently, not included, nor is the use of bicycle. However, the use of horses is an important part of the mobility figures in the last century and the first decades of this century (Høyer, 1995)

***Table 1** The development of person mobility in Norway. Kilometres per inhabitant per day*

	1855	1875	1900	1930	1950	1960	1970	1980	1990	1995	2000[1)]	2010[1)]
Bus, train, tram					3.30	3.80	4.00	4.70	4.10	4.20	4.20	4.10
Private car					1.20	3.60	12.60	20.40	27.00	26.60	28.20	29.80
Aeroplane					-	0.08	0.40	1.00	1.70	2.20	2.70	3.40
Other					0.70	1.32	1.30	1.10	1.30	1.60	1.30	1.30
In all	0.05	0.15	0.50	2.50	5.20	8.90	18.30	27.20	34.10	34.60	36.40	38.50

[1)]The figures are based on the projection of the population worked out by Statistics Norway

Sources: Høyer (1995), Rideng (1996), Samferdselsdepartementet (1992, 1993, 1996)

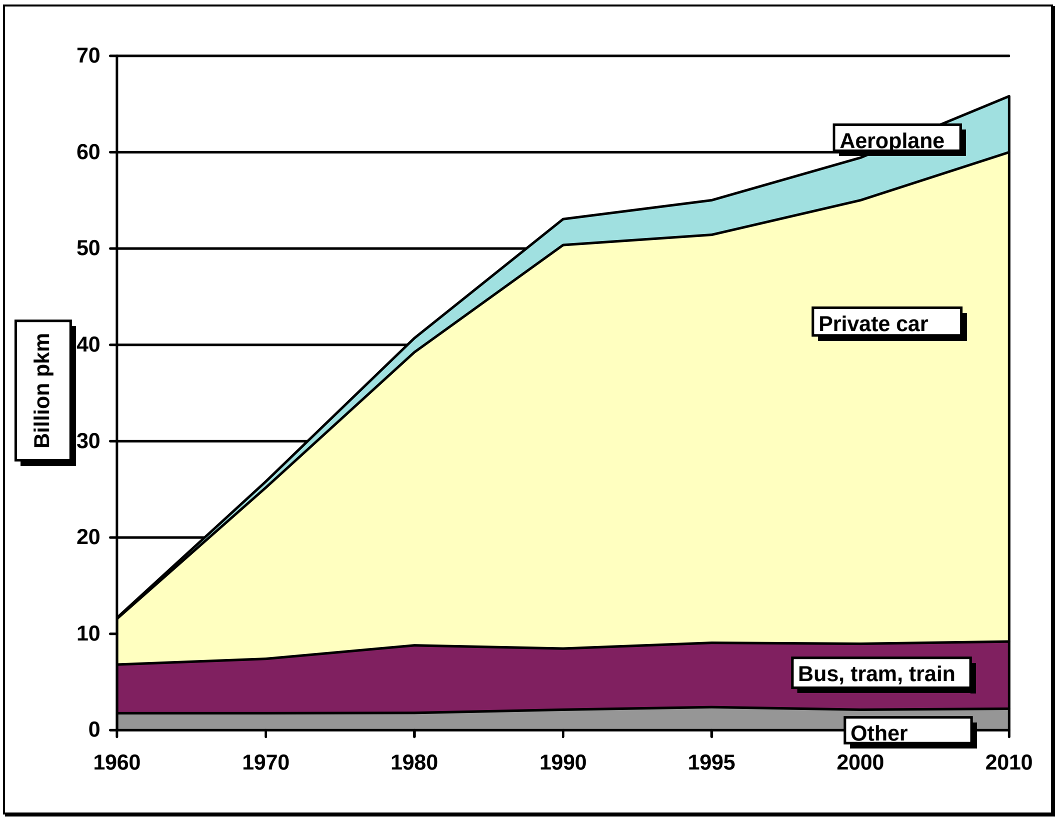
The mobility today accounts for approximately 35 kilometres per day per inhabitant. This is about a four-fold increase since 1960, and a doubling since 1970. What we have referred to as *automobility* is clearly the predominant factor behind this increase. At present, it makes up about 80% of the average mobility. In 1960, we moved nearly four kilometres per day by private car. Today this has increased to approximately 27 kilometres.

The public transport means on the ground give us a total of about four kilometres per day. We see that this figure has remained relatively constant in the past 40 years. This underlines the fact that we cannot reach any mobility level based on such environmentally friendly transport means.

The public transport mobility in the air has increased five-fold since 1970. Just in the course of the past 15 years it has been more than doubled. Unless extremely restrictive measures are implemented, it seems as if this increase will continue. In this respect it must be emphasised that the figures in the table do not include mobility outside the national borders. A study by Western Norway Research Institute shows an especially high volume of air transport in connection with leisure mobility. The study reveals that the air mobility linked to tourism alone accounts for six kilometres per day on average, or about three times the figure in the table. We can use the term *aeromobility* to describe the development we now seem to witness. No matter which thematic components of the concept of sustainable development we take into consideration, this emerges as a particularly problematic type of mobility. The result is that a small minority of the world's population travels longer and longer distances. It implies that a larger share of the total global mobility is gathered in a few hands. It is particularly serious because the aeromobility leads to such major ecological consequences. This applies to all the nodes that the international air tourism is directed towards, but most particularly to the more vulnerable parts of the global commons (climate balance, stratospheric depletion of ozone) (Høyer & Simonsen, 1996; Høyer, 1996a; 1996b).

Actually, it is not the individual mobility which primarily leads to such ecological impacts. In line with our volume perspective, it is the magnitude of the overall societal mobility volume which is the decisive factor. The historical development of this is illustrated in *Figure 1*. The unit is now *billions of person kilometres*. It is often referred to as a unit for *person transport work.* The figure shows the development for the three main categories of transport means from 1960 to 1995. In addition, there is a prognosis up to the year 2010. It is based on the same presuppositions as in table 3 (see the discussion below). The reason why we show only the development after 1960 is that this was the year the post-war import restrictions on private cars were lifted. In this way, this is a special illustration of the significance of the growth and volume of automobility (Høyer, 1995).

Figure 1 *The development in the person transport work in Norway. Billions of person km for main categories of transport means. 1960-2010*

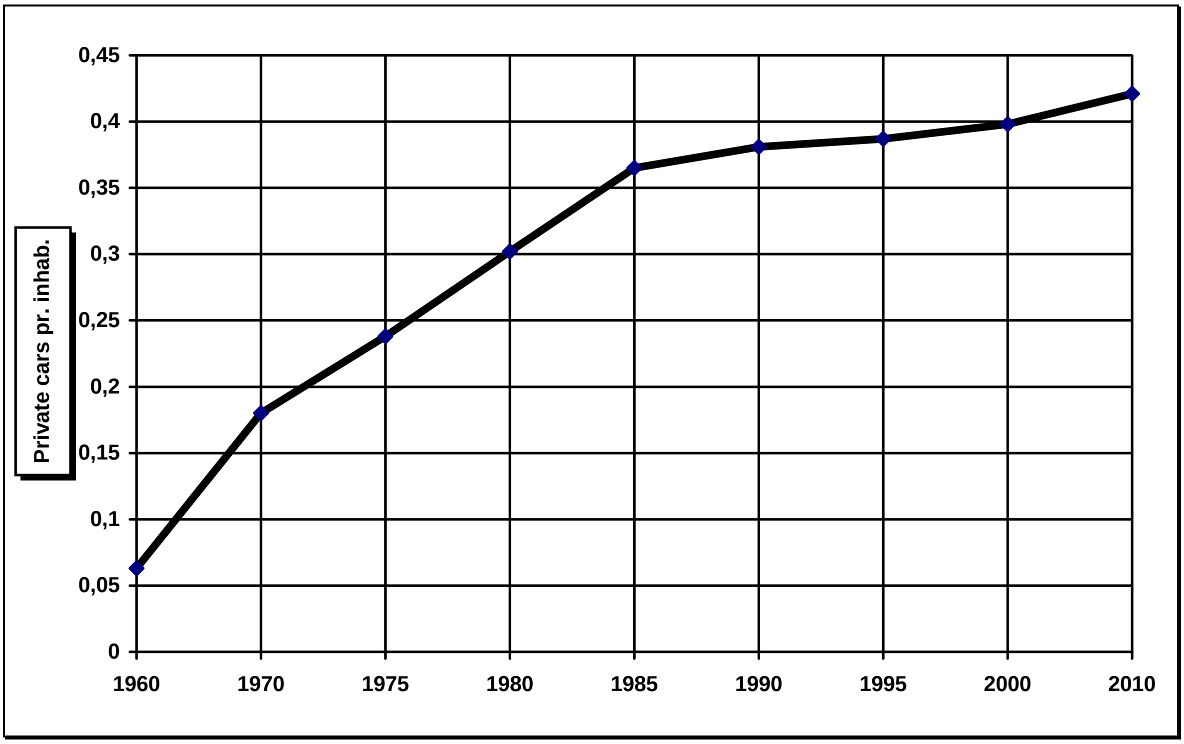


The figure shows a relative levelling-off of the growth, both in terms of automobility and the overall mobility. There is necessarily much uncertainty in such estimates. In this case, it is based on a low alternative. There are, however, prognoses indicating higher figures with a total mobility of *42.6 km per day* in the year 2010. The prognoses include the mobility-generating effects of the extensive investments in the transport infrastructure, and they lead to higher growth in both auto and aeromobility (Samferdselsdepartementet,1996). Without any application of severely restrictive policy measures as regards air and car transport in particular, there are few indications that the growth will level off completely in the course of the first decades of the 21st century. Earlier prognoses from other European countries such as Sweden and France show a development towards an average of 60 km per day in the first half of the next millennium (Örtendahl, 1990; Vilhelmson, 1990). In that case, this will match the present level in the USA. According to an analysis by Schipper et alia (1992), this level was 60 km per day as early as 1987. There must, consequently, be a significant potential for continued growth, not only in aeromobility, but in automobility as well. Car density is an important factor. Coupled with investments in new and more efficient infrastructure, more private cars contribute to releasing potential mobility. *Car density* is a measure for the number of cars per inhabitant [7). With a car density of 0.38 we match the OECD average. In comparison, the USA has a car density of 0.57 (in 1993).

A levelling-off of this disparity by increasing the car density in the poor countries will have catastrophic ecological impacts. It is, therefore, not in accordance with the demands for sustainable development, no matter if the cars are assembled of recycled material resources, or if they are generated by biodiesel, hydrogen, or solar-cell electricity. But can we then justify an automobility which is still reserved for the few in the world community? If that is the case, this would give these few a right to keep their present high share of the loads on the global commons, whether this applies to the material and energy resources of the commons or its ecosystems and limited recipient capacity. This is not in accordance with the demands for sustainable development either.

Figure 2 shows the development of the car density in Norway in the period 1960-2010. The prognosis figures are based on the same presuppositions as in figure 1 for the development of private car transport.

Figure 2 *The development of car density in Norway. The number of private cars per inhabitant 1960-2010*



3.7. Goods mobility

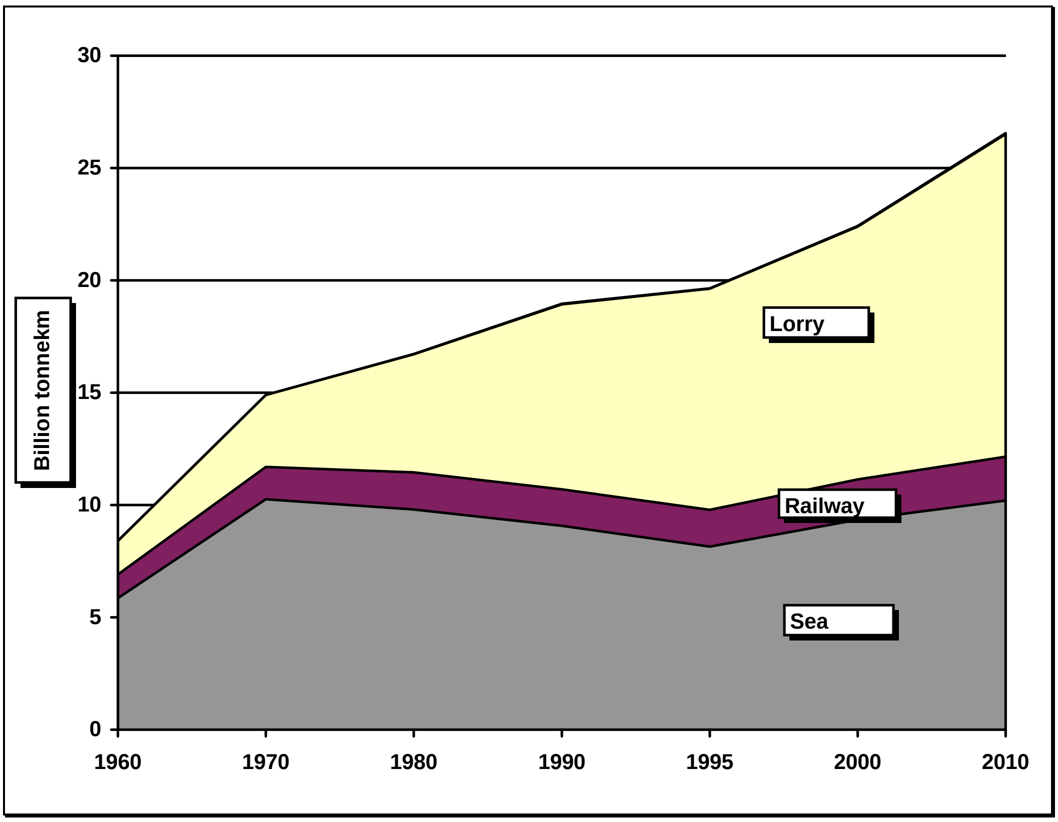
In our context the attention is not only directed towards person mobility, but towards *goods mobility* as well. We have presented a person mobility which consists of two main components: the number of persons who are moved, and the distance or number of kilometres they are moved with various means and modes of transport. It is the product of the two which decides the extent of ecological impacts. Similarly, the goods mobility consists of two main components; the number of tonnes of raw materials and processed and manufactured goods which is moved, and the number of kilometres covered by the movement with transport means such as lorry, boat, aeroplane, and so on. Mobility can then increase in two ways, either by an increase in amount or distance, or a combination of the two.

We only refer to domestic goods transport [8)] . Since the early 1970s, there has been no significant change in the average transport distance, but the number of tonnes under movement has increased considerably.

This has resulted in a major increase in the goods mobility, especially for the part linked to the transport means of *lorries*. For this very transport means, by the way, there has *also* been a steady increase in distance (Rideng, 1996).

This development is illustrated in *Figure 3.* As was the case with the person mobility, the period 1960-2010 is covered.

Figure 3 *The development in goods transport work in Norway. Billions of tonnes km for main categories of transport means 1960-2010*



Sources: Rideng (1996), Samferdselsdepartementet (1992; 1993; 1996)

Table 2 shows the same figures expressed as *goods mobility* per inhabitant.

***Table 2** The development of goods mobility in Norway. Tonnes km per inhabitant per day. 1960-2010.*

	1960	**1970**	**1980**	**1990**	**1995**	**2000**	**2010**
Sea	4.50	7.30	6.60	5.90	5.15	5.70	6.00
Railway	0.80	1.05	1.10	1.05	1.05	1.10	1.15
Lorry	1.15	2.25	3.50	5.30	6.20	6.90	8.40
Aeroplane	0		0.01	0.01	0.01	0.02	0.02
In all	6.45	10.60	11.21	12.25	12.41	13.72	15.57

Sources: Rideng (1996), Samferdselsdepartementet (1992; 1993; 1996)

We see that the goods mobility has approximately been doubled from 1960 to the present time. For the road-based mobility in particular, there is a six-fold increase in the same period. After a levelling-off of the growth in the overall goods mobility in the past few decades, it is expected that another increase will occur up to the year 2010. This is again connected to the growth in the road transport, a parallel to the *automobility* of the person mobility. There are many reasons for this development. In the first place, it is linked to the mobility-generating effects of the investments in new transport infrastructure in recent years. In the second place, it is linked to assumptions of the significance of more fundamental societal development characteristics, where especially the investments in the infrastructure of road transport constitute one element [9)] .

Many and specialised deliveries lead to many and specialised transports. Thinner and thinner streams of commodities between the various units in the production networks result in a big and varying diversity in the transport networks. The establishment of complex networks of sub-contractors over long distances implies that the extent of transports back and forth and transport distances increase. The opportunities for co-ordinating energy-efficient and environmentally sound bulk transports such as rail and sea transport are diminished. At the same time, it requires an infrastructure consisting of a highly fine-meshed network of transport chains, primarily *roads.* This is a type of infrastructure which gives the necessary preconditions for flexible couplings of the producing nodes.

Reloading is time-consuming and expensive. *Lorry transport* in particular gives opportunities for order-managed door-to-door transports, and it can in a flexible way meet the demands for high frequencies and high regularity. These, then, are development characteristics which supposedly are an important reason for the growth in the lorry transport. On the other hand, it is important to underline that the development of the transport sector in itself contributes to flexible specialisation. The development has been made possible by keeping the costs of the transport sector very low, and by extensive public investments in the infrastructure (Høyer, 1995). Such mutual relations between changes in transport structure and production structure are corroborated by analyses carried out in Denmark (Pedersen, 1987).

3.8. Infrastructure

Analyses carried out by the Nordic Institute of Regional Policy Research (NordREFO) (Elling, 1996) show that in the past few years there have been many major transport infrastructure projects under development and planning in the Nordic countries. The overall investments are extensive. This is especially the case with the development of infrastructure for road transport. For Norway this is shown in table 3.

***Table 3** Public allocations for road and railway purposes in Norway. 1990-93 and 1994-97. Billions of NOK.*

		1990-93	1994-97(1)
Road	Investment	17.8	17.2
	Maintenance	14.6	15.6
	Other (2)	6.9	6.8
Railway	Investment	2.6	3.7(4)
	Maintenance	6.1	6.7
	Other(3)	6.9	7.2
In all		55	57

1) Applies to proposals in the Norwegian Road and Road Traffic Plan, and Norwegian Railway Plan
2) Comprises county roads and administration
3) Comprises operation of and investments in vehicles and material
4) Investments of NOK 2.7 billion in new railway line to the national airport of Gardermoen must be added to this sum (public loan financing)

Source: Høyer (1996c)

When infrastructure for the air transport is included, the total investments (including maintenance) amount to approximately *NOK 70 billion* in the present four-year period. This includes the funding of the new national airport at Gardermoen (Høyer, 1996c).

We are facing the biggest and most spectacular construction projects in our history of infrastructure. It is not more than 10 years since records were broken when tunnels of more than 10 kilometres were built. In 1996, construction was started in Norway of the world's longest road tunnel of 24 km. This alone represents an investment of close to NOK 1 billion. However, what transport function it actually is supposed to have is still quite uncertain.

The launching of this investment boom can be dated to the latter half of the 1980s. The analyses of NordREFO (Elling, 1996) show that this is common to all the Nordic countries. At the same time, this is a development they share with the rest of western Europe (Albrechts & al, 1994; Banister & Berechman, 1994). According to existing European plans, the total investments in the transport infrastructure thus constitute NOK 8,000- 12,000 billion for the former EU-12 in the period 1990-2010. In addition to comprehensive investments in high-speed trains, this includes, for example, approximately 12,000 km of new motorways (Whitelegg & al, 1993). In this connection, it is worth noting that the English Channel tunnel is the biggest construction project ever in Europe.

This is a paradox. The presentation of the Brundtland Commission report, and the countries' participation in international processes to work out a policy for *sustainable development* has taken place in the same period. We have above pointed out that the development of infrastructure is inconsistent with important demands for such a development. Even if the EU (EU COM 1992) has attempted to place it within the framework of its concept of «sustainable mobility», sustainable development is not really the issue when substantiating the plans. We shall elaborate on this.

One argument is as follows. In large parts of western Europe, there has since the early 1970s been a relative decline in the investments in infrastructure for transport. It has been stated that this has given a situation where the capacity is not in proportion to the increased transport needs that have arisen in connection with the strengthened European market integration. This is referred to as Europe's «infrastructural deficit». Major Norwegian infrastructure projects can hardly be placed in such a context. There are indications of strong tendencies of «over-investment» even in relation to an expected transport increase. The NordREFO analysis previously referred to documents extensive investments in new parallel projects which will have to compete with each other, and which are partly planned explicitly with competition in mind. Each of these will have mobility-generating effects, but they will still have a collective capacity which far exceeds possible transport increases (Høyer, 1996c). In a sustainable perspective, this has particularly grave consequences. It implies a targeted «over-investment» in natural and environmental encroachments.

Another argument is connected to the investments link to high unemployment rates and tendencies of a neo-Keynesian policy to solve this problem. The extensive construction work does not only employ a high number of people, but also creates high demand effects in the economy. In the EU white paper on growth, competitiveness, and employment (1993) the new infrastructure projects are placed into such a context. It does not exactly make it easy to argue that it is *also* a question of investments as a result of rational transport planning.

Albrects & al (1994) gives a third reason. They look upon the investments in connection with the crisis in European economy which has lasted since the early 1970s. This is a crisis marked by the presence of large amounts of so-called «surplus capital», but with limited possibilities for investing the capital in ordinary productive activity. In this situation the long-term investments in infrastructure and other types of built structures function as a suitable outlet for the surplus capital. According to Albrects et alia, these investments serve as a way of «investing surplus capital away for the future». Since the early 1980s, then, there has been a large-scale movement of capital towards the built structures. In the first phase in the form of buildings such as office blocks and luxury apartments in many of Europe's major cities (as in Oslo), linked to extensive renovation and redevelopment schemes of the harbour areas. Gradually this has also been in the form of investments in large-scale tourist and leisure complexes, shopping centres, and transport infrastructure. If this is capital invested away for the future, there is no basis for referring to it as a *sustainable future.*

There are arguments pointing in the direction that we are faced with a pattern of investments in infrastructure where sustainability comes out the loser. The new infrastructure leads to local natural and environmental conflicts even if it is not used to the extent indicated in the plans. This is corroborated by the analyses carried out by Western

Norway Research Institute on the plans for a coastal highway between Kristiansand and Trondheim (Høyer, 1991a). More and more extensive infrastructure gives significant ecological encroachments in the landscape, with negative impacts on the biological diversity.

The development of new systems for high-speed trains and express ferries also reduces the energy and environment merits of these transport means. When the speed of sea transport increases sufficiently, they lose their merits in terms of energy consumption, emissions of greenhouse gases, and other types of air pollution. These are paradoxically some of the factors used to argue for a strengthened development of sea transport. In ordinary person transport in Norway there has already been such a development. The new express boats along the coast have an energy consumption and emissions of greenhouse gases per person km which are higher than any other transport means, planes included. Even if the boats were filled to capacity with passengers, they would not perform better than the air transport (Høyer & Heiberg, 1993). New express ferries across the Skagerrak actually have energy consumption and greenhouse gases emission per person km approaching the level of air traffic.

Whitelegg & al (1993) further maintains that high-speed trains, in addition to bigger ecological encroachments on the landscape, as well as local natural and environmental conflicts, produce 40% more noise than conventional trains, twice as high energy consumption (at 300 km/h), and a material resource consumption up to 40% higher. Besides, they state that there is no reason for saying that the new high-speed trains will contribute to reducing the air transport. On the contrary, they will be part of a general mobility increase, as other major speed-increasing transport technologies have been throughout history. At the same time, both the development of express ferries as well as high-speed trains in actual fact serve just as much as facilitating the problematic transport modes of road and air.

An «over-investment» in the infrastructure will also in other ways strengthen negative ecological effects. In the first place, as we have pointed out above, new infrastructure in itself has a mobility-generating effect. In the second place, an intensified competition between various transport systems may imply the implementation of policy measures to create more transport. But most of all, it contributes to a relative reduction in the capacity use both in established and new systems alike. A lower capacity use leads to a relatively higher energy consumption, emissions of greenhouse gases, and other types of environmental impacts (Høyer, 1996c).

3.9. Sea transport

According to the background material for the above-mentioned coastal highway plans, western Norway has a «backward» transport system because the percentage of road-transported goods is as low as 2. Increasing the volume and relative share of the road transport is expressed as a target for a future-oriented development of the region (Høyer, 1996c). This is a problematic line of argument, for at least two reasons.

Firstly, there is a global perspective. The type of sea-based goods transport which makes up the high export and import volumes in western Norway is not energy demanding, and has relatively low emissions of significant types of air pollution. This, then, is a completely different picture than what is outlined for the new, express person transport at sea. If larger shares of this transport were to be transferred to the road, this would result in high increases in energy consumption and emission of greenhouse gases.

Table 4 shows the advantages of freighters in terms of various types of air pollution, including emissions of CO_2.

Table 4 *Emission efficiency of goods transport. Comparison between boat, train, and lorry[1)]Figures in grammes per tonne km*

Emission substance	Boat	Train	Lorry
CO_2	16.70	34.50	84.00
Nox	0.30	0.63	1.02
CO	0.0041	0.084	0.570
Particles	0.005	0.011	0.038

[1)] In this case boat applies to smaller coastal freighters. Higher efficiency can be attained by the use of larger tankers, for example. The trains are supposed to be diesel-powered.
Source: Wisman (1996)

The table underlines the fact that there is also a local and regional perspective. If the road transport were to be brought to volumes which matter in relation to the extensive existing sea transport, it would lead to a substantial increase in the lorry traffic. Present urgent local and regional environmental problems such as noise and air pollution would be intensified, not only in western Norway, but also through Denmark and further down the continent. In western Norway down to Kristiansand, there would be a substantial increase in lorry traffic through most major urban areas. If the share of road transport were to be doubled from the present level, this would imply an additional 50-100 articulated lorries daily through the city of Kristiansand. Nevertheless, the transport system would still be «backward» with a goods share of only 4% (Høyer, 1996c).

This type of problem issue brings in the question of investments in *sustainable infrastructure*. We have pointed out that investments in road, railway, and airports are mainly financed over national budgets. When it comes to ports, on the other hand, the investments mainly take place through loan financing in private banks, in addition to financing over the ports' own operational budgets. It represents not only a contrast in terms of financing, but also in the size of the amounts. Throughout the 1980s, for example, the annual investments in all national traffic ports amounted to approx. NOK 150 million. In the same period, the state expenditure on investments and operation of roads, railways, and airports totalled NOK 10-15 billion per year, that is, nearly 100 times higher. Of the 150 million kroner, less than one tenth came in the form of national grants or loans in public banks. This is about 0.1% of the national investments in the three other transport sectors (Høyer, 1996c).

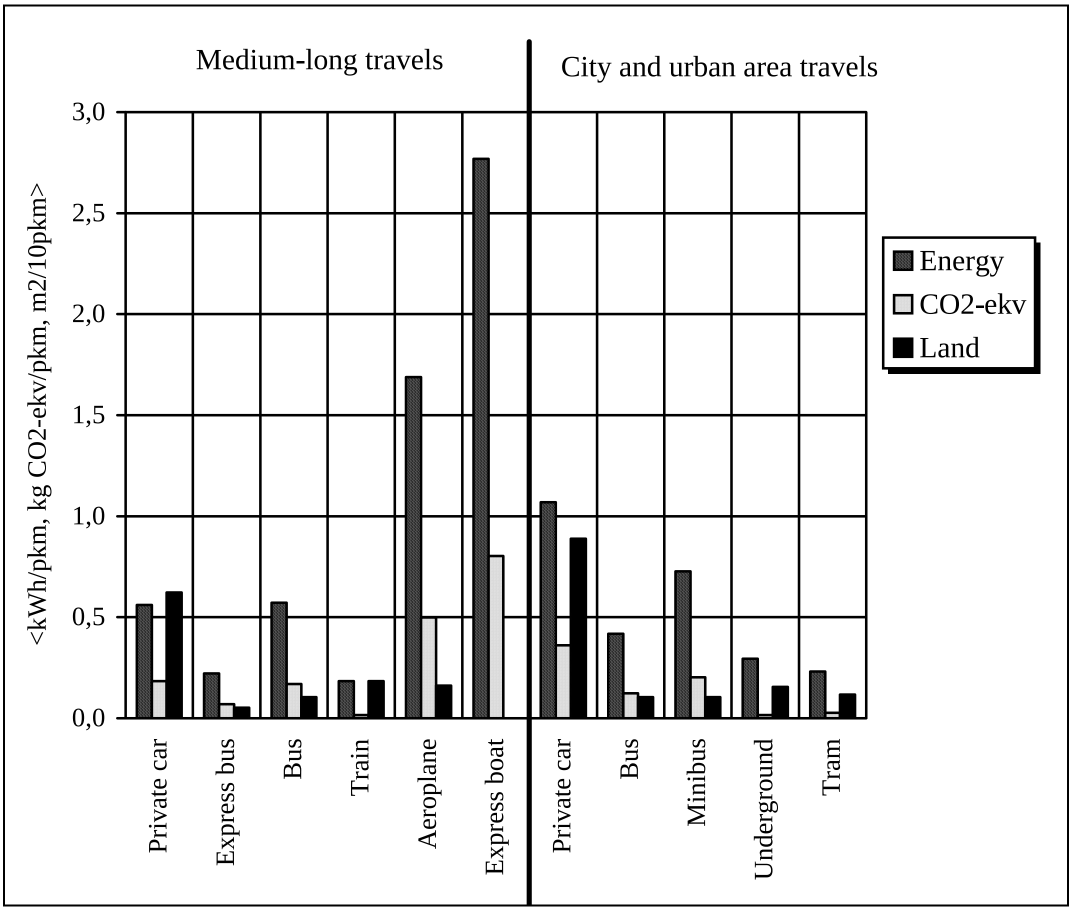
3.10. Public transport on land

Whereas the infrastructure of the sea transport to a large extent is a municipal responsibility, it is the *county municipality* which has the major responsibility when it comes to public transport both at sea and on the road. It is privately and publicly owned traffic companies which carry out the transport function. In this context, a distinction must be made between infrastructure and operation. The responsibility of the county municipality applies to the operation. Formally there is no public body which has the responsibility for the development of the specific infrastructure. Both state, county and primary municipality can assume this responsibility, but they can equally well refrain from doing so (Spangen, 1995).

Admittedly, public transport in itself can be understood as a part of the society's *infrastructure*. This is an understanding which, for example, is embodied in the Transport Act of 1976. It is not just any type of transport, something more than the mere use of roads, rails, and ports. It is primarily attributed superior social functions for taking care of welfare, environment, and regional development. Public investments in public transport is an alternative to the facilitation for private car transport that the community must otherwise be responsible for. Neither buses nor trams need so many and broad roads as the private car. Ferry and boat services are alternatives to investing in roads and tunnels. This is the same understanding of transport solutions which follows of our perspective on sustainable development (Høyer, 1996c).

Figure 4 illustrates the ecological merits of the land-based public transport even under today's conditions with intense competition from the private car. With a targeted prioritising, and a subsequent increased capacity use, these advantages will be even more pronounced (Høyer & Heiberg, 1993).

***Figure 4** Overall intensities for energy use, emissions, and land use for the various transport means for city travels, urban area travels and medium-long travels. Figures for 1990.*



Source: Høyer & Heiberg, (1993)

We have previously shown in this article that the extent of the land-based public transport has remained constant throughout more than 30 years. In the same period the total person mobility has seen a five-fold increase. Without stringent political changes in priorities, there are few indications that this will change up to the first half of the next millennium. On the contrary, the present situation gives very little cause for optimism.

Several analyses can point to the fact that the conditions for public transport have deteriorated since the mid 1980s. It has been pointed out that it is hard to do long-term planning, and there are fewer possibilities for a real transport-political commitment on the part of the county municipality (Røe & Stigen, 1995). The result has been that public transport in the last few years has been given lower political priority in most county municipalities (Andersen, 1993). Demands for savings in public spending have been given priority. Savings in the budgets of the county municipalities have in several countries particularly caused reductions in the funds for public transport. This has at the same time only strengthend the discussion about solutions reducing the political and economical responsibilities of the county. The substantial deregulation in the sector since the late 1980’s has actually been supported on this regional political level (Andersen, 1993). In addition, the county municipalities have taken the initiative to more far-reaching privatisation solutions, for example in the form of converting county-municipal transport companies into limited companies.

This has led to a situation which in many ways is paradoxical. Whereas the priority of the sector at the level having the political responsibility has been reduced, it has once more increased at the level - the national - from where the responsibility was transferred from in the first place. In the wake of the discussion of sustainable development public transport has become - at least verbally - an important, national area of politics. Extensive, nationally funded pilot schemes for public transport have been adopted, both in the form of new organisational solutions, grants for reorganising transport services, and in the form of new technological solutions (like alternative fuels). And while the current initiatives in the county municipalities imply a reduction of the public responsibility, the environmental-politically founded understanding of public transport as infrastructural measures highlights the need for strengthening this responsibility.

3.11. TP 10

TP10 was launched in 1989 [10)] . The plans of the cities were to be presented in the summer of 1991 to serve as contributions to the processes concerning Norwegian Road and Road-traffic Plan (NVVP) and Norwegian Railway Plan (NJP) for the period 1994-97. The superior objectives of TP10 were as follows:

- develop overall transport systems across sectors and management levels which attend to the consideration for the ease of movement of all groups of transport users, traffic safety, as well as health and environment

- integrate environmental considerations in the planning in such a way that it becomes a premise for and not just a consequence of the plans presented today

- assess area planning and transport systems coherently and facilitate for increased public transport

The TP10 plans were also meant to be strategic plans for prioritising the resource effort in various areas of the transport sector, and, as mentioned above, form an important foundation for NVVP and NJP 1994-97.

In accordance with the joint guidelines for the planning work, the transport plans of the cities should contain alternative transport solutions, preferably with scenarios as a starting-point. Three alternative scenarios were outlined, all of them with given demands and presuppositions as to the content:

- *Trend*; projection of today’s traffic situation
- *Public transport*; strengthened public transport, but without any restriction on car use
- *Environment*; restrictions on local car traffic, strengthened public transport. Stringent national environmental taxes on fuel and environmental quality norms

In relation to previous road and transport reports, TP10 should imply the following new features:

- Co-ordination of land and transport policy
- Co-ordination of all public operation and investment initiatives
- Concentrated effort on public transport as a measure in environment policy
- Environment as a premise, and not only as a consequence of the transport planning
- Discussing policy measures to slow down the growth in private car traffic
- Discussing scenarios for alternative transport solutions
- Careful consideration of various initiatives within an overall budget framework

One major purpose of TP10 was that environmental considerations to a much larger extent than previously were supposed to be a premise in the transport planning. This has been the case only to a small degree [11)] . They have been included as a consequence on level with other objectives for transport, safety, welfare, and use of resources. Besides, the cities have applied a delimited environment concept, with emphasis on security, traffic safety, and urban environment. According to the joint guidelines for the planning work, more importance should be attached to environmental considerations, both globally and locally. Little emphasis is given to the global environmental considerations in the choice of strategy for developing the road network. In some plans the building of roads emerges as an important environment initiative, based on local environmental considerations. It is used as an argument for heavy investments on the construction of roads. The TP10 plans actually came to serve as arguments for *heavier* road building (Mydske & al, 1992; Strand, 1992).

Public transport and land use has been shown considerably less attention. This lack of balance in the planning phase is strengthened in many of the cities through the follow-up of the transport plans. The intention that TP10 as co-ordinated planning was meant to contribute to an environmental-political change of course seems therefore to have failed. This can partly be explained on the basis of today's institutional framework conditions, as well as the organisational weight of the road sector. In the assessment the question is raised whether an increased emphasis on national/global considerations requires a firmer national management - scientifically and politically - of local planning. With today's *institutional situation* in the transport sector, an even firmer national management would maybe be needed to meet the TP 10 objectives. A possible decentralised model demands that local and regional carriers of environmental considerations are strengthened in the planning process, similarly for public transport on municipal and county municipal levels. The question may be asked whether this can be done without any changes in the institutional conditions in county municipal and primary municipal transport planning (Mydske & al, 1992).

3.12. Co-ordinated land and transport planning

The results from the TP10 were a let-down in relation to the expectations of changes in the direction of a sustainable urban policy with emphasis on energy consumption, transport extent, and public transport. In 1989, the Ministry of Environment announced that it would put forward national guidelines for co-ordinated land and transport planning. The objective was to achieve a better coupling between development patterns and transport needs, strengthen public transport and reduce the need for car use and parking spaces in the urban areas. Besides, pedestrian and bicycle lanes *had to* be built not only to make activity areas safer, but also with the view of making continuous transport arteries, according to the Ministry (Miljøverndepartementet, 1989). These guidelines should form the basis for a long-term, sustainable perspective in planning (Miljøverndepartementet, 1993).

The draft of these guidelines was sent out for consultation in 1991. On account of considerable disagreement between the Ministry of Environment and the Ministry of Transport and Communications the first guidelines were passed by Order in Council in 1993. Substantial changes had then been made to the draft, a draft which, by the way, on the whole was based on the results from research on land and transport in the late 1980s. There is sufficient evidence that the views of Ministry of Transport and Communications to a large extent won the day and the Ministry of Environment came out the loser (Strand, 1993).

The final guidelines comprise the following *10 main principles* (Høyer, 1993):

1. There should be a co-ordinated planning of development patterns and transport systems
2. Emphasis should be put on solutions which lead to short distances between functions. This is the so-called *distance structure principle* to counteract unnecessary generation of transport
3. Clear boundaries should be established between residential areas and the so-called ANR areas (Agricultural, Natural, and Recreational)
4. Encroachments on natural areas should be concentrated as much as possible. These two principles represent the so-called *encroachment principle*
5. Emphasis should be put on increased concentration of development. This is the so-called *concentration principle*
6. In the planning of residential areas and transport systems national norms and guidelines for local environment quality should be taken into consideration (this applies, for example, to norms for noise and air pollution)
7. The development pattern should facilitate for the use of public transport
8. It should be made easier to use the bicycle as a transport means, that is, not only as an activity for recreational use. These two principles represent the so-called *transport means principle*
9. Huge, transport-generating establishments in the form of regional shopping centres, and so on, should be subjected to special regional overall assessments, and should be localised in the vicinity of important public transport chains
10. Special establishments generating heavy transport should be localised to railways, ports, trunk-road networks, etc. These two principles represent the so-called *localisation principle* for major single establishments

These principles are important enough and they are also consistent with results from research in this field (Høyer, 1991b; 1994; Næss,1992). Nevertheless, the changes from the consultation document are so significant that there is reason to believe that the guidelines will be of far less importance than originally anticipated. Professor Arvid Strand (1993) has referred to this as let-down no. 2 (after TP10) in the work of developing a land and transport planning which does not compromise the prospects for future generations [12)] .

As yet there are no results available from a more comprehensive assessment as to how and to what extent the new guidelines have been applied. A preliminary assessment carried out by Western Norway Research Insitute of the current trunk-road planning for the coming plan period (1998-2007), however, seems to confirm that they have been of minor importance (Høyer & Holden, 1996). There is a demand that this planning must be consistent with the national guidelines. The assessment reveals that on the whole there are no references to the guidelines, neither in the superior strategies nor in the planning of the individual projects (Høyer & Holden, 1996).

3.13. Environment cities

In the autumn of 1992, the Ministry of Environment invited the 20 major cities in Norway to apply for participation in a project and development scheme for sustainable city and urban development. From early 1993, further co-operation was established with the cities of Fredrikstad, Kristiansand, Bergen, Tromsø, and the old city of Oslo in order to develop these cities into so-called *environment cities*. For this reason the programme is referred to as the «Environment cities programme».

An important objective of the pilot project is to develop models for a *sustainable urban development*. In this context it is also underlined that the programme may give important examples of *Local Agenda 21* (Miljøverndepartementet, 1995). *10 common objectives* have been decided on for these environment cities, with a set of indicators attached to each one of them. The following objectives are of special interest in our context:

- Reduce land use for development and transport purposes
- Reduce energy consumption for transport and heating
- Reduce air pollution and noise
- Increase the share of environmentally sound transport

The concrete follow-up of these objectives will take place through the following six *target areas:*

1. Land and transport planning
2. City development
3. Viable local communities
4. Green areas, nature and recreational life
5. Waste and recycling of waste
6. Forming of urban space and cultural monuments

Under the *first* target area environmentally sound transport must be given priority to the car. Public transport, pedestrian and bicycle lanes must link together residential areas, centre, and places of work. Energy consumption, noise, and pollution from transport will consequently be reduced. In addition, there is a need for clearing up the previously extensive traffic load on the cities. New development should preferably take place in a concentrated form to avoid further urban sprawl. This makes it possible to get a more intensive use of the present infrastructure. All in all, it is underlined that a concentrated city will lead to less use both of land and resources.

Under the *second* target area the need for developing a city centre with mixed functions is highlighted, that is, a mixture of residences, places of work, and cultural facilities. The organisation and planning of good accessibility to the centre, especially by public transport means, on foot or by bicycle, will contribute to making the city centres more attractive for a wider variety of users than today.

Under the *third* area the need is underlined for the local communities within the cities to have private and public services, which makes it unnecessary to use the car for everyday functions such as primary school, nursery school, grocer's shop, and bank / post office. The local communities should also have a continuous network of pedestrian and bicycle lanes linking residences, services, and near-by free areas (Miljøverndepartementet, 1995).

Based on this description, the *Environment cities programme* is the closest we have come in a Norwegian context to the descriptions in the Brundtland Commission and Agenda 21 of a sustainable transport and urban policy. In this respect, we refer to the introductory part of this article. There is a large degree of concurrence of principles and interpretations which can very well also serve as models for cities in other parts of the world. This is, for example, the case with the emphasis of an intensive, *sustainable infrastructure*, understood as a movement away from the classical extensive infrastructure development. This is particularly highlighted in Agenda 21, and it is incorporated as a decisive element in what is referred to as *urban ecology.* Similarly, the importance of the *distance and function structure* for transport and environment is underlined, locally as well as globally. There is to be a systematic planning for short distances between key functions and for a comprehensive mixture of functions [13)] .

3.14. Conclusions

As yet there is no assessment of the Environment cities programme. The traces from the superior transport planning, TP10, and National guidelines for land and transport planning do not give grounds for undue optimism.

The analyses of the superior transport planning throughout the period after the presentation of the Brundtland Commission report show that there have been no changes, neither *to* nor *in* tracks. On the contrary, the investments in the extensive road-based infrastructure have been heavier than ever before. This applies both to outside and inside urban areas. In both contexts, the period has given us the most spectacular construction projects in the history of infrastructure.

Public transport has not been given the priority that was stated originally. In important areas there has been a deterioration. At the same time, it has been pointed out that in the course of the period, there have been significant changes in the ambitious objectives put forward in the late 1980s.

In TP10 it was the environment alternatives which came closest to the original ambitions. Nevertheless, it was the road plans which won the day. Environmental factors were not presupposed as a premise in the planning, and the effort on public transport did not emerge as a real alternative. Instead, the TP10 plans came to serve as arguments for a stronger development of roads in many urban areas.

With today's structure, even if the *Environment cities programme* were to be a success, the most important preconditions will be maintained, preventing the transport development from being changed in a sustainable direction. It affects our distinctions between *volume* and *intensity perspective* as well as *transport* and *mobility*. New infrastructure and more transport means in the form of new private cars and air schedules contribute to releasing potential mobility. In a wider social context, they generate mobility. It may well be that through the Environment cities programme it is possible to attain a larger degree of intensive infrastructure development and related mobility reductions. However, this will only take place within the boundaries of the cities. The major share of the movements, both of people and commodities, occurs in the large spatial structures outside and between the cities, both at home and abroad. As long as priority is still given to extending the extensive infrastructure outside the cities, the necessary volume reductions will not be attained. In addition, the conflicts between city and surrounding areas are intensified. A larger capacity on the infrastructure outside, increases the pressure on the structures inside. Possible gains in the cities can thus only be of a temporary character (Goodwin, 1994).

A *sustainable mobility* demands that the infrastructure and the related transport systems are developed according to the same principles outside the cities as prescribed by the Environment cities programme inside. This implies giving priority to land-based public transport; besides, not more, but less road capacity, and not more, but fewer air schedules.

In its original form, the national guidelines expressed clear ambitions of management, not only of the co-ordinated land and transport planning, but also of important aspects of the transport development. However, things turned out differently. In the political process concerning the formulation of the final guidelines, it was the Ministry of Transport and Communications which won over the Ministry of Environment. This meant the omission of clear preferences of placing the land and transport planning within the framework of a policy to achieve reduced energy consumption, and to comply with national objectives and international commitments in terms of polluting emissions to the air. In addition, a number of concrete demands for the prioritising and development of an environmentally sound transport system are not included in the final guidelines.

Such experiences highlight the necessity of *institutional reforms* in order change the development in a sustainable direction. This is underlined both in the Brundtland Commission report and in A 21. In a fundamental, institutional reform of the transport policy it will be particularly important to upgrade the position of public transport and sea transport, coupled with a downgrading of the current dominant position of the road transport.

3.15. Notes

1) The chosen evaluation model is corresponding to what Baklien (1993) calls the "ideal-reality tradition" in evaluation research. Baklien identifies four major approaches in Norwegian evaluation research. The first is the "ideal-reality tradition" where the evaluation focus is to decide to what extent ideals and aims have been achieved. The

second is “causability-analysis” or “effect-evaluation”, where the evaluation focus is to decide whether actions and measures have had the expected effects. The third Baklien identifies as “action research”. Traditionally this has focused on actions to increase social welfare and has in particular emphasized to be close to the actions of actors. The last approach is “implementation analyses” where the main focus is on explaining difference and similarity between intentions and realities (referred from Lafferty & Langhelle, 1997).

2) Agenda 21 is the main action plan decided at the Rio-Conference

3) In the period after the presentation of the report, however, they have been subjected to much attention. This is the case within the framework of the UNCED process itself, but also in other international fora assessing social impacts of an operationalisation of the concept of sustainable development. EU and OECD are two cases in point of international organisations which have focused especially on the problematic relations between transport and sustainability. In EU this applies, for example, to the processes linked to their green paper on transport and environment, referred to as a strategy for «sustainable mobility» (EU COM, 1992; 1993). In OECD there have been a number of initiatives. In a current project, for example, environmental criteria for «sustainable transport» are being developed. There are proposals of far-reaching criteria, for example, an 80% reduction of CO_2 emissions and a 90% reduction of pollution with regional and local impacts (OECD, 1996).

The basis for this particular attention on transport can be summed up in the following seven *points*:

1. Compared to other sectors in the society, the transport sector is the source of an unusually *wide range of environmental impacts*. They cover a range from global to isolated local effects, from consequences for the natural environment to health effects, from impacts on the cultural landscape to destruction of cultural monuments and valuable built environments.

2. The transport sector accounts for a large share of the society’s total consumption of energy and material resources. In the rich industrialised countries, more than 30% of the total energy consumption is on the whole linked to transport - when all direct and indirect items are added together (Høyer & Heiberg, 1993). The high consumption does not only constitute a problem of a global, distributive character, it is also in itself the source of environmental impacts where the resources are consumed in terms of exploitation, production, and transportation. Thus the *transportation* of the transport means and the related fuels is one of the heaviest items in the global streams of goods transport. Bearing the concept of «sustainable production and consumption» in mind, this is, consequently, a sector which represents especially big challenges (Høyer & Simonsen, 1996).

3. The transport sector is an important source of many of the most urgent environmental impacts caused by emissions of polluting substances, especially to air. These are emissions of CO_2, No_x, VOC, CO, etc. NO_x also causes pollution, linked both to the acidification of soil and water and to various types of health effects in cities and urban areas. Similarly, there are serious health effects linked to the emissions from the transport sector of CO, particles, and dust. Several of the emission substances are also

important in the formation of tropospheric ozone, which in turn is a source of health effects, impaired plant growth, degradation of biological diversity, and, in addition, is a greenhouse gas in its own right. Noise can also be understood as a type of emission to air. In this respect transport is a dominating source, both in cities and urban areas, as well as along important transport areas elsewhere. *Table 5* shows the significance of the transport sector in Norway as a source of important types of air pollution.

Table 5 *The transport sector's share of various types of air-polluting emissions. Figures in Norway as percentage of total emissions (approximate figures 1995)*

	CO_2	NOx	VOC(NM)[1)]	CO	SO_2	Particles
Transport in all	40	80	35	80	25	40
Road transport in all	25	35	30	75	10	25

1) NM = Non-methane (that is, VOC except for methane)
VOC = Volatile Organic Compounds

4. The sector is special in the way that it is practically 100% based on the application of fossil energy, that is, the energy resource that many of the most urgent environmental impacts are linked to. Historically, it is hard to see the growth in the transport sector disconnected from the growth in the application of fossil energy. It has been pointed out that the «fossil society» and the «mobile society» have been like «*Siamese twins*» (Høyer & Selstad 1993). Whether they can be disconnected from each other in an meaningful way is a critical question. There are indications that this is not possible. In other words, substantial reductions in the society's dependency on fossil energy will imply reductions in the mobility (Høyer & Heiberg, 1993; Holden, 1996; Høyer, 1996b).

   Globally, oil products account for 98% of all energy consumption for transport purposes. This represents more than 60% of the consumption of all oil products in the world, but obviously a smaller share of *all* fossil energy (which also includes natural gas and coal). Road transport is completely based on oil, and it dominates in terms of volume as well. In the OECD countries road transport on average makes up 80% of all oil used for transport. Most of the remaining 20% is used for air transport, whereas rail and boat just account for approximately 5%. In this context Norway is in a special situation with its high share of sea transport (OECD, 1996).

   The transport sector's share of the total global CO_2 emissions has increased significantly in the past 20 years. In the 15-year period between 1973 and 1988, the global emissions from transport increased by 30%, whereas they were reduced by 2% for the other sectors in all. This difference is even more pronounced in the OECD countries. In the United Kingdom, for example, the transport sector's *share* of the total CO_2 emissions increased by 13 to 34% in the period 1970-1990. At the same time, the overall emissions from industry were lowered by 34% and from the households by 24%, whereas they increased by 65% from transport (OECD, 1996). According to current prognoses, it is expected that this trend will continue (OECD, 1996; EU COM, 1996). This is illustrated in *table 6.*

***Table 6** Prognoses for the growth in road transport 1990-2030. OECD and other countries. All figures in per cent.*

	Light cars	Heavy cars	All cars
OECD countries:			
Number of cars	73	94	74
Number of car kilometres	76	100	79
Weight of fuel	- 8	97	18
Non-OECD countries:			
Number of cars	305	300	305
Number of car kilometres	318	288	312
Weight of fuel	136	289	206
All countries:			
Number of cars	137	190	140
Number of car kilometres	137	192	144
Weight of fuel	25	181	74

Source: OECD (1996)

5. The development of the infrastructure of transport, coupled with the barriers caused by its use, are - as elements in an increasingly more extensive and finely-meshed network - important sources of the degradation of biological diversity and other values linked to the characteristics and localisation of land. In the latter case, this refers, for example, to the deterioration of cultural landscape values and of production values for human activities (primarily agriculture) (Aall, 1996).

6. The infrastructure of transport, but also the polluting emissions from the use of the transport means, is an important, perhaps *the* most important source of the deterioration of cultural monuments and valuable built environments. This applies especially to cities and urban areas. In this context, it has been suggested that the transport sector in the past few decades can be blamed for more destruction of such cultural values in western European cities than the total of all bombing during World War II (Høyer & Simonsen, 1996). In strongly car-based cities and urban areas, the transport land areas may occupy 30-40% of the total land. In some American cities this percentage is even higher (Høyer, 1996).

7. In all OECD countries, the transport sector is the main source of the special accumulation of serious environmental impacts we get in the biggest cities and urban areas. This is particularly the case with environmental impacts that affect the health. According to SFT's recommended limits for outdoor air quality, there are today 600-700,000 people in Norway living in areas with too high concentrations of NO_2 and particles. The critical concentration for ozone - with regard to plants as well as to human health - is exceeded practically all over the country. Road traffic alone leads to an excess of recommended limits for outdoor noise in residential areas for about 1.35 million people (Bernes, 1993). In addition, of all the society's economic sectors, transport accounts for the major share of fatal accidents and accidents causing injuries to people. This is the reason why we in the European city planning debate find the concept of *saturated* cities (EU COM, 1990). The idea is that it is no longer possible to

base the solution to the environmental problems of cities by increasing the capacity and extent of the classical infrastructure. On the contrary, the objective must be to reduce the capacity and to a larger degree turn from extensive to intensive infrastructure networks. This will, for example, imply less area for roads and fewer parking spaces on the part of the transport infrastructure. These are familiar principles from the so-called *urban ecology*. In our context, it is of interest that Agenda 21 expresses such an understanding when it comes to the content of a sustainable city policy (Sitarz, 1994).

4) A series of regional conferences formed part of the preparations for the Rio conference in 1992 (UNCED). The conference for member countries of UN's economic commission for Europe (ECE), comprising Europe and North America, took place in Bergen 8 - 16 May, 1990, and it was hosted by the Norwegian government. Immediately after this so-called Bergen conference, the Norwegian national committee for UNCED was established to co-ordinate Norway's preparations for the Rio conference.

5) For example in the recommendation of the following programmes and activities (Sitarz, 1994):

- Promoting efficient and environmentally friendly transport systems should be a priority in all countries
- Land and transport planning should promote development patterns which reduce the need for transport
- Urban transport programmes which favour efficient public transport should be implemented
- Substantial support should be given to private and public initiatives which promote the use of non-motorised transport, car pools, as well as improved traffic safety

6) The growth in person mobility is a prominent feature in the development in the industrialised countries. It seems to be closely linked to the very phenomenon of *modernity* (Walzer, 1990; Tengstrøm, 1995). Consequently, we cannot transfer this type of welfare development to other parts of the world without a corresponding increase in person mobility. This is one of the more fundamental challenges we are faced with in the issue of *sustainable development*. Mobility implies not only social, but also environmental changes. When it becomes high enough, the ecological sustainability is threatened, locally as well as globally. The reason may be that the present mobility in the industrialised countries is far higher than what is sustainable for an entire world. It is at least evident that the use of the private car in these countries - which is the main reason for the high mobility - will exceed the local and global limits if it were to be applied for the whole world (Høyer, 1996a; Høyer, 1996b). It represents a different, but more basic aspect of what we have referred to as the *volume perspective*; the problems are not only caused by the volume of the energy use, but of the very societal mobility level. Thus they will not be solved through energy efficiency and alternative sources of energy, but through measures to reduce the mobility. This is the basis for a concept of *sustainable mobility* in relation to the more limited *sustainable transport* (Høyer, 1996a).

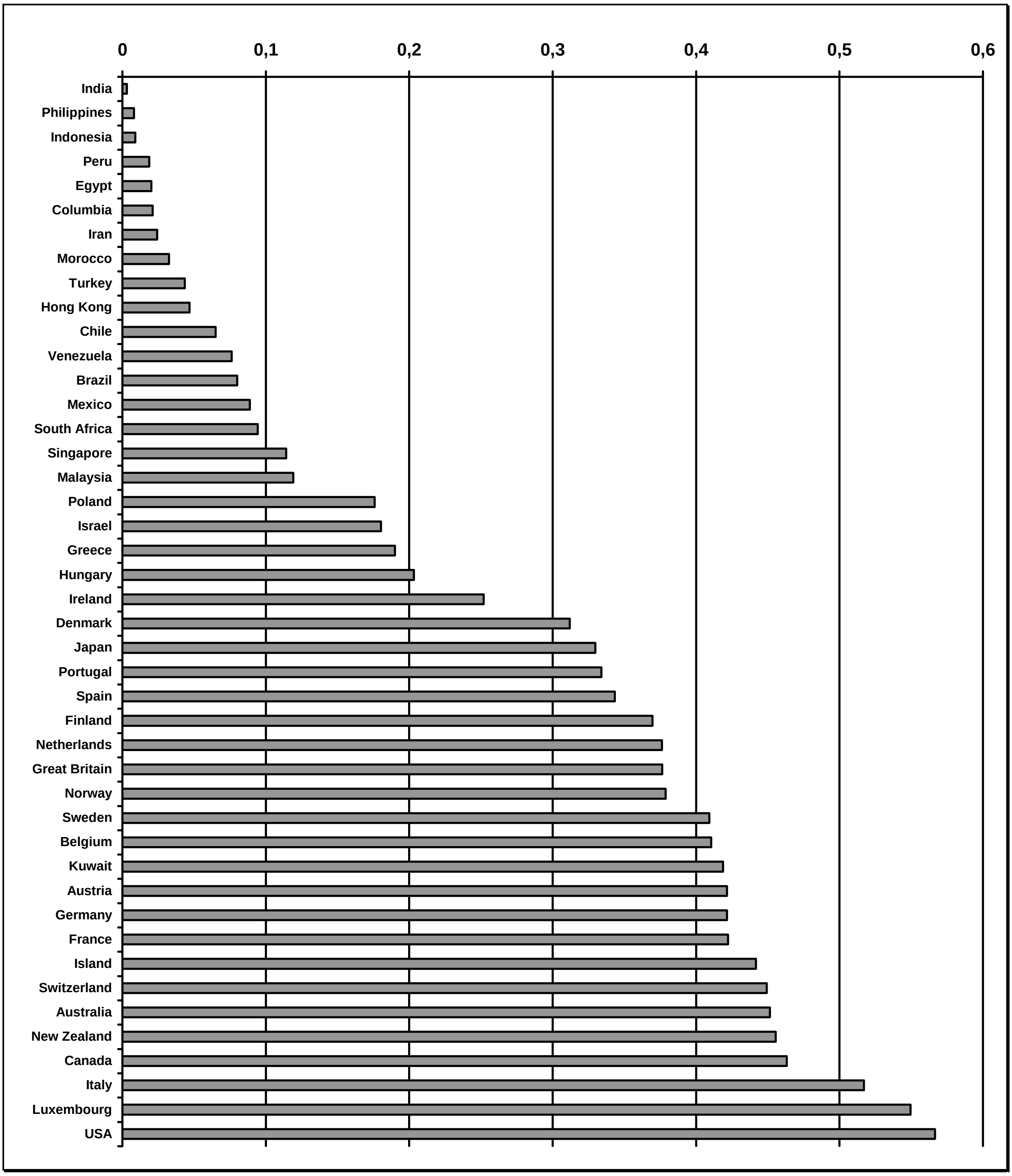
Mobility is not only linked to modernity, but also to late modernity or the *post-industrial* society. Vilhelmson (1988; 1990; 1992) outlines three phases in the growth in mobility.

The first phase is *geographical stability* with societies dominated by rural structures and low mobility. The second is the main phase of the industrialisation or modernity, described as *geographical specialisation.* The growth in mobility is strong, but it is characterised by transport streams through fixed nodes in space. This is the phase of the urban tailbacks and the single drivers. The last phase - *geographical flexibility* - is linked to the post-industrial society. The growth in mobility is still strong, but it is now to a larger extent linked to transport streams which constantly change directions. They, or what is transported, choose nodes relatively freely in space. There are major shifts in the course of the day, the week, or the year. Vilhelmson links the substantial growth in *leisure mobility* to this phase. Western Norway Research Institute has shown that this type of mobility implies a considerable use of environmentally harmful transport means, primarily aeroplanes (Høyer & Simonsen, 1996).

However, such a phase in the development has been made possible primarily by the proliferation of the car. The first cars were actually used mainly for leisure travels, as a sport or to get out of the cities in the weekend or in the holidays. In the 1950s and 1960s, this was a dominant feature in our country (Høyer, 1995; Tengstrøm, 1991). With the proliferation of cars completely new perspectives were attached to time and space. And it was only with the advent of the car that we got a transport system which gave us both an extensive geographical range and individual freedom of action, at the same time as it became available to the large majority of people. The old travel post system had the same characteristics, but was reserved only for the few (Rosengren, 1996). We link the concept of *automobility* to a mobility which has the car as its dominant presupposition (Tengstrøm, 1995).

7) The figure gives an international comparison. The figure shows that Norway does not top the list within the group of industrialised countries.

Figure 5 *Car density in various countries. Number of private cars per inhabitant in 1993*



The figure illustrates at the same time the disparities between rich and poor countries.

8) A common thesis put forward in connection with analyses of «post-industrial» development characteristics is that it is the transport distance which increases, whereas the transported volume rather is reduced (Örtendahl & al, 1990). Comparisons with various Northern European countries show that there is not automatically any basis for such a thesis. In the case of Sweden, it appears to be correct, where the number of tonnes in domestic goods transport has been substantially reduced from the early 1970s to the 1990s. The number of tonnes carried on lorries has also been reduced. On the other hand, in the same period there has been a significant increase in the transport work, that is, the aggregate of volume and distance. This is particularly true on the part of the lorries (Nordström, 1996). The development in Norway has been completely different. Once again we refer only to *domestic* goods transport.

9) In this context, we shall give a theoretical perspective on the latter reason. In order to explain the period of growth we seem to experience at present, we used the concept of *geographical flexibility* (after Vilhelmson 1988; 1990). The single household or individual relates to a series of specialised nodes scattered in space. They will alternate between several nodes in the course of a day, and rapid alterations will also take place between various nodes, even if they represent the same type of activity (f.ex grocer's shops). Different households and different individuals within one and the same local community can also relate to widely different nodes scattered over a vast geographical space (Høyer, 1995).

In order to explain important aspects of the growth of goods mobility in this period, we can use the concept of *flexible specialisation.* In a fundamental way it expresses the same type of socio-structural development characteristics. It elaborates the theoretical basis for operating with *a superior concept of mobility* (Høyer, 1995).

One of the scientific classics in this field defines *flexible specialisation* as:

> «a strategy of permanent innovation: accommodation to ceaseless change, rather than an effort to control it»

(Piore & Sabel, 1984)

It can be viewed as a strategy firms apply to meet changed market conditions, primarily preconditions caused by increasing internationalisation. It is a strategy which seeks to meet unstable markets caused by frequent changes in economic development and shorter durability of products. The re-organisation of production strategy applies to external as well as internal condititions in the firms.

One central element is to reduce the time it takes for the raw materials to pass through the whole production system, that is, increase this type of goods mobility. It implies doing away with stocks. The organisation of the production requires fast readjustment to adaptation and to new products, in other words, flexibility and ability to adjust. The time factor is important. The goods must be produced in the shortest possible time before being used in the next stage, whether this is in the form of sub-delivery or final product. This forms the basis for the concept of *just in time*. However, it is not only a question of deliveries at the right time. It also includes the right, customer-adapted, that is, specialised products or services (Georg & al, 1989; Örtendahl & al, 1990; Kalsaas, 1995).

Flexible specialisation means the establishment of *sub-contractor networks*. The firms specialise in producing part products which form the part of the production of other firms. This no longer forms the basis for economics of scale in the individual industrial firm. On the contrary, the risk and production is spread out on the sub-deliveries, and the individual firms are tied together in a network of contracts concerning the various deliveries. The entire production structure will be strongly split up. The individual product will be composed of many part products in a network of production nodes scattered in space, nationally and internationally (Georg & al, 1989).

10) The extensive distortions in the organisation of public transport compared with the road sector are expressed in the experiences from TP10. Professor Arvid Strand (1992) has summed up the experience in an article entitled *«The environmental alternatives were best, but the road plans won the day»*.

11) In consultation with the Ministry of Transport and Communications and the Ministry of Environment, the consultancy group for TP10 started on an *assessment programme* as soon as the first cities had finished their planning and report stages in 1991. This was concluded in the course of 1992 (cfr. f.ex. Strand, 1992; Sager & al, 1992; Tjade & al, 1992; Mydske & al, 1992).

The purpose of the assessment was to produce information and give feedback to central authorities as to how the participants in the TP10 work had reacted to the initiative, how they had carried out the work locally, and to what extent the work had been carried out in accordance with the original intentions. The assessment was meant to give a description of how the TP10 plans had turned out, and how the planning work had functioned in the local planning and decision-making processes. An assessment of the scientific methods had the concrete aim of contributing to improved methods and models in the transport and area planning.

The impact assessments and the socio-economic analyses in most urban areas show that the scenario alternative of «Environment» comes closer to most objectives one wanted to realise through the TP10, compared with «public transport» and «trend». Many urban areas, nevertheless, have favoured more trend-oriented alternatives, at least in terms of the short-term recommendations. There may be many reasons for this choice. In the first place, being pressed for time in the work, and the fact that short-term and long-term assessments therefore must take place alongside eachother. In the second place, strong premises had been laid in previous planning work. Most urban areas have thus for many years been working with plans to clarify future main road networks, to a large extent consisting of highways. In the third place, there were also premises to the effect that the TP10 process was meant to serve as short-term contributions to the national work with the NVVP and NJP (Strand, 1992; Spangen, 1995).

12) The changes have occurred along three dimensions. In the first place, «must» is replaced by «should» in a number of places. According to the draft, for example, land use and transport systems *must* be planned and developed in such a way as to promote a more environmentally sound development, and development patterns and transport systems *must* be subjected to a co-ordinated planning. In the second place, the references in the draft to the need for reducing the energy consumption and emissions to the air in

accordance with Norway's national targets and international commitments have been deleted in the final guidelines. The wording is now somewhat less binding to the effect that a long-term sustainable perspective must form the basis in the planning. In the third place, a number of concrete demands directed towards the future development of the *transport system* have been omitted in the final guidelines. In the original draft, for example, it was said that it was necessary to facilitate for an overall transport system which comprises public transport, freight transport, road network, as well as a network for pedestrian and bicycle lanes, and hiking paths. Furthermore, public transport by rail, urban rail or tram, bus, and boat must be planned and developed into a co-ordinated system for the region. This has now been left out.

13) From a theoretical point of view, this takes us back more than 30 years in time to the American urban planning theoretician Jane *Jacobs* (1961) and her descriptions of the shortcomings of American urban planning. These are principles which represent highly fundamental changes of the function-detached and zone-oriented planning which have prevailed in the entire post-war period.

The threads back to Jacobs also emerge in an even more fundamental way. As in her case, it is a *normative urban understanding* which prevails (Jacobs 1969, 1984). This is important in an environmental-historical perspective. The cities are no longer understood as necessary evils in an environmental context. Schools of thought within urban ecology which imply dissolving them as cities («ecology without city») have no place within this framework of understanding. Under the premise of a sustainable urban development, cities will not only be good places to live in, they will also give quite significant contributions to reducing the loads on the global ecosystems. Without such contributions from the world's cities an ecological sustainable future will not be possible either.

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4. Recycling: Issues and Possibilities

4.1. Introduction

The large volumes of material resources in circulation in the world's economy generate major environmental problems. During the extraction of raw materials, local ecosystems can be severely damaged, both because of the quarrying and mining of large masses of earth and rock and because of polluting emissions from the resulting tailings. When the raw materials are being transformed in various industrial manufacturing processes, other environmental problems are generated. They can take the form of emissions to air and water or of solid and fluid wastes. Some manufacturing processes are particularly energy intensive and so are causing gaseous emissions of major regional and global importance, either directly or indirectly through the distribution of electricity from nuclear or fossil fueled power plants. Even the final products are the cause of serious environmental problems when their useful lives are over and they become waste.

Large volumes of raw materials, industrial products and wastes are transported locally and regionally and also across national borders. This requires energy in the form of fossil fuels, again contributing to serious regional and global environmental problems. Transport infrastructure also consumes large areas of land and interferes with fragile ecosystems. The construction of it consumes substantial volumes of material resources.

The focus of this chapter is on quantitative issues, that is, the scale of the problems connected with the sheer volume of the material resources in circulation. Other issues are mainly qualitative in character. This is the case when resources are transformed into particularly hazardous or toxic substances, and when the seriousness of the environmental problems is associated with the hazardous/toxic qualities and, to a lesser extent, with the volumes of transformed resources. The solution at hand is then generally to cease manufacturing these substances altogether. When the problem is predominantly quantitative, the solution is rather to reduce the volumes.

In an article on industrial ecology, Hardin Tibbs (1992) elucidates the importance of this issue of scale. The problem is that the global industrial system has been steadily growing larger than the natural systems. The industrial flows of nitrogen and sulfur are now equivalent to, or greater than, the natural flows. For metals such as lead, cadmium, mercury, nickel and vanadium, the industrial flows are as much as twice the natural flows. In the case of lead it is 18 times greater (Tibbs, 1992).

This chapter focuses on the transport sector. Globally transport accounts for about 30% of the total energy consumption, and about 60% of the total amount of oil products consumed (Keating, 1993). In Organisation for Economic Co-operation and Development (OECD) countries, the sum of direct and indirect energy use for transport is normally around 30-35% of the total (Høyer and Heiberg, 1993).

4.2. Reduction in Flows of Material Resources

The United Nations Conference on Environment and Development in Rio de Janeiro in 1992 established a new UN body, the Commission on Sustainable Development (CSD), which meets annually to review and promote the follow-up of the main action plan from Rio known as Agenda 21. After a proposal from Norway, the CSD meeting in January 1994 focused on sustainable consumption by arranging a symposium in Oslo (Hille, 1995). With reference to a Dutch study, the summary of the symposium identifies the following four goals needed to attain a society based on sustainable consumption (Ofstad, 1994):

- Close process cycles (aiming at achieving complete reuse, recycle and repair)
- Halving fossil fuel use (by maximizing the use of energy conservation measures, shrinking energy intensive sectors and introducing energy taxes)
- Improving the quality of materials (using a cradle-to-grave approach to get products which are more durable, repairable and recyclable and avoiding the use of scarce or hazardous materials)
- Reducing transportation (providing goods and services as close as possible to the consumers in accordance with the proximity principle)

The first three fall within the concept of industrial ecology, which will be discussed in more detail later. The fourth is outside the usual scope of this concept. It emphasizes the complexity of transportation problems, and the need to address these even when extensive recycling of material resources is achieved. A recycling society by itself can, in principle, imply more transportation and larger environmental problems because of demands for energy and infrastructure.

The aim of recycling and reuse in the above context is to reduce the environmental burden caused by the extraction of raw materials and the generation of waste. But by how much must the global environmental load be reduced, and what reductions in the flows of material resources must be achieved by wealthy OECD countries?

At the German Wuppertal Institute, reseachers have developed the concept of “material input per service unit” (MIPS) referring to the amount of materials consumed per unit of utility provided by the goods made with them. MIPS values have been derived for several products. Studies by the Institute have suggested that the aggregate global level of material resources inputs should be reduced by 50% by the middle of next century. This is based on estimates of what ecosystems globally can tolerate by way of flows of material resources in order to keep within long-term sustainable levels (Schmidt-Bleek, 1994). Rensvik (1994) suggests the need for an even larger reduction of 70%.

Weizsäcker (1994) considers it necessary for OECD countries to reduce their average MIPS values by at least a factor of 12. This is based on the following condition:
- Global equity;
- Doubling of the human population;
- Current per capita material resources flows being at least three times larger in OECD countries as in developing countries;
- Reduction in the global flows of material resources;
- A standard of living equivalent to that in today’s OECD countries in all nations

With the recommendation from the UN climate panel, the Intergovernmental Panel on Climate Change (IPCC), of 60-80% global reductions in CO_2 emissions, there is a similar need for a reduction by a factor of 10 in the use of fossil fuels in OECD countries (Weizsäcker, 1994).

It is hard to substantiate whether such degrees of "dematerialization" are obtainable. For instance, it is difficult to envisage how a world with twice today's population can have the same car-based personal mobility as the current OECD average, yet still achieve a 50% reduction in the global flows of material resources and 60-80% reduction in the use of fossil energy resources. Establishing the required transport infrastructure alone would generate an increase of factor ten in the mobilization of material resources for such purposes. It is not possible to reduce the use of fossil fuels substantially without consequences for the levels of mobility, both for people and commodities (see chapter 18). [1]) This forms a background for the concept of sustainable mobility, which is something more than just sustainable transportation.

4.3. Dematerialization

According to Hardin Tibbs (1992), the basic trend towards dematerialization is well established and is environmentally favorable, since it demonstrates that economic growth is becoming increasingly uncoupled from growth in use of materials. He defines dematerialization in this way:

> *"In industrially developed economics, dematerialization - a decline in materials and energy intensity in industrial production - is an established trend. When measured in terms of physical quantity per constant dollar of GNP, basic materials use has been falling since the seventies, and has even leveled off when measured in terms of the quantity consumed per capita. Practical examples of this trend are the steadily declining size and increasing power of computers, or the nearly 20 percent drop in the average weight of US automobiles between 1975 and 1985. And microstructural engineering of smart materials is yielding even lighter, higher performance components".*

This is a view supported by Graedel and Allenby (1995), amongst others, while Frosch (1995) and Ardekani et al. (1989) are more critical. However, they all consider reuse and recycling of materials to have fundamental importance in achieving further dematerialization.

As the cited example illustrates, it is evident that a decline in resource intensity has been taking place at the level of single units of industrial products. However, whether this is a systematic process towards dematerialization on a global, societal level is another question[2)] . In addition, it is not certain that it implies environmental improvements. It is, for instance, possible that the substitution of aluminium and plastics for carbon steel and other metals in automobiles can increase total environmental loads. Mining of bauxite is far from environmentally benign and the the production of aluminium is very energy-intensive. Plastics are produced from fossil fuels and create problems regarding recycling and waste disposal (Frosh, 1995).

The answer to whether dematerialization is really taking place depends on how it is defined. From an environmental point of view, a definition would be:

“Dematerialization is the decline in the total global amount of resources (i.e. material and energy) mobilized in order to manufacture one unit of an industrial product, without changes in the basic qualities of the product”.

It is similar to the definition of MIPS, but more comprehensive. This chapter uses the case of automobiles to elucidate the importance of such a definition. Since the mid 1970s there have been efforts in order to develop “clean” cars, i.e. cars with small emissions on No_x, HC and particulates. Today all new petrol cars are manufactured with 3-way catalysts, at least in all OECD countries. The catalysts give extensive reductions of the above pollutants when the cars are in normal use. At the same time, the new average car has become smaller, lighter and more energy-efficient.

The real picture is, however, more complicated. Firstly, the car with the catalyst consumes 5-10% more fuel under average driving conditions than a similar car without one (Høyer and Heiberg, 1993). Secondly, and more importantly, the catalysts contain platinum. This is found in ores at concentrations of around 7 ppm. Graedel and Allenby (1995) point out that the yearly USA production of only 143 tonnes of purified metal requires the extraction and processing of around 20 million tonnes of ores. It involves encroachment into large areas of land, movement of large volumes of earth and leaves behind millions of tonnes of polluted tailings and polluted surface and ground water (Høyer, 1990; Weizsäcker, 1994). So far this has not been included in the debate of “clean” cars.

The average car has become lighter. There has been a substantial decline in the application of carbon steel and cast iron, substituted by high strength steel, aluminium, new lightweight alloys, plastics and various composite materials. Every kilogram of high strength steel replaces 1,3 kg of standard carbon steel (Tibbs, 1992). This generated large changes in the car industry during the 1970s and 1980s.

Whether such changes confirm trends towards dematerialization in a broader sense is not yet evident. There are environmental and resource problems caused by the extraction and manufacturing of aluminium and plastics. In addition, there is a limit to how light a car can become before other qualities are affected. Ardekani et al. (1989) refer to a USA study showing that en unbelted driver is 2,6 more times as likely to be killed in a single car collision in a car weighing 1 000 kg compared to one weighing twice as much. The relative difference is much the same even when the driver is belted.

4.4. Limits of Dematerialization

The prime example used to illustrate trends towards dematerialization is the development in information technology. It certainly is impressive how larger and larger amounts of information can be processed in smaller and smaller microchips. But whether this is confirmation of dematerialization is a more complicated issue.

The silicon wafers used to manufacture microchips do not generate major waste problems as the volumes are relatively small. Even so, it is environmentally important due to the application of toxic chemicals in the manufacturing processes (Ardekani et al., 1989). Three other trends in the information technology industry also emphasize larger environmental and material resource problems.

- Every computer needs a metal and plastic covering in order to contain and cool the microchips. The computer has become an ordinary consumer product, so that means a lot of coverings.
- Every computer is manufactured by putting together parts and subassemblies delivered from almost every corner of the world. In this way raw materials, individual parts and finished computers are transported to and fro between continents. For instance, the parts in every Apple II microcomputer are manufactured in California, Texas, Ireland, Denmark, Germany, Japan, Taiwan, Singapore and several other Southeast Asian countries. The 42 “chips” in each computer have altogether traveled about 2×10^6 km before finally being connected (Høyer, 1995).

The development in information technology has not been followed by a decline in paper consumption, as was expected. On the contrary, there has been a steady increase in paper use on almost every level of society. This represents one of the more fundamental paradoxes in modern industrial development (Ardekani et al., 1989). [3)]

To sum up, therefore, both dematerialization and materialization are taking place. Which is the resulting trend is mostly a question of definition. From an environmental viewpoint, and according to the definition given above, the dominating trend might just as well be materialization. [4]) There is no firm empirical knowledge substantiating that an uncoupling of economic growth and resource consumption is possible. Extensive reuse and recycling are expected to generate more profound achievements. As emphasized earlier, this implies a long-term aim to reduce the average, total environmental load at current production and consumption levels by a factor of 10-12 in OECD countries.

These are high expectations. They have both practical and theoretical limitations. Before returning to them, a deeper understanding of the recycling society, with the concept of industrial ecology as a basis is required.

4.5. Industrial Ecology

The concept has grown out of earlier studies on industrial metabolism (Ayres, 1989). They usually focused on single materials, product or facilities, for instance, the flow of a particular material through the economy. The studies were predominantly descriptive.

Industrial ecology is a broader concept in that it covers both materials, processes, products and facilities, how these are linked together through flows of material resources and how this interacts with natural ecosystems. The focus is more on a complexity of facilities and their total relation with nature than on single facilities. The concept is normative in that the aim is to create new industrial systems that minimize the environmental load and develop new processes and products that imitate nature as far as possible. In this way, fundamental qualities of nature itself are to serve as norms for industrial development. Concepts such as "industrial ecosystems" and "industrial foodwebs" are applied (Tibbs, 1992).

Industrial ecology has its basis in the historical perspectives on the development of environmental problems (see Chapter 2) [5)]. Experience has shown how difficult it is to "solve" the problems when they first appear and when they are addressed as being single-issue in character. The solutions themselves under such conditions might create new types of environmental problems, or simply move the problems from one place to another, or from one societal sector to another. Industrial ecology illustrates the implications of a transition from classical "end of pipe" to "source of cause" oriented solutions in environmental policy (Graedel and Allenby, 1995; Welford and Gouldson, 1993; Roberts, 1995).

The concept covers the following principles (mostly based on Graedel and Allenby, 1995 and Roberts, 1995):

1. Principle of resource minimization. Industries should minimize their use of material and energy resources in products, processes and interconnected services.
2. Principle on non toxicity. In their design of products and processes, industries should use relatively abundant and non toxic materials.
3. Principle of nature imitation. In their design of products and processes, industries should use materials and manufacture products that are biologically degradable or otherwise, as far as possible, imitate products and processes found in nature.
4. Principle of recycling. At all levels industries should favor the recycling of used materials instead of incorporating virgin resources, even when these resources are abundant. There are two forms of recycling in this context.
- Horizontal, implying the reuse of materials to make the same type of product;
- Cascade, the reuse of materials in other products (Graedel and Allenby, 1995)
5. Principle of energy "cascade connection". Industries should reuse energy through applying "cascade connection" in their processes, or by transferring energy to other forms of manufacture in neighboring industrial plants. "Cascade connection" is a system where energy is used to perform a series of tasks, each of which uses the energy left remaining after the previous task is completed. These last two principles might be promoted by the establishment of ecoindustrial clusters (or parks) that locate different industries within the same area.
6. Principle of product recyclability. Any product should be designed for recyclability by preserving the inherent utility of the materials it consists of.
7. Principle of product disassembly. Any product should be designed for disassembly to allow for reuse in new products when the lifetime of the original product is over, or when it has become obsolete. This can imply changes in the whole idea of product lifetime. Manufacturers might wish to have the products returned from the consumers before they are worn out if this is better for disassembly and recycling (Frosch, 1995).
8. Principle of packaging minimization. Through the whole life cycle of products, that is from "cradle to grave", industries should aim to minimize the use of packaging. This requires cooperation with other industries, eg retail businesses.
9. Principle of minimum local intrusion. Any industrial plant should be planned, constructed and operated so that intrusions into local ecosystems, habitants and resources can be avoided or kept to a minimum.

10. Principle of manufacturer responsibility. The manufacturers should assume responsibility for their products through the complete life cycles. In this way, the manufacturers become the prime stewards of their industrial products. This principle has already been included in environmental legislation in some countries, notably in Germany, where it is a requirement in the handling of certain product categories.
11. Principle of life cycle assessments. Industries should apply the analytical tool of life cycle assessments (LCA) to compare different processes and products in order to decide which is to be preferred according to the total environmental loads and resource implications from "cradle to grave".

Changes are underway in line with some of the principles. This is also the case in the automobile industry. Due to German legislation, Volkswagen has developed an integrated system for recycling. This includes the establishment of a recycling center at Leer in East Frisia where used cars are disassembled and parts are sorted into four main categories:

- Solutions are collected and sent for reprocessing;
- Steel parts are shredded and alloys are remelted;
- Batteries are disassembled and recycled;
- Plastics and rubber are sent for reprocessing by specialized companies.

This initiative also implies development of designs for disassembly and recyclability.

Other automobile manufacturers have followed. In a joint venture, the British Rover group plans to establish a recycling facility for all common types of cars, even those made of other major manufacturers (Roberts, 1995).

4.6. Recycling Society: Some Theoretical Limitations

The concept of a "recycling society" denotes a situation where the basic principles of industrial ecology have been achieved on a total societal level. It is a society where the classical one-way flows of material resources are kept to a minimum; but to what extent does this mean the preservation of physical resources?

The answer to this question requires an understanding of fundamental laws of physics. Of particular importance are the two main laws of thermodynamics. Originally they were developed to describe conditions governing transformation of energy, but they can be applied to the transformation of material resources. The two laws are:
- The law about constant quantities of energy (and material) resources;
- The entropy law, or the law of the loss of quality when energy and material resources are being transformed (Høyer, 1995; Høyer and Groven, 1995).

The first law tells us that energy or other physical resources can neither be created nor destroyed, they can only be changed from one form to another. If energy in any form disappears in one place, then the same quantity must be found in another form or in another place. The fundamental implications are that something can never become nothing, and vice versa.

There is nothing in the first law that says it is not achievable. In principle it accepts that any resource-transforming process can go both forwards and backwards: but it is known that this cannot be the case.

The second law dispels any thoughts about the possibilities of "perpetuum mobile". It is easiest to explain in relation to energy. When energy is used, that is transformed from one form to another, it will incessantly move towards an increased degree of disorder. Another word for disorder is entropy in this context, thus it is called the entropy law. Thus, when energy is used, it irrevocably loses some, or all, of its ability to do further work. High quality energy, with a large working capacity, proceeds towards more inferior energy with less capacity. Eventually there is complete disorder, or maximum entropy, in the form of finely dispersed heat energy (Høyer and Groven, 1995).

When material resources are used in manufacturing, they occur in ordered forms in the products in many cases on a higher quality level than as raw materials. Apparently a counter-entropic process has been put in system. Every time raw materials are extracted, and every time they are transformed in the manufacturing process, energy in one form or another is applied, even if only to transport the material resources from one place to another. This gives an increase in entropy. It emphasizes that the utilization of material resources is related to time and space. Time cannot be reversed, and the resources cannot be returned to their original state without further generation of entropy.

It is important to realize that entropy is not only an index of disorder for energy, but for material resources as well. All processes in the transformation of resources generate an increase in disorder for the total system. Not even on a purely material resources basis can recycling be complete, for example. There is always certain wear and tear and an irrevocable loss of resource quality following any type of transformation and use og material resources. The Rumanian-American economist Nicholas Georgescu-Roegen (1971) expresses it this way:

> *"The upshot is clear. Every time we produce a Cadillac, we irrevocably destroy an amount of low entropy that could otherwise be used for producing a plow or a spade. In other words, every time we produce a Cadillac, we do it at the cost of decreasing the number of human lives in the future. Economic development through industrial abundance may be a blessing for us now and for those who will be able to enjoy it in the near future, but it is definitely against the interest of the human species as a whole, if its interests is to have a lifespan as long as is compatible with its dowry of low entropy. In this paradox of economic development we can see the price man has to pay for the unique privelege of being able to go beyond the biological limits of his struggle of life".*

He also refers to solve the problems through recycling:

> *"So, when everyone (in the countries with "better and bigger" industrial production) was, literally, hit in the face by pollution, scientists as well as economists were taken by surprise. But even now no one seems to see that the cause of all this is that we have failed to acknowledge the entropic nature of the economic process. A convincing proof is that the various authorities on pollution now try to sell us, on the one hand, the idea of machines and chemical reactions*

that produce no waste, and, on the other , salvation through a perpetual recycling of waste. There is no denial that, in principle at least, we can recycle even the gold dispersed in the sand of the seas, just as we can recycle the boiling water (in my earlier example). But in both cases we must use an additional amount of low entropy much greater than the decrease in the entropy of what is recycled. There is no free recycling just as there is no wasteless industry".

This implies that the theoretical foundation for a recycling society is just as rickety as for the classical one-way flow of material resources. It is not an argument against recycling as such. In most cases, recycling is to be preferred to one-way flows. But not always and it should not be considered as a panacea. In some cases the increase in entropy can be larger with recycling than when the material resources end up at waste deposits, and the environmental problems generated can be more severe.

It depends on the societal conditions. Most fundamental is the issue of scale. Recycling is hardly compatible with continuous growth in the scale of the economy. In principle the growth can be supported in two ways; in reality probably by a combination of the two (Høyer and Groven, 1995). Either the volumes of manufactured products in circulation in society can grow, at some time giving an increase in material resources use and extraction, or the circulation can be accelerated by giving the products ever shorter lifetimes and by continuously transforming capital equipment and connected infrastructure. Industrial ecology contains at least some element of this. Secondly there is the issue of loops. The long, global flows of material resources and industrial products generate entropy and serious environmental problems. Closing these loops, i.e. establishing a global cycling of waste, used materials and products, will increase such problems. Again the elements of this lie in the principles of industrial ecology. Environmentally benign and resource-effective recycling requires short loops.

4.7. Automobile Life Cycles: an Empirical Analysis

The Western Norway Research Institute (for the Norway Research Council) has compared different means on passenger transport by applying the tool of life cycle assessment (Høyer and Heiberg, 1993). This was part of a national research program on public transport. The research project analyzed energy, environmental and regional impacts of transport means such as the the private car, bus, train, subway, airplane and boat, and compared them. This was done in relation to two main categories of travel; urban travel and longer, regional travel. This section focuses on the findings for cars.

The analysis was for two different years, 1990 and 2010. The future situation included the use of alternative energy sources as natural gas, methanol from biomass, hydrogen and electricity.

The total energy consumption was calculated for each means of transport and energy source. This gave figures for the energy intensity, i.e. the energy consumption in relation to transport work per vehicle kilometer (vkm), per passenger kilometer (pkm) and per capacity passenger kilometer (ckm). These are called energy use factors. The factors are given for the total of direct, gross direct and indirect energy consumption:

- Direct energy is the energy required to drive the different means of transport themselves;
- Gross direct energy includes the addition for the energy required to produce and distribute the different fuels and energy sources;
- Indirect energy is the energy consumed in constructing, manufacturing and maintaining the transport means and their respective infrastructure.

Emissions of air pollution were calculated on the basis of the same three main categories of energy consumption. The total emissions were given as figures for emission intensity called emissions factors. The analysis included the following pollutants: carbon dioxide (CO_2), nitrogen oxide (NO_x), carbon monoxide (CO), hydrocarbons (HC), methane (CH_4) and dinitrogen oxide (N_2O).

The greenhouse effect is the main focus when it comes to the environmental effects of the gases. To summarize the greenhouse effect, the CO_2-equivalents of the relevant gases were calculated in addition to the emissions of CO_2 itself. Research also included an analysis of area consumption, calculated for each means of transport and for each corresponding energy source. This gave figures for area intensity, i.a. the total area consumed in relation to each unit of transport work. These are called area use factors. Some of these results are presented in Chapter 18 and this topic will not be covered futher here [6)].

Figures for gross direct energy require an analysis of the energy lost and energy consumed at every link in the complete energy chains for the fuels (or electricity). Basically any energy chain consists of four links (or processes):

- Extraction of energy source;
- Transport of energy source;
- Production of fuel;
- Distribution of fuel.

The figures were calculated by summing up the energy lost and consumed at all links. The sums of the related polluting emissions were analyzed in the same way. Life cycle assessments (or analyses) of different transport energy sources are being performed.

4.8. Indirect Energy and Materials Recycling

As noted above, the term indirect energy implies energy consumed in order to manufacture and maintain transport means, and to construct, operate and maintain the necessary infrastructure. The analysis included the following links:

1. Manufacture and maintenance of vehicles:
- Extraction of raw materials;
- Processing of materials;
- Manufacture of parts and subassemblies;
- Assembly of parts;
- Transportation between the various stages in the production process;
- Maintenance and repair.
2. Construction, operation and maintenence of infrastructure:
- Constructional use of energy materials;
- Maintenance
- Operational requirements;
- Distribution.
3. Loss of energy due to refinement etc. of the primary energy sources applied:
- Extraction;
- Transport;
- Refinement/production;
- Distribution.

The last list covers an analysis based on the term “gross energy” but in this case they are given as figures for gross direct energy.

The method required a detailed analysis of a number of different materials, products and production processes. This made it necessary to rely extensively on estimates. It was also necessary to limit the types of energy requirements considered.

Table 1 *Degree for recycling of selected materials achieved by the Norwegian automobile industri, 1990*

Material	**Level of recycling (%)**
Aluminium	90
Steel	85
Copper	60
Car tyres	20
Batteries	90

Sources: Høyer and Heiberg (1993); Heiberg, (1992)

For instance, no account was taken of energy used to provide comfort for the workers, energy required for sales and marketing and similar external requirements (e.g. energy to transport for workers to the factory, energy consumed by administration, energy required in cleaning up oil spills, etc). Infrastructure is limited to roads, tracks etc. and does not consider the energy requirements for construction and operating train stations, bus terminals, parking lots etc.

The analysis for the 1990 situation is based on the present level of energy efficiency, materials use and recycling in industry. The energy requirements were amortized over the lifetimes of the vehicles and the infrastructure. Infrastructure energy requirements were shared between passenger and freight transport according to the 1990 volumes.

Table 1 shows the degrees of recycling of some materials applied in the analysis for 1990. Table 2 gives a detailed presentation of the assumed degrees of materials recycling in 2010 and the gains in energy efficiency that are achieved through this and the general increase in industrial energy efficiency.

The analysis for the year 2010 is based on assumptions about changes in industrial production regarding energy use and materials recycling. Changes are assumed to take place within the following areas:

1. Primarily in relation to manufacture of transport means:
- A general increase in energy efficiency in industry;
- Increase in degrees of recycling of materials;
- Reduced weight and changes in material consumption of vehicles;
- Reduced lifetime of vehicles;
- Increased efficiency in energy production.
2. With particular relevance to infrastructure:
- A general increase in energy efficiency in construction and maintenance;
- Increase in traffic intensity;
- Changes in the share between freight and passenger transport;
- Changes in the requirements for standards of infrastructure;
- Reduction in lifetime for infrastructure.

***Table 2** Projected degree of recycling and potential energy savings (relative to 1990) in the Norwegian automobile industry, 2010*

Material	Level of recycling (%)	Energy consumption (%) reduction relative to 1990
Cast iron	95	36
Steel	95	62
Aluminium	95	82
Copper	95	80
Other metals	95	74
Glass	60	40
Plastics	40	37
Composites	0	0
Rubber	40	38
Wood	0	28
Glass fibres	0	30
Textiles	0	30
Paints	0	30

Source: Høyer and Heiberg (1993)

4.9. Effects on Total Energy Use

The average Norwegian passenger car in 1990 weighed 1 000 kg and is predicted to weigh 900 kg in 2010. Not only is the total weight changing, so is the material composition. On the basis of a detailed analysis of material composition for new cars marketed in the 1980s, changes are assumed to take place for each type of material in cars in 2010. This includes further reductions in the use of steel and cast iron and relatively large increases in the use of aluminium and plastics.

Figure 1 gives a comparison between the energy use factors in 1990 and 2010 under both urban and regional driving conditions. The unit is energy (kWh) per passenger kilometer (pkm). The last is based on empirical data and assumptions about the average number of persons in each car in 1990 and 2010 respectively. These differ for urban and regional travels, just as they do for direct energy due to differences in driving modes. Even though the reduction in direct fuel consumption (petrol) is supposed to be substantial (about 25%), there is a relatively small decrease in total energy use from 1990 to 2010. For urban travels the decrease is about 10%, while it is 20% for regional travel.

Figure 1 *Energy use factors for petrol passengers cars in 1990 and 2010 in kWh pkm^{-1}. Regional and urban travels (After Høyer and Heiberg, 1993)*

Due to the combined effects of decreased weight, changes in material composition and extensive recycling, reductions in indirect energy use is larger, about 30%. This has minor importance for total energy as the indirect energy only takes up a relatively small share (10-15%).

Figure 2 gives a corresponding comparison of the greenhouse gas emission factors. Again reductions in relation to indirect energy as such are substantial, 50% or more, although this has minor effects on the total emissions due to its small share. The net effects are due to the assumption of reduced fuel consumption during driving.

Figure 2 *Emission factors for petrol passengers cars in 1990 and 2010. CO_2 equivalents in g pkm^{-1}. Regional and urban travels (After Høyer and Heiberg, 1993)*

There has been discussion whether a forced exchange of old cars for newer ones will give environmental gains. Those arguing in favor claim that there will be benefits due to the combined effects of reduced fuel consumption, more extensive materials recycling and catalytic equipment. Results from several life cycle assessments focusing on this issue, however, support the opposite conclusion (Hille, 1991; Holden, 1993,1994). Regarding energy use and emissions of greenhouse gases there are no immediate gains. Due to catalysts in all new cars, total emissions of pollutants of primarily local importance are reduced. The results are in this respect not totally conclusive, although generally they give no basis for the argument that definite environmental gains can be won through a forced exchange of older cars (Høyer and Heiberg, 1993).

A more fundamental discussion is about the prospects for “zero emission vehicles”, i.e. electric cars. To what extent are they “zero emission” in a life cycle perspective? Life cycle analysis of electric cars in comparison with petrol cars, based on today’s average mode of electricity generation, shows that the total energy use and CO_2 emission factors are very much the same. Even the total emissions of pollutants of mainly local and regional importance are at similar levels. Under some conditions they are even higher from electric cars. They are not emitted from the cars themselves, but result from electricity generation. This does not make them more harmless in all respects (Graedel and Allenby, 1995).

Figure 3 Energy use and emission factors for electrical and petrol cars in 2010. kWh and CO_2 equivalents per pkm. Regional and urban travels (After Høyer and Heiberg, 1993)

Figure 3 shows some results from the life cycle analysis for the 2010 situation. It is assumed that the electricity is generated in advanced and highly effective power stations fueled by natural gas. A comparison is made with petrol cars.

The figure illustrates that there will not be a “zero emission” situation, even in the future. However, under urban driving conditions substantial reductions in emissions og greenhouse gases can be achieved. This is not the case for rural journeys which not only give lower reductions in emissions, but also give rise to an increase in total energy use. The reason is the substantial losses in efficiency for electric cars in rural driving modes. It is worth emphasizing in this context that a large share of the total, national volume of passenger kilometers is actually connected to travels outside urban areas (Høyer and Heiberg, 1993).

4.10. The Crucial Issue of Mobility

This chapter has substantiated the claim that both theoretically and empirically materials recycling in the automobile industry can yield only limited environmental improvements. The reason for this rests with fundamental issues such as total energy use and greenhouse gas emissions. The total environmental impacts from automobiles are mainly generated in relation to driving and, to a lesser extent, to manufacturing the cars. Energy used during driving can obviously not be recycled or cascade-connected to other users.

The recycling society offers no solution to the majority of environmental problems caused by transport. On the contrary, it might even generate more transport. This serves to emphasize the crucial issue of the level of mobility in society. There is no answer to this problem in extensive recycling, industrial ecology or electric cars, which represent some of the reasons behind the current international focus on the concept of sustainable mobility.

4.11. Notes:

1) Chapter 18 refers to another article I have published in the same book. The article (or chapter) is titled “Transport and Mobility”. The links between mobility and use of fossil fuels are here analyzed in a historical perspective. It is claimed that the “mobile society” and the “fossil society” are like Siamese twins. They cannot be decoupled without substantial changes in both; substantial reductions in the use of fossil fuels will also imply reduced levels of mobility.

2) The development in transport of goods on a gross societal level gives an input to this discussion. What I call “goods mobility” consists of two main components; the number of tonnes of raw materials and processed/manufactured goods which is moved, and the number of kilometres covered by the movement with various transport means. Mobility then can increase in two ways, either by an increase in amount of distance, or a combination of the two.

A common thesis put forward in connection with analysis of “post-industrial” development characteristics is that it is the transport distance which increases, whereas the transported volume rather is reduced (Örtendahl & al. 1990). This could also support a thesis on dematerialization. Comparisons between various Nordic countries show that there is not any clear basis for such theses. In the case of Sweden, it appears to be correct, where the number of tonnes in domestic goods transport has been reduced from the 1970’s to the 1990’s. The number of tonnes carried on lorries has also been reduced. On the other hand, in the same period there has been a significant increase in the transport work, that is, the aggregate of volume and distance. This is particularly true on the part of the lorries (Nordström, 1996; Steen & al, 1997).

The development in Norway has been quite different. I do, however, only refer to *domestic* goods transport. Since the early 1970’s there has been no significant change in the average transport distance but the number of tonnes under movement has increased considerably. This has then resulted in a major increase in goods mobility especially for the part linked to the transport means of lorries. For this very transport means, by the way, there has also been a steady increase in distance (Rideng, 1996).

The number of tonnes transported domestically in Norway increased by about 50% in the period 1970-95. However, the increase in transportation to and fro other countries was larger, about 75% growth in the number of tonnes and more than 200% growth in the number of tonne-kilometres. It should be emphasized that these figures do not include the pertroleum sector in the North Sea (Rideng, 1996).

3) The relation between (physical) transportation and growth in information technology (IT) is another such paradox of special interest in our context. It is quite common to anticipate that a substantial increase in the use of information technology will imply reductions in the need for person transport and thereby have positive energy and environmental consequenses (Niles, 1994).

Several studies on a macro level have estimated posssible, long term effects on the volume of person transport due to application of IT. One such study performed by the US Department of Transport (USDOT, 1993) expects a certain relative reduction in person transport in the next century related to IT application. However, such a reduction is more than compensated by the expected growth in person transport in general. In another study the US Department of Energy (USDOE, 1993) gives no support even to this minor, relative reduction due to long term effects of IT having a travel stimulating character. The study considers in particular to such indirect effects:

- Increased "urban sprawl"
  The socalled tele commuters will take advantage of better conditions for living farther from city centres. This will reinforce sub-urbanization and urban sprawl, which again will cause longer travel distances and more construction of transport infrastructure.

- Increased liberation of latent mobility
  Extensive tele commuting will give less traffic jam during rush hours. This will give more even traffic during the day. Others will take advangtage of this bettering of traffic conditions. These others, might be persons who formerly travelled less or before used to travel by public transport means.

Historical experiences seem to support these assessments. During more than a century the growth in tele communication and physical transportation has taken place in parallel. The extensive growth in use of telephones has for instance not resulted in any evident lowering of growth in person mobility, even though the technology in itself has such a potential. In the same way has the growth in new forms of IT developed in parallel with a further increase in person mobility, particularly in its most environmentally harmfull forms: private cars and aeroplanes. Similarly is the situation in USA today that a 10% yearly growth in the number of tele commuters takes place at the same time as the volume of person kilometres generated by American households is increasing just as much as before (Engström and Johanson, 1995; Niles, 1994).

4) This can be further elucidated through examples from transport of goods. Two examples are the common commodities *bicycle* and *house*.

Even the "environmental benign" bicycle hides in its life history material resources and components transported from almost all over the world. This even applies to the common categories of manufactured products as bearings, chains, seats and tires. The Finnish Tunturi bicycle, for instance, consists of 103 different parts. Only 11 of these are made at the Tunturi-factory itself. The other parts come from about 30 manufacturers in 5 different countries. The chain, pump and front wheel hub come from Germany. The chain track and wheel bearing from France. Pedals and seats from Italy, and the back wheel hub from Japan. In addition the material resources in the Finnish parts are also mostly imported. They comprise metals and additives from Sweden, Russia, Ghana, Norway, Poland and USA (Paloheimo, 1994).

Within the Nordic research project "The ecological basis for regional policy" (NordREFO - Nordic Institute for regional policy research) there was made an analysis of the chain of deliveries for construction of one single family house in each of the Nordic countries. The Norwegian "case" house was under construction at Volda. The analysis shows a large complexity even for the last links in these chains, that is for the final transports to the construction site. In the Norwegian case only the final link deliveries are 18 covering a transport distance of 6500 km. For the four Nordic houses altogether there are about 300 different places where the deliveries come from (for all links in the chain). They are scattered all over Europe. Some places are even found in Canada, USA, Chile and Brasil (Hägerstrand & al., 1993).

5) Chapter 2 refers to the article “World in Environmental Transition”, published as an introductory chapter in the same book.

6) See Note 1.

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5. Rural industries and the Environment

5.1. What is the state of affairs of sustainability?

The main purpose of the research project which forms the basis for this article is to give a broad analysis of local and global environmental challenges which may have an impact on the future development of rural areas in Norway. [1)]

The relationship between rural communities and environment has been a subject for political debate in recent years. Whereas the sparse population and the environmental advantages of the rural industries were accentuated throughout most of the 1970s, it is rather the problems which have come to the fore when these issues are discussed now, 20 years later. Researchers have also taken part in these discussions. In the book *Norway in the Global Greenhouse* (Bergesen & al, 1995), the sparse population is emphasised as especially problematic, and the effect of the policy measures in terms of climate may be that people will have to migrate from rural to urban areas. Similar assessments have been expressed in ministerial reports (Miljøverndepartementet, 1991). In one of the main reports from our research project we conclude that there is not necessarily any basis for such assessments (Høyer, 1995)

It must be underlined that we are faced with complex connections. Furthermore, these may also contain highly different dimensions. Both the rural settlements and the rural industries cause environmental problems. In this respect there may be significant differences between urban and rural areas. Most importantly, however, major changes may have occurred over time, for example through the development of partly new rural industries such as tourism and aquaculture.

The environmental problems also have impacts in the society as well as in nature. There are other types of environmental problems and other types of impacts which are focused today than what was the case a few decades ago. Both industries and settlements are exposed to varying degrees, and once again there may be significant differences between rural and urban areas as to the extent and the ways they are exposed.

Similarly, there may be differences in the impacts of the environmental policy - or the environmental-political solutions. In this connection it may be a question of various categories of environmental policy measures, aimed both at industries and settlements. Economic policy measures in the form of CO_2 taxes on fuel are but one of many. Others may be the establishment of recycle systems for wastes, or new types of drainage solutions. These have consequences for the rural infrastructure. New environmental-politically based demands on the design of the infrastructure may lead to substantial changes in the future development conditions in the rural communities.
In this article the attention is focused on two rural industries, fisheries and aquaculture. They are both well suited for throwing light on all the key dimensions in the relationship

between rural community and environment we have outlined. They cause environmental problems, both locally and globally. The development over time illustrates how the environmental problems have changed in character. This forms the basis for discussing the concept of sustainable resource management and, consequently, some conditions for sustainable rural development. Either industry causes environmental problems which contribute to changing, even undermining the preconditions for future activities. In the same way, various types of environmental-political solutions will create new preconditions for the future development of these two industries.

The project has its starting-point in some basic theses. In the first place, it is the thesis of the increased significance of diffuse environmental problems. Somewhat simplified, we can distinguish between concentrated point sources of environmental problems on the one hand, and many small and dispersed - or diffuse sources on the other. The latter represents a situation in which every single source is so small that it appears to be insignificant, but where the sum effects, nevertheless, are very serious. This is a type of environmental issue which necessitates an attack on all the sources when solutions are to be implemented, regardless of their location, and independent of large distances between them or their being concentrated in a few areas.

5.2. Horisontal and Vertical Environmental Problems

In the second place, it is the thesis of the increasing horisontality of the environmental issue. Once more somewhat simplified, we can distinguish between a vertical and a horisontal environmental issue. Verticality is spatially confined. The environmental problems are created and emerge within the framework of limited local and regional resource streams. Horisontality appears in two ways. Firstly, the environmental problems which emerge locally are caused by distant sources, disconnected from local resource streams and completely outside local, or for that matter, national control. Secondly, the local activities themselves are sources of such environmental problems occurring at completely different locations. An obvious example is the introduction of restrictions on breast-feeding among Eskimos on account of added environmental poisons through the food chains in the ocean. Some of the environmental poisons come from the use of pesticides at far-away places in the world. Another example is the introduction of restrictions in parts of Australia as to the time school children are allowed to stay outdoors on sunny days. This is linked to the problems in connection with the stratospheric depletion of ozone caused by CFC gases emitted elsewhere on the globe.

5.3. “-the worst thing that has happened in the history of environment in Norway”

In the third place, it is the thesis of the double environmental crisis in rural areas. These areas have lost their environmental legitimacy from the 1960s and most of the 1970s. This applies not only to the rural industries, but also to the rural settlements. A clear expression of this is the fact that the former chairman of the Norwegian Association for the Conservation of Nature states that the development of aquaculture is the worst thing that has happened in the history of environment in Norway. He also maintains that we are now faced with something similar through the heavy investments in tourism (Malkenes, 1994).

If we go back about 20-25 years in time, the development of the traditional rural industries of agriculture and fisheries, as well as the strenghtening of the sparse population had both a regional political and environmental basis (Høyer & Selstad, 1991). The second aspect of this double environment crisis is the fact that the rural communities can be hit particularly hard by the impacts of the environmental problems. This applies both to the industries and to the settlements. It is a paradox that the environmental crisis may actually become a more urgent problem in rural than in urban areas. This has been discussed more thoroughly in one of the main reports of the project [2] (Høyer, 1995).

5.4. Environmental problems are created, not only solved

It happens that it is necessary to state the obvious. Environmental problems are not only something that is “solved”, they are also “created”. They are created by what we may refer to as resource mobilisation. Whenever resources are mobilised for human purposes, changes in the natural environment will occur. In turn, these changes are the causes of what we refer to as environmental problems.

We can make a distinction between quantitative and qualitative environment issues. In the former case, it is primarily the extent of the resource mobilisation which constitutes the problem. In the latter case, it applies to a larger degree to the way it takes place.

The greenhouse problem linked to the emissions of CO_2 is a typical quantitative environment problem. Nobody would suggest that we should not burn coal, oil, and natural gas. It is a question of extent. CO_2 is originally part of a natural cycle. The problems arise only when the man-made additions become too big. The same thing applies to area-linked problems. We must obviously have a transport infrastructure which necessarily ties up areas. The problems are above all linked to the fact that the area encroachments become too large.

From a historical point of view, a situation with urgent quantitative environment problems is not new. What is new is primarily the extent of the systems being destroyed or disturbed. For the first time in history we are faced with a situation where the really large global cycles are disturbed and where the entire global “common” is threatened.

If we take the long historical perspective into account, on the other hand, the qualitative environmental issue is new. It has followed the application of science-based technology. This is a development that was started in the mid 19th century, but which has accelerated particularly from the 1950s.

The qualitative problems occur through fundamental manipulations with the resources. The entire industrial production of environmentally alien substances, such as ozone-depleting CFC gases, is in this respect a qualitative problem issue. The same thing applies to nuclear fission, manipulation of organic molecules in petrochemical industry, as well as production of gene-manipulated organisms. One nuclear power station may cause more than enough problems. We do not need hundreds to achieve that. Similarly, a single gene-manipulated organism may cause enough havoc when it is released in natural ecosystems.
We use the term resource synonymously with natural resource. This is in itself a controversial concept in the environmental-political debate. [3] All the recent Norwegian

environment debate from the late 1960s has been focused on environment and resources. The resource concept has even had a particularly central position. Earlier works *by Hartvig Sætra* (1971, 1973) and *Ottar Brox* (1972) have undoubtedly been significant in this context. These provided an internationally unique connection between populism and international environment challenges. Even the first descriptions by Arne Næss (1976) of the deep ecology were strongly populistically inspired with husbandry and distribution of resources, devolution, local communities, regional development, and self-support as five of nine key elements (Høyer & Selstad, 1991). This is a paradox when we see how the Norwegian deep ecology later has inspired American environmental organisations in particular (Armstrong & Botzler, 1993).

Both in the Norwegian ecophilosophy and in the conception of environment it has given inspiration to in the environmental organisations, we find a dual attitude to nature. Nature is a resource. On the other hand, it also contains individuals, species, and systems with an intrinsic value. This demands respect and treatment regardless of the instrumental value for mankind. This view is not extraordinary. Traditional animal husbandry is based on the same duality. What is special is its strong foundation in the Norwegian conception of environment compared with other countries.

5.5. Ecological sustainability, what is it?

In the wake of the discussion on sustainable development we have seen tendencies, both within politics and research, of a narrow understanding of the concept of ecological sustainability. Within the fisheries this is turned into a question of keeping within the highest sustainable yield for the species. In principle, then, it may be ecologically sustainable to establish a fishery consisting of a small fleet of energy-demanding trawlers which take care to keep the catch of certain species within the sustainable yield. In principle, there is nothing wrong with exporting the fish products by jet plane to Japan, either.

Sustainable development is a wide concept. It consists of two main parts: “sustainability” and “development”. We are here concerned with the sustainability aspect. It is understood as ecological sustainability. Within the framework of a sustainable development, however, this is a far wider concept than that. The concept of ecological sustainability comprises the following; let us call them “prima characteristics”:

1. A resource exploitation taking place within the framework of the sustainable yield of the resource, including a safety margin for long-term uncertainty.

2. An environmental load taking place within the framework of the sustainable limit *of* tolerance of the ecosystems, once again including a safety margin for long-term uncertainty.

3. A resource exploitation and an environmental load maintaining a biological diversity both at levels of individuals, species, and ecosystems.

4. A resource exploitation and an environmental load showing consideration for nature’s intrinsic value. This makes the maintaining of biological diversity at all

levels an independent objective, regardless of whether this serves any human purpose or not. In the Brundtland Commission report, for example, special emphasis is given to the fact that the protection of nature is a *moral obligation* to other living species (Brundtland & al, 1987). A similar understanding is expressed in the Rio Convention on biological diversity (Utenriksdepartementet, 1993).

Of these follow several what we may call "secunda characteristics"*:*

5. The harvesting of resources must take place in such a way that the encroachments in the biological diversity are kept at a minimum. As for fisheries, this excludes certain types of fishing methods, among them trawling.

6. The harvesting of resources must take place in such a way that the resources are exploited optimally, so that the production of offals is reduced to a minimum. This excludes, for example, certain types of fishing methods in which secondary catches are scrapped.

   Some cases in point: According to *Peter Weber* (1994, 1995), prawn trawling in general implies secondary catch percentages of 80-90, or 10-15 million tonnes annually on a world basis. On the whole these are resources that are not exploited. Regardless of catch levels for prawns, this is not in accordance with ecological sustainability. In addition, from the Norwegian production of prawns we know that by-products corresponding to 70% of the catch volume of prawns are not further exploited (Rubin, 1994).

   The same thing applies to Norwegian cod fisheries. Of a total catch of 720,000 tonnes by Norwegian and foreign vessels in 1993, approximately 240,000 tonnes were dumped into the ocean or in coastal waters. This represented a doubling of the dumped volume from 1991, when the catch volume amounted to 490,000 tonnes. The increase to the 800,000 tonnes quota in 1994 will further increase the dumped volume (Rubin, 1994). It is more ecologically sustainable to limit the catch volume to a level where the by-products are exploited. This is corroborated by the fact that the dumping in coastal waters also constitutes local environment problems.

7. The harvesting of resources must take place in such a way that the total application of resources is kept at a minimum. This applies both to energy and material resources. This implies that particularly energy-demanding types of fishing methods are not in accordance with ecological sustainability, even if the harvesting takes place within the framework of the sustainable yield.

8. A wider concept of ecological sustainability means that it is the total consumption of energy and material resources which must be reduced. This requires life cycle analyses of each product and type of production in the society. The resource consumption of the individual productions and environmental loads must be monitored from "cradle to grave". It is not in line with ecological sustainability if an industrial enterprise carries out an "environmentally friendly" production of "environmentally alien" products. Similarly, it is not consistent with ecological sustainability to transport fish products by jet plane to Japan, even if the fishery itself is carried out within the framework of a sustainable yield.

9. In particular, the consumption of fossil energy resources must be reduced. This demands restrictions in the forms of harvesting, production, and transport with a high consumption of fossil energy. There are good reasons for maintaining that the fossil society and the mobile society are like Siamese twins. The expansion of high-mobile forms of harvesting and commodity transport is linked to the free application of fossil energy. Substantial reductions in the consumption of fossil energy will lead to less mobility. Alternative sources of energy do not give preconditions for sustaining a high mobility (Høyer & Selstad, 1993).

5.6. Exergy, information and resource quality

We turn to physics for basic definitions of the concepts. Put simply, energy is the capacity to do work. Work is carried out when a force moves an object over a certain distance. Still, we say that energy can be found at different quality levels, that is, with different capacity to do work. Besides, energy is found in many forms: heat energy, mechanical energy, electrical energy, chemical energy, light energy, and others.

When energy is applied, it is changed from one form to another. What happens then can be described through the two main laws of thermodynamics. According to the first law - the law of conservation of energy - the energy within an isolated system is constant. Energy can be changed in form, but it can neither be created nor destroyed. When it is applied to do work, and, consequently, changes in form, the total energy *volume* remains constant even after the transformation.

According to the second law - the law of entropy - there is still something that is always lost in such transformations. This something can be referred to as energy quality. This implies that any transformation of energy will be less than 100% efficient; some high-quality energy will always be transformed to low-quality heat energy. In this context we can say that there is also something that is generated; it is disorder or entropy. The concept of entropy gives a measure of the lack of quality. The inverse is negative entropy or negentropy. This is a direct measure of quality.

In brief, the two main laws of thermodynamics express that energy resources are carriers of quality. The volume remains the same, but at any stage in the transformation some of the quality is lost. It is the quality we can make use of. A similar connection can be expressed for material resources which can, therefore, also be understood as carriers of quality. *Hall, Cleveland, & Kaufmann* (1992) give a comprehensive discussion of the application of the concept of energy and resource quality.

Exergy can be applied as such a collective term. It is closely related to negentropy, and they always concur. If one of them is zero, so is the other. In its basic definition, exergy is the energy which is available as mechanical work. The concept of mechanical work may serve as an example of a completely ordered form of energy, that is, with zero entropy, which can be transformed to other forms of energy. At the same time it is a general term for quality and a measure of how much a system departs from equilibrium with its surroundings (Wall, 1977; Delin, 1981; Eriksson, 1983).

The more a system departs from equilibrium with its surroundings, the more information is needed to describe it - and the higher its capacity to carry information. Exergy and information - or information capacity - are for this reason closely connected. In this way resourecs can be understood as carriers of information. If we consider natural resources as informed matter and energy, and their transformations as transmission of information, this will provide us with a totality framework for resource analyses (Wall, 1977; Delin, 1981).

However, the relationship between thermodynamics and information is a controversial theme both within biology and physics. For an updated discussion of the controversies, cfr. Schneider (1988) and Weber & al. (1988).

5.7. In an ocean of exergy

In the concrete analysis of environmental problems linked to fisheries and aquaculture we start with the concepts of exergy, energy, and information.

Any system which is different from its surroundings contains exergy. The higher the contrast to the surroundings, the larger the exergy content. In a total levelling-out, that is, when the system does not differ from its surroundings, the content is zero. At the same time, it expresses that differences are a necessary condition for everything that has life and value. Thus, if we ask the question what we really live on, then the answer must be exergy. Without exergy no life-giving processes are possible. Nor will there be anything we could call “resources”. Even biological resources can be described in exergy terms. Exergy-rich sunlight is the energy behind the photosynthetic processes tying up the exergy in the biological resources. Energy flows through the various transformation stages in the food chains. According to the first law of thermodynamics, the total volume of energy is constant, but at any stage of transformation there is loss of exergy. For each successive stage less remains of the original content of exergy.

Biological resources consist of two types of exergy, chemical and structural. Chemical exergy accounts for most of it. With the intake of biological resources in the form of food, we consume both types. We need chemical exergy to provide us with our daily supply of energy. This is what we refer to as kilocalories. The structural exergy is needed to build up and maintain the various structures in the human body. Parts of the exergy - chemical as well as structural - still remain in the residue. This can be reused, both for energy purposes and as a basis for building up new biological structures.

The structural exergy of biological resources gives an opening for discussing the link to the information concept. A system which deviates significantly from its surroundings also has a high information level. Much information is needed to describe it. In all real transformation processes there is not only a loss of exergy, but a loss of information as well. We can have more or less efficient transformation processes leading to various degrees of loss of information. Consequently, resource husbandry is about establishing systems which can retain as much information as possible.

This leads us back to the fish. *Staffan Delin* (1981) has illustrated how the harvesting of fish resources can be understood in relation to the concepts of exergy and information. Fish carry out collection and distribution work when they swim around in the ocean, eating and transforming the nutrients. With their waste fish return a flow of nutrient salts to marine life. It stimulates their growth, and provides the basis for the development of more fish. Consequently, a larger proportion of the exergy-rich solar energy is taken care of over a larger area. It is used to build up complex structures, and a smaller proportion of the information capacity is lost.

Any harvesting of fish has an impact on these mechanisms. By depleting the fish stocks we remove structures which are carriers of information. It implies a reduction, not only in the rate of return, but also in the information of the system. The exploitation of the solar-energy exergy is reduced. A greater share of the solar-energy information capacity is changed to useless waste heat, and a smaller share will remain in biological structures (Delin, 1981).

5.8. In a net pen of exergy

In principle aquaculture can be an efficient way of building biological structures and retain the information capacity. It may even be highly efficient. *Åsgård and Austreng* (1994) show that by intensive cultivation of salmon, 0.46 kg of salmon can be produced from 1 kg of capelin, which gives 0.3 kg of edible fish meat. In natural systems, the same quantity of capelin will give 0.2 kg of cod, or 0.07 kg of cod fillet. A total energy audit for trawl fishing and the production of frozen cod fillet show an energy output factor of 0.04 (the relation between total energy input and energy in the fish meat, (Lorentzen, 1978)). In the opinion of Åsgård and Austreng, the cultivation of salmon based on capelin can give an energy output which is 10 times higher. Aquaculture also compares favourably with animal husbandry. Whereas 30% of the protein, fat, and energy in the feed remain in the edible parts of salmon, the respective percentages are only 18, 13, and 3 for chicken, pigs, and sheep. This is due to the fact that salmon has a higher share of edible muscles, but also lower loss of energy to heat and breeding (Åsgård & Austreng, 1994).

This is the reason why the initial building-up phase of Norwegian aquaculture was favourably received by Norwegian environmental organisations. Several leading persons in the environmental organisations actually entered research and education in this field. The reason for this was the importance we have previously referred to as the “resource view” had in the environmental understanding in the organisations. However, when the chairman of the Norwegian Society for the Conservation of Nature in the early 1990s, as mentioned, referred to the development of aquaculture as a disaster in Norwegian environment history, it is obvious that the experiences are out of proportion to the expectations. Why did it turn out like this, and what has this to do with exergy and information?

The efficiency in the transformation from feed to fish meat is obviously important. However, it constitutes but one of many links. In order to get a comprehensive picture of the economising of exergy and of the attention to the information capacity, we shall have to analyse what occurs in all the links of transformation. If not, we risk that efficiency in one link not only implies, but also directly may presuppose inefficiency in the others. This means that the exergy problems are just moved. It corresponds to the phenomenon "movement of environmental problems", that is, solutions to environment problems in one link of the chain lead to their being moved, or even reinforced, in other links and at other levels.

This is the crux of bitter experience. It is based on some key questions; where does the feed come from, and which exergy losses are linked to procuring the feed? To what extent are the waste substances from the fish returned to the food chains? To what extent does the production presuppose ecological system conditions implying loss of exergy and information through disease and death? To what extent does the production presuppose the use of species implying loss of information capacity in the total species system (spreading of diseases and genetic erosion)? In what way do we take care of the offals and dead fish? How is the produced fish meat used, and how is it transported?

Some connections are obvious. When a share of the feed supply is based on fish raw material from Chile, heavy exergy losses are linked to the transport. Intensive cultivation leads to a concentrated storage of nutrients in the form of feed waste and excrements. Exergy is lost when these are not, or only to a small degree, returned to the food chains. Besides, this leads to local pollution problems. Generally speaking, the local load of such waste substances is five-ten times higher with the present intensive cultivation compared with semi-intensive cultivation (Åsgård & Austreng, 1994).

5.9. Exergy and energy analysis

An exergy analysis of industrial activities such as fisheries and aquaculture implies a calculation of the loss of exergy. In other words, the loss of energy and material-resource quality in all links of transformation from the production of feed or the primary absorption of nutrients by the fish to the distributed fish meat to the consumer. This gives an opening for assessing the environmental problems. In all the links where the exergy losses are substantial, one can safely assume that significant environmental problems will arise. At the same time, this provides a basis for calculating the total exergy efficiency of the industrial activities. If it is low, the activity does not manage the information capacity properly, in addition to causing major environmental problems. In this way the activities can be subjected to comparisons. Such comparisons will reveal whether high efficiency in one link only occurs at the expense of lower efficiency in other links, in other words, that the exergy and environmental problems are moved.

Instead, we choose a somewhat simplified methodology which may be termed energy analysis. It includes energy quantity and not energy quality (=exergy). In each link in the industrial activities of fisheries and aquaculture the "consumption" of energy is analysed. Besides, some important environment indicators are linked to the quantities of energy consumed.

We concentrate our analysis on the following two items:

- Emissions of CO_2
- Emissions of NO_x

CO_2 (carbon dioxide) is the most important greenhouse-producing gas. NOx (nitrogen oxides) constitute an important source of a series of environmental problems, ranging from local health problems and regional acidification problems to global climate problems.

In accordance with the main objective of the whole research project, the analysis is carried out in the perspective of change as well as a local perspective. It has its basis in the following issues:

- How have the energy consumption and environmental problems in the two industrial activities changed over time, with special reference from the 1960s to the 1990s?
- How are these changes expressed in a local situation, viz. the municipality of Askvoll? In this lies naturally the limitation that there was no aquaculture activity in the 1960s, and very little in 1970s. On the other hand, it is of interest to look upon the relation between fisheries and aquaculture, and how any new dimensions in the consumption of energy and environmental problems are linked to the development of the aquaculture industry. This is based on the following issue:
- Does the development of aquaculture contribute to reducing the local attachment and to reinforcing the “globalisation” of the environmental problems?

5.10. The one-sided mobile-energy municipality

Figure 1 shows the total energy consumption per kilo fish for catch, cultivation, and transport/export of fish. The stastistical material is based on average national figures as of 1990. Two alternatives for fisheries are shown. The first one is coastal fisheries of cod fish with export of fillet products to Europe by boat. The second one is trawl fisheries of cod fish with export of fillet products to Europe by articulated lorry. For cultivation the one alternative is shown as an average of all export today (1990), whereas the second shows the average for the airborne export to Asia. This illustrates not only the significance in terms of energy of various types of operations and transport in the fishing industry, but also the substantial effects of an aquacultural industry which to a large extent is based on export by air to far-away markets.

***Figure 1** Total energy consumption for catch, cultivation, and transport of fish. National figures in KWh/kg fish 1990*

Coastal fisheries / fillet = Coastal fisheries of cod fish including boat transport to Europe
Trawler fisheries/ fillet = Trawler fisheries of cod fish, including lorry transport to Europe
Aquaculture / all export = Aquaculture including energy for the production of feed and
the average for all transport of whole fish
Aquaculture/ airborne export = Aquaculture uncluding energy for the production of feed and

the average for airborne transport of whole fish to Asia

After: Høyer & Groven (1995)

Figure 2 shows the development in Askvoll of the energy and emission coefficients of fisheries and aquaculture. The coefficients are per kilo fish. The figures for fisheries and aquaculture do not contain the production chain, that is, filletting, freezing, and so on. In line with the main objective of the project, the analysis includes only the mobile energy and the ensuing emissions.

Figure 2 *Energy and emission coefficients of fisheries and aquaculture in Askvoll, 1960 and 1990. Coefficients per kilo fish*

Fisheries = catch + transport of fish products
Aqua = production of feed + transport of cultivated fish
In all = fisheries + aquaculture

After: Høyer & Groven (1995)

The figure illustrates the development towards an ever-increasing energy and emission-intensive fishery. We see that aquaculture also in Askvoll gives extremely high figures per kilo fish compared with the usual mobile fishery. On account of relatively smaller quantities of fish, this does not have much effect on the total coefficients. However, this will occur if the aquaculture industry increases further in volume, and especially if such an increase is based on more airborne transport of whole fish to the markets in East Asia.

Figure 3 *Energy output of fisheries and aquaculture in Askvoll, 1960 and 1990. Energy output seen as the relation between nutritional energy and operational energy.*

Nutritional energy = kWh nutritional energy per kilo fish
Cod fish: 0.95 kWh/kg
Cultivated salmon: 2.22 kWh/kg
Operational energy = in all energy for catch, production of feed, and transport of fish products (per kg fish)

After: Høyer & Groven (1995)

Figure 3 shows how the development has resulted in a marked reduction in the nutritional energy output in fisheries and aquaculture. The output has been reduced by approximately 70% in the period, even if the cultivated salmon contains significantly more nutritional energy per kilo than the dominating cod fish species of cod and coalfish. This corroborates the critical comments we have expressed previously to the limited interpretations of the concept of “sustainable aquaculture”. Even if aquaculture seen in isolation gives a high energy output in relation to the energy content of the feed, the picture looks different when we include mobile enrgy for the production of feed and the transport of the fish products.

Figure 4 *Energy consumption and emissions for all transport, fisheries and aquaculture in Askvoll (1960-1990) and Norway (1990). Figures per inhabitant / day*

e/fishery = all transport energy in Askvoll excluding fisheries and aquaculture
in all = all transport energy in Askvoll including energy for fisheries and aquaculture
Norway 1990 = all mobile energy in Norway

After: Høyer (1995)

Figure 4 shows the development in energy consumption and emissions linked to all types of mobile energy in Askvoll. Except for fisheries and aquaculture this applies both to person transport and all other transport carried out by means of transport in the municipality.

The figure shows how the development within fisheries and aquaculture dominates the environmental load caused by industrial activities in Askvoll. It is clearly shown that this development has led the municipality into a situation where the energy consumption and the emissions of CO_2 and NO_x are three-four times higher per inhabitant than the national average. It can be descibed as a one-sided mobile-energy municipality. In this type of rural municipalities this dependence on mobile energy is substantially higher than what is usual nationally. It provides a parallel to the strong dependence of one-sided industrial communities on stationary energy for the energy-demanding industry.

5.11. What about sustainability?

In the wake of the discussion of sustainable development we have seen tendencies, both in politics and research, of a narrow understanding of the term ecological sustainability. In fisheries this is made into a question of staying within the maximum sustainable yield for the species. In principle, then, it may be ecologically sustainable to establish a fishery consisting of a small fleet of energy-demanding trawlers which make sure that the catch is kept within the sustainable yield. Consequently, there is in principle nothing to prevent the exportation of fish products by jet plane to Japan. It is evident that this is not consistent with the understanding of ecological sustainability which ensues from the term sustainable development, for example in the way it is described in the Brundtland Commission report. (Brundtland & al, 1987)

The analyses reveal a fishing industry which has become increasingly energy demanding, and a more important source of global environmental problems than previously. This is a development which is very clearly revealed in the rural municipality of Askvoll. Primarily because of the development in fisheries and aquaculture, it may be referred to as a «one-sided mobile-energy municipality». The total consumption of fossil-based, mobile energy may be three-four times higher than the national average, even higher than in urban areas, for that matter. If strict environmental policy measures are implemented in all mobile sectors, and not only in terms of person transport, this indicates that the effects will be especially harsh for rural communities like Askvoll. However, the effects may not necessarily be completely negative. Strict environmental policy measures of this type will not be applied in a social vacuum. They will imply a restructuring of the fishery industry. The effects can be more small fishing vessels, more fishermen, and a firmer basis in local/regional resources. In that case, it will bring back a stronger element of the classical, resource-based rural industry. Similar conclusions are drawn in a major international study. This study emphasises that management and restriction of the energy consumption in the fishery industry is a vital policy measure not only to reduce the environmental problems in this industry, but also to establish an ecologically sustainable management of resources (Hall, Cleveland & Kaufmann, 1992)

The analyses of the aquaculture industry in Askvoll reveal that the development has moved in a favourable direction in terms of local environmental problems, local pollution, and the use of medicine. At the same time, however, they show an industry which has developed markedly from a local/regional to a global environmental issue. In order to supply important markets in Asia and America with fresh fish from the aquaculture stations, the transport takes place by plane. This leads to an 11 times higher consumption of energy and emissions of greenhouse gases compared to transportation of frozen fish by boat. At the same time, almost half the raw materials for Norwegian aquaculture production in recent years are imported. Approximately a quarter of the imported fish raw material comes from Chile, and a major share of the vegetable raw materials come from North America. This means an industry which has increasingly become globalised, resulting in a high consumption of energy and substantial emissions of greenhouse gases. In this way, what could have become a sustainable rural industry, has become a significant contributor to the gravest global environmental problems. Even if the local environmental problems have been reduced, this development has resulted in an industry with a very limited basis in local resources. An alternative development based on principles for ecological sustainability would imply a strengthening of the local basis. However, it would not provide the basis for the production volumes currently developed. This means that the application of strict environmental policy measures would lead not only to changes in the aquaculture industry, but also to a reduction of today’s activity level.

The total picture shows development features which are typical both of the rural industries and the rural settlements. This is confirmed by the study on person mobility conducted in the project (Høyer 1995). Both the industries and the settlements cause environmental problems of a global character. These are problems with such grave consequences that they contribute to changing, partly undermining the preconditions for future activities unless far-reaching environmental-political policy measures are implemented. Similarly, any application of such policy measures will create new preconditions for rural development. It is the latter point we can refer to as sustainable rural development.

The significance of the mobile energy has been emphasised. When the rural municipalities of the 1990s can be described as one-sided mobile-energy municipalities, and the rural industries have become global mobile industries, this underlines the challenges we are faced with. A sustainable development demands strict environmental-political policy measures especially to reduce the mobility and reduce the society's application of mobile energy. It will have social effects. It can be argued that these policy measures to a large extent will benefit the rural areas, for settlements as well as for industries (Høyer, 1995; Høyer & Groven, 1995). A sustainable rural development, therefore, is not only socially necessary. From the point of view of the rural communities it is even desirable.

5.12. Notes

1) In the project the relationships between rural community and environment are analysed over time. This is done by comparing the environmental situation in two periods of time, 1960 and 1990. In addition, we have included assessments of how the environmental challenges will turn out in the future. We throw light on the problem approaches for two typical rural municipalities, Askvoll in the county of Sogn og Fjordane, and Hemsedal in the county of Buskerud. This article, which mostly deals with fisheries and aquaculture, applies solely to Askvoll. Further documentation is found in Høyer & Groven (1995).

2) For instance could "the greenhouse effect" have substantial impacts on production conditions in biological industries. When changes corresponding to ten thousand years of natural climate changes are taking place in the course of a century, new presuppositions arise as to the location and quality of rural communities. It can though be argued that it is in the best interests of rural areas that sustainable policies are implemented to prevent our moving into the "greenhouse society".

In the same report (Høyer, 1995) I also consider a phenomenon like "acid rural areas". The acidification of soil and water is primarily a problem for and in rural areas. It has an extent which has both short-term and longterm effects for the conditions in rural communities. The effects are large even today. They imply reduced income possibilities, reduced harvesting of resources in rural areas, and reduced values connected to the rural population's own participation in leisure activities.

Even the term "rural areas in ozone" is used. The health effects of too high concentrations of ozone are felt throughout the country, even in rural areas. Crop damage in agriculture, and a possible reduced forest production, already have substantial economical impacts on the biological industries.

3) Some refrain from using it at all. It is understood as an anthropocentric concept. Indeed, some link it even to technocentrism. The use of resource as an expression for nature supports conceptions of a nature which is solely ascribed an instrumental value for mankind, and which we are at liberty to recreate for our benefit by means of technologies.

This dissociation from using the resource concept is fairly widespread in European and Amercian environmental organisations. This is with insight discussed by *Anthony Giddens* (1994) in his book “Beyond Left and Right”. He links the use of the resource concept to “environmentalism” or “shallow ecology”, while within “ecology” (or “deep ecology”) such a concept is not accepted at all. Nature is there considered to be a whole within a holistic framework. As I have shown this is not quite consistent with Norwegian ecophilosophy and the original presentations of “deep ecology” by *Arne Næss* (Høyer & Selstad, 1991).

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6. Sustainable tourism - or sustainable mobility?

The Norwegian Case

6.1. Abstract

This paper gives a critical discussion of the internationally prevailing understanding of the concept "sustainable tourism". It is argued that the current focus on stationary activities and local, intensive environmental issues is too limited both in relation to the concept of tourism and the concept of sustainable development. There is no tourism without travel. And, as shown in a Norwegian research study, tourism travels are major sources to serious environmental problems. The paper emphasizes that sustainable tourism should be linked to a concept of sustainable mobility. However, such a mobility would imply not only a change in the means of transport but also a reduced level of mobility in the rich part of the world. As this would give basis for new forms of tourism, other than those solely based on auto- and aeromobility, it represents a major challenge for the future development of tourism.

In the book *Transport for Tourism,* S.Page (1994) emphasizes that in spite of a comprehensive research in recent years on the areas of "transport and environment" and "tourism and environment", these are in most cases still seen as isolated from each other. Later in this article I will show that this is to an even larger extent the case when we introduce the concept of *sustainable development* instead of "environment". Page also underlines the importance of getting more knowledge on environmental impacts both of tourism-related transport infrastructure and the transport itself.

One of the few attempts at making an empirical survey of the connections between tourism, transport, and environment has been based on Tyrol, the most important tourist region in Austria (Langer, 1995). The results from this empirical study can probably to a large extent be transferred to the adjacent regions in Switzerland, Northern Italy (South Tyrol) as well as the Alpine regions in the south of Germany. They may, in addition, have relevance to other nature-based destination areas at a regional level, for example in Scandinavia (Teigland & Holden, 1996).

The conclusion is that *40-60%* of the environmental loads linked to tourism are caused by the *transport* of tourists between their homes and the destinations in Tyrol, as well as in the *local transport* within the destination area. The environmental loads do not only include the impacts of the energy consumption, but also noise, other types of pollution, wastes, and encroachments into landscapes and housing areas. A smaller share, *20-30%* are linked to the activities of the tourist industry within the destination area. This applies to facilities for accommodation, restaurants, and other types of related services. These loads are primarily linked to land use and landscape encroachments in constructing the facilities. They are to a lesser extent linked to operation. The remaining 20-30% are loads in connection with the tourists' own leisure and recreational activities (Langer, 1995).

The analyses from Tyrol focus on connections between tourism, transport, and environment within a large region. If we move down to a *location* and *attraction level*, we can refer to more results, both in terms of impact studies as well as of implementation of measures to manage and limit the tourism-related transport (Teigland & Holden, 1996; Høyer & Simonsen, 1996).

When it comes to measures for transport restrictions at town level, the Swiss towns in the association called *GAST* (Gemeinschaft Autofreier Schweitser Touristmerorte) are of special interest. It encompasses nine smaller tourist resorts. All of them are totally or virtually car free. The aim of GAST is to work for the development and promotion of common interests with other car-free towns in Switzerland. This implies common policy measures and initiatives to implement car-free towns in all its member towns , as well as to apply uniform standards for developing forms of tourism with a minimum of environmentally harmful transport (Høyer & Simonsen, 1996).

It is underlined that if the concept "car free" is to be something else than a simple marketing gimmick, the towns must remain car free throughout the year, and not only in the tourist season. A parallel is found on the Greek island of *Hydra*, a two-hour voyage from Athens. A complete freedom from motorised vehicles is vital in the profilation of the island as a tourist attraction. There is not only a ban on motorised vehicles; it even applies to bicycles. Besides the use of boats to the beaches, the means of conveyance are donkeys and shank's mare. The utility transport is carried out by means of donkeys and handcarts (Høyer & Simonsen, 1996).

The case of Hydra provides us with a distinction between two different perspectives as to how the relations between tourism, transport, and environment can be understood. The island is in itself free from environmentally harmful means of transport. On the other hand, this does not apply to the many transports tourism on the island depends on. To a large extent these transports are carried out by cruise boats and by a combination of planes and express boats. These are means of transport with the highest environmental loads, at least when it comes to energy consumption and emissions of greenhouse gases (Høyer & Simonsen, 1996).

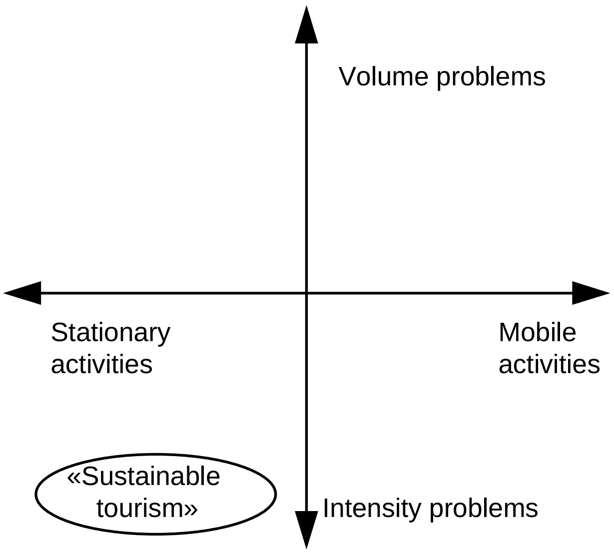
Hydra represents what we can refer to as an *intensity perspective.* The attention is here directed towards the problems caused by an accumulation of transport means within defined local areas. This is a prominent perspective in the ways cities today seek to solve environment and health problems caused by *traffic*. In the case of Hydra there is an awareness that the island's basic qualities as an attraction will perish if the ban on motorised vehicles were to be lifted.

Whether the global environment is destroyed by all the transports taking place to and fro is a matter outside such an understanding. On the other hand, it is of superior importance in an alternative *volume perspective.* The focus is here on the problems caused by the total transport volumes independent of geographical limitations. Later in this article, I shall present some results from a research study which has analysed tourism-related transport to, from, *and in* Norway based on this perspective.

6.2. Perspectives on sustainable tourism

The intensity perspective forms the basis of an internationally prevailing understanding of the concept of *sustainable tourism,* admittedly without a focus on transport. In *Figure 1* this understanding is placed in relation to two dimensions: *Volume / intensity* problems along the one axis, and *mobile / stationary* activities along the other.

Figure 1
The internationally prevailing understanding of sustainable tourism



The domination of the intensity perspective is evident in a number of books and articles published in the 1990s. According to Butler (1993), sustainable tourism is tourism of a type that makes it sustain its viability in *one area* for an indefinite period of time. A similar definition is given by Squire (1996). In several studies attempts have been made at applying the concept of *carrying capacity*. This refers to the maximum number of people who can use *an area* without an unacceptable reduction in the quality of the experiences that visitors may gain (Williams & Gill, 1994). In an article analyzing conditions for the transformation of eco-tourism into sustainable tourism Welford & Ytterhus (1998) similarly limit this to issues raised at the local level. Their conditions for sustainable tourism are very much the same as the core indicators of such tourism developed by WTO (1995). All these works in addition exclude transport-related problems from their analytical framework.

These are perspectives which have been met with criticism by some. Hunter (1995, 1996), underlines the fact that sustainable tourism must primarily be developed in the point of intersection between tourism as a global phenomenon and sustainable development as a global task. In his opinion, the focusing on defined destination areas by trying to implement policies and measures for a sustainable tourism implies a danger by ignoring the further connections the area is a part of. Similar assessments are given by Müller (1994).

The limited application of the concept appears somewhat paradoxical in view of the understanding of sustainable development expressed in the Brundtland Commission report (WCED, 1987). Key characteristics are ecological sustainability, globality, and fair distribution over time and in space. The distribution aspect is linked both to benefits and burdens. In a historical perspective, there is nothing new in the fact that limits for ecological sustainability are exceeded, locally and regionally. The crucial challenge is that this now also is a global phenomenon. The sum of the man-made encroachments has become too big, even when what happens locally - within the local context - is not. This may be referred to as "the tyranny of the small decisions" and expressed as a *volume problem.*

Based on such an understanding, an analysis of the potential ecological significance of the encroachments should be placed in a global context. Management tools and initiatives should be based on distribution criteria. As long as there is a *global common* with a limited extent and capacity, the basic principle must be that everybody has a similar right both to exploit the benefits of the common as well as bringing upon it loads which in sum are within the limit of what it may tolerate. These "all" are both present - poor and rich alike - and future generations. This requires that those who today exploit the common most, should also assume the largest burdens to remedy the existing overload. The types of encroachments tourism represents cannot be exempted from such demands, especially when they are linked to a concept like "sustainable tourism" (Lafferty & Langhelle, 1995; Høyer, 1997).

In *Figure 1* the concept is also placed in relation to another dimension: *stationary / mobile activities.* This brings us back to the introduction to the article. "Tourism and environment" and "transport and environment" have to a large extent been treated as isolated research themes. The same applies when "sustainable development" is substituted by "environment". Not only is this the case in a volume perspective, but also in an intensity perspective. This is evident in several studies on *sustainable urban tourism* (e.g. Burke & Newton, 1995; Hinch, 1996). Environment and health problems caused by transport represent one of the major challenges for the development in large cities, both in industrialised and developing countries. Both short-term and long-term precautionary measures and initiatives to reduce such problems constitute a central component in the international concept of "Sustainable Cities" (EU/COM, 1990, 1996; Næss, 1995). We know that in major tourist cities such as Paris, the tourism-related *traffic* is an important source of local noise and pollution problems (Teigland & Holden, 1996). This underlines the paradox that there to such a large extent is used a concept of sustainable tourism which does not include transport. Hjalager (1996) even argues for actively not including issues about reductions in travels; "Tourism and travel will probably continue to grow. Thus, we are left with the problem of how to plan and regulate tourism in order to limit environmentel damage and to harvest the benefits of sustainable tourism" (p. 214).

Below I shall discuss some more principal aspects of the missing link of transport in the sustainable tourism concept. The first aspect is *etymological*. The second is *generic*, the third *evolutionary*.

6.3. Tourism without travels?

"Tourism" has its origin in the word "tour". It is etymologically derived from the Latin *tornare* and the Greek *tornos,* that is, the movement in a circle around a central point or axis. The word tourism, then, actually means taking a round trip. The core lies in the movement itself - away from the starting-point and back again (Theobald, 1994).

This is expressed in the generic application of the term. There are, indeed, a number of definitions of tourism. Broadly speaking, they can be placed in two different categories: *conceptual* and *operational* (Theobald, 1994). The former comprises those definitions which seek to establish a framework for identifying significant characteristics of tourism. One case in point is:

> "Tourism is recreation in connection with movement, where one participates in activities away from the home, and where the travel itself is at least a part of the satisfaction sought."

Operational definitions have a more targeted objective. They seek to establish an overall framework for the collection of statistical data both nationally and internationally, for example, so they can be used as a basis for comparative studies (Theobald, 1994). The World Tourism Organization has provided such a definition which is frequently quoted:

> "Tourism includes all travels which imply a stay of at least one night, but less than a year, away from the home."

This definition has been applied in our study, from which I shall later deal with the results.

My primary concern, however, does not lie in the significance of various categories of definitions, but rather in the prominent position occupied by the travel itself, regardless of the definition used. This is in line with the etymological origin of the concept. In some countries, Norway for one, this appears in the common use of *travelling* or *touring* with the same meaning as tourism above, and tourism is actually called *travel industry* in Norwegian. There is of course no tourism without travelling. Admittedly, we may have sustainable *development* without tourism, but there can be no sustainable *tourism* without travelling. In order to travel, we need means of transport.

The *evolutionary* aspect underlines the close relations between the development of tourism and transport systems. We cannot have any type of tourism in combination with any type of transport. The volumes and the forms of tourism representing the major challenges in a sustainability context have their basis in the growth of certain transport systems, primarily linked to the transport means of *private car* and *aeroplane.* In the latter case, we may even call it a strongly mutual relation; the substantial growth in international air transport in recent decades would not have been possible without a corresponding growth in international tourism.

As a matter of fact, we can draw the historical threads linking the development of *mass tourism* to the development of transport systems even further back than that. *Shaw & Williams* (1994) outline five historical phases in the development of mass tourism, all linked to the growth of certain transport systems. The first phase dates from the 1920s and 1930s in the USA, linked to the the extensive proliferation of the private car which occurred in those decades [(1)] .

In the course of the 1920s, approximately half of all American households had become owners of at least one car. This was a car density reached 40-50 years later in European countries. The first proliferation of cars in Northern Europe in the 1950s formed the basis for the second phase of mass tourism, but also the development of public transport systems such as train and bus were important in some countries. This was a type of tourism which was of a mainly domestic character, with destinations in coastal and rural areas.

The development of *air transport* is the vital precondition for the next three phases. With the planes it is the international travels which dominate the further growth of mass tourism. From the late 1950s and the early 1960s there was a third phase with mostly American and Canadian tourists in movement across the American continent and the Atlantic. In the fourth phase, a europeanisation of this international tourism took place from the 1960s. To a large extent the movements occurred between countries on the European continent. This was the beginning of charter-plane tourism from Northern Europe to sunny coastal areas in the south. However, linked to the substantial growth in car density, this also included significant increases in the volume of international motoring.

The fifth and so far the latest phase has been under development in the last couple of decades in the 20th century. We can now refer to a *globalisation* of mass tourism. The destinations have become more and more remote, and the movements take place both to and from more countries and continents. Americans are not the only ones travelling to new places; America itself has become a major destination for tourists from other continents. New destinations and tourism groups arise in South-east Asia, Japan and Africa. With the present development in the world economy in mind, we may predict a *sixth phase* in the first years of the next millennium: the Chinese under movement to other continents. This globalised mass tourism is solely linked to the international development of air transport.

6.4. The growth in mobility

The growth in person mobility is a conspicuous feature in the development of industrialised societies. *E. Tengström* (1995) links this to the very phenomenon of *modernity*; individuals living in modern, complex societies have over a long period of time been expanding their mobility, and they have done so for a number of reasons. Modern man is frequently extremely mobile, and modern woman obviously strives to reach the same level of mobility (Tengström, 1995).

M.Walzer (1990) maintains that mobility is deeply rooted in the liberal ethos. In his opinion, we are at present living in thoroughly unstable societies, where the individuals continuously are in motion, frequently in loneliness and apparantly at random, imitating what physicists call Brownian movements. According to Walzer, there are *four types of mobility*, all of them interwoven: *geographic*, *social*, *marital*, and *political* mobility. The effects of the four mobilities are strengthened in various ways by other societal development features we tend to link to a common metaphor for *movement*: the dissemination of knowledge, technical progress, and so on.

Such theoretical perspectives highlight the fact that mobility does not occur in a societal vacuum. We cannot have any mobility volume in a combination with any type of society.

Similarly, mobility has no environmental neutrality; consequently, we cannot have any mobility volume with any type of environmental state. The idea of the societal and environmental neutrality of movements - or mobility - prevails in many contexts. In the brilliant, brief article *Mobility*, the Swedish geographer *T. Hägerstrand* (1993) links this to the growth of the mechanistic world view after Galileo and Descartes.

Mobility is not only linked to modernity, but also to late-modernity or the *post-industrial* society. *B. Vilhelmson* (1988; 1990; 1992) outlines three phases in the growth in mobility. The first phase is *geographical stability* with societies dominated by traditional rural structures and low mobility. The second is the main phase of the industrialisation, described as *geographical specialisation.* Mobility increases, but it is characterised by transport streams to fixed nodes in space. The last phase - *geographical flexibility* - is linked to the post-industrial society. The growth in mobility is strong, but who - or what - is being transported operates in relation to a diversity of nodes in space. There are major shifts in the course of the day, the week, or the year. This is a mobility marked by a high degree of spatial interaction. Vilhelmson links a substantial growth in *leisure mobility* to this phase.

It is primarily the proliferation of the car which has made such a phase possible. With the proliferation of cars completely new perspectives were attached to time and space. And it was only with the advent of the car that we got a transport system which gave us both a large geographical range and individual freedom of action, at the same time as it became available to the large majority of people. The old travel post system had the same characteristics, but was reserved only for the few (Rosengren, 1996). We can link the concept of *automobility* to a mobility which has the car as its dominant presupposition (Tengstrøm, 1995).

Table 1 shows the development of the domestic person mobility in Norway since 1855. In this case we use travel distance as an indicator expressed in the number of kilometres each inhabitant on average covers each day. The table only includes the mobility linked to the use of transport means. Walking is, consequently, not included, nor is the use of bicycle. However, the use of horses is an important part of the mobility figures in the last century and the first decades of this century (Høyer, 1995)

Table 1 *The development of person mobility in Norway. Kilometres per inhabitant per day*

	1855	1875	1900	1930	1950	1960	1970	1980	1990	1995
Bus, train, tram					3.30	3.80	4.00	4.70	4.10	4.20
Private car					1.20	3.60	12.60	20.40	27.00	26.60
Aeroplane					-	0.08	0.40	1.00	1.70	2.20
Other					0.70	1.32	1.30	1.10	1.30	1.60
In all	0.05	0.15	0.50	2.50	5.20	8.90	18.30	27.20	34.10	34.60

Sources: Høyer (1995; 1996)

The mobility today accounts for approximately 35 kilometres per day per inhabitant. This is about a four-fold increase since 1960, and a doubling since 1970. What we have referred to as *automobility* is clearly the predominant factor behind this increase. At present, it makes up about 80% of the average mobility. In 1960, Norwegians moved nearly four kilometres per day by private car. Today this has increased to approximately 27 kilometres. The public transport means on the ground give a total of about four kilometres per day. This figure has remained relatively constant in the past 40 years. This underlines the fact that we cannot reach any mobility level based on such (environmentally friendly) transport means. Similarly, they will also by themselves put restraints on the character and volume of tourism.

The public transport mobility in the air has increased five-fold since 1970. Only in the course of the past 15 years it has been more than doubled. Unless extremely restrictive measures are implemented, it seems as if this increase will continue. In this respect it should be emphasised that the figures in the table do not include mobility outside the national borders. We know that the air-based mobility in particular is high when international flights are included. This has been documented in our study which I shall refer to later. The study reveals that the air mobility linked to tourism alone accounts for approximately six kilometres per day on average, or about three times the figure in table 1. This is a mobility very much on the increase. We can link the concept of *aeromobility* to a development in which plane travels occupy an increasingly larger share of the overall person mobility.

6.5. Leisure mobility and tourism

A distinction can be made between person travels taking place in the *tied* and *untied* time. Within untied time we can distinguish between production travels (work and service travels) and reproduction travels (shopping and care travels). The travel purposes in the untied or *free* time include entertainment, recreational activities, holidays, visits to friends and acquaintances, etc. These are all travels characterised by a high degree of freedom, and the travellers themselves have much influence on the travel pattern. Tourism has its substantial basis in this *leisure mobility* (Høyer, 1996).

B. Vilhelmson has provided especially valuable contributions to the studies of this type of mobility. His analyses of data from Swedish travel patterns surveys date back to the mid-1970s (Vilhelmson, 1988; 1990; 1992). He emphasizes the fact that the increase in leisure mobility is the most conspicuous feature in this development. Regardless of indicators used - travel time, travel distance, travel frequency - the analyses show that travels of the free time make up about half of the total.

This correlates well with the results from my own analyses of Norwegian travel patterns surveys as shown in *table 2* (Høyer, 1995).

***Table 2** Travel distances, travel time and travel frequency for various travel purposes in Norway. Persons above the age of 13. Figures for 1992*

Travel category	Travel purpose	Travel distance km/day	Travel distance (%)	Travel frequency (%)	Travel time (%)
Production	Work Business School	14.7	34	30	30
Reproduction	Shopping Service Care	6.7	16	30	20
Free time	Entertainment Recreational activities Holiday / Weekend Visits Misc.	21.8	50	40	50
In all		43.2	100	100	100

Source: Høyer (1995)

The table shows that about half of the average travel time and travel distance in Norway is linked to leisure mobility. The percentage of number of travels, that is, travel frequency, is somewhat lower. This is due to the fact that for reproduction purposes in particular there is a relatively higher share of short, frequent travels. The figures apply for all types of travels. The less frequent long travels, such as holiday travels, have been converted to a daily average.

According to this table, the total daily mobility is 43.2 km per day. This is higher than the 34-35 km shown in table 1. The most important reason for the discrepancy is that the earlier figures apply for an average of the *whole* population, whereas in table 2 the figures apply for people aged above 13. In addition, the latter table includes movements carried out by means of walking and biking.

It is travels with private cars and airplanes which constitute the dominating share of the overall person mobility in all advanced industrialised countries. Measured in terms of the number of kilometres each inhabitant on average moves in the course of a year, they amount to a total of 80-90%. This implies that transport would hardly have been an environmental problem without the growth of these two means of transport. Similarly, there would not have been any reason for putting a theme such as *sustainable mobility* on the agenda.

Throughout this century, there have been obvious relations between the transport means of private cars and airplanes on the one hand and leisure mobility on the other [(2)] . Indeed, in the case of the car, we can go back all the way to the final years of the last century. Coupled with the development in leisure mobility, there has been a development of dominating forms of tourism.

The car was not something that should be used - or needed to be used - to go to work or to go shopping. People still walked, used the bicycle, or took the bus or tram (Welle-Strand, 1981). The car was a means of transport to take the population of industrialised cities out into the invigorating country air. It was, for example, advertised that driving would prevent diseases, mainly tuberculosis; the fresh air stream would activate the lungs of drivers and passengers, and thus be beneficial to the respiratory organs (Høyer, 1995; Tengström, 1991).

The stream of cars out into the rural areas gradually formed the basis for a tourist industry. This has been described by *Belasco* (1984), who has analysed the travel patterns of the early American motorists. In the first period - 1900-1920 - primitive camping prevailed. This led to litter problems, at the same time as farmers reacted to campers trespassing on their properties. In the second period - in the 1920s - a number of municipal camping sites were established of varying standards and services. This became popular among motorists who drove further in their holidays and weekends than before. Standards increased with the gradual development of camping cabins as part of the services offered. This meant an extended basis for a tourist industry. In the last period - in the 1940s - it is the hotel interests which win the competition for the motorists through the establishment of chains of motels along the roads (Tengström, 1991).

A similar development for Norway has been described by *Welle-Strand* (1981), but occurring 30-40 years later. As early as in the 1930s, Norwegian farmers along the roads advertised “rooms for rent”. However, it was only with the lifting of the car import restrictions in 1960 that the development really accelerated. As Welle-Strand points out, it was not the tourist bosses or researchers who discovered the economic opportunities in the fast increasing car use. It was the rural population itself who built numerous camping cabins. Later in the 1960s, camping sites were redeveloped for cars towing the new caravans. In the last decade, they have also been working to create a business out of the increasing foreign camper van tourism.

However, the relations between air transport and tourism is even more conspicuous. With the plane the real increase in distance could take place. The first charter planes from Norway and other Northern-European countries took off in the 1960s. At the other end a speedy development of new hotel resorts took place in the Mediterranean countries, first on Mallorca and along the Italian and Spanish coasts. Later this spread to the Portuguese coast and new Greek islands. Compared with car tourism, air-based tourism is characterised by strong concentration. The travels take place from (airports) and to (hotel resorts) concentrated points. At either end environmental loads arise besides the diffuse loads caused by the travels themselves. When there are enough points, the loads are also generated over larger areas. The airport landscapes themselves appear as aesthetic as well as partly ecological catastrophes. But no less conspicuous are the total loads in terms of landscape and water pollution impacts all over the Mediterranean. Without a basis in air transport, such a development would not have been possible.

6.6. Tourist travels as volume problems

In the last part of this article I shall present the results from a research project where we have analysed the volume of tourist travels and its significance in an environmental context. The project has been carried out for the Norwegian Ministry of Industry and Energy, but it forms a part of a major research project on environmentally adapted tourism for the Norway Research Council. Methodology and results are reported in *Høyer & Simonsen* (1996).

The project is confined to an analysis of environmental *impacts*, that is, the extent of the impact factors which imply changes in the environmental state. It is also based on a limited number of *indicators* for impact. These are: consumption of energy, land consumption, and emissions of CO_2, NOx, CO, VOC, and SO_2 (3) . Land consumption is used as an indicator for various relations between transport, environment and land use.

The analyses of the transport volume comprise all tourism-related transport both in Norway and to/from Norway, that is, person transport linked to Norwegians going abroad *as well as* person transport linked to Norway as a destination and tourist country. This means that special calculations are made for travellers from a series of countries, linked to combinations of the number of travellers (persons), distances, and means of transport. The figures for Norwegians travelling within Norway are based on data from the latest national travel pattern survey (1992), linking travel purposes – holidays and leisure time – to different transport means. These data also give figures for Norwegians travelling with cars and ferries abroad, while figures for Norwegians air-travels to different destinations (countries) abroad are produced from the particular surveys on travels to and from Norwegian airports. Statistics made available from the Norwegian tourism marketing organisation (NORTRA), and based on international surveys summarized in the European Travel Monitor (1992), give figures for the numbers of foreign tourists and their countries of origin. Linking different nationalities to the use of different transport means is based on data from several national tourism travel surveys (Høyer & Simonsen, 1996).

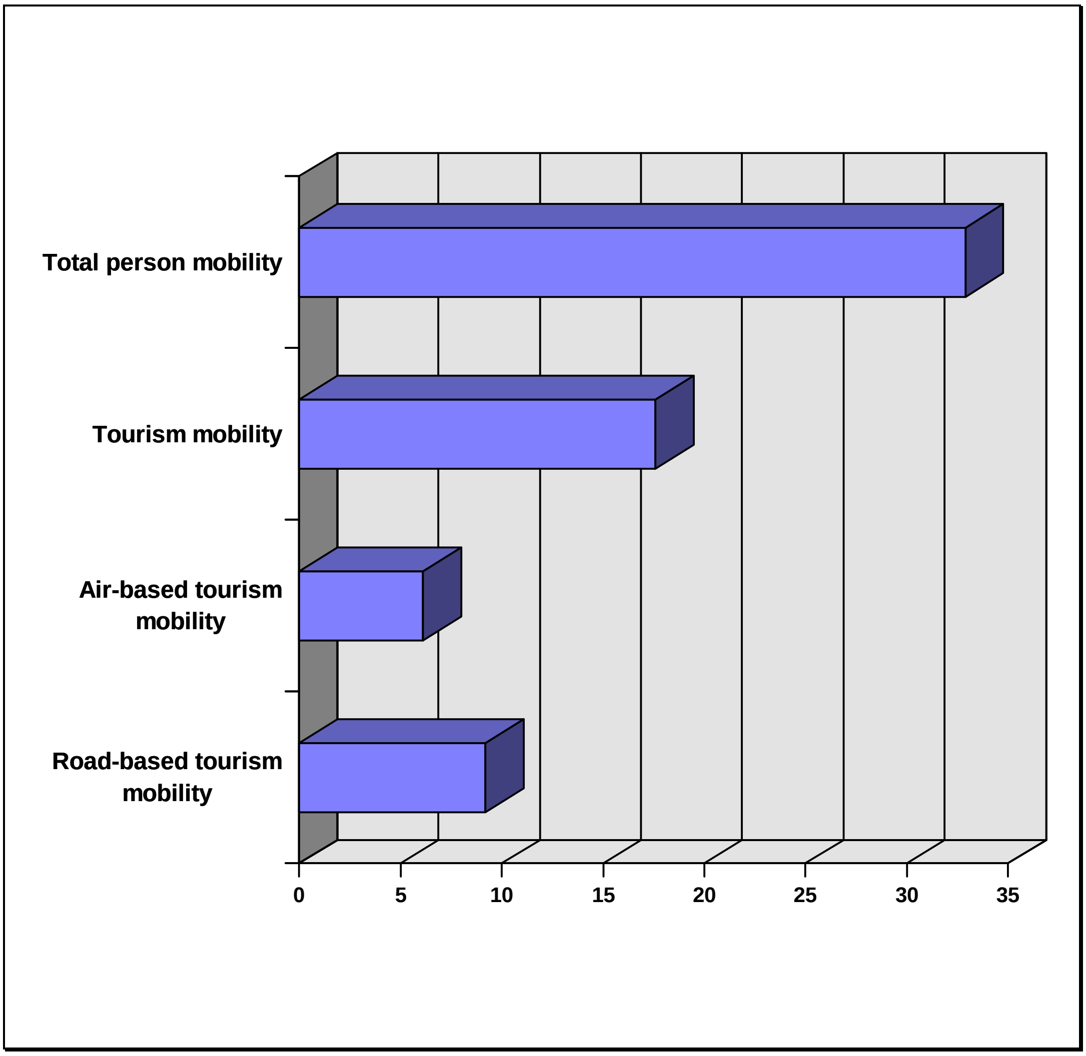
The following means of transport are included in the calculations: private car, motor caravan, camper van, bus, airliner, charter plane, train, ferry, coastal steamer, and leisure boat. The reason for such a detailed division is the fact that different sizes of the environmental indicators are linked to the various means of transport. Figures used for these indicators are based on former works made by Western Norway Research Institute (Høyer & Heiberg, 1993). Load factors used for tourism travels with the different transport means are based on data from the national tourism travel surveys (cars and vans) and data from transport companies (buses, trains, ferries, boats and airplanes).

The analyses show that the total volume of all tourism-related transport in and to/from Norway is about 37 billion person km (in 1992). The travels carried out by Norwegians constitute a dominating share, approx. 27 billion person km, or 74%. In comparison the total *domestic* person transport work was approx. 52 billion person km in 1992. Tourism-related transport, then, has a substantial share in volume.

For the individual means of transport there is good reason to underline two points. The first point is the large volume of air transport which accounts for approx. 30% of the total tourism-related transport. This is to a large degree linked to the extent of Norwegians travelling by air. It corresponds to as much as 70% of the sum of all road-based tourism transport. The second point is the relative large extent of Norwegians crossing the Skagerak and the North Sea by ferries solely for leisure purposes.

The significance of tourism mobility is illustrated in *figure 2.* For all person transport carried out by Norwegians the average mobility is about 33 km per day and per inhabitant in 1992. The total tourism-related mobility makes up about half of this, or about 17 km per day. On average, then, every inhabitant in Norway travels 17 km per day to fill his life with tourist-related activities. These travels take place both within the country and abroad. Of the 17 km, the air-based tourism mobility constitutes about 6 km. The road-based mobility is obviously larger, but the difference is still not significant. It represents a marked contrast to the distribution of the total person mobility, which is predominantly road based as shown in *table 1*.

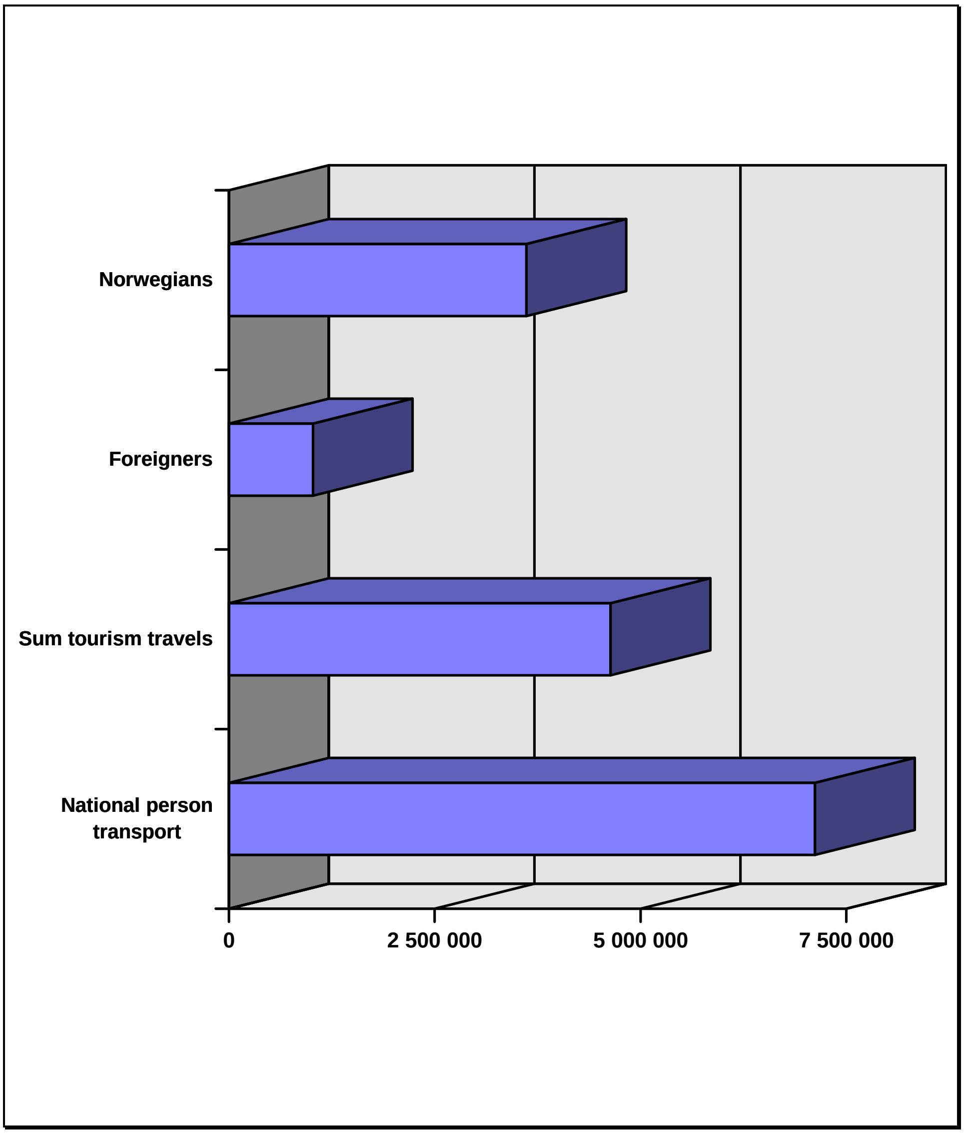
Figure 2. *Tourism-related mobility compared to all person mobility. Figures per inhabitant in Norway. Kms per day in 1992.*



The results from the individual environment indicators in sum on the whole follow the pattern for transport volume. The environmental impacts from Norwegians travelling predominate.

A comparison with environmental impacts from all domestic transport shows that tourist transports are very important. Both in terms of CO_2, NOx, and SO_2, the shares are extremely high. For CO and VOC, however, they are of less importance. This may be explained by the fact that these are emissions where local transport is the most important sources. Results for CO_2 are shown in *figure 3.*

Figure 3 *Emissions of CO_2 from all person transport and from all tourist-related transport in Norway. Figures in tonnes per annum (1992)*



The analyses for the individual means of transport show that the ferry transport is highly significant for indicators such as NOx and VOC. For SO_2 it is quite decisive. At the same time this underlines the fact that there are substantial environmental impacts linked to sea transport. This is the case not only for intensity per transport unit, but also in the form of volume problems. In such a context the current transition to high speed ferries appears especially problematic.

However, the environmental impacts from air transport are generally more important. For the critical indicators of energy consumption and CO_2, the air transport of tourists implies greater environmental impacts than all road-based tourism transport. The real environmental impacts linked to the energy consumption of the air transport may be greater than what is included in the analyses. This is connected with the fact that the relative environmental importance of emissions may be greater when they occur in the higher layers of the atmosphere than when they take place at ground level.

6.7. Sustainable tourism and sustainable mobility?

The results from the project substantiate the following main points underlined in the article:

- Mobility in the free time accounts for a substantial share of the total mobility. When we include the travels undertaken outside the national borders, this share is more than 50% for the central indicator of travel distance.

- This mobility, which to a large extent is linked to the service industry of tourism, is mainly based on transport means which imply an especially high load on environment and resources. This applies to the private car, aeroplanes, as well as ferries used for person transport. Tourism travels, then, account for a substantial share of the ecological impacts caused by transport.

- The growth in tourism is closely linked to the growth of *automobility*. Throughout the history of the private car, there has been a close connection between leisure mobility and the use of private cars. An extensive proliferation of cars also leads to an extensive leisure mobility, which, in turn, constitutes the dominating basis for tourism.

- This connection applies to an even greater extent to the ever-increasing *aeromobility*, that is, a mobility where the use of aeroplanes becomes more and more important. Both nationally and internationally, the large volume of the air-based mobility is directly linked to tourism.

This emphasis on the mutual relations between private car, airplane, and tourism brings me to the connections between *sustainable mobility* and *sustainable tourism.*

Sustainable mobility is a mobility which is in accordance with the demands for *sustainable development*. This is a concept containing the following core characteristics (Lafferty & Langhelle, 1995; Høyer, 1997):

- Ecological sustainability
- Human sustainability, that is, satisfaction of basic needs
- Fair distribution of benefits and burdens
- Future responsibility
- Global responsibility

A globalised *automobility* will be fundamentally inconsistent with the demands for sustainable development. This is independent of the fact whether the cars are assembled of recycled material resources and driven by biodiesel, hydrogen, or solar-cell electricity.

However, can we defend a non-globalised automobility, then, which is still to be reserved for the few in the world community? If that is the case, this would give these few a right to retain their high share of the loads on the global commons, whether this applies to the material and energy resources of the commons or its ecosystems and limited recipient capacity. Based on the above characteristics, this is not in line with the demands for sustainable development either.

Aeromobility is of course no better off in such a context. On the one hand, it is globalised. Though in another sense. It is globalised in two ways. In the first place, it makes a tiny minority of the world's population travel all over the global space. This means that an even larger share of the overall mobility measured in person kilometres is accumulated in a few hands. I have stressed the connections between movement and environmental change. A large movement volume in a few hands also gives them a large share of the change volume. In the case of aeromobility, the global, ecological changes are of an especially serious character. This applies to all the concentrated target points for international air tourism, but particularly in the more vulnerable parts of the global commons (climate balance, stratospheric depletion of ozone) at cruising altitudes.

A *sustainable mobility* is thus without the auto and aeromobility familiar to the rich countries of the world today. This is a mobility which implies significant reductions in the car and plane use in these countries. The basis must lie in walking, bicycling and other land-based means of transport such as bus, train, and tram. However, such transport means do not form any basis for sustaining the present levels of mobility. A sustainable mobility thus means a reduced mobility in the rich part of the world (Høyer, 1997).

Tourism cannot be detached from mobility and transport means. Reduced mobility will result in reduced tourism volumes. A basis on bicycle, bus, and train will, in particular, lead to *other types of tourism* than those founded on car and plane. In this respect, we are faced with some of the fundamental challenges in terms of developing aims and means to realise a policy for sustainable tourism. This demands a coupling of the two concepts. A tourism which is developed detached from the restrictions implied in a sustainable mobility, will not be in accordance with the demands for sustainable development.

Internationally there are several examples giving clues to how issues related to tourism, transport and environment can be addressed within a common context of sustainability. Restrictions and management of both *external* and *internal* transport are principles embedded in the environment-market plan for Salzburger Land in Austria, where the objective is to manage the development of tourism in the region in order to limit environmental impacts. Reorganisation and reductions of transport constitute important elements in the plan, notably in the form of policy measures to reduce the use of private cars and to manage and control the development of interconnected infrastructure for transport, accommodation and attractions. In cooperation with tour-operators favourable offers on train- and bus-travels to the region are launched in combination with price-reductions on admissions to the most visited attractions. Within the region measures include the use of electrical minibuses, investments in an extensive net of bicycle-pathways and marketing of attractions connected to bicycling as a major transport alternative (Teigland & Holden, 1996).

Røros is a norwegian town with a population of only 4500. As an old mining industry town it is renowned for its traditional wood-houses. With about 800 000 tourists per year it is one of six major destinations in Norway. The town has taken part in a national action-program targeted on developing ”Sustainable local communities”, where achievments form the basis for more permanent LA21-processes (Local Agenda 21). External and internal tourism transports are again focused, including both passenger and goods transportation. In the last case the aim is to reduce the volume of transport work in deliveries of goods to the tourist industry through increases in the use of local resources, local food-specialities and other locally manufactured products. These are also aspects in a locally initiated system for environmental certification of hotels and restaurants. As regards the internal transport of tourists the aim is to substantially increase the use of environmentally benign means of transport. This implies applying several measures to restrict the use of private cars and to increase the use of bicycles in the summer and the norwegian speciality ”chair sledges” in the winter time. Both bicycles and chair sledges are made readily and freely available at the hotels as well as at other important places visited by tourists. In cooperation with train- and bus-companies measures are applied to increase use of these means of transport for tourist travels to and fro the town. A particular focus is in this context put on the situation during a yearly - and heavily visited - winter-event, where even travelling by horse sledges from distant areas both in Norway and nearby Sweden are organised as transport alternatives (Aall & Bjørnæs, 1998).

A similar combination of measures is applied by the organisation ”Ökomarkt Graubünden” in the region around Davos in Switzerland. It is based on the long-term aim to create a regional recycling economy in accordance with ecological criteria. Transport (”Verkehr”) is one of ten problem-areas included in their regional system for ecological certification of hotels (”Ökomarkt”). The purposes of the system are to give tourists opportunities to choose the most ecologically sustainable offers, to stimulate hotels to engage in developing such offers and to promote demand for ecological and local/regional products. Within the area of transport a list of measures used in the certification analyses includes actions to increase the availability in relation to public transport means, to favourise the use of such forms of transport in addition to bicycles and horses, to make parking of private cars expensive, difficult and unpleasant or not to offer own, local parking lots, and in the information about the hotel and surrounding area to lay emphasis on the unattractiveness of car use and the attractiveness of other means of transport (Aall & Bjørnæs, 1998).

However, such measures will hardly affect the large volumes of national and international tourism travels with cars and planes. This requires more far-reaching policies directed towards the transport sector in general and is not attainable only through changes in the tourist industry ; we can not disconnect leisure mobility and the other forms of mobility, neither can we disconnect their respective relations to the transport system. It has one important exception. There is urgent need for strict measures to reduce the volumes of international tourism travels with airplanes, due to the heavy environmental loads on global commons caused in particular by long distance and intercontinental flights and the large share tourism has of such flights. Amongst other, measures can be in the form of high environmental taxation on all international charter flights.

Ensuing reductions in the volumes of national and international travels with cars and planes, while mostly not attainable through changes in the tourist industry, will still have profound effects on the future development of this industry. Analysing such effects are necessary efforts within a concept of sustainable tourism. But not only that. It should also include development of plans and actions to adapt todays tourism activities to these long-term changes. The examples described illustrate what such adaptions could encompass. Applied within a context of economical realism they can give a tourism industry which is more robust against the effects of future changes in transport patterns and volumes. There are also *learning implications*. Disseminating knowledge about possible adaptions and related experiences can generate learning in the whole industry and thus contribute to more profound changes. But not the least, there are learning potentials at an individual level. The issue is whether systematic efforts within tourist industry can be used to strengthen alternative, environmentally friendly modes of transport *and* at the same time teach travellers to see the value of such a transport. In their holidays and leisure time travellers are less prejudiced and more open to new solutions. Time efficiency is not of prime importance. On the contrary, old, traditional means of transport and the means taking the longest time and with most stops on the way are frequently particularly attractive. Haimayer (1991) has expressed it this way : *we need to be taught how to drive by driving practice. Maybe we'll have to do "practice travelling" in the holiday to learn other forms of mobility*.

6.8. Notes

1) The development of types of mass tourism can be traced further back in the past. During the Industrial Revolution in the 19th century, certain aspects of mass tourism arose in England. These included travels from the expanding industrial cities to the seaside resorts especially along the eastern coastline. The travels were linked to the development of the railway network.

It is also possible to go all the way back to Roman times. The aristocracy and the rich middle class of that time then travelled to their holiday villas by the sea at Pompeii and Herculaneum. It gave them the opportunity to get away from the oppressive summer heat in Rome. This has been aptly described by *Goscinny & Uderzo* in the *Asterix* comic strip. There urgent tailback problems occur in the prevailing transport system of that age: horse-drawn carriages on narrow and winding roads to the seaside resorts.

2) The first car use was even reserved for leisure. In his book, "The 25th September Square", the Norwegian writer *Dag Solstad* (1974) writes about the new opportunities which the car opened up for the families of industrial workers in the 1960s:

> "What now? Their leisure time became different. It was extended. Places they previously could not even consider going to, they could now get to in a matter of a few hours... The bicycle trips in their earlier existence were all right, but by car you could get so much further. And you get more time doing what you would like to do. Go swimming, for example. Go fishing, for example. Or go to the forest to pick wild berries. The travel time is shortened; you get more available time at your destination. It would not be a lie to say that both Lise and Håkon could enjoy their leisure hours more after they got their car than before. Go skiing, for example.... Freedom, freedom, this is already our cry. These wonderful winter Sundays with the skis strapped to the roof rack, the wife sitting beside him in the front seat, their second home, and the kids in the back seat.... In the holidays, however, they went away. They take long drives. Imagine, that they would be 50 before they discovered how beautiful Norway was! None of them had hardly left the city of Halden before they started motoring in the summers. Now they got to see the country which was theirs."
> (My translation from Norwegian).

3)
CO_2 = Carbondioxide
NO_x = Nitrogenoxides

CO = Carbonmonoxide
VOC = Volatile Organic Compounds
SO_2 = Sulphurdioxide

4) Mobility can be expressed through several indicators. In this article I have attached importance to the length of transportation. This is usually called *travel length* in travel surveys which give basic empirical data to studies of person mobility. Travel length reflects *interaction in space*. Mobility is high when the interaction is large. *Travel frequency* is another indicator. It expresses how often people travel and reflects a *societal interaction*. Mobility is high when people travel often, even though each travel not necessarily needs to be long. A third indicator is *travel time*. It expresses how much time is used for travelling and reflects something that might be called *interaction in time*. Mobility is high when much time is used.

A theoretical basis for such analysis is found in the *time-space geography* developed by the renowned Swedish geographer *T. Hägerstrand* (1993b; Hallin, 1988). In my works I am inspired by this branch in geography.

Travel studies show a different development through time for the three indicators. It is only for travel length there has been a substantial increase in mobility through several decades, or even continually through a whole century as shown in table 1. Regarding the other two - travel frequency and travel time - it is at most a matter of marginal increases. Several empirical studies show a relative stability through time for both of these mobility indicators. However, this presupposes that all movements away from own dwelling are defined as travels, also short local movements by feet or on bikes.

Hupkes (1981) has stated "The Law of Constant Travel Time and Trip-rates". In addition to his own surveys from Holland this is based on a comparative study of travel surveys, from different countries (referred after Vilhelmsom, 1990; 1992). In his analyses of Swedish travel survey data the Swedish cultural geographer *B. Vilhelmson* (1988, 1990, 1992) finds empirical proof for similar relations. According to his analyses the adult population in Sweden on average travel 80 minutes per day and person. This average time use is relatively similar for all major categories of households and also through their complete life cycles. It even applies to households both with and without private cars. Vilhelmson thus claims that there is a large degree of social stability in time used for transportation. In addition it has also been relatively stable through the last couple of decades. Vilhelmson shows that the same form of stability also applies to the travel frequency.

It is first of all the thesis of a *constant travel time* which has been subject to international attention in research on transportation. Through analyses of time budgets for individual inhabitants in 12 countries from all parts of the world *Szalai* (1972) was already in the early 1970's able to confirm the thesis. He showed that the total travel time for work and leisure on average added up to 90 minutes per day and person. Other empirical confirmations have been given by *Zahavi* (1977; 1978) and *Marchetti* (1988; 1994).

Marchetti even considers it possible to show that travel time has been constant over a very long time span, possibly centuries or more. He gives this an individual/genetical explanation where man still is considered to posses an instinct as "caveman" from the former time as hunter and collector. Under such conditions man would not expose himself to risks outside the cave for a longer time than necessary in order to collect for life support. According to Marchetti there is still a strong driving force in man not to exceed such a time of exposure to risk, considered to be about an hour a day (referred after Åkerman, 1996).

I shall in this context not discuss such theoretical explanations, but consider it sufficient to emphasize the empirical relations. I agree with Vilhelmson (1990; 1992) who claims that the constant travel time should not be understood as a deterministic law of nature, whether it is on an individual level, group level or on the level of total population. It is complex societal interrelations. The travel time probably will and can be changed. However, it could be understood as a matter of *social inertia*. It is hard to affect, and will only be changed in the long term. However, such an inertia has important implications for relations between transport, infrastructure, leisure time and mobility.

While travel time is relatively constant, travel length increases, even substantially. At the same time has there through the whole of this century been a steady transfer to faster means of transport. It implies that the time savings made possible by the faster transport means are not realized , but on the contrary used to spend more time in them and to gain more distance. Faster means of person transport - first of all in the form of transfer from walking, bicycling, trams and buses to private cars - then result in increased mobility. The same applies to investments in a steadily more time saving and dispersed infrastructural net. Time saved is taken out in the form of increased use of the new effective bridge-, tunnel- and road-connections. As for private cars relative time savings through increased use of airplanes and high speed trains, including the infrastructure establishing the conditions for their use, are taken out in the form of longer travel distance. This has negative ecological consequences as these first of all are generated by the interactions in space. At least this applies to the category called *problems of volume*.

Increases in leisure and tourism-related mobility might be understood in a similar context. Gradual reductions in working hours and corresponding increases in leisure time generate additional increases in leisure mobility (as the total travel time is constant). Tourism is at the same time to an extreme degree based on use of the problematic means of transport. This gives extra increases in travel length and thereby in the overall mobility.

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7. Sustainable Development

7.1. Introduction

In the report *Our Common Future*, the UN-based Brundtland Commission launched the term “sustainable development” (WCED, 1987). Since then it has been widely used and is today a major political aim for various national and international organizations as well as for national governments. New international bodies have been established to promote sustainable policies, notably the UN Commision for Sustainable Development (CSD) [1)].

When the editorial staff of the journal *The Ecologist* published their “A Blueprint for Survival” in 1972, they wrote: "Our task is to create a society which is sustainable and which will give the fullest possible satisfaction of its members". (*The Ecologist*, 1972; Basiago, 1995). The first UN Conference of the "Human Environment" took place the same year in Stockholm. It brought developed and developing nations together to discuss the future of the global environment. Deterioration of the global climate, including the greenhouse effect, was one of the issues on the agenda. Even poverty issues and relations between development and ecological balance were focused upon, but without using the term "sustainable development". Most importantly, however, the conference established the foundation for addressing environmental problems in a global context and a process of negotiating international conventions within a United Nations (UN) framework. This has, of course, become an important part of making "sustainable development" a practical reality after the 1987-report *Our Common Future* (Høyer, 1991; Basiago, 1995) [2)] .

The *World Conservation Strategy* (1980) of the International Union for Conservation of Nature, The United Nations Environmental Programme and the World Wildlife Fund (IUCN/UNEP/WWF) is often referred to as the first global statement on sustainable development (Adams, 1990; O'Riordan, 1993). Sustainable utilization of natural resources is one of three priority areas in this strategy. The three are (IUCN/UNEP/WWF, 1980):

- Maintenance of essential ecological processes
- Preservation of genetic diversity
- Sustainable utilization of species and ecosystems

A later version (IUCN/UNEP/WWP, 1991) has put greater emphasis on protection of cultures and indigenous ways of utilizing resources. However, as issues related to poverty and global equity are not given priority, the strategy is still limited in scope compared with the term sustainable development (Adams, 1990) [3)] .

7.2. Sustainable development

A frequently quoted formulation from the Brundtland Commission report is: "Sustainable development is a development which meets the demands of today without destroying the possibilities for future generations to satisfy their needs" (WCED, 1987). Some have called this a definition and have tried to express it in operational terms based on scientific concepts. These attempts at "operationalization" are dominated by two different approaches. Economists, for obvious reasons, have emphasized the question of criteria for the exploitation of non-renewable and renewable resources. Ecologists and other environmental scientists have emphasized questions concerning the greenhouse effect, pollutant effects, carrying capacity, and the like. A group calling themselves "ecological economists" have tried to bridge the two main approaches. Important contributions from this group have been made, amongst others, by Daly and Cobb (1991), Costanza (1991), Goodland (1991), Daly (1993) and Turner (1993).

Within the economist group there are two main approaches. The first can be referred to as technocentric, the second anthropocentric. Technocentrism is a special form of anthropocentrism. In this approach, nature is attributed an exclusively instrumental value in that it is looked upon solely as a resource for human industrial and economic exploitation. Sustainable development then becomes simply a matter of achieving more efficient exploitation of natural resources and so is reduced primarily to ways of achieving satisfactory technical solutions to the exploitation processes.

Anthropocentrism often shares the same view of nature as something instrumental. Nature is without any value unless it contributes to the realization of human values. On the other hand, these approaches differ in the question of the sufficiency of technical fix. In anthropocentrism the challenges in sustainable development run far deeper than efficient exploitation of resources and technical solutions. Issues related to "limits to growth" and the scale of the human economy are often considered crucial. According to pure technocentrism, there is no limit of scale.

A third approach can be referred to as ecocentrism. It has its basis in ecological sciences. The key difference from the two others is that nature is attributed a value in itself, the so-called intrinsic value of nature. In ecocentrism proper, this applies to species and individuals, plants and animals alike, as well as to whole ecosystems (Vilkka, 1994).

These different approaches have naturally led to highly different interpretations of sustainable development. Internationally, at least 40 different “definitions” have been registered, all of them intended for a role as useful working tools (Torgerson, 1994) [4)] .

7.3. With a Little Help from Brundtland

The formulation quoted from the Brundtland report automatically implies a series of problems. A key question is: What is meant by need? Is this a question of basic needs or is it any type of consumption that is understood as need? Is it humans’s needs, or is it based on fair distribution, not only across generations but across the globe as well?

Another problem is the strong element of anthropocentrism in the formulation. Do other living organisms not have needs, in other words, does nature solely have an instrumental value for people and no intrinsic value? Is it the case that all kinds of human needs are acceptable even if they can only be met over generations in a destroyed or significantly changed natural environment? Intuitively, people know that this is not the meaning of sustainable development; nevertheless, these are the answers we easily can get by "operationalizing" the formulation above.

Actually, the Brundtland Commission report itself helps us to a large extent. In the main part of the report on "the term sustainable development", the quoted formulation is immediately followed up with: "It [sustainable development] comprises two key elements:

- Satisfying demands, especially the basic needs of the world's poor, which should be given top priority;
- The idea of the limitations put by today's technology and social organization on the possibilities of the environment to satisfy present and future needs."

It may seem a bit surprising, especially considering the historic development of the term, that this so rarely is quoted. In the first few pages of the main chapter on sustainable development there is an elaboration of the most important elements (WCED, 1987, pp. 42-44). In my further discussion I shall use this as a starting-point, as well as when referring to material from UN-based, follow-up conferences of the Brundtland Commission report .

The Brundtland Commission's report is the main report from the United Nations World Commission for Environment and Development. It has been dealt with in a series of UN-based follow-up conferences. Of special importance are the declarations from the ECE Conference in Bergen, May 1990 (Ministry of the Environment, 1990; NAVF, 1990) as well as declarations and written convention material from the main conference in Rio in June 1992 (Ministry of the Environment, 1992 b; Agenda 21). Among other contributions are Næss (1991 a, b; 1992); Stenseth and Hertzberg (1992); Redclift (1993); Turner (1993); Lafferty and Langhelle (1995); Høyer (1991); Høyer and Selstad (1993); Høyer (1995a) and Høyer and Groven (1995). As in Mysterud et al. (1993), Høyer has taken a more explicit ecological starting-point.

First of all it is necessary to point out a common misunderstanding. What used to be called protection of the environment is now frequently referred to as sustainable development. The issue is, however, not as simple as that. As examples of what contributes to “sustainable development” the following from a Norwegian Parliament bill (Ministry of the Environment, 1992 a) can be mentioned:

- Improved purification methods of sewage and industrial waste;
- Remedial action of old environmental sins

This has little bearing on sustainable development. All types of environment protection represent social benefit; however, only certain types are in accordance with the principle of sustainable development. Furthermore, only by an even stronger limitation can they actually contribute to promoting such development. It is confusion such as this that has led to the increasingly loose use of the term in recent years.

7.4. Relativism or Universality

It might be problematic to relate to sustainable development as a concept in a classic, scientific sense. It is not easily defined and it is even harder to find a definition that forms a clear basis for operationalization, which is a normal requirement, at least within the applied research tradition.

In his article *Strategy and Ideology in Environmentalism*, Douglas Torgerson (1994) argues against demands for “defining” and “operationalizing” sustainable development. He ascribes such demands to the classic rationalistic view of science and what he refers to as an “administrative mind”. In his opinion, the quest for a definition should be abandoned. The administrative approach must be replaced by a more flexible one in which great tolerance is given to the diverse, even conflict-ridden, approaches involving clashes of interest.

The author concurs with this only to a certain extent. It is a point of view that easily reduces to relativism, i.e. it suggests an understanding that implies that this type of concept can never have a universal content and that it always has to be related to particular interest groups or different cultural and social contexts. Taken to the extreme, this can give rise to a situation where any definition (and policy) is found acceptable, just because it belongs to an interest group or is developed within a particular social context.

However, the other extreme position of universality is equally dangerous. This is an understanding which implies that there is one universal, operational definition of sustainable development, and that it is found throughout the world independent of differing cultural and social conditions.

The best approach is to find a middle course between these two extreme positions: relativism on the one hand and universality on the other. This contends that the concept "sustainable development" has within it central features which are core (major) characteristics. They are universal characteristics. However, they do not constitute one operational definition. There is still room for different interpretations, in terms of policy implications, although only within certain limits which are tighter than before. The room for manoeuvering is smaller than it has been at any time in the history of industrialization. Historically there is nothing new in such a challenge. Development of democracy and the welfare state has both constrained and put particular directions to the social manoeuvering. Still, there has been sufficient room for different interpretations and policies. These constitute continuous processes, also with clashes of interests, that are still going on and are far from finished. This theme, the understanding of sustainable development as an unfinished social process, will be referred to again later [5)] .

Earlier in this chapter "sustainable development" was referred to as a term. It is more suitable to call it a concept. Concepts are important to us, both in politics and science. Concepts, to a large extent, control what people take notice of , particularly in matters that people can not directly see, touch or feel (Brox, 1995).

There are different types of concepts, or rather there are differences in understanding how concepts should be used between various fields of science. In natural science concepts are given a precise and clearly delimited definition and thus can easily be made operational.

Economic science is dominated by the same understanding. This understanding is, of course, due to the strong influence natural scientific perspectives have had on the development of economics. Confronted with the many different approaches to "sustainable development", this should be borne in mind as economists perhaps are the one group most vigorously involved in definitional efforts. In other social sciences concepts are often given a somewhat looser meaning, only requiring that a core of aspects and dimensions are present. The approach in this chapter to the concept "sustainable development" comes within this last understanding. It should be considered to be on the same level as democracy, liberty and social welfare. This also implies that it is a normative concept, and not purely descriptive as concepts usually are within natural sciences. The desire is to achieve goals of a social character. This must necessarily be based on choices of certain values and norms. However it differs from the other in one important way: the concept originates from natural sciences and it must include considerations for species and systems in nature. Encircling it, thereby, requires a cross-disciplinary or rather a cross-scientific approach.

The Swedish historian Sverker Sörlin (1991) has placed the development of environmental protection within a similar context. According to his analysis, the present is a historical epoch where substantial changes are taking place. Humans are about to develop fundamentally new rules on how to associate with nature. He calls this a contract with nature. The term is chosen with care. An analogy is drawn to the later influence on society by the political philosophers of the 17th and 18th centuries who developed their thoughts about a social contract. The most outstanding political work of Rousseau was simply titled *Du contrat social* (1762).

Concepts about democracy, liberty and welfare are based on these earlier works about a social contract. The processes of implementation in actual social structures have been continuous and are still going on. This, of course, has also given some changes in our conceptual understanding [6)] .

7.5. Major Characteristics

The following question must be asked: What primarily characterizes sustainable development? The answer provides an outline of what can be referred to as the major characteristics. They are found on three levels: extra prima, prima, and secunda. These are terms borrowed from thermodynamics. Extra prima denotes energy (or other natural resources) at superior quality levels. Prima implies lower quality, but still very high. Extra prima and prima, then, are what is mainly an answer to the characterization "major". Secunda has been included to put into context characteristics prevailing in the current debate on “operationalization”. Extra prima characteristics are:

- Ecological sustainability;
- Satisfaction of basic needs;

Prima characteristics:

- Nature's intrinsic value;
- Long-term aspect;
- Fair distribution of benefits and burdens globally;
- Fair distribution of benefits and burdens over time;

- Causal-oriented protection of the environment;
- Public participation;

Secunda characteristics:
- Reduction of today's total energy consumption in the rich countries;
- Reduced emissions of greenhouse gases, especially carbon dioxide;
- Reduction of today's consumption of non-renewable energy and material resources in the rich countries;
- Increase of today's consumption of renewable energy and material resources;
- Pollution levels within the tolerance levels of the ecosystems;
- Giving priority to technological development for efficient exploitation of natural resources.

This final list could be very long. The term “secunda” implies that it can be derived from extra prima and prima characteristics. Consequently, a demand for reduced emissions of greenhouse gases is necessary, based on a superior demand for ecological sustainability. However, any type of policy aiming at reduced emissions is not necessarily in line with sustainable development. In addition, fair distribution is needed, globally and over time, as well as priority to the satisfaction of basic needs.

7.6. Extra Prima Characteristics

Ecological Sustainability
The very term "sustainability" has its origin in ecological science. It was developed to express the conditions that must be present for the ecosystems to sustain themselves in a long-term perspective. In the Brundtland Commission report there are several references to the necessity of ecological sustainability, such as: *"The minimum requirement for sustainable development is that the natural systems which sustain life on earth, in the atmosphere, water, soil and all living things, are not endangered"* and *"There is still time to save species and their ecosystems. This is an absolute precondition for a sustainable development. If we fail to do this, future generations will never forgive us."*

This “minimum requirement” means a requirement to sustain biological diversity, corresponding to the so-called diversity norm which has prevailed in Norwegian eco-philosophy. The diversity of species, life forms and ecosystems must be sustained as a necessary but not sufficient precondition for sustainable development .

There is further corroboration of this in the Rio Convention on biological diversity. In the Convention, biological diversity is defined as the variability among living organisms of any origin, including terrestrial, marine or other aquatic ecosystems and the ecological complexes they are a part of; this comprises diversity within the species at species level as well as at ecosystem level (Ministry of Foreign Affairs, 1993).

It is important to underline that the diversity norm does not imply a requirement that biological diversity should be promoted or developed - just protected as a condition for maintaining long-term ecological sustainability. In connection with genetic technology, this raises an important discussion as to the relation between "old" and "new" nature. Can genetically modified organisms contribute to biological diversity, or can they be applied to regain lost biological diversity? In other words, can technology be applied to create biological diversity?

This issue has been raised by Mysterud et al. (1993). In their opinion, nature or diversity cannot be created in this way, and the diversity norm also requires respect for the "old nature". The idea of applying gene technology in such ways is placed within the framework of more extreme forms of "technology optimism", that is a further development of a paradigm which has been a key precondition for creating environmental problems of our time.

Satisfaction of Basic Needs
This represents the core of the development part of sustainable development. As with ecological sustainability, it constitutes a necessary precondition. The other characteristics have no meaning unless these two preconditions are fulfilled. This is the basis for extra prima characteristics.

Still, there is an important difference. Maintaining ecological sustainability is a negatively defining obligation. It is about restricting the extent of man-made encroachments in nature to maintain the necessary ecological sustainability. It is not a primary objective to develop maximum ecological sustainability at the expense of satisfying basic needs. As for the fundamental development part, it is, on the contrary, a question of a positively developing obligation (Næss, 1992). A large number of people do not get their basic needs satisfied today. These must be given priority, even if it may imply a reduction of the biological diversity. At the same time, the total population is too high and measures must be implemented to reduce the population if the ecological sustainability is to be maintained in the long term.

The Brundtland Commission's report underlines the fact that a living standard beyond the necessary minimum to satisfy the basic needs, is only sustainable if all consumption standards, both present and future, are established in terms of what is sustainable in the long term. The majority of people in the rich world live far beyond the ecological sustainability (WCED, 1987). A reduction in consumption levels is needed. Consequently, the ceiling has in principle already been put on the contribution these give to reductions in ecological sustainability. Only a lowering of the ceiling is in line with sustainable development.

As for the core of the development part, the following may be emphasized:

- It presupposes measures for satisfying the basic needs in poor countries, as well as reducing the consumption in rich countries;
- Further reductions in biological diversity are today only in accordance with sustainable development when it is linked to the satisfaction of basic needs;
- The latter point is also valid as a condition for encroachments on nature in, or carried out, by rich countries.

What, then, is meant by the concept basic needs? [7)]
In their prize-winning book *A Theory of Human Need,* Len Doyal and Ian Gough (1991) have given an important contribution to the analysis of basic needs. They consider physical health and autonomy to be the two groups of basic needs for individuals. These must be

satisfied in order to avoid the serious harm of fundamentally impaired participation in life. Physical health is given biomedically. These needs are met if the individuals do not suffer *"in a sustained and serious way from one or more particular diseases"* (Doyal and Gough, 1991). This is more extensive than just mere physical survival. However individual autonomy must also be sustained and improved. This entails the level of self-understanding a person has and understanding about immediate society, the psychological capacity to formulate options and the consequent opportunities to act accordingly. These two groups of basic needs apply to everyone everywhere. They are universal [8)] .

Many goods and services required to satisfy the basic needs "physical health" and "autonomy" are culturally variable. Basic needs, then, are always universal, but what is required of objects and activities to satisfy them (their "satisfaction") is often relative (Doyal and Gough, 1991). Nevertheless, some satisfiers can have a universal character; they apply to all cultures. Doyal and Gough denote them intermediate needs. They are necessary conditions for satisfying the basic needs [9)] .

7.7. Prima characteristics

Nature's Intrinsic Value
In its most elementary form, it means that biological diversity must be attributed a value in itself, independent of the instrumental value for mankind. The fact that the earth's biological diversity must be protected for its own sake, was initially stated internationally in the UN Natural Protection Charter from 1982. The initiative for the charter was taken by a number of poor countries. It was passed by the United Nations General Assembly by a majority of 111 to 1. The one vote against it was cast by the USA (Næss, 1992). It has been corroborated in the Brundtland Commissions report: *"Protection of the environment is not only a target of development. It is also a moral obligation to other living things and for future generations."*

In the Rio Convention on biological diversity, the "intrinsic value" of biological diversity is included in the preamble: *"The contracting parties, being aware of the intrinsic value of biological diversity, as well as the ecological, genetic, social, economic, scientific, recreational, and ethical values implied in biological diversity and its components."* (Ministry of Foreign Affairs, 1993).

Norwegian eco-philosophy, particularly based on the works of Arne Næss, has enjoyed a central international position in the discussions of what norms for action which ensue from having to pay attention to nature's intrinsic value. Within the field of environmental ethics, this is a prevalent theme.

In the book *Environmental Ethics - Divergence and Convergence*, Susan Armstrong and Richard Botzler (1993) give a comprehensive international survey over this scientific area. Important contributions to the discussion of action norms ensuing from "the intrinsic value of nature" are Goodpaster (1993), Taylor (1993), Næss (1993) and Sylvan and Bennett (1994).

The intrinsic value of nature can have important consequential-ethical as well as duty-ethical implications. The possible long-term consequences for both non-human individuals, species, and ecosystems in connection with new encroachments into nature must be taken into consideration. This implies that nature must be included in its different forms as a morally considered part in our calculations of the best future situation for all parties [10)].

Long-Term Aspect

Sustainable development presupposes a long-term aspect. This is a pervasive theme in the Brundtland Commission's report and relates both to the sustainability and the development parts of the term. The theme has been very much to the fore in the economic considerations of the consequences which can be drawn from sustainable development in terms of criteria for the exploitation of natural resources .This is a question that is discussed within what I have referred to as ecological economy. See in particular Daly and Cobb (1991), Costanza (1993), Daly and Townsend (1993) and Turner (1993).

Sustainable development characteristically gives no acceptance for neoclassical economic ideas of complete interchangeability between human generated capital and natural capital. On the contrary, it is emphasized that such a development demands a reduction of the total consumption of non-renewable energy and material resources. Consequently, the earth's natural capital is seen as a finite quantity, whose use must be spread out over time in order to benefit as many generations of people as possible. This introduces the long-term aspect question.

The Norwegian professor in philosophy Jon *Wetlesen* (1975) has in an earlier article discussed the question of how many future generations we have an ethical duty to show consideration for. He thinks it is hard to imagine a line to be drawn somewhere without it being ethically arbitrary. From an ethical point of view, we have a right and a duty to stand our grounds as long as possible.

The demand for a long-term aspect implies, moreover, an obligation to emphasize future environmental consequences at least as much as the present ones. An increased willingness to take into consideration consequences far into the future , and in this context include nature as a morally considerate party, can lead to an extended consequential-ethical basis for action [11)].

Fair Distribution of Goods and Burdens, Globally and Over Time

These characteristics relate to the former discussion of basic needs. They and the intermediate needs necessary to satisfy them, should be met all over the world by all future generations. In this context the claim is that this should also be based on a principle of fair distribution, within each generation (intra-generational) globally and between all future generations (inter-generational). These are fundamental elements of a global ethics.

United Nations conventions are of some help. In particular, this is true with The World Declaration on Human Rights from 1948 and the UN International Conventions on Human Rights from 1966. The 1966 Convention on economic, social, and cultural rights expresses what kind of welfare any human being is entitled to. It suggests minimum requirements for a good life in the following way: any human being has the right to work, to fair and good working conditions; to social security; to a satisfactory living standard for himself and his family including adequate food, clothing, housing; a highest obtainable health condition both in physical and mental terms, besides the right to an education, and the right to participate in the cultural life. The application of such norms, however, needs further specification. This has been done by UN organizations such as the FAO with its nourishment standards when it comes to physiological minimum requirements per person to satisfy the need for calories, proteins, vitamins, certain mineral substances, and so on [12)] .

All humans should receive the minimum requirements for basic needs in the same degree. This lays down the premises for the issue of fair distribution. Wetlesen has formulated the following superior norm (1975):

"In the distribution of the limited natural resources relevant to the fulfilment of the human rights, nobody should get more than what they need to meet the minimum requirements, unless it can be justified that this unequal allotment is in the interest of all parties concerned, including the least favored party."

Wetlesen emphasizes that this norm is universal, not only in the present, but also in the future. All human beings have equally strong claims to a share in the goods laid down in the norm, wherever and whenever they live. This is the basis of the so-called global ethics (Wetlesen, 1975; 1995).

Underlying the suggestion of an opening for preferential treatment is an argument propounded by the American John Rawls in the book *Theory of Justice* (1971). His theories are actually based on the seventeenth and eighteenth century works on social contract theory, but extend them. Rawls argues that there may be a well-founded preferential treatment in terms of economic, social, and cultural rights, but not when it comes to civil and political rights. Whether preferential treatment is justified or not for any of these rights must be documented for the least favored of the parties [13)] .

This relates to the issue of fair distribution of burdens. Environmental burdens are not equally distributed. The impacts are more serious in some parts of the world than in others and this applies, for example, to the greenhouse effect. Similarly, future generations are going to be hit harder than the present one. The implications are that the remedial actions, i.e. environmental policies, must be such that they take into consideration the situation for the least favored members of the global society, now and in the future. However, it should be emphasized that such an interpretation represents an extension of the original theories by Rawls (Doyal and Gough, 1991; Wetlesen, 1995).

Causal-Oriented Protection of the Environment

The Brundtland Commission report outlines two major approaches to environmental policy. The former is characterized as "the standard programme", reflecting an attitude to environmental policy, acts and institutions with the main emphasis on environmental effects. The latter reflects an attitude focusing on the practise causing these effects;
"These two attitudes represent clearly diverging views both of the problems and of the institutions which are to deal with them."
(WCED, 1987).

A distinction is made between effect-oriented and cause-oriented environment policy. The Commission emphasizes that it is the former which has prevailed until now, whereas it is the latter which must be included in sustainable development.

Various solution principles in terms of traditional emission problems (i.e. problems linked to emissions of pollution) may serve as an illustration of what is implied in such a distinction. One the one hand there is the so-called end-of-pipe solutions in which attempts are made to reduce the problems after they have emerged. Various types of purification technologies represent such solutions. On the other hand, there are source-oriented solutions. In this case attempts are made to solve the problems where they emerge and not where they end. Within environmental sciences this is refered to as input solutions or input control. This requires control and management of what goes in, i.e. the processes causing the emission problems (Høyer and Selstad, 1993).

The internationally accepted precautionary principle is an important policy-tool for achieving such changes. This principle is now widely included in international environmental conventions, and is considered to be crucial for operationalizing the environmental characteristics of sustainable development (Høyer, 1995b).

In connection with the greenhouse issue, causal-oriented solutions will be the ones implying significant and long-term reductions in the emissions of carbon dioxide. Reduced consumption of energy and reduced consumption of fossil energy in particular must be a part of these solutions. In comparison, forestation to increase the natural absorption of CO_2 will be a typical end-of-pipe, or effect-oriented solution.

The discussion on causal-oriented solutions has been of fundamental importance for the thinking concerning the protection of the environment. Nature is referred to as an ideal and a model. The development in recent years of ecological techniques in water, drainage and wastes has, for example, consisted of a combination of management and limitation of material supplies as well as an exploitation / imitation of nature's own cleaning and absorption systems.Even in industry such a development is taking place, with a highest possible application of biological substitutes in the production and a higher degree of imitation of natural processes. These are principles within the concept of industrial ecology.

Public Participation

The Brundtland Commission report states that sustainable development must include "*promoting initiatives on the part of citizens, giving grassroot organizations more power, and strengthening local democracy*". This emphasizes the linkages between sustainable development and democracy. They should not be considered to be independent of each other. It has important duty-ethical aspects. Not only does it matter that sustainable development is achieved, but it matters how it is achieved. People’s actions must be morally connected and acceptable. They must thus be based on fundamental democratic principles. However, linking sustainable development and democracy is challenging. It requires further development of the concept of democracy into some sort of ecological democracy. However, when the Norwegian environmentalist Hartvig Sætra (1990) proposes a world government consisting of two or three ecologists with wide political authority, this is not consistent with such a concept.

The democratic aspects were brought to the fore under the ECE follow-up conference in Bergen in 1990. In the joint plan for action from the Bergen Conference, the following points are raised (Ministry of the Environment, 1990):

- Participation should be stimulated through increasing a common awareness of and access to information on the state of the environment and future environment conditions, obligations in terms of the general public's right to be informed and the popular participation in the decision-making process;

- The use of environment impact analyses should be extended and strengthened in order to take into account the likely effects and dangers of political decisions, projects, and industrial installations which may have a negative impact on health or environment. Procedures assessing potential effects or health effects of products should be developed and extended. The public must have access to all relevant information;

- Scientists have an absolute duty both to provide the best possible information and a clear explanation of the scientific state of knowledge, including the elements of uncertainty. Researchers have a duty to share research and knowledge across national borders and with all political decision-makers.

- Researchers must be allowed to do research and publish their results regardless of any consequences of their predictions and analyses. Researchers have a duty to listen to people's fears and expectations and include these in their research.

These last two points can be interpreted as the precautionary principle of science; if scientists believe that their research can have serious and irreversible environmental impacts, they are obliged to inform society and the public about this, even though there are not firm proofs for such views (Høyer, 1995b). The above principles have been further substantiated in the declarations from the Rio Conference in 1992, the so-called Rio Declaration with its principles on general rights and obligations and in Agenda 21.

7.8. Secunda Characteristics

The Case of CO_2

The greenhouse effect is generally considered to be one of the world's most serious environmental problems. It is a problem about common property. The atmosphere is common to all people. And like other common properties it has a finite size. While the human encroachments into it get larger, the atmosphere does not. If some people take up too large a share of what the atmosphere can tolerate, then there will not only be anything left for others and the negative consequences will, in addition, be felt by everybody. In this sense it is a type of problem Garrett Hardin (1968) has termed tragedy of the commons. However, it is not like any other common property. It is global. It is shared by everyone all over the world. They all have equal rights to it. In addition, the future issue is included. The encroachments of today's people neither affect themselves nor their neighbors. Only very distant people, living sometime in a distant future, will be severely affected. However, there can be winners and losers even in this context. Nature creates no conditions for a fair distribution of environmental burdens. Some people and some ecological systems might be hit much harder than others. This is, for instance, the case when some island societies are confronted with the possibility of complete eradication (Alcamo & al., 1995; Glantz, 1995,).

This constitutes the background for using emissions of CO_2 as a case in elucidating the implications of sustainable development characteristics. The total global emissions of CO_2 were about 21,600 million tons in 1990. The Organisation for Economic Co-operation and Development (OECD) countries' share of this was 48%, while all the rest of the world had 52%. There are large differences even between countries. The USA has the largest emissions with 23% of the total. The former Soviet Union accounts for 17%, while China and Japan have shares of 11% and 5%. Most other countries are in comparison small contributors. Examples are Canada (2.3%), Australia (1.3%), Norway (0.2%) and Luxembourg (0.1%) (OECD, 1994).

The second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) maintains that in order to stabilize atmospheric concentrations of CO_2 at near current levels, worldwide CO_2 emissions would need to be reduced immediately by 50-70%, with further reductions thereafter (IPCC, 1996). This chapter applies a 60% reduction and assume that this can be achieved within the first half of the next century. Even though this seems to be a more modest aim, it is sufficient in order to elucidate the consequences of applying sustainable development characteristics.

One possible way of addressing the issue is to consider it a conventional point-source problem at a national level. Focus must then be on the largest sources and they must make major contribution to the reductions. This would include the USA, China and Japan. Only smaller contributions would be necessary from a country like Australia, while one more or less could forget about Norway, Luxembourg and several other minor countries.

It would not be consistent with the principles of fair distribution of goods and burdens. In 1990, the USA had CO_2 emissions of 21 tonnes per capita, while China had about 2 tonnes per capita. Australia had 16 tonnes per capita, Norway 8.6 and Luxembourg 27 (OECD, 1994). The point-source approach would thus imply that some societies have to undertake large burdens on behalf of the rest of the world only because there are many people living there (the Chinese case). Other societies can continue to live in affluence only because they are few people (the Australian, Norwegian and Luxembourg case) [(14)] .

Table 1 illuminates the effects of an alternative per capita approach.

Table 1 *Per capita emissions of CO_2 for different parts of the world that would be needed in order to produce an overall 60% reduction in global emissions from 1990 levels by the year 2050*

Region/Country	Per capita CO_2 emissions (t a^{-1}) 1990	2050	Reductions 1990-2050 (%)
World	4.1	0.9	80
OECD	12.3	0.9	93
EU	9.1	0.9	90
Former USSR	3.7	0.9	75
North America	20.8	0.9	95
Latin America	1.9	0.9	50
Australia	16.2	0.9	95
Asia	1.1	0.9	20
Africa	1.0	0.9	10
Middle East	3.9	0.9	80
USA	21.1	0.9	95
Japan	8.2	0.9	90
China	2.0	0.9	50
Luxembourg	27.2	0.9	97
Norway	8.6	0.9	90

The calculation of the percentage reduction in per capita CO_2 emissions that would be required to produce an overall 60% reduction in global 1990 emissions of CO_2 by the year 2050, assumes an increase in the world population to 10 x 10^9 persons by 2050, and an uniform per capita level of CO_2 emissions across the world in 2050.

Source: OECD (1994)

If the necessary policies are implemented by democratic means and through a causal-oriented approach (which will probably have to be the case if such substantial reductions are to be achieved), there is the situation where there is agreement with all the major characteristics of sustainable development. Some societies of the world will then have to take on a much larger responsibility than others to remedy the fact that they have consumed an unfairly large share of the global commons.

The Case of Automobility

Implications of sustainable development characteristics can further be elucidated through the case of automobile-based mobility, i.e. automobility.

The transport sector makes significant contributions to several types of environmental problems that are important at global, regional and local levels. Globally, transportation, both of freight and persons, accounts for about 25% of total energy use and about 20% of total emissions of CO_2. For OECD countries these percentages average 30 and 25 respectively. Actually, there are only small differences in these shares between countries with very different societal conditions. In the USA transportation accounts for about 28% of CO_2 emissions and for 24% in Australia and in such differing countries as UK, Portugal and Greece (EU/COM, 1996; OECD, 1996; UN/DPCSD, 1996).

However, the shares taken up by transportation are steadily increasing. In the 15 year period between 1973-1988, the total global emissions of CO_2 from transportation increased by 30%, while the emissions from all other sources fell overall by about 2%. The differences are starker in OECD countries. In the UK, for instance, transportation's share of total CO_2 emissions increased from 13 to 24% between 1970 and 1990. During the same period industrial emissions decreased by 34% and household emissions by 24% (while private and public service increased by 20% and transportation by 65%) (OECD, 1996). According to current projections, it is expected that these trends will continue far into the next century (EU/COM, 1996; OECD, 1996). This is illustrated in table 2, which, however, only applies to road transport.

***Table 2** Projected changes in selected road transport indicators for OECD and non-OECD Member countries, 1990-2030*

Indicator	% change, 1990-2030		
	Light vehicles	Heavy vehicles	All vehicles
OECD countries			
Number of vehicles	73	94	74
Kilometers travelled	76	100	79
Weight of fuel used	-8	97	18
Non-OECD countries			
Number of vehicles	305	300	305
Kilometers travelled	318	288	312
Weight of fuel used	136	289	206
All countries			
Number of vehicles	137	190	140
Kilometers travelled	137	192	144
Weight of fuel used	25	181	73

Source: OECD (1996)

The relation between transportation's shares of energy use and CO_2 emissions emphasizes the fossil energy basis of the sector. Globally, oil products constitute 98% of all energy use in transport. This represents a consumption of more than 60% of all oil products in the world, but ,of course, a smaller share of all fossil energy (which also includes natural gas and coal). Road transport is solely based on oil and is dominant as regards volumes as well [15)]

Globally, passenger travels account for about 60% of energy use in transportation and movement of goods 40%. Similar percentage shares are known from OECD countries, for instance Norway. Passenger transportation is dominated by the automobile. In the USA and several European countries it accounts for about 80% of the total number of person kilometers traveled. Only Japan has a pronounced smaller share with 50%. Similarly goods transportation is dominated by road vehicles with an OECD average of about 70% of all tonne kilometers (OECD 1996; UN/DPCSD, 1996).

Automobiles (and the related person mobility) have in addition several conspicuous characteristics. They are a major cause of serious environmental and health problems in cities all over the world, in developed as well as in developing countries. They form the societal sector, at least in OECD countries, that causes the largest number of accidents resulting in human deaths and injuries. The manufacture of automobiles is one of the largest world industries. Both the cars themselves and the related infrastructure consume a large share of the world's material resources, although this is, to an extreme degree, unfairly distributed among the people of the world. The OECD countries, with 16% of the world population possessing more than 80% of all private cars. In this way the automobiles in particular give a very forceful expression of the advanced consumption society (Tunali, 1996).

Unsustainable Automobility

As an introduction to discussing what compliance with the requirements of sustainable development would imply, the impacts of a possible fair distribution of automobility sometime in the future should be considered. Average private car ownership was 0.41 car per capita in OECD countries in 1990. Several countries have higher ownerships, notably the USA with 0.58 cars per capita (Hille, 1995; OECD, 1996). However, this chapter will use 0.40 as a possible obtainable average for the world population of 10 billions in 2050. This would imply a total of 4000 million cars and a yearly production of about 300 million (an average lifetime of about 14 years for each car). Today’s figures are about 500 million cars and a yearly production of 35 million (Tunali, 1996). So it is generally a matter of a ten-fold increase. This would have a variety of impacts according to different perspectives. Four will be dealt with here: a material resources perspective, an energy resources perspective, a greenhouse gas perspective and a land resources perspective.

A yearly production of 300 million cars demands large quantities of material resources. Based on a 2010 standard car it would require about 90 kg of steel and iron per capita, including material for the related infrastructure. This is 70% of today's total consumption of these metals. In addition, it would require 8 kg of aluminium per capita (180% of today's consumption), 9 kg of plastics (60%) and 125 kg of cement for infrastructure (60%). Materials for other transport means, notably heavy road vehicles, must be added to this. The overall picture, then, is that there would be a doubling of today's mining and production of crucial material resources in order to make the current OECD transport standard available for the whole world. Even if manufactured for complete recyclability this would still be the case. Almost all the new cars would have to be manufactured from virgin material resources as today's capacity (35 million) only gives minor opportunities for recycling. Table 3 gives a summary of the major impacts of making the OECD average car ownership available worldwide. As mentioned above, requirements for other transport means must be added. They can generally be assumed to have the same size as for cars (Høyer and Heiberg, 1993; Hille, 1995).

An increase in mining and production of material resources as outlined is highly incompatible with the fundamental requirement of ecological sustainability, with or without recycling. Several studies have suggested that the aggregate global level of material resources inputs should be reduced by at least 50% by the middle of next century. This is based on estimates of what ecosystems globally can tolerate in terms of mobilization of material resources in order to keep within long- term sustainable levels (Rensvik, 1994; Schmidt-Bleek, 1994).

***Table 3** Estimated and projected impacts of car ownership if the present level of car ownership within the OECD was extended worldwide (annual values)*

Environmental impact	1990 (all sectors)	Next century (cars only)	% change
Consumption of:			
Iron & Steel	700 x 10^6 t	540 x 10^6 t a	77 b)
Aluminium	23 x 10^6 t	50 x 10^6 t a)	217 b)
Plastics	80 x 10^6 t	50 x 10^6 t a)	63 b)
Cement	1100 x 106t	750 x 10^6t a)	68 b)
Energy use	90 000 TWh c)	50 000 TWh d)	55
CO_2 emissions	21 600 x 10^6 t	13 000 x 10^6 te)	60
Land use for infrastructure	36 ha f,g	320 x 10^6 ha h)	890

a) Consumption data are based on an assumed materials composition of the average new car in 2010. Materials consumed in infrastructure are as of 1990 (Høyer and Heiberg, 1993)
b) These figures differ from those given in the text due to assumed differences in the total world population
c) Data refer to the world's total primary use of so-called commercial energy. Biomass energy, which is widely used in developing countries, is not included
d) Estimate is based on an assumed 2010 average energy use of 0,9 kWh per vehicle km for the sum of direct, gross direct and indirect energy use. Eash car is assumed to travel 14 000 km pr. year (Høyer and Heiberg, 1993)
e) Estimate is based on an assumed 2010 average CO_2 emission rate of 240g CO_2 per vehicle-km for the sum of direct, gross direct and indirect energy use. Each car is assumed to travel 14 000 km per year (Høyer and Heiberg, 1993)
f) Assumes a standard level of transport infrastructure similar to that in Norway, i.e. 0,8 da of paved land (direct and indirect) for each car. This is actually the same as in the USA (Aall, 1992; Høyer and Heiberg, 1993; Tunali, 1996). The 1990 car population is assumed to be 450 million cars.
g) This value compares to an estimated world cultivated land area of about 1 400 x 10^6 ha for the period 1980-90. Cultivated land refers to arable plus permanent cropland (Hille, 1995)
h) Assumes that the amount of land used for transport infrastructure is 0,8 da per car throughout the whole world.

Table 3 shows that it would be necessary to increase energy use by more than 50% only in order to cater for the private cars. For the whole transport sector this would imply about a doubling of today's energy use. Again this is in conflict with the extra prima ecological sustainability requirement [16)] .

This conflict is even more evident in the case of CO_2 emissions. The implications of making the OECD transport standard global would be more than a doubling of total future CO_2 emissions for the transport sector as a whole, while private cars would only give an increase of 60%. Global emissions must be decreased by at least 60% in order to be within ecologically sustainable limits.

Consumption of land resources for infrastructure gives basis for a similar conclusion. An increase of 890% would imply adverse effects on biological diversity all over the world. This would, in addition, require paving over crucial agricultural areas. A future infrastructure of this size would correspond to 25% of the world's current cultivated land. Used solely for producing grain that much land could feed a world population of 4000 million (Tunali, 1996). In this way it is in conflict with the extra prima sustainable development requirement of giving priority to satisfaction of basic needs.

Sustainable Mobility

What transport standard, and what level of person mobility is compatible with sustainable development requirements? To what extent is there room for automobility within such a level? In other words; what are the implications of sustainable mobility?

To answer these questions the same four perspectives can be taken as a starting- point; but with one more added. This is termed the mobility resources perspective. The results are summarized in table 4 [17)] .

Table 4 *The implications of applying the principles of sustainable development to car ownership worldwide (values are annual per capita values)*

Environmental aspects	Current status, all sectors (1990)	Sustainable limit for person mobility (next century)	Average no. of cars (next century)	Percentage decrease in no. of cars, OECD only
Iron & Steel consumption	140 kg	3,5 kg[a]	0,007[b]	98
Cement consumption	220 kg	5,5 kg[a]	0,004[b]	99
Energy use	18 000 kWh[c]	1 300 kWh[c]	0,130[d]	67
CO_2 emissions	4 300 kg	135 kg[e]	0,057[f]	85
Infrastructure (land use)	72 m^2	36 m^2 g	0,045[h]	89
Person mobility	3 000 km[i]	5 000 km[j]	0[j]	100 (60)[j]

a) Assumes a 50% reduction in today's production, with 10% being available for private cars and 20-25% for the whole transport sector, and a world population of 10 000 million persons.
b) The limit for steel & iron consumption is set by the amount of iron used in reinforced concrete for transport infrastructure. This corresponds to 1 t per car year (Norwegian standard) which is assumed not to be recycable. Similarly, for cement the consumption limit is set by the amount used in infrastructure at 2,5 t per car per year (Norwegian standard) (Hille, 1995)
c) Assumes that 30% of total primary energy is available for transport purposes, half of which is for private car transport. The world population is assumed to be 10 billion persons.
d) Assumes each car (at 2010 standard car) consumes energy at an average rate of 0,7 kWh person-km^{-1} travelled and travels 14 000 km per year (Høyer and Heiberg, 1993)
e) Assumes a 60% reduction in global emissions (from 1990 levels) and a world population of 10 000 million persons. 30% of total CO_2 emissions are assumed available for transport purposes, with half of this being available for private car transport.
f) Assumes each car (a 2010 standard car) emits, on average, 0,17 kg CO_2 per person-km travelled and travels 14 000 km per year (Høyer and Heiberg, 1993)

g) Assumes a constant total volume of global infrastructure and a world population of 10 000 million persons
h) Given av constant infrastructure volume, the per capita number of cars is the same as that in 1990.
i) Assumes that 1 billion people have an OECD per capita mobility standard of 13 000 km per year (or 35 km per day). The remaining 4 000 million are assumed to have an average per capita mobility of 400 km per year (or 1 km per day). This level of mobility can be achieved solely with bicycling and walking (Høyer, 1995a)
j) By 2010 efficient buses and diesel trains will be able to achieve average CO_2 emissions of 0,048 kg person-km^{-1} and an energy use of 0,20 kWh person-km^{-1} for the sum of direct, gross direct and indirect energy (Høyer and Heiberg, 1993). Applying the sustainable levels of available CO_2 emissions and energy use, this allows average per capita mobilities of 2 800 km and 6 500 km respectively. If these allowances were applied to cars only, mobilities would be restricted to 800 km and 1 800 km, respectively. With land resource requirements (an average 0,008 m^2 person-km^{-1}), efficient buses and trains would give the opportunity for an average per capita mobility of 4 500 km (Høyer and Heiberg, 1993). For cars only this would be reduced to 500 km. It is therefore concluded that in order to get the maximum out of available resources, there is no room for private cars. The reduction in mobility in OECD countries would be about 60%, while the reduction in number of cars would be 100%.

Sources: Høyer (1995a); Høyer and Heiberg (1993); Hille (1995)

Table 4 shows that the material resources requirements, i.e. regarding material resources needed for construction and maintenance of the transport infrastructure, imply very heavy restrictions on the number of cars. Globally there will only be room for 40-70 million cars, about a tenth of today's number.

The energy resources requirement gives fewer restrictions. It makes it acceptable to have 1.300 million cars running, or about three times the current number. However, this is not consistent with sustainable development as it is highly incompatible with the material resources requirements. Our per capita quota of 1300 kWh for energy used in transport of persons is in accordance with figures given by Johansson et al (1985) in an analysis of the future energy situation. They consider it acceptable for each individual to perform all crucial tasks efficiently with 1 kW; 27% of this can be used for transport purposes. Half of this again, i.e. energy used for person transport only, corresponds to about 1200 kWh per capita per year (Høyer, 1989).

Restrictions due to emissions of CO_2 and consumption of land for infrastructure give room for a world total of 450-570 million cars, or about the current number, although this again will be a violation of the material resources requirements.

A sustainable level of person mobility seems to be about 5000 km per capita per year. This, then, is a sustainable mobility available to all people of the world. It can be attained within limits set both by energy resources, greenhouse gas emissions and land consumption, and as it seems also by material resources available for infrastructure (Høyer and Heiberg, 1993).

It could consist of about 1000 km a year from cycling and walking, about 3000 km a year from fossil-fuel-based bus and train transport and the rest from such transport based on renewable energy fuels (like biodiesel). This implies that there will be no room for private cars. Should cars be applied instead, this would give a very limited mobility, and thereby violate the principle of getting the most out of available resources. The very limited number of cars, would, in addition, not be in compliance with the principle of fair distribution of goods and burdens. This is because these few cars could only serve a very small part of the population with a relatively high mobility.

A mobility of 5000 km (about 14 km a day) would require a 60% reduction of the current average level in OECD countries, which is about 13,000 km a year and 35 km a day. In a historical analysis of the growth of mobility in Norway since the mid-19th century, a mobility of about 5000 km on average was reached around the year 1965. In the Norwegian case buses and trains were only able to give a yearly mobility of 1500 km per capita (Høyer, 1995a). This emphasizes that, even with extensive cycling and walking, it will be a formidable task to achieve a world average of 5000 km [18)].

7.9. Notes

[1)] At least when it comes to the use of the term, *Our Common Future* has had an epoch-making influence. However, the term was not new. It should be placed within a wider historical context. We can go back as early as to1969. According to an international convention that year, nature conservation should involve management of air, water, soil, minerals and living species, including man, so as to achieve the highest *sustainable* quality of life. It was then signed by 33 countries in the Organization of African Unity and agreed under the auspices of the International Union for the Conservation of Nature (IUCN) (O'Riordan, 1993). This use of the term "sustainable" covers important aspects of the later "sustainable development".

[2)] With “practical reality” in this context I only imply operationalizing of the term, not necessarily practical policies

[3)] Such a limitation is understandable. The conservation strategy has its basis in ecological science. This is also where the term "sustainable" originates, at least when it refers to conditions in natural ecosystems. It has been developed and applied as a concept in a strict natural scientific sense. *Carrying capacity* is a crucial concept in ecology, and which *sustainable* is related to. The carrying capacity of a species within an area is reached when the size of the population has come to a limit determined by how many individuals of the species which can live under the conditions set by the surrounding environment. Man can take out a "maximum sustainable yield" from a species or other natural resources, if this takes place within a limit where the level of the yield can be kept constant in all future, that is without deteriorating the carrying capacity (Mysterud & al, 1993). Historically, then, it is our later extension included in the term "sustainable development" which has introduced a new aspect.

[4)] Based on an analysis of works done within the field of economics *Turner* (1993) differentiates between four main categories of approaches. They are: *very weak*, *weak*, *strong* and *very strong sustainability*. Very weak merely implies that the overall stock of capital assets (or "resources") remains constant over time. Resources in this case are natural, man made, human and cultural. It presupposes complete substitution between these different forms of resources and thereby considered sustainable if we consume all of a natural resource as long as we at the same time build up similar assets of man-made or human (knowledge) resources.

Weak sustainability is only a modified form of the very weak. It accepts non-substitutability of certain types of natural resources, notably keystone species and keystone environmental processes ("sink"-processes in natural ecosystems). This implies that there will be some degree of restriction on resource-using activities of man. Where substitutability is considered to exist, it is still consistent with a continuously declining level of environmental quality and natural resource availability (Turner, 1993).

While weak sustainability only implies a protection of a smaller part of the natural resources, strong sustainability requires that their assets are kept constant in themselves. With technological anticipations about prospects for recycling of resources this is, however, in principle consistent with a continuous growth in the human economy.

In very strong sustainability there is no such consistency. The focus is here on what *Daly and Cobb* (1991) has termed the *problem of scale*. Thermodynamic limits imply that 100%-effective recycling is impossible and that there always will be a net loss in energy. From this follows that there are limits to the overall scale of the man-made activities.

[5)] The following words by *O'Riordan* (1993) express the same way of reasoning: "Sustainable development may be a chimera. It may mark all kinds of contradictions. It may be ambiguously interpreted by all manner of people for all manner of reasons. But as an ideal it is nowadays as persistent a political concept as are democracy, justice and liberty. Indeed, it cannot be disconnected from these three other ideals. If the prospect of an earth uninhabitable for many millions of people does not encourage the fusion of these great verities of human existence, this speaks much for the failure of the human family to manage its earthly household".

[6)] I launched the term *unfinished*. It is borrowed from the Norwegian professor in sociology Thomas Mathiesen (1971). He draws parallels to the greek *oracles*. They gave only rough outlines. Just by being presented as unfinished, this was their very strength as alternatives. According to Mathiesen, this is a necessary condition for fundamental social changes. In order to create the enthusiasm and pressure needed in a political movement, the alternatives must be real alternatives to the established and they must be mere sketches. It is even a requirement for keeping up the process of change that there always are elements of something unfinished, also after policies following the original alternative have been implemented and subject to inclusion (Mathiesen, 1971).

[7)] The most influential analysis into the topic has been made by Maslow (1962). He is the father of the so-called *Maslow-pyramid* of needs. According to Maslow, needs must be organized in a hierarchical system. There are five levels. At the very basis there are physiological needs for food and drink, and protection against pain, cold and heat. According to Maslow, they will totally dominate the mental processes and behavior of man if they are not satisfied. When satisfied, the next level will be dominating in this way, and so on. The second level is the needs for safety, while social needs for belongingness and love are at the third level. Fourth and fifth are esteem needs and the needs for self-actualization respectively. The works of Maslow have been strongly criticized. This applies especially to his strict temporal sequencing of levels of needs, but also to the elements of élitist thinking in his elaboration of the top self-actualization needs (Håland, 1995; Doyal and Gough, 1991). But in assertaining that there are *universal* needs, Maslow's analysis has been important as a counterweight to the many relativistic approaches.

[8)] It is interesting to note that they are similar to the division made between societal *self-sufficiency* (physical conditions) and *self-supportability* (physical and autonomy) in Norwegian eco-philosophy

[9)] Examples are nutritional food and clean water, protective housing, appropriate health care, secure childhood, appropriate education, etc. Doyal and Gough give examples of how such needs can be measured through the use of quantitative, universal *indicators*.

[10)] Whenever we are faced with such questions, we can, moreover, have a moral *duty* to emphasize the non-human life's integrity at individual level, independent of what the consequences are. Even they have an independent right to live and have their needs satisfied. It will then be exclusively morally right to *act* on their behalf.

In both cases, that is in consequential-ethical terms and in duty-ethical terms, the demands are directed towards actual policies as well as towards basic reseach, applied research, and development work. There is, then, no basis for making less severe demands on what is consciously referred to as "basic research". This means that a consideration for the nature's intrinsic value contributes to strengthening the criticism of some classic formulations of the so-called *value freedom thesis* in science. The fundamental value freedom thesis is that science is or should be value free. There is, however, a series of definitions of this, used in varying degrees (Tranøy 1986; Gilje and Grimen, 1993). Usual formulations, though, are the theses of the value-free knowledge production, and the fact that researchers should not concern themselves whether the results are applied for good or evil purposes. Similarly, this contributes to our having to take a critical look at those dividing lines so frequently found between basic research and "other" research.

[11)] *How many years*, then, can long-term mean in the environmental context? There is no simple answer to this question, and it will partly depend on the type of issue. The debate concerning environmental impacts of nuclear energy may serve as an illustration. Plutonium-239 has a physical half-life of approximately 24,000 years. This means that environment and health impacts must be analyzed in such a time perspective. Once technologies are created with possible effects over such a long time, then it is the total effects which must put restrictions on our actions today. This has implications for the *cost-benefit-analysis* tools often applied. In order to make future benefit and future costs comparable quantities today, it is common to make use of calculated interests in one way or another. This means that future occurrences are given relatively less weight, and that occurrences far into the future are given no weight. This is not consistent with the long-term aspect requirement in sustainable development.

[12)] In 1976, The International Labor Organization (ILO) adopted principles and an action programme for a basic needs strategy. Some years later the World Bank also initiated such work to collect data for and construct indicators of basic-need satisfaction. These initiatives, however, gave priority to a small set of needs, typically nutrition, health, water supply, sanitation and housing. UNDP, on the other hand, has constructed a Human Development Index (HDI). It is what we would call a composite indicator, combining life expectancy, literacy and income for a decent living standard. As it includes important aspects of *autonomy*, it is much in line with the definition of basic needs I have given earlier (Wetlesen, 1975; Doyal and Gough, 1991).

[13)] Rawls' theory of justice, based on *contract theory*, represents a continuation of a long historical tradition in political philosophy that goes back to the works of Locke, Rousseau and not the least Kant. The fundament in such a theory is that a political arrangement is legitimate if the people living under it – as free and equal individuals - can give it approval as a social contract. As emphasized Rawls argues that there can be well-founded reasons for treating people differently regarding economical, social and cultural rights, but not regarding basic human and political rights. Whether such causing of differences can be considered to be fair or not, has to be given grounds for in each case in relation to the situation of the least favoured parties. His theory comprises the following three principles :

1. *The freedom principle* says that all shall have equal right to the most comprehensive system of equal, basic freedoms which at the same time is compatible with a corresponding set of freedoms for all ;
2. *The difference principle* says, as mentioned, that social and economic inequalities shall be arranged in such a way that they both are of the largest benefit to the least favoured members of society and are compatible with justice between generations ;
3. *The principle of equal opportunities* says that inequalities as these must be connected to positions in society that are open to all with equal opportunities.

The freedom principle is given priority. Rawls empasizes that this not only implies that everybody has the right to equal political rights in a formal sense, but also that it presupposes a superior principle of satisfaction of basic needs. The two other principles express that all primary goods in society should be distributed equally unless inequalities in the distribution of each and any of these goods are to the benefit of the least favoured members of society. This can even be related to the socalled *maximin-principle* : the total distribution in society shall benefit to maximum the situation for the least favoured members, or in other words ”maximize minimum”.

[14)] In the Norwegian debate it has been proposed to use a *land-use criterium* instead (Skjeggedal, 1996). It would imply that the societies share of reductions are made dependable on their total emissions per unit of land. Evidently, this is based on an understanding that sparsely populated societies need a relatively high use of fossil energy to keep their societal structure running. Statistical data document that this would even to a smaller degree than the point-source approach comply with the principles of fair distribution of goods and burdens. Sparsely populated countries such as Australia and Norway would be free riders, while several developing countries with both small per capita and total emissions would have to undertake large shares of the reductions.

[15)] In OECD countries this mode of transport on average accounts for more than 80% of all oil used for transportation. Most of the remainder is used in air transport, while rail and sea together only accounts for an average of about 5% (OECD, 1996). A strong fossil basis, the volume of the sector and the trends towards large further increases are obvious reasons why transport, and in particular road transport, are in focus when sectoral consequences of policies to achieve global reductions in CO_2 emissions are on the agenda.

[16)] The Brundtland Commission report (WCED, 1987) claims, for instance, that the world's total energy use needs to be stabilized at today's level for ecological reasons, and that only at such a level is there ecologically acceptable room for a substantial share from renewable energy sources. A major challenge, then, will be to distribute this total energy use fairly among a future world population twice as large as the present (Høyer, 1989).

[17)] This implies application of an analytical approach based on the concept of *ecological space*. Other terms for the same concept are “environmental space” and “just environmental space”. The last emphasizes that it is not only a matter of calculating the acceptable ecological space in physical terms, but also of applying an “equity principle” or “distributive justice” (Spangenberg, 1995; Svensson, 1995).

In his study “Sustainable Norway” John Hille (1995) uses this definition:

> “The “environmental space” for a given resource is the maximum amount that the world may sustainably consume per year, given the constraints imposed by long-term availability as well as by the environmental effects of its extraction and use. Once the environmental space for a given resource has been defined at the global level, environmental space per capita is given by the assumption that each world citizen has an equal right to consume. Similarly, the environmental space available to the Netherlands or any other country will be given by its share in world population”.

The last he denotes *environmental share*, that is the share in the global environmental space to which each person, or country, is entitled. A similar definition is given by one of the original Dutch studies (van Brakel & Zagema, 1994):

> “Environmental space is the total amount of pollution, non-renewable resources, agricultural land and forests that we can be allowed to use globally without impinging on the access of future generations to the same amount”.

While it is not clearly expressed in this definition, their equity principle covers both inter-generational (future) and intra-generational (global) justice. An analysis based on the concept must then include the following four dimensions:

1. Source limits
Limited quantities and availabilities of both renewable and non-renewable natural resources.

2. Sink limits
Limitid capacities of ecosystems to absorb the environmental loads from extraction, production and use of renewable and non-renewable natural resources

3. Inter generational equity
Establishing levels of production and consumption today which enable future generations similar shares of the limited sources and sinks

4. Intra (global) generational equity
Giving all parts on the world similar shares of the limited sources and sinks

In their book “For the Common Good” Herman Daly and John Cobb (1991) are promoting the same basic ideas. According to them the economy is subject to three different challenges: *volume, distribution* and *allocation*. The first two can not be solved by economy itself. The volume, or acceptable *scale* within source and sink limits must be defined on a superior societal level. Similarly must the distribution be based on principles and policies superior to the sphere of economics. They - volume and distribution - are data-input needed by an economy so that it can solve the problems of allocation. It should be emphasized that Daly & Cobb write about limitations and prospects for a *market*-economy.

Actual approaches based on the concept of ecological space fall within a broader family of methods applied to analyze the ecological effects of different forms of human encroachments into natural ecosystems. However, distinct from more traditional environmental impact analyses towards all parts of the global streams of natural resources the varying activities are based on *and* the adherent environmental effects in the totality of global space. *Ecological footprint* (Wackernagel & Rees, 1996) and *ecological backsack* (Svensson, 1995), and basically also *life cycle analysis,* belong to this family. Ecological space analysis differs from these as presuppositions about distributive justice are included in the main approach.

In this way it is very much dependent on presuppositions made about the actual scale of the acceptable ecological space in a global context. The analysis in this chapter explicitly assumes that a 50% reduction in the global input of basic natural resources is needed in order to remedy todays overload on sinks and sources (Schmidt-Bleek, 1994; Spangenberg, 1995). Necessarily there will be various opinions not only about the exactness, but also about the reality of such figures. However, they are not fundamentally different from recommendation of 60% reduction in global emissions of CO_2 made by the UN Intergovernmental Panel on Climate Change (IPCC) or of 50% reduction in levels of energy consumption in rich countries made by the UN Brundtland Commission. Developing policies on the basis of such recommendations would in addition be unacceptable if not based on some sort of distributive justice.

The actual figures generated in this chapter should not be taken absolutely. The author favors an approach where calculations such as these are applied to elucidate a way of reasoning and to give a rough understanding of the scale of the challenges.

[18)] A person mobility of 5000 km per capita and year is of course today far from the reality a large part of world population live within. In itself it is neither a political aim which should be put in front. However, it should be considered to be part of a context where the major aims are general and fair development of social welfare in the poor countries of the world, also a crucial aspect of a sustainable development. Placed in such a context, and with the condition that development of transport infrastructure in the poor countries is directed towards creating conditions for walking, bicycling, railways and buses, the analysis actually elucidates that there are no serious ecological limits to the growth in mobility which is included in a growth in social welfare.

7.10. References

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8. Conclusions

This Ph.d thesis has elucidated the following *superior issue*:

- How can we understand the concept of sustainable mobility?

With this conceptual approach an intention of the articles has been to give a *critical* contribution to the *discourse* on sustainable mobility. According to the social scientist *M. Hajer* (1996) a discourse is a “specific ensemble of ideas, concepts, and categorisations that are produced, reproduced, and transformed in a particular set of practices and through which meaning is given to physical and social realities". I share the view of Hajer that discources play a key-role in processes of political change. According to the Norwegian social scientist *W. Lafferty* (1996) the term *critical discourse* covers problematization, alternative conceptual constructions, identification of values and development of characteristics. All these have been elements in my approach.

Three *leading issues* have in a more operational sense defined the scope of the articles. They are:

- How can we understand the concept of sustainable development, in particular in a context of environmental problems?
- How can we understand the concept of and focus on mobility in such a context?
- What are the implications of sustainable mobility in relation to the requirements of modern transportation systems?

Sustainable mobility is a mobility that is in accordance with sustainable development requirements. This emphasizes the necessity of addressing the two basic concepts of *sustainable development* and *mobility* as it is expressed in the first two of these issues. Both are however broad concepts. With a focus on the development part of the concept sustainable development may include issues both in relation to economical and social development, not only between rich and poor countries but also within each country. My focus has primarily been on the sustainability part or more precisely the context of environmental problems. Similarly the concept of mobility is primarily addressed in its relation to environmental problems. This has had two major reasons. Firstly, I have a background in environmental sciences and have worked extensively within the field of enviromental problems for more than twenty years. Secondly, my empirical research the last years has been carried out with a prime focus on - and within a context of - environmental issues. This research has given the basis for the articles included.

Further, my research has mostly been confined to the transport sector, that is the relations between *transport and environment*. This is expressed in the third leading issue above. I have thus in particular wished to elucidate and discuss the implications of a concept of sustainable mobility in relation to the requirements of our modern transportation systems.

This is not the least important as the concept itself originated in policy documents discussing implications of the serious environmental problems caused by growth in transportation.

My analyses and discussions related to the last issue in particular lead to the following conclusions:

- The volume of private car transportation in the rich part of the world must be substantially reduced. This is equally necessary outside as inside urban areas. Principally there is no room for private car transportation in a future fullfilling sustainable development requirements. This is a global demand.
- The volume of airplane transportation must be substantially reduced. This is equally necessary globally as inside and between the rich countries of the world. Principally there is no room for airplane transportation in a future fullfilling sustainable development requirements. This is a again a global demand.
- The volume of lorry transportation in the rich part of the world must be substantially reduced. This is equally necessary outside as inside urban areas.
- The effects of these reductions are considerable reductions in levels and changes in patterns of mobility in the rich part of the world. This applies both to person and goods mobility and on individual and societal levels.
- There is a need of keeping substantial volumes of enviromental space available so that the levels of mobility in the poor part of the world can be increased. This applies both to person and goods mobility and also to individual and societal levels.
- The current high levels of mobility in the rich countries can not be upheld with alternative renewable energy sources, neither in regional contexts nor globally. With such energy sources as a substantial basis for the future transportation systems the implications will be reduced levels of mobility.
- Quite high levels of mobility can be attained even when the volumes of private car, airplane and lorry transportation are low. This applies equally to the rich as the poor part of the world.
- Such sustainable levels of mobility have on average been experienced in the rich part of the world only a couple of decades ago. Substantial groups of the population within the rich part of the world do even experience such levels of mobility today. This helps to moderate the wider societal implications of sustainable mobilities.
- The basis for the upholding of these sustainable levels of person mobility are the public transport means on the ground, buses and various rail-systems, both inside and outside urban areas. This applies equally to the rich and the poor parts of the world.
- Even if reductions in average levels of mobility may be moderate, there will be substantial changes in patterns of mobility. This follows from the substantial changes in the basic transportation systems.

These are characteristics of transport systems and transport that are in accordance with sustainable mobility requirements. Such more operational characteristics do however not give due credit to the complete thesis. Firstly, they need to be substantiated in a more coherent way than the separate articles have made possible. Secondly, the superior issue has been to *understand* a concept, not primarily to develop its operational characteristics. Through my critical analyses of the two basic concepts sustainable development and mobility more complex and wider relations have in addition been addressed.

It should be emphasized that the work with the conclusion chapter has given me the opportunity to rethink and restructure the material in the articles. Not the least has it given me the opportunity to link this material together within some common themes across the separate articles. By this I have myself learnt very much.

The following represents my efforts to pass on this learning. They are thus the conclusions regarding the major parts of the thesis, and can be summarized within seven main headings:

1. The Concept of Mobility
2. The Changed Character of Environmental Problems
3. The Major Characteristics of Sustainable Development
4. The Precautionary Principle
5. The Limitations of Technical Fix
6. Some Sectorial Implications of Sustainable Mobility
7. The Environmental Ethics Basis

8.1. The Concept of Mobility

My empirical research has a focus on *transport*. I still use the concept *mobility*. This has five main reasons. The first two are metaphorical, the next two are operational and the last one is a more pragmatic one. They are :

a. Mobility is a methaphor of movement. Change and movement are inter-related. Movements imply both social and physical environmental changes. I have substantiated the thesis that the volumes of movements are more decisive for such changes than the individual means we use to carry out the movements. These means belong to the concept of transport. The metaphorical meaning of transport is not first of all movements, but more cars, buses and trains.
b. Mobility is a metaphor of movements in social contexts. It is thereby expressed that social relations are affected and involved. Transport is mostly a metaphor for physical movements.
c. Mobility is a concept used in many different social contexts and social science disciplines. Concepts as labour-mobility, social mobility, family-mobility, settlement mobility, etc are used. A thesis is that all these mobilities are inter-related with transport related mobility. By using one common concept – mobility – such inter-relations can be focused and explored. It should however be emphasized that this only to a minor extent actually has been carried out in my Ph.d. thesis.
d. My focus is on the volume of movements. In my empirical research I use indicators to express these volumes. They are primarily the number of personkilometers and the number of tonnekilometers. But also indicators as

travel-frequencies and travel-times are used. All are indicators of mobility. They are not as evident as expressions of transport.

e. Within some traditions of transport research mobility is defined only as the potentiality of travels or movements and not the actual realization of these movements. My studies of transport research litterature have however revealed that the actual movements generally are included in their use of the concept. This is for instance the case in a major work on the state-of-the-art of travel and transport research in Europe. My use of the concept is thus in accordance with the way it is used within mainstream European transport research.

My historical analysis of the development in *domestic person mobility* in Norway since 1855 elucidates important quantitative and qualitative changes. Travel distance is used as an indicator of mobility, expressed in the number of kilometers each inhabitant on average covers each day. The figures only include the mobility linked to the use of extra-energy transport means. Walking is, consequently, not included nor is the use of bicycle. However, the use of horses is an important part of the mobility figures in the last century and the first decades of this century.

In 1855 each Norwegian moved on average 50 meters a day. This was increased to 500 meters around the turn of the century. Today this mobility accounts for approximately 35000 meters, or 35 kilometers a day. It is about a four-fold increase since 1960, and a doubling since 1970. The Norwegian after-war ban on importing private cars was lifted in 1960 after a gradual liberation in the late 1950's. During the more than hundred years between 1855 and 1960 the average individual mobility increased by about 9 kilometers a day. In the 35 years between 1960 and 1995 the increase has been about 3 times as large, or 26 kilometers a day. What is referred to as *automobility* – a mobility based on the use of automobiles or private cars - is the predominant factor behind this increase. At present, it makes up about 80% of the average domestic mobility. In 1960, each Norwegian moved nearly 4 kilometers per day by private car. Today this has increased to approximately 27 kilometers.

This development gives an emphasis of the close connections between *transport systems and mobility*. Our current levels and patterns of mobility are to a large extent based on a transport system of private cars. The two – mobility and transport system – can not be disconnected. A social development without private cars, or at least with much less car use, would not only imply other patterns of mobility but also substantially lower levels of mobility.

The public transport means on the ground today give each Norwegian a total of about 4 kilometers per day, a figure that has remained fairly constant in the past 40 years. Since 1950 the increase in this type of mobility has been less than 1 kilometer per day on average.
Figures from other rich countries show that it may be possible to attain a higher mobility through public transport systems. But even in countries with large concentrations of population this mobility is far below levels reached through a system of private cars. This underlines the fact that we cannot reach any mobility level solely based on such environmentally benign transport means as trains, buses and trams.

The Norwegian public transport mobility in the air, on the other hand, has increased five-fold since 1970. Just in the course of the past 15 years it has been more than doubled. However, these figures do not include mobility outside the national borders. Another of my empirical analyses shows an especially high volume of air transport in connection with *leisure mobility*. It reveals that the air mobility linked to tourism travels by Norwegians accounts for as much as 6 kilometers per day on average. Large future increases in mobility, if they take place, will be connected to the growth in air transportation. The term *aeromobility* is used to describe this development, where *globalization* processes in transportation have a major importance.

My attention is also directed towards *domestic goods mobility*. An analysis shows a doubling from 1960 and to the present. The indicator is tonne kilometers per inhabitant and day. For the lorry-based mobility in particular, there is a six-fold increase in the same period. With current trends further increases are expected at least up to the year 2010. Again the connections between a particular transport system and levels and patterns of mobility are emphasized. The importance of the *lorry-mobility* as a component of the overall goods mobility has its parallel in the *automobility* of the overall person mobility. As they are linked to the same *infrastructure* these mobilities should also be understood in their relation to infrastructural conditions and development patterns.

8.2. The Changed Character of Environmental Problems

Since the presentation of the Brundtland Commission Report in 1987 (WCED, 1987), environmental issues have been strongly focused, nationally and internationally. Important processes have particularly taken place in the early 1990s. However, this focus on environmental issues is by no means new. Something similar happened in the 1960s and 1970s. The publication of the book “Silent Spring” by American ecologist *Rachel Carson* (Carson, 1963) was an important releasing force. The ensuing debates laid the foundation for new environmental organizations all over the Western world and changes in public focus and policies followed.

Thus, two historical situations, approximately 20 years apart and both characterized by substantial attention directed at environmental problems, have occurred. The first resulted in public policies in the form of new legislation and new institutions. It was built on an “apprehension” of the environmental problems regarded as the most critical and on the prevalent environmental-political understanding of these problems. I give the concept *environmental problem* a rather wide definition. In one of my former works (Høyer and Selstad, 1993) related to this Ph.d. thesis I have defined it as follows :

> *“.. a collective term for all types of human encroachments and loads causing “problems” in natural ecosystems. Partly the concept is also connected to the problems themselves as they arise in the ecosystems.”*

Further my understanding corresponds with the following from *J.S.Dryzek* (1996):

> *“..the way we construct, interpret, discuss, and analyze environmental problems has all kinds of consequences.”*

Today, in the 1990s, this picture looks different from the 1970s; *the environmental problems have changed in character*, which then is reflected both in differences in what types of environmental problems that are most serious, *and* in a different understanding of how environmental problems should be understood and in what ways they should be addressed.

My analysis of how the environmental problems have changed in character comprises five dimensions, each expressed through two concepts. One concept is used to elucidate the understanding around 1970, while the other similarly elucidates the understanding in the 1990s. Thus, there are five different concepts linked to each historical situation. Necessarily, this is an *ideal-typical* presentation. The real situation is more complex, without such an unambiguous distinction in understanding. However, it serves the purpose of putting focus on some major aspects of the historical development in *and* in understanding environmental problems.

The five dimensions are expressed through the following pair of concepts:

1970		**Post 1990**
Resource limits	→	Recipient limits
Local recipients	→	Global recipients
Short feedback loops	→	Long feedback loops
Point sources	→	Diffuse sources
Production related problems	→	Product related problems

Essential to the environmental discussions that took place around 1970 were problems related to the available quantities of natural resources. A dominating view was that absolute limits to anthropogenic activities would be determined by the limited quantity of resources. These may be termed *resource limits*. They are not considered prominent today. Of far more importance are the limits determined by the recipients limited capacity for dealing with the wastes caused by the human transformation of resources. These are termed *recipient limits*. Internationally it is more common to use the pair of concepts *source problems* and *sink problems*.

To put it concisely, the problem is not that there is too little coal, oil or natural gas, but rather that there is too much. The recipients cannot deal with all the waste products from resource transformation. An important written contribution expressing the prevailing 1970-understanding was the report “The Limits to Growth” from the socalled “Rome-Club” (Meadows & al., 1972). By advanced computer-models they outlined absolute physical limits for a continued growth in the extraction of crucial natural resources. 20 years later the same research group title their book “Beyond the limits” (Meadows & al., 1992). Their main focus is now on “recipient limits”.

8.2.1. The Globalization of Environmental Problems

Another distinction is made between *local* and *global recipients*. Compared with earlier situations, anthropogenic activities and encroachments today represent substantial volumes in comparison with the global ecosystems. There are good grounds for maintaining that in this way the relationship between the human society and the global natural environment has changed in character.

Throughout history, local and regional recipient limits have been exceeded. However, such a comprehensive exceeding of local, regional and global recipient limits has never been seen before. It is at the least an indication that the volume of human activities constitutes a problem, independent of the qualitative technologies of which they are comprised. This is referred to as a quantitative problem and here it is globally encompassing.

The distinction between *short* and *long feedback loops* comprises several dimensions. Firstly, there is a spatial one. Consistent with the development from local to global recipients, feedback loops have become longer. They penetrate and make up a larger part of the global ecosystems. Secondly, it is a matter of time. Long feedback loops mean that it takes a long time until the full effects in the ecosystems are felt. An encroachment today can in some cases give a full backlash only in a hundred years, even if, in the meantime, the extent of the encroachment is reduced.

Furthermore, there is a dimension related to the question of clarity. There has been a development from clear to more diffuse feedbacks. The cause-effect chains are no longer so obvious. The effects, e.g. dying forests can be obvious enough. The causes, however, are diffuse. It may be an interaction of many causes - some natural, others of human origin. This is the issue of *diffuse sources*. Diffuse, many conflicting and major delays in terms of feedback can be particularly disastrous in systems undergoing rapid change, particularly where the quantity of anthropogenic encroachments is substantial. The *precautionary principle,* which I shall return to, is formulated in order to take into consideration problems emerging from such diffuse feedbacks.

A fourth distinction is made between *point sources* and the mentioned *diffuse sources*. Point sources are few, large and easily defined. Diffuse sources are many, small, dispersed and not easily defined. Each and every one is apparently without any significance. They can, in addition, be scattered over large distances, or comprise different types of sources, nevertheless causing the same major environmental problem. Even if each point is small, the sum loads on recipients and ecosystems are substantial. And it is of course these sum-effects that matter.

In the 1990s, problems linked to diffuse sources have prevailed in environmental focus. Previously, point sources were dominant, and both people, legislation and institutions have become used to dealing with environmental problems as if they were of point-source character. Thus conventional technical solutions have dominated, often taking the form of “end of pipe” solutions. Diffuse sources pose other challenges. There will be problems if they are dealt with as point sources as they demand source-oriented solutions; that is controlling what is generated at the ultimate sources and not only limitating what is emitted at the ends. Such solutions are not within a usual concept of “technical fix”.

The last distinction is made between the environmental problems of *production* and of *products*. Environmental problems arise during the manufacture of products: these are the traditional point source problems. Today these problems are reckoned to be of less importance. More attention is given to the environmental problems of the products, both when they are used and after use when they become waste. This is linked to the problems of diffuse sources. In a way the problems have been moved from the manufacturing company to the products in circulation in society. Each product constitutes a source of environmental problems, however minor. But there are many products; they are dispersed and not easily defined. The sum-effects constitute major environmental problems.

With my background in environmental sciences it is interesting to note that the essence of the changed character of environmental problems is described with insight by two outstanding social scientists in the 1990s. They are *Anthony Giddens* and *Ulrich Beck*, both sociologists. In his book "Beyond Left and Right" *Giddens* (1994) puts the ecological crisis at the core of his analysis. That crisis, "are expressions of a modernity which, as it becomes globalized and turned back against itself, comes up against its own limits" (p. 11). He considers *globalization* and *manufactured risk* to be major aspects of the new form of ecological crisis linked to "post"- or "late"-modernity. *Mass transportation* forms an important part of intensified globalization processes. Manufactured risk implies that the human population is confronted with risks manufactured from within, but which still is largely unpredictable.

In his works on"Risk Society" *Beck* (1992, 1997) presents a similar analysis. In the risk society, which is linked to "late" modernity, the "logic" of risk production and distribution dominates the "logic" of wealth production and distribution. This relationship was the reverse in the classical industrial society. A problem is that social-theoretical thinking still is dominated by this reversed relationship, in particular the "logic" of distribution of wealth. In late modernity the risks are produced by modernization in itself and they increasingly overshadow the gains from technical-economical progress. Both globalization and irreversible effects on the lives of plants, animals and humans are crucial parts of the new "logic" of risk production.

Both Giddens and Beck emphasize that the classic concept of "externalities" can not be used to understand the logic of risk society; in late-modernity the ecological crisis is deeply integrated and "internalized" in the human society. Classic environmental "management", with its basis in a concept of "externalities", will neither be able to address problems related to such an understanding. These are views corresponding to those expressed in this Ph.d. thesis. The environmental problems caused by transportation are integrated in those from other sources. And transportation cannot be "externalized" from mobility. This is in itself a reason for using the concept "mobility" when we focus on how to understand and analyze the implications of "sustainable development". The concept of mobility expresses close relations to fundamental aspects in the human society. Policies to achieve sustainable development cannot be "externalized" from these aspects.

8.2.2. The Relations between the Changed Character of Environmental Problems and the Focus on Mobility

The changed character of environmental problems – and the inherent globalization of environmental problems – give a back cloth for understanding the concept of *sustainable mobility* in a historical context. This applies to both parts of the concept ; the *sustainability* part and the *mobility* part. The five concepts expressing the 1990s understanding of environmental problems are all included in the concept *of sustainable development* as it is used in the Brundtland Commission Report (WCED, 1987) and in the follow-up national and international political processes, notably the processes before, at and after the Earth Summit in Rio in 1992. The report – and the follow-up processes –

could in themselves be understood as responses to the challenges raised by the changed character of environmental problems.

A focus on *mobility* should be placed in a similar context. Transportation – or mobile systems - have increased vastly as sources to recipient problems. In Norway person mobility – measured as the average number of kilometers each inhabitant travels – has increased by more than 100% between the early 1970s and the late 1990s. A similar development has taken place not only in other rich countries, but in most of the rest of the world. Transportation is almost entirely based on the use of fossil energy, thus having become an important source to *global recipient problems*, particularly caused by emissions of CO2. But this increased burning of fossil energy has also become an important source to several macro-regional recipient problems that are quite different in character from the local recipient problems of the 1970s. Both globally and macro-regionally they constitute crucial parts of the concept of long feedback loops.

Through the focus on globalization of environmental problems a formerly locally defined problem as reductions in biological diversity is in addition given a global re-definition and relevance. This is expressed in the global convention on biological diversity endorsed at the Earth Summit in 1992. Land-use encroachments caused by transportation infrastructure have increased as sources to losses of biological diversity. Transportation, both the mobile systems and the infrastructure, are not typical of the point sources of the 1970s. On the contrary, they represent typical *diffuse sources*. They are many, small, dispersed and not easily confined. Each and every one is apparently without any significance. They can, in addition, be scattered over large distances, or comprise different types of sources, nevertheless causing the same major environmental problem. Even if each point is small, the sum loads on ecosystems are substantial. This gives a close linkage to the focus on *product related environmental problems* instead of problems related to production or manufacture.

The term “product related” covers several, partly overlapping dimensions. Firstly it is the problems caused by the products when they are used and when they become obsolete, not the least as volume problems when the number of products become large. The private car is notable as such a product. The major problems are connected to its use not to its manufacture, particularly so because the numbers are so large. Secondly it is a matter of “consumption related” environmental problems. Again the private car has a notable position, both directly and indirectly. Not only does it take up a large share of the total private consumption in all rich countries, but it also serves a function as the basis for other forms of consumption. In this last context it is even closely linked to the most extravagant forms of consumption also being important sources to environmental problems, namely tourism. The increase in leisure time mobility – and the tourism connected to it – has been particularly large since the early 1970s. Thirdly it is a matter of “distribution related” environmental problems. Major societal and industrial changes since the early 1970s have highlighted increases in transportation intensities in the distribution chains both within structures of manufacture and between places of manufacture and places of sale and consumption. Not the least have increases in the use of environmentally harmful means of transportation, lorries and planes, been put into focus.

8.3. The Major Characteristics of Sustainable Development

8.3.1. The Problems of Volume

The environmental problems of transport do not constitute a separate theme in the Brundtland Commission Report. Still, there are several references to them. One is found in the report's main chapter on energy. Transportation is an important source of three of the four environmental problems the commission highlights as implied in a high future consumption of energy. Within the recommended low-energy strategy the Commission delineates possibilities for a reduction of the energy consumption per capita in industrialized countries of 50% and an increase of 30% in developing countries. Transportation is one of the areas which is explicitly linked to such targets for reductions of the primary energy consumption in the rich part of the world. In this context energy resources are understood as *global resources*, and the environmental problems caused by the consumption of energy are understood as loads on a *global commons*. Even the exploitation of renewable energy sources is defined primarily as a global responsibility and as a matter of fair distribution of scarce resources.

This perspective I describe as a *volume perspective*. It relates to the concept *problems of volume*, which expresses that the problems are linked to the total volume of energy use; in this context, this means the volume of transport energy. Global environmental problems are global just because they are problems of volume, that is they are added up from many small local contributions to large global sums. Sustainable solutions primarily demand reductions in volumes, however implying reductions both in and of all the local contributions. This is a basic understanding entailed in the sustainable development concept of the Brundtland Commission Report. However, the report also includes another perspective, which I describe as the *intensity perspective*, and relate to the concept *problems of intensity*. Here the attention is mainly directed towards the special accumulation of problems found in urban areas. Within this last perspective the Commission focuses on the urban environmental problems both in industrialized and developing countries.

My concept problems of volume is similar to the concept *issue of scale* as it is used by the American economist *Herman E. Daly*. In discussing social conditions for achieving sustainable development he considers it necessary to make a difference between three different issues:

- *Scale.* Refers to the total volume of the throughput of natural resources and waste- and emission-products. Thus, it refers both to the volumes of sources and sinks.
- *Distribution.* Refers to the distribution between people of the throughput of natural resources in the form of end-use products and services. Thus, it refers to how much of the resources that are distributed to you and me, to other people far away in space, and to people in future generations.
- *Allocation.* Refers to the distribution of the throughput of natural resources to different end-use applications. Thus, it refers to how much of the resources that are used to private cars, houses, cloths, water and sanitary purposes, etc.
  (Daly, 1992; Daly and Cobb, 1991).

Daly's main thesis is that the acceptable volumes must be decided *before* distribution and allocation. At the same time these volumes must be determined through political decisions, and theses decisions must reflect physically defined ecological limits. The next step is to decide on distribution through criteria of distributional justice. Even this is then a matter of political decisions. Only after having politically determined the ecologically acceptable volumes and the ethically just distribution can, in the cause of effectivity, allocation take place through marked economy.

8.3.2. The Historical Context of Sustainable Development

In the Brundtland Commission Report (WCED, 1987) the concept of *sustainable development* is presented. Since then it has been put into use in a lot of contexts. Almost all over the world it is included as an important political goal, for national and international organizations as well as for national governments. The two Norwegian social scientists W.*Lafferty and O.Langhelle* (1995) call attention to that there are few – if any – other examples of a superior political goal with such a comprehensive political approval internationally.

In this way sustainable development can be analyzed and understood as political processes. But it is also a concept in a more limited sense. My approach is primarily to make it subject to a *conceptual analysis*. Concepts are of course important to us, both in politics and science. They, to a large extent, control what we take notice of, particularly in matters that we cannot directly see, touch or feel. But there are different types of concepts, and not the least differences in understanding how they should be used between various fields of science.

In natural sciences concepts are given a precise and clearly delimited definition and thus can easily be made operational. Economic science is dominated by the same understanding. This, of course, is due to the strong influence natural science perspectives have had on the development of economics. Confronted with the many different approaches to "sustainable development" this should be borne in mind as economists perhaps are the one group most vigorously involved in definitional efforts. In other social sciences concepts are often given a somewhat looser meaning, only requiring that a core of aspects and dimensions are present. My approach comes within this understanding. Sustainable development should be considered to be on the same level as democracy, liberty and social welfare. This also implies that it is a normative concept, and not purely descriptive as they usually are within natural sciences. The desire is to achieve goals of a social character. This must necessarily be based on choices of certain values and norms. However, it differs from the purely social science concepts in one important way: it originates from natural sciences and must include consideration for species and systems in nature. Encircling it thereby requires a cross-disciplinary or rather cross-scientific approach.

The Swedish historian *Sverker Sörlin* (1991) has placed the development of environmental protection on a similar level. According to his analysis, the present is a historical epoch where substantial changes are taking place. Humans are about to develop fundamentally new rules on how to associate with nature. He calls this a contract with nature, a term chosen with care. An analogy is drawn to the later influence on modern societies by the political philosophers of the 17th and 18th centuries who developed their thoughts about a social contract. The most outstanding political work of Rouseau was simply titled *Du contrat social* (1762). Sustainable development can be understood as processes towards *Du contrat nature*.

This further emphasizes that sustainable development should be understood in a historical context. It comprises two major parts. One is sustainability, related to the term *ecological sustainability*. The other is development, which comprises two dimensions. Firstly , to achieve ecological sustainability is a matter of social development processes. Secondly , it is a matter of achieving *social development* in socalled development countries and that the issue of ecological sustainability should be related to such processes. I have formerly claimed that the concepts expressing the changed character of environmental problems are included in the ecological sustainability part, and that sustainable development even can be understood as a response to these changes. This serves to place the concept in a historical context of changing (views on) environmental problems. But there is also a historical thread in the development part. The environmental discourse in the early 1970s had a parallel focus on ecological issues and development issues in poor countries. This came to expression in the UN-conference on “The Human Environment” arranged in Stockholm in 1972, where both developed and development countries for the first time came together to discuss environmental problems and threats to the human environment. Relations between social development and ecological balance were in particular put into focus. In the following years, however, this coupling of issues should become much less prominent, before it was returned to in the Brundtland Commission Report.

This brings me back to the normativity of sustainable development. It is a *normative concept* in two different ways. Firstly, as outlined above, it is about achieving ecological and social goals. This necessarily raises *ought to–issues* and not only are-issues. Secondly, and as ought to-issues must be related to certain values, the concept itself encompasses several normative values, such as equity, justice and even the intrinsic value of nature. We should bear this normativity in mind even when the focus is on achieving sustainable development within certain sectors of society, in our case the transportation sector. Sustainable mobility covers processes in transportation that are in accordance with sustainable development requirements. Not only does this imply to analyze the implications of such processes in relation to ecological issues, but also to relate these to - and to analyze - the implications of development issues in poor countries.

8.3.3. The Major Characteristics of Sustainable Development and their Relation to Mobility

Within this framework of historical context and normative aspects what, then, primarily characterizes sustainable development? The answer provides an outline of what can be referred to as the major characteristics. They are found on three levels: extra prima, prima and secunda. These are terms borrowed from thermodynamics. Extra prima denotes energy (or other natural resources) at superior quality levels. Prima implies lower quality, but still very high. Extra prima and prima, then, are what is mainly an answer to the characterization of “major”.

Secunda is included to put into context characteristics prevailing in the current debate on “operationalization”. The list of such characteristics could be made very long. Reduced emissions of greenhouse gases, in particular CO_2, belong to this category. The term "secunda" implies that it can be derived from extra prima and prima characteristics. Consequently, a demand for such reductions are necessary, based on a superior demand for ecological sustainability. However, any type of policy aiming at reduced emissions is not necessarily in line with sustainable development. This demands accordance with the requirements of the characteristics of higher order.

There are two *extra prima characteristics*. They are:

- Ecological sustainability ;
- Satisfaction of basic needs.

The very term "sustainability" has its origin in ecological science. It was developed to express the conditions that must be present for the ecosystems to sustain themselves in a long-term perspective. The Brundtland Commission Report refers to *Ecological Sustainability* as a minimum requirement, that is the diversity of species, life forms and ecosystems must be sustained as a necessary but not sufficient precondition for sustainable development. I have formerly elaborated further on the content of this characteristicum.

Satisfaction of Basic Needs represents the core of the development part of the concept. As with ecological sustainability, it constitutes a necessary precondition. Other characteristics have no meaning unless these two preconditions are fulfilled. Still, there is an important difference. Maintaining ecological sustainability is a negatively defining obligation. It is about restricting the extent of manmade encroachments in nature to maintain the necessary ecological sustainability. Satisfaction of basic needs is on the other hand a positively developing obligation. It must be given priority, even if it may imply a reduction of the biological diversity.

Sustainable development presupposes a *long-term aspect* as one of the prima characteristics. This is a pervasive theme in the Brundtland Commission Report and relates both to the sustainability and the development parts of the concept. The Norwegian professor in philisophy *Jon Wetlesen* (1975) has discussed the issue of how many future generations we have an ethical duty to show consideration for. He thinks it is hard to imagine a line to be drawn somewhere without it being ethically arbitrary. From an ethical point of view, we have a right and a duty to stand our grounds as long as possible. This implies an obligation to emphasize future consequences at least as much as the present ones.

The prima characteristics of *Fair Distribution of Goods and Burdens*, globally and over time, relate to satisfaction of basic needs. They, and the intermediate needs necessary to satisfy them, should be met all over the world by all future generations. In this context the claim is that this should also be based on a principle of fair distribution, within each generation (intra-generational) globally and between all future generations. These are fundamental elements of what is termed a *global ethics*. However, they also relate to ecological sustainability. Environmental burdens are not equally distributed. The impacts are more serious in some parts of the world than in others. This applies, for example, to the greenhouse effect. Similarly, future generations can be hit harder than the present one. The implications are that sustainable development processes must be such that they take into consideration the situation for the least favored members of the global society, now and in the future.

As the requirements of ecological sustainability are fundamental in understanding the concept of *sustainability*, the requirements of basic needs and connected characteristics are fundamental for relating this to the concept of *mobility*. Policies to satisfy basic needs in developing countries will be part of welfare-policies as they have been developed in the rich part of the world. Such processes of early *modernization* are not neutral in relation to mobility. On the contrary, they are closely linked both to changes in patterns and increases in levels of mobility. These processes are not only conditioned by but also have such changes and increases in mobility as consequences. This applies to the mobility of goods as well as persons.

The changes in mobility are not environmentally neutral either. They will increase total environmental loads, locally and globally. Large investments in infrastructure will cause serious land-use encroachments, losses of biological diversity and extensive transformation of energy and material resources. But most fundamentally: it will lead to large increases in the use of fossil energy in order to keep the new means of transportation running. The argument is put forward that the use of fossil energy in transportation is linked to the changes in mobility in modernization processes in developing countries. This is related both to its ubiquity and its uniqueness as source for mobile purposes ; it is easy to transport and to store, it is readily available in diverse motor-concepts and -sizes, it is part of a technology that is well known and which is not to demanding in maintenance structure, it is part of a well developed global system and it can be applied in transportation systems without giving excessive demands on infrastructural investments. As the challenges are to achieve substantial reductions in the global use of fossil energy, the mobility connection in satisfying basic needs in developing countries imply that these reductions in rich countries must be larger than they else would have been. Also due to the inherent links between the *mobile* and *fossil societies* this will deeply affect patterns and levels of mobility in rich countries. This is a thesis I shall return to.

8.4. The Precautionary Principle

After the presentation of the Brundtland Commissions Report the *precautionary principle* has been internationally endorsed, and is considered to be a part of the concept of sustainable development. It can be defined in the following way:

> "In those cases where there is a danger of irreversible or serious environmental consequences, the lack of full scientific proof should not be an argument for failing to implement actions and measures which reduce the environmental problems".

Still, the precautionary principle is subject to various interpretations. There are, in particular, two relations that seem to cause some confusion. They are:

* the relation to *prevention*
* the relation to *uncertainty*

Both in terms of its conceptual core and practical implications, the precautionary principle is a *preventive* environmental-political principle. It hinges on the fact that precaution implies the *prevention* of damage, rather than a reparation afterwards. However, this is not the same as saying that all types of preventive environmental policy and environmental standards are a precautionary principle, too. These can be *non*-precautionary principle or precautionary principle to a varying degree. On the other hand, a standard or an implemented measure based on a precautionary principle can never be non-preventive. This is a distinction which is clarified through the discussion of the relation to uncertainty.

All formulations of the precautionary principle stress the element *uncertainty*; a lack of full scientific certainty should not be used as a reason for putting off measures with a view to avoiding environmental deterioration. The fact that such a lack exists - in this respect understood as uncertainty - is a *sufficient* basis for acting to the benefit of nature, or more specifically for implementing preventive or regulative measures in those environmental cases where the principle can be applied. This then stresses two other major aspects of the principle ; *doubt* – or uncertainty – shall be *to the benefit of nature* and when there is such doubt there is an *obligation to act* (to the benefit of nature). The precautionary principle *does not apply* when it is certain that environmental damage will occur. Nor does it apply when damage is likely to occur.

The precautionary principle states implicitly that it is preferable to run the risk of overestimation than underestimation. It requires types of worst-case analyses. The advantages of the regulative measures are supposed to be high, and the disadvantages correspondingly low, precisely because "the worst" is assumed as for possible environmental consequences. This aspect of the principle has been discussed by the two British environment lawyers *James Cameron and Will Wade-Gery* (1992). They draw a parallel to *insurance*. The precautionary principle can be regarded as an environmental insurance policy. Those who pay their insurance premiums in other contexts rarely feel they do not get their money's worth simply because what they are insured against does not occur. The value is normally considered to lie in the fact of being insured. Similarly, regulative measures based on the precautionary principle are of value not only because of the actual avoidance of environmental damages, but because of the insurance value itself. The latter point is *not* influenced by the ensuing course of events (Cameron and Wade-Gery, 1992).

The term *uncertainty* has so far not been discussed thoroughly. *What kind of uncertainty* are we talking about? It has to do with our knowledge of connections between man-made encroachments and effects in the ecosystems. However, it comprises at least two different dimensions in terms og this knowledge. In the first place, it has to do with our knowledge of *cause-effect relations.* An important aspect of this uncertainty basis is linked to the fact that we are faced with cumulative causes as well as cumulative effects. In both cases they can be antagonistic, purely additive, or synergetic. In our modern history of environmental issues, such complex environmental connections have, in fact, received much attention. In the second place, it is a question as to what knowledge we have of *the extent of the effects.* Either form of uncertainty gives the basis for special forms of regulative measures.

However, this does not mean that the whole question of "what kind of uncertainty" has been answered. There are at least two more factors. It is not enough with *just any form* of uncertainty. It must be a case of potentially *significant* connections. All formulations of the precautionary principle refer to serious or irreversible environmental damage. This means that the uncertainty must be linked to the cause-effect relations which may produce new, even more serious or irreversible damage than what we already have knowledge of. There may be uncertainty of even more serious effects with a basis in the cause-effect relations we know of. In addition, there may naturally be a more fundamental lack of knowledge concerning the whole complex of cause-effect relations, but where the potential for serious or irreversible damage nevertheless is present.

The *greenhouse* issue is in the latter category. This means that the principle should be applied in relation to all human activities causing major emissions of greenhouse gases, notably CO2. Transportation is such an activity. But the principle also applies to other environmental problems where transportation is an important cause. Examples are loss of biological diversity , as emphasized in the UN-convention endorsed at the Earth Summit in Rio in 1992 , but also problems connected to the many categories of polluting emissions. All together with profound implications for the future development patterns of transportation.

8.4.1. The Scientific Implications of the Precautionary Principle

Another aspect has to do with what kind of demands on arguments that might be relevant. Or, to pinpoint the question: does the precautionary principle imply a free-for-all as to any kind of hypothesis of uncertainty, put forward by anybody? In other words, does this imply a stronger *non-scientification* of the decision basis in complex environmental cases?

The English professor in environmental sciences, *Timothy O'Riordan* (1992) argues towards such a standpoint. He maintains that the precautionary principle accepts a *non-scientific* basis for decision-making, requiring as many interest groups as possible to be involved in the decision process. This leads to a greater pressure on political institutions by forcing them to implement regulative measures both in the public and private sectors without having to refer to any formal-scientific authority. O'Riordan maintains that this gives a special basis for national and international pressure groups to aggressive participation in political decision-making processes. These groups can exploit the uncertainty and political decision problems that occur as a result of having to put more emphasis on such uncertainty. His argument is that the precautionary principle thus results in a *democratization* of national and international environment regimes. According to O'Riordan, by explicitly underlining the limitations of scientific criteria, a stronger degree of political decision of these questions is legitimised.

This raises more complex issues in relation to science. And it should be emphasized that the precautionary principle is the one principle in sustainable development having the most profound implications for scientific thinking and practise. It is beyond the realm of *normal science*, when this is understood to be mainly positivistic inclined. Such normal science has a strong focus towards producing reliable empirical proofs, thus focusing on scientific *certainty* as an absolute condition before drawing conclusions or publicizing scientific findings. In normal science it is of utmost importance not to make claims that later are found to be wrong. The precautionary principle on the other hand requires scientific work to attach particular importance to *uncertainty* in the empirical material produced within the established theoretical boundaries, but also to possible uncertainties if these boundaries are extended or if alternative theoretical perspectives are accepted as basis. If such uncertainties are found scientists are obliged to make the results public so that they can form a basis for decisions in a societal context. Just as the precautionary principle obliges the society to act for the benefit of nature if there are sufficient degrees of uncertainty in existing scientific knowledge, the scientists are obliged to make public this knowledge about such uncertainties. This is expressed in the *precautionary principle of science* endorsed at the formerly mentioned ECE-conference in Bergen in 1990 :

> ” When there is a threat of serious or irreversible damage to nature and environment, the lack of full scientific certainty should not be used as a reason for not informing the public about the possibilities for such damages.”
> (Høyer and Selstad, 1993)

These aspects (focus on uncertainty, base decisions on uncertain knowledge, accepting a low treshold for ”proofs”, publish about uncertain knowledge and accepting a high probability of making claims that later are found to be wrong) are parts of a concept of *post-normal science* (Teigland, 1997). Implications are a science with rather fundamental changes in criteria for control of validity and quality (NENT, 1997).

In their theories about *risk society* formerly mentioned *Ulrich Beck* (1992, 1997) and *Anthony Giddens* (1994) include such changes in scientific thinking and practise, but without explicitly referring to the concepts post-normal science and precautionary principle. These changes are crucial in their concept of *late modernity*. Beck (1992, 1997) distinguishes between sceptisism in the internal and external aspects of scientific work. He claims that methodological *sceptisism* – at least as an ideal – is institutionalized in modern science, but that it is confined to the internal scientific work. It should be emphasized that I here use the terms ”internal” and ”external” aspects of science differently from Beck. With late modernity – and in confrontation with the challenges of risk society – this sceptisism is extended to the very foundations for and the external risk implications of scientific work. This double sceptisism or *doubt* at the same time leads to a situation where science is demystified and made common. Normal science looses its monopoly of truth and has to accept that it is only one of many ways of generating knowledge about this ”truth”.

In discussing how science should respond to a situation with extended sceptisism, Beck (1997) refers to the science theoretician *Imre Lakatos’* criteria for ”positive” (or ”negative”) *problemshift*. According to these decisive of a ”right” science is to what extent claims about facts, questions, problems, falsifications and developing perspectives, so far having stayed in the shadow of dominating theories and controversies, can be uncovered and made subject to interesting research and public debate. This is similar to the requirements of a science responding to the precautionary principle.

8.5. The Limitations of Technical Fix

I have formerly defined technical fix as :

> ”Technical fix is understood as a fixation on technical solutions. The fixation is made applicable to many types of problems, also those that are socially and/or enviromentally complex. Technical fix implies to address problems delimited from their social, organisational and institutional implications and interrelations.”
> (Høyer and Selstad, 1993).

There are many threads to this end. It follows from the precautionay principle. One of the backgrounds for the principle is just the problems caused by, and the limitations of technical approaches based on ”normal” natural sciences. A focus on uncertain knowledge regarding cause-effect relations and scope and seriousness of effects is quite different from the usual certain knowledge basis of technical solutions. It also follows from the changed character of environmental problems included in the characteristics of sustainable development and which the precautionary principle is responding to. Long feedback loops, with their uncertain time lags and cause-effect relations, are much less prone to technical solutions than the more easily defined short feedback loops. Similarly, it is easier to develop and implement technical solutions when sources are a few concentrated and well defined points than when they are many, scattered and diffuse. The same applies to the change from production to product oriented problems. It is not appropriate with a technical fix approach when problems mainly are generated through consumption and in distributional chains.

The Brundtland Commission Report outlines two major approaches to environmental policy. The former is characterized as ”the standard programme”, reflecting an attitude to environmental policy, measures and institutions with the main emphasis on environmental effects. The latter reflects an attitude focusing on the practises causing these effects ;

> *”These two attitudes represent clearly diverging views both of the problems and of the institutions which are to deal with them”.*
> (WCED, 1987).

A distinction is thereby made between effect-oriented and *causal-oriented environmental policy*. The Brundtland Commission emphasizes that it is the former which has prevailed until now, whereas it is the latter which must be included in sustainable development. It is one of the *prima characteristics* of sustainable development. The American ecologist *E.P. Odum* (1989) uses the concepts *output*- and *input-control* to express the same change in environmental policy focus. Output-control refers to the traditional ”end-of-pipe” solutions. According to Odum these have proven unsatisfactory, particularly so when they are responding to the issues of diffuse sources. Instead there is a need to seek solutions in the opposite end, that is to control the inputs to production and consumption chains. While output-control represents the very core of a technical fix approach in environmental policy, input-control and the corresponding causal-oriented environmental policy are well outside the boundaries of such an approach.

8.5.1. The Limitations of Recycling Society and the Relation to Mobility

The large volumes of material resources transformed and circulated in the world’s economy generate major environmental problems. Large volumes of raw materials, industrial products and wastes are transported locally and regionally and also across national borders. This requires energy in the form of fossil fuels, contributing to serious regional and global environmental problems. Transport infrastructure also consumes large areas of land and interferes with fragile ecosystems. The construction of it consumes substantial volumes of material resources.

The aim of *recycling* is to reduce these volume-related problems. It is strongly focused in the Brundtland Commission Report and not the least in the follow-up processes from 1987 and onwards. New concepts expressing the focus have been subject to considerable interest, notably "industrial ecology" and "sustainable production". It is often interpreted as "technological optimism", as it envisages a global development where the total environmental loads are considerably reduced at the same time as both the global economy and the rich countries' economies continue to growth (Lafferty and Langhelle, 1995). Due to the large degree of diminution of environmental loads connected to economic processes it is almost a complete uncoupling of the two that is envisaged. Technical solutions applying the principle of recycling are the very basis for this uncoupling. It is thus a form of technical fix.

International studies have suggested that the aggregate global level of material resources inputs should be reduced by at least 50% by the middle of next century. Applying a principle of global equity this could require a factor 10-12 *dematerialization* in the economics of OECD-countries (Schmidt-Bleek, 1994 ; Spangenberg, 1995). This is based on the precondition that there is no *further* material resources growth in these economics. However, the Brundtland Commission Report prescribes a 5-10 factor increase both in these economies and in the size of the global economy. As this would demand further material resources growth, even with much weaker requirements than absolute global equity such a degree of dematerialization serves as an illustration of the challenges ahead. This is emphasized through the following reported from the "Oslo Ministerial Round Table on Sustainable Production and Consumption":

> *"OECD countries will need to cut their per capita pollution and resources intensities by a factor of 10 or more over the next half century if they are to reduce the burden they place on the global environment to sustainable levels".*
> (Miljøverndepartementet, 1995).

It is hard to substantiate that such a degree of dematerialization is obtainable. For instance, it is difficult to envisage how a world with twice today's population can increase the car-based person mobility towards the levels of *current* OECD-average, yet still achieve a 50% reduction in the global mobilization of material resources and a 60-80% reduction in the use of fossil energy resources. Establishing the required transport infrastructure alone would generate an increase of factor 10 in the mobilization of material resources for such purposes.

Extensive dematerialization, however, can in principle be achieved through the *Recycling Society*. This term can be placed in relation to the concept *industrial ecology*. It is a concept that cover both materials, processes, products and facilities, how these are linked together through flows of material resources and how this interacts with natural ecosystems. The focus is more on the complexity of facilities and links, and their total reduction in environmental loads, than on single facilities. Development of products, processes, facilities, and the linkages between them, within a framework of recycling as an overriding principle constitute the crucial elements. The *recycling society* denotes a situation where basic principles of industrial ecology have been achieved on a superior societal level.

However, to what extent this actually implies a total preservation of natural resources is a matter of both *theoretical* and *practical limitations*. Theoretically it can be discussed in relation to the two main laws of thermodynamics in physics. The first law tells us that energy or other physical resources can neither be created nor destroyed, they can only be changed from one form to another. The fundamental implications are that something can never become nothing, and vice versa. The second law - the entropy law - is easiest to explain in relation to energy. When energy is used, that is transformed from one form to another, it will incessantly move towards an increased degree of disorder. Entropy is another word for disorder.

When material resources are used in manufacturing, they occur in ordered forms in the products in many cases on a higher quality level than as the original raw materials. Apparently a counter-entropic process has been put in system. However, every time raw materials are extracted, and every time they are transformed in the manufacturing process, energy in one form or another is applied, even if only to transport the material resources from one place to another. This gives an increase in entropy. It emphasizes that the utilization of material resources is related to time and space. Time cannot be reversed, and the resources cannot be returned to their original state without further generation of entropy.

My empirical analyses show that recycling in the automobile industry only can yield limited environmental improvements. The reason for this rests with fundamental issues, such as total energy use and greenhouse gas emissions. The large share of total environmental loads from automobiles is generated in relation to driving and, to a lesser extent, to manufacturing the cars. Energy used during driving can obviously not be recycled or cascade-connected to other users. Neither does the recycling society offer any solution to the majority of other environmental problems caused by transportation. Infrastructure, and the natural resources transformed and used in its construction, can not practically be recycled. In addition, the recycling society might in itself generate more transport. Circulation of recycled products over larger distances can be particularly transportation intensive. This serves to emphasize the connections to the issue of mobility.

8.5.2. The Limitations of Technical Fix in Transportation

Environmental problems caused by transportation can be reduced or solved through different categories of measures. I have identified the following seven in order of superiority of social and environmental context :

1. Reductions in mobility ;
2. Reductions of infrastructure ;
3. Transfer between different modes and means of transport ;
4. Increase in load factors ;
5. Use of alternative energy sources ;
6. Increased energy efficiency ;
7. Purification of polluting emissions.

All have been addressed in the research works this Ph.d. thesis is based on, mostly so also in the included articles. A basic understanding expressed is that the higher we come on this ladder of environmental policy measures in transportation the more we reach of the core of a concept of sustainable mobility. It is an understanding based on both theoretical and empirical analyses of technical fix approaches, partly elucidated through the two former concluding theses. The purpose here is to give further elucidation with particular reference to technical fix in transportation. However, of the seven categories above only the last three fall within my understanding of technical fix. The presentation beneath is thus limited to these types of measures.

The American ecologist *Barry Commoner* (1990) makes a distinction between two main strategies for solving environmental problems, *prevention* and *control*. It is in accordance with my former distinction between causal-oriented and effect-oriented or input- and output-oriented environmental policies. According to Commoner the control strategy mainly seek solutions through technological means. 20-30 years experiences with extensive application of this strategy have demonstrated that it largely has been futile. Even though there have been some successes in singular, delimited cases, the strategy has been unsuccessful in a wider context. One thing is to apply technologies with potentials of large reductions of polluting emissions in every singular case, another is to achieve similar reductions for the total volume of cases and in particular for the environmental problems the emissions are sources to. This even illustrates the point of making a difference between addressing problems of *intensity* and problems of *volume*.

To substantiate his claim Commoner uses as case the relation between private car transportation and air-quality in large American cities. In this context he launches the thesis of *The California Effect*. For almost 30 years California has had a leading position internationally in the development of emission-requirements in transportation, particularly for private cars. These requirements have continuously become stricter and have all the time been several years ahead of standards set by other American states. Still, this has only had minor effects on the air-quality in the cities, notably Los Angeles. To the extent that reductions in concentrations of major air-pollutants have been achieved they have been far from the original aims. And at the same time as emission-requirements gradually have become stricter the dates set up for attaining these aims have continuously been postponed. The main reason is that reductions gained in the singular cases are captured by increases in the number of cases, that is by increases in the number of cars and the distances they drive. According to Commoner these are necessary limitations of the traditional, technologically focused control-strategy. An alternative prevention-strategy would imply to reduce the number of sources, that is to reduce the number of cars.

Other limitations with emission-purification technologies in transportation are supportive to this view. They are of *three different types* in addition to the number-issue presented above. *Firstly*, and most fundamentally, these technologies do not purify or reduce emissions of CO_2. Neither do they contribute to reductions in energy consumption. It could be the contrary. A car with modern catalyst technology might give (minor) increases in energy consumption and thereby increased emissions of CO_2 in comparison with a similar car without this technology.

Secondly, these technologies do not cover regulations of all other air-pollutants either. The number of potentially harmful substances in emission gases is very large. This has claimed attention to the need to include some of the formerly unregulated emissions in new regulation requirements. As long as the number-issue is not addressed, and when remembering an environmental history of shifting focus on different environmental problems, it is reason to believe that there will be more or less a continuous process of addressing the need to make new emission substances part of regulation requirements. In such a process there will necessarily be serious time lags and uncertainties to whether new technologies are effective and viable.

Thirdly, the purification technologies can themselves generate other environmental problems. An example is higher emissions from cars with 3-way catalysts of the strong greenhouse gas N2O. Another is that particle trap technologies reduce the mass of particles emitted, but might increase the amount of particularly harmful, small particles. Also another is that new pollutants might be generated and emitted from the catalytic metals in the catalysts.

8.5.3. The Limitations of Alternative Energy in Transportation

Environmental problems in transportation may be reduced or solved through application of alternative energy sources. Of particular interest are those sources that can imply zero emissions of CO2. They fall in three distinct categories :

1. Hydrogen
2. Biomass
3. Electricity

All are subject to different types of limitations. On a superior level limitations are related to the fact that they are *energy carriers* and not sources as such. Biomass is of course a source, but can not be applied directly in transportation means. It has to be made into different carriers, notably the socalled motor-alcohols methanol and ethanol. Hydrogen must be produced by applying electricity, and this electricity has to come from some energy sources. Similarly, if the electricity is applied directly in electrical vehicles, it has first to be generated from some source. The implications may be that the environmental problems only are moved from one level to another, from the level of transportation means to the level of energy production. And the implications may also be that while some environmental problems are reduced or solved, new ones are added in connection with the energy production.

To address such issues I have carried out *energy-chain analyses* of the alternatives. This is an analytical tool that covers analyses of consequences at all links in the energy chains, from production of the primary energy to its end-use in transportation means. It thus falls within the broader category of *life-cycle analysis*. I have placed the development of these types of analytical tools in the historical context of environmental problems. The changed character of environmental problems and the related precautionary principle stress the importance of such tools. They are tuned to address consequences of chains that are complex and widely spread both in time and space, and thus to uncover important aspects of uncertainty. In this sense traditional environmental impact analyses represent quite another category of tools.

Results from the analyses emphasize that limitations are substantial. *Firstly*, there is an issue of overall *energy-efficiency*. The alternative chains have in general a lower energy-efficiency than the conventional ones based on fossil energy. In some cases differences can be very large. Application of hydrogen and biological alcohols may increase the total energy used in transportation by a factor 2-4, that is by several hundreds of percents. This implies a development contrary to the global energy-future prescribed by the Brundtland Commission Report. Here a 50% reduction of total energy use in rich countries is recommended, even when alternative sources are included in the potentials. The reduction is necessary to give room for an increase in developing countries. It is based on an understanding, but also empirical material, substantiating that there is not an unlimited amount of alternative energy available.

Secondly, this also relates to an issue of *alternative use of resources*. There are other users both to the energy carriers and to the basic sources involved. Electricity has a lot of applications for stationary purposes. Only a minor share is in principle available for mobile purposes. There are also a lot of competing users to the land areas required and the crops grown to produce biomass. The most crucial issue globally is whether to use these land areas and crops to produce *food or fuel* in transportation. There can be no question what to give priority according to the basic needs requirement of sustainable development.

Thirdly, there is the related issue of *land consumption*. The production of primary energy in the alternative energy chains in general requires large areas of land. They are *sparse resources*, and in this sense fundamentally different from the concentrated fossil energy. Besides the conflicts to other land-use interests, losses of biological diversity will increase. The land-use efficiency can be very low. Analyzed for the complete chains application of hydrogen and bio-alcohols may result in a factor 2-3 increase in land consumption compared to fossil fuels. In a volume perspective there might practically not be enough land available. In Norway, a sparsely populated country with large forest resources, one would have to more than double the harvesting of biomass from these forests only to keep the current Norwegian transportation sector running on bio-alcohols. In reality this would bind the whole forest land area only to this purpose. If the whole of EU should reach the current Northern European level of mobility, to keep the transportation sector running on "clean" electricity from solar cell power stations would occupy 10% of the total EU land area, or 50% of the German area, notably for this single purpose power production alone (Høyer and Selstad, 1993).

Fourthly, there is the issue of *air-polluting emissions*. Burning of bio-alcohols generates many of the same regulated emissions as fossil fuels. Some of the unregulated emissions might increase. If they result in zero net emissions of CO2, they do not give zero emissions of other greenhouse gases. Emissions of such strong greenhouse gases as methane and N2O might increase when all links in the energy chains are included.

Lastly, all these issues are related to an *issue of scale*. Alternative energy sources, understood as alternatives with zero net emissions of CO2, are not able to support a transportation system adapted to today's levels of mobility in the rich part of the world. Even an extensive application of such alternatives will require transportation systems adapted to lower levels of mobility.

8.5.4. The Inherent Links between the Fossil and the Mobile Society

The relations between the Fossil and Mobile Societies should be understood in a historical context. In some of the research work this Ph.d. thesis is based on I have written extensively about the history of energy use in transportation (Høyer, 1990; Høyer and Selstad, 1993). This history should be understood in relation to my analysis of the history of mobility. I use the term *Fossil Society* to describe a society where fossil energy, in particular petroleum energy, is totally dominating as energy source in transportation. In general more than 90% of today's energy use in transportation is covered by petroleum fuels, internationally and nationally. The term *Mobile Society* is used to describe a society which have reached today's high levels of mobility in the rich part of the world, and where the development of mobility in general follows the pattern described by the history of mobility in Norway.

Alternative energy sources have been used in earlier phases in the history of modern transportation. They have even been part of fairly well developed technologies. This for instance applies to bio-alcohols. The most widely used basic motor-technology in petrol cars today – the socalled Otto-motor – was originally developed for the use of alcohols as fuel. In the 1920's and 30's in all western countries there were extensive use of bio-alcohols both in passenger cars and lorries. It decreased somewhat during the depression in the 30's, only to expand again during the Second World War.

The first experiments with electrical vehicles were carried out around 1840. In the 1860's, when the lead battery was invented, the first electrical vehicles were put into practical use. In the late 1800's several types of electrical vehicles were well established. At the first mainly in connection with the use of lead batteries in passenger cars, but later also through the use of rail-connected (trains and trams) and wire-connected (trolley-buses) transportation systems.

In the early 1900's electrical cars could achieve a top speed of more than 100 km/h and a reach of more than 100 km without battery charging and when driving carefully. Such performances are even hard to achieve in the electrical cars developed now 80 years later. During the first two decades of the 1900's electrical cars were an important and well-developed technology. In these years as much as a third of all vehicles in large American cities were electrical. After decreased use in the 1930's, a new expansion took place in most Western countries during the World War. The most extensive system of electrical cars we have had in history – the English milk-vans – was for instance developed during the War.

The petroleum fuels have been totally dominating after the War. It is also in this period the really large increases in mobility have been experienced. Liquid petroleum products have a lot of advantages as fuels in mobile technologies. Costs of production have been low. The fuels have high energy densities, both on weight- and volume-basis. They can easily be stored and transported under normal conditions of temperature and pressure. This gives only minor losses during transport and low costs of distribution. It can be said that the petroleum fuels are *highly mobile* and flexible energy sources. They are well adapted to a structure that consists of mobile units.

Non of the alternative energy sources can give a corresponding number of advantages. Costs of production are high. Usually losses are high when transforming primary energy to fuels. Energy densities are in most cases very low. In those cases where higher densities can be achieved this requires storing and distribution under special conditions in temperature and pressure. In addition the alternatives often require complicated and expensive infrastructures, not only for production but also for transport and distribution. This is for instance the case for electricity which else may have some of the same flexibility as petroleum fuels. The alternatives are thus generally *little mobile* and flexible sources, poorly adapted to mobile purposes.

The thesis of the inherent links between the Fossil and Mobile Society should not be understood as a matter of *determinism*. My claim is not that the development of mobility is determined by the development of the Fossil Society in a one-way process. However, the two have not been independent processes. The claim is that they can not be uncoupled. Our current levels and patterns of mobility and the Fossil Society should be understood as interrelated. An opposite thesis, that the two can be uncoupled, is unduly idealistic. In reality it uncouples the historical development of transportation from important changes in material structures.

There are *two major implications* of the thesis. *Firstly*, processes to uncouple the modern societies from their dependence on fossil energy will deeply affect patterns and levels of mobility. The Alternative Energy Society is interrelated with a mobility that is highly different from the mobility interrelated with the Fossil Society. The *second* implication has been outlined under the thesis of the major characteristics of sustainable development. Policies to satisfy basic needs in developing countries will be part of welfare-policies, processes that not only are conditioned by but also have changes and increases in mobility as consequences. This applies to the mobility of goods as well as persons. It will lead to large increases in the use of fossil energy in the new transportation systems. As the challenges are to achieve substantial reductions in the global use of fossil energy, such reductions in rich countries must be larger than they else would have been, emphasizing their effects on patterns and levels of mobility.

8.5.5. The Limitations of Aeromobility

Airplanes require large amounts of energy in comparison with other means of transportation, thus giving relatively higher emissions of CO2. This applies both to transportation of persons and goods. However, the total environmental effects of airplanes can be substantially larger than indicated by these more common forms of comparisons. This is due to the fact that emissions high up in the atmosphere may have much more serious effects than emissions on ground level as a result of several complex, but not completely understood processes. It is a valid situation for application of the *precautionary principle*, implying the need for severe restrictions on the volume of air transportation. There are thus reasons to talk about the *particular* limitations of *aeromobility*.

Emissions from airplanes flying deeply into the stratosphere – the upper part of the atmosphere - cause breakdown of the protective *ozone-layer* in this part of the atmosphere. They are thereby involved in processes causing one of the more serious global environmental problems. Not the least problematic are airflights over northern and polar areas, where the stratosphere stretches lower down than in equatorial areas and the ozone-layer has proven to be very vulnerable. A lot of intercontinental airflights penetrate these areas to day.

Emissions high up in the atmosphere may make substances that are harmless at ground level into serious environmental pollutants. Water vapour is such a substance. In higher layers of the atmosphere emitted water vapour can boost two fundamental types of global environmental problems : the breakdown of stratospheric ozone and the greenhouse effect. In both cases this is related to the creation of ice-clouds in layers of the atmosphere normally free of clouds. It has been estimated that a few percent increase in the extent of these artificial clouds may generate the same greenhouse effect as a doubling of CO2-emissions (Høyer and Selstad, 1993). Particularly vulnerable to emissions is the transition-zone between the stratosphere and the troposphere, the socalled tropopause. This is a common atmospheric level for a large share both of national and international airflights today. Similarly, emissions of NOx at these levels can be involved in complex processes further significantly boosting the greenhouse effect.

Whether they are based on alternative energy or coventional petroleum sources all types of fuels for airplanes generate emissions of water vapour and NOx. The emissions are there even if the alternative fuel is *hydrogen* produced through use of electricity from environmentally ”clean” power stations. Implications are severe restrictions on the volumes of air transportation. This would have profound effects both on patterns and levels of mobility. In all rich countries aeromobility takes a large share of the total mobility of persons. Even the aeromobility of goods is reaching significant levels, at least in some sectors as is shown in my analysis of transportation of fish. Expected future increases in mobility are largely conditioned by further increases in the extent of air transportation, particularly in the form of intercontinental flights and related global movements. *Anthony Giddens* (1994) links global ”mass” transportation to his very concept of ”late” modernity. These forms of globalization can only be attained through the use of airplanes. This emphasizes the social implications of such profound encroachments in modern transportation systems. Further, it elaborates the reasoning behind the use of the concept ”mobility” instead of ”transport” when sustainable development requirements in *transportation* are in focus.

8.6. Some Sectorial Implications of Sustainable Mobility

8.6.1. The Implications in Rural Communities

In the wake of the discussion of sustainable development there have been tendencies, both in politics and research, of a narrow understanding of the concept. In fisheries for instance it is made into a question of staying within the maximum sustainable yield for each species. In principle, then, it may be ecologically sustainable to establish a fishery consisting of a small fleet of energy-demanding trawlers which make sure that the catch is kept within the sustainable yield for crucial species. Similarly, there is within such an understanding nothing to prevent the exportation of fish products by airplanes from Norway to Japan. However, it is evident that this is not consistent with the more complete understanding of the concept I have described.

My empirical analysis reveals a fishing industry which has become increasingly energy-demanding, and a more important source of global environmental problems than previously. This is a development which is clearly revealed in the “case” rural municipality of Askvoll in the county of Sogn og Fjordane. In the 1970s there was a strong focus on problems created by and within *one-sided industrial municipalities* in Norway. Primarily because of the development in fisheries and aquaculture, Askvoll in the 1990s may be referred to as a *one-sided mobile-energy municipality*. The total consumption of fossil-based, mobile energy per capita may be 3-4 times higher than the national average, even higher than in urban areas, for that matter.

The analysis of the aquaculture industry in Askvoll reveals that the development has moved in a favorable direction in terms of local environmental problems, local pollution, and the use of medicine. At the same time, however, it has become an industry which has developed markedly from local/regional to global environmental issues. In order to supply important markets in Asia and America with fresh fish from the aquaculture stations, the transport takes place by plane. This leads to an 11 times higher consumption of energy and emissions of greenhouse gases compared to transportation of frozen fish by boat. At the same time, almost half of the raw materials for Norwegian aquaculture production in recent years are imported. Approximately a quarter of the imported fish raw material comes from Chile, and a major share of the vegetable raw materials comes from North America. This implies an industry which has increasingly become globalized, resulting in a high consumption of energy and substantial emissions of greenhouse gases. In this way, what could have become a sustainable rural industry, has become a significant contributor to the grave global environmental problems. Even if the local environmental problems have been reduced, the development has resulted in an industry with a very limited basis in local resources.

The total picture shows development factors that are typical both of the rural industries and the rural settlements. This is confirmed by the study of person mobility conducted in the same research project the article is based on. The significance of the mobile energy in this context is emphasized. When the rural municipalities of the 1990s can be described as one-sided mobile-energy municipalities, and the rural industries have become global mobile industries, this underlines that the challenges of a sustainable development are just as fundamental in rural as in urban communities.

8.6.2. The Implications of Sustainable Tourism

The internationally prevailing understanding of the concept "sustainable tourism" limits the focus to *stationary* activities and *local* intensive environmental issues. This is too limited both in relation to the concept of tourism and the concept of sustainable development. There is a necessary link between the two concepts : sustainable tourism and sustainable mobility.

The use of the concept "sustainable tourism" can be discussed in relation to two dimensions: *volume/intensity* problems is one and *mobile/stationary* activities the other. The domination of the intensity perspective is evident from a number of international research studies in the 1990s. A common understanding is that it is tourism of a type that makes it sustain its viability in *one area* for an indefinite period of time. This appears somewhat paradoxical in view of the common understanding of sustainable development, not the least as it is expressed in the Brundtland Commission Report. A crucial challenge is that limits of ecological sustainability are exceeded globally. The sum-effects of man-made encroachments have become too large, even when what happens locally – analyzed within the local context - is not. This is the essence of the problem of volume.

However, the focus on stationary activities, and the missing link of *transport* in the sustainable tourism concept, is no less paradoxical. "Tourism" is etymologically derived from the Latin *tornare* and the Greek *tornos*, that is, the movement in a circle around a central point or axis. The core lies in the movement itself - away from the starting-point and back again. In some languages, Norwegian for one, tourism is even called *travel* *industry*. And, of course, historically there have been close relations between the development of tourism and transport systems. This history underlines that there cannot be any type of tourism in combination with any type of transportation. The volumes and the forms of tourism representing major challenges in a sustainability context have their basis in the growth of certain transport systems, primarily linked to the transport means of *private car* and *airplane*. In the latter case, we may even call it a strongly mutual relation: the substantial growth in international air transportation in recent decades would not have been possible without a corresponding growth in international tourism. The current phase of *globalization of mass tourism* is solely linked to air transportation.

A distinction can be made between person travels taking place in the *tied* and *untied* time. The travel purposes in the untied or *free* time include entertainment, recreational activities, holidays, visits to friends and acquaintances, etc. These are all travels characterized by a high degree of freedom, and the travelers themselves have much influence on the travel pattern. The increase in this *leisure mobility* seems to be one of the most conspicuous features in the growth of mobility in societies characterized by “late” modernity. Tourism, of course, has its substantial basis in such a mobility.

My empirical analysis of tourism-related travels by Norwegians shows that the leisure mobility accounts for a substantial share of the total mobility. When travels undertaken outside the national borders are included, this share is more than 50% for the crucial indicator of travel distance. This mobility is mainly based on transport means which imply an especially high load on environment and resources. It applies to the private car, airplanes, as well as ferries used for person transport. Tourism, then, accounts for a substantial share of major ecological impacts caused by transportation. The growth in tourism is closely linked to the growth of *automobility*. Throughout the history of the private car, there has been a close connection between leisure mobility and the use of private cars. This connection applies to an even greater extent to the ever-increasing *aeromobility*. Both nationally and internationally, the large volume of the air-based mobility is, as emphasized, directly linked to tourism.

Tourism, then, can neither be detached from mobility nor from the major means of transport. Changes in levels and patterns of mobility, as required by a sustainable mobility, will demand profound changes in tourism, in volumes as well as patterns. A basis in environmentally benign transport means as bicycle, bus and train will, in particular, lead to other types of tourism than those founded on car and plane. It is in this respect we are faced with some of the more fundamental challenges in terms of developing aims and means to realize a policy for sustainable tourism. The demand is a coupling of the two concepts. A tourism which is developed detached from the restrictions implied in a sustainable mobility, will not be in accordance with sustainable development requirements.

8.6.3. The Implications for Transportation Infrastructure

Mobility and transportation infrastructure are inter-related. Without the extensive road-infrastructure current patterns and levels of auto- and lorry-mobility are not attainable. Similarly, we would not have the current levels of aeromobility without the capacity of airports. At the same time the infrastructure causes serious environmental problems partly independent of the extent of use by transport means. They are problems as losses of biological diversity and related landscape ecological qualities, particularly caused by ever more finely meshed infrastructural nets, but they are also related to a large consumption of natural resources needed to build the infrastructure.

As outlined earlier great achievements in reducing environmental loads can in principle be obtained through extensive dematerialization in a recycling society. A degree of dematerialization corresponding to *a factor 10-12 decrease* in resource intensities is considered necessary in rich countries in the long term. However, material and land resources needed for construction and maintenance of infrastructure can not practically be recycled. If the rest of the world should reach the current OECD-levels of mobility, the required transport infrastructure alone would generate about *a factor 10 increase* in the global input of crucial material resources for such purposes. A similar increase would be needed in the consumption of land resources. Besides unacceptable losses of biological diversity this would require paving over crucial agricultural land. A future transport infrastructure of this size would correspond to 25% of the world’s current cultivated land, enough to feed a population of 4 billion if used solely for grain production. These particular limitations of infrastructure emphasize that even much more modest global increases in mobility are considerably in conflict with sustainable development requirements.

While decisions to use the infrastructure with transport means are individual and private, the infrastructure itself is established through public planning. This emphasizes the importance of planning as steering instrument within transportation and mobility. Through all history of infrastructure in modern societies connections to planning have been very close. The claim can even be made that the foundations for what we today term public, physical planning were laid through infrastructural planning in the early phases of modernization (Benevolo, 1968). My analyses show that there has been a particular “boom” the past few years in planning and development of major transport infrastructure projects, not only in Norway but in all the Nordic countries. The overall investments are extensive. This is especially the case with the development of infrastructure for road transport. We are facing the largest and most spectacular construction projects in the whole history of infrastructure.

In one way major projects are now established with looser connections to public planning than before. While the infrastructures themselves are established through common public planning procedures, in several projects the relations to superior transport planning are dubious or non-existing. They are planned with the *purpose of competition* with other infrastructure, that is to attract both transport of persons and goods from these (Elling and Høyer, 1996).

The launching of this investment “boom” can be dated to the latter half of the 1980s. The analyses show that this is common not only to all the Nordic countries, but to the rest of Western Europe as well. This is a paradox. The presentation of the Brundtland Commission Report, and the countries’ participation in international processes to work out policies for *sustainable development* has taken place in the same period. It is pointed out that the extensive investments in new transportation infrastructure are inconsistent with important demands for such a development.

A thesis on *surplus capacity* in infrastructure has been launched (Elling and Høyer, 1996). In addition to larger losses in biological diversity and larger consumption of natural resources this has several negative environmental effects. The new infrastructure in itself generates more mobility, not the least when targeted measures are used in the competition between different infrastructures to attract and generate transport both of persons and goods. But a surplus also contributes to a relatively lower level of utilization of the capacity both in old and new transport systems. To reduced utilization of capacity is connected relatively larger consumption of energy and relatively larger emissions of greenhouse gases and other air pollutants.

Speed is an important competitive factor for the new infrastructure. This also has negative environmental effects. High speed trains and fast ferries reduce the energy and environmental advantages these transport means originally have. Further, they are not only alternatives to other means. New high speed railways are in many cases established in connection with airports, in reality to serve the purpose of making air transportation more effective and attractive. Similarly are new fast ferry routes established to increase the capacity of road based transportation. In addition, when sea transport reaches higher speeds advantages in energy consumption, emissions of greenhouse gases and other air pollutants are lost. These are just the factors used to give the grounds for a more extensive development of sea transportation. This is a well known situation in Norway. New fast boats used for passenger transportation along the coast have energy consumption and emissions of greenhouse gases per personkilometer higher than any other transport mean, included airplanes. The same applies to the new fast ferries between Norway, Sweden and Denmark. Even if the boats should be full of passengers they would not be better off than air transportation.

An *Environment Cities programme* launched in Norway during the first half of the 1990s encompasses some promising elements regarding connections between sustainability and mobility. However, even if it were to be a success, the most important preconditions would be maintained, preventing the development of mobility from being changed in a sustainable direction. It affects the distinction between *volume* and *intensity perspectives*. New infrastructure and more transport means in the form of new private cars and air schedules contribute to generating mobility. It may well be that through the Environment Cities programme it is possible to attain restrictions in infrastructure development and capacity and related mobility reductions. However, this will only take place within the boundaries of the cities. The major share of the movements, both of people and commodities, occurs in the large spatial structures outside and between the cities, both at home and abroad. As long as priority is still given to extending the extensive infrastructure outside the cities, the necessary volume reductions will not be attained. In addition, the conflicts between city and surrounding areas are intensified. A larger capacity of the infrastructures outside, increases the pressure on the structures inside. Possible gains in the cities can thus only be of temporary character. A *sustainable mobility* demands that the infrastructure and the related transport systems are developed according to the same principles outside the cities as prescribed by the Environment Cities programme inside.

8.7. The Environmental Ethics Basis

I have been engaged in works on environmental ethics since the early 1970's. It started when I took part in the first Norwegian seminar groups on *ecophilosophy* headed by the philosophers *Arne Næss* and *Sigmund Kvaløy* at the University of Oslo. This is a type of knowledge which is reflected in my works on sustainable mobility.

It is a field of philosophy covering the following topics (von Wright, 1994; 1996; Næss, 1993 ; Høyer, 1998) :

1. What responsibilities we – as human beings and societies – have towards other individual *species in nature*, particularly the animals that are closest to us in their ecology ;
2. What responsibilities we – as human beings and societies – have towards *entities in nature* as biological diversity, landscapes, local and even global ecosystems ;
3. What resonsibilites we – as human beings and societies of today – have towards human beings and societies in the *generations after us* ;
4. What responsibilites we – as human beings and societies in the rich part of the world – have towards human beings and societies in the *poor parts of the world* ;

Internationally most of the discussions on environmental ethics are about the first two topics. The term *global ethics* is sometimes used for the last two (Wetlesen, 1995). I prefer to connect all four to the term *environmental ethics*. To consider them as parts of the same superior topic follows, as emphasized, a long tradition in Norwegian ecophilosophy. Besides, it is most relevant to the composition of the sustainable development concept.

It should be understood as a *discourse*. So this last conclusive point is about placing my works on sustainable mobility in the discourse of environmental ethics. Mobility implies human actions. I have the understanding that ethical values usually are involved in such actions. They can be implicit or explicit. When we use the very term ethics it is about the explicity. *Ethics* covers that part of philosophy which addresses norms for our actions, that is what we ought to do respectively refrain from doing. I have formerly used the term *normative*, and claimed that sustainable development – and thus sustainable mobility – are normative concepts. A norm is a criterium that tells us what is the right behaviour. I have also used the term *value*. From the latin *valere* this is something which is strong and which we value. There are many different classes of values. Freedom, justice and solidarity are examples of *normative* (or ethical) *values*. Other classes are economical values, esthetical values and values connected to different types of human tastes. Both norms and values can be on individual and social levels. Similarly with the ethical framework. The environmental ethics of a society expresses collective attitudes.

There is a difference between *instrumental* and *intrinsic* values. An instrumental value serves as an instrument to achieve something. It is a value just because it serves the purpose of achieving something other of value. Intrinsic values are non-instrumental ; they are values in themselves. It is generally accepted that each human being has an intrinsic value. Human beings do not serve purely instrumental purposes. With *Immanuel Kant* we have come to accept that human beings never should be used as means but always understood as ends in themselves. It is even today generally accepted that certain human societies, notably settlements of indigenous people, have an intrinsic value. But each human being does also possess an inherent value. In environmental ethics the term *inherent value* is used as a more specific form of intrinsic value. When we talk about the inherent value of species in nature or nature as a whole these are values independent of any attention, interest or joy from any conscious human being. This implies that nature and/or its species are considered to have *moral status* ; they are morally considerate parties in principle just as human beings, but of course without the moral capacity of humans. In practical life it is necessary with some sort of *gradualism*, giving a stricter *regulative moral status* to the forms of life that most resemble humans (Høyer, 1998).

In classic nature conservation nature only has instrumental values. The number of such values to be considered has eventually become very large, particularly during the development of environmental policies since the early 1970's. The 1992 Rio-convention on biological diversity specifies as instrumental values both ecological, genetic, economical, scientific, educational, cultural, recreational and esthetical values. This implies that if all these values are taken seriously there are not necessarily large practical differences between an instrumental and an inherent value position. However, there is one difference of a possible substantial character. With an inherent value position human encroachments causing losses of biological diversity are only acceptable if they serve the purpose of satisfying basic human needs. When it is a matter of other types of human needs the basic needs of species and entities in nature should be given priority, but all the time with the application of some sort of gradualism between different types of species and entities. Such probably more extensive restrictions on human actions can not be deduced from a purely instrumental position (Næss, 1993; Høyer, 1998).

I have given the grounds for that consideration of the inherent value of nature should be included in processes to achieve *sustainable development*. In my conceptual analysis it is one of the prima characteristics. The needs to consider both species and systems in nature as morally considerate parties are expressed in the Brundtland Commission report. In the Rio-convention there are explicite references to the inherent value of biological diversity.

Ethical issues related both to aims, means and consequences of human actions are included in the discourse of environmental ethics. Thus crucial issues are : What aims are the right ones ? Which means have we the rights to apply in order to achieve these aims ? Which consequences of our actions are the right ones ? In the part of ethical theory called *deonthological* ethics the focus is on criteria for right actions without including a valuation of the consequences. When we act according to certain definite duties – for instance the Ten Commandments – we are within deonthological ethics. Similarly with an ethics on fundamental rights, for instance human rights or animal rights and rights of other ecological species. In *consequential* ethics the focus is on results of actions, that is criteria for right actions are defined by what type of consequences they actually have. In *teleological* ethics the focus is on whether the purposes of our actions are the right ones.

In my conceptual analysis of sustainable development *deonthological* perspectives are much focused. More specifically they refer to works on an ethics of fundamental rights. They belong to a field called contract ethics, or *contract theory* in social sciences. It is part of a long historical tradition that goes back to the works of *Locke*, *Rousseau* and not the least *Kant* under a common heading of *social contract* theory. In newer time works by the American *John Rawls* belong to the same tradition. His theory (1971) comprises the following three principles :

1. *The freedom principle* says that all shall have equal right to the most comprehensive system of equal, basic freedoms which at the same time is compatible with a corresponding set of freedoms for all ;
2. *The difference principle* says, as mentioned, that social and economic inequalities shall be arranged in such a way that they both are of the largest benefit to *the least favoured* members of society and are compatible with *justice between generations* ;
3. *The principle of equal opportunities* says that inequalities as these must be connected to positions in society that are open to all with equal opportunities.

The freedom principle is given priority. Rawls empasizes that this not only implies that everybody has the right to equal political rights in a formal sense, but also that it presupposes a superior principle of *satisfaction of basic needs*. The two other principles express that all primary goods in society should be *distributed equally* unless inequalities in the distribution of each and any of these goods are to the benefit of the least favoured members of society. In all cases we are talking about principles which form part of a *sustainable development* concept. This emphasizes that such contracts should be understood as social arrangements to guarantee the realization of important normative values.

Inspired by the Swedish historican *Sverker Sörlin* (1991) I use the term *nature contract* as a way of understanding sustainable development processes as the creation of social arrangements for the realization of important normative values also in human relations towards nature. The *precautionary principle* is such an arrangement or contract principle with – as I have already concluded - profound implications in relation to sustainable mobility.
It is more than any environmental policy principle. Basically it is an *ethical principle* (Zeitler, 1995; NENT, 1997; Høyer, 1998). An ethical value is that ”doubt shall benefit nature”. There is also an obligation to act ; when our knowledge about the effects our actions have on nature are uncertain, we are obliged to act to the benefit of nature. It comes in addition to our obligations to act to the benefit of nature when we have certain knowledge about the negative effects. In both cases, with and without uncertainty, regulative measures become more extensive when taking the inherent value of nature into consideration. The precautionary principle applies both to the immediate nature surrounding us today and to the global nature, that is the nature far away in space. Similarly it is a matter of the future nature and our relations to future generations. We have today a one-sided obligation to give future environmental risks and values of nature at least as much weight as todays. The principle thus implies an ethical obligation to harmonize our interests with the assumed interests of future generations. This gives the principle a global ethical foundation, both in relation to time and space (NENT, 1997).

However fruitful a term as nature contract might be we are still talking about *social arrangements* and *social actions* to implement processes of change. I have highlighted the deonthological perspectives and the realization of normative values in sustainable development processes even in this context. These are issues addressed in basic sosiological theory. *Max Weber* (1999) distinguishes between four types of actions : *traditional, affective, value rational* and *purpose rational* actions. Value rational actions are right in themselves, without taking into consideration their immediate effects. When they are denoted *rational* it is not because of relations between aims and means, but because they are based on extensive theories or theoretical positions and consistent arguments. In purpose rational actions the actors have definite aims, and explore and apply the means which are best adapted to achieve the aims. The actors analyse positive and negative consequences of the different means in order to choose the best ones. In planning theory it is called *rational planning* when we consider actions based on such an ordered system of aims and means. Much of the planning theory since the early 1970's has focused on a development of alternatives to this way of understanding social planning.

The American *Amitai Etzioni* is a crucial actor in this discourse. He (1991) stresses the importance of deonthological perspectives, or what he calls a *moderate deonthological position* in planning theory. According to Etzioni (1991) normative values, besides being important in themselves, help ensure the primacy of aims. A preoccupation with means, enhancing their strength, scope and quantity, he emphasizes is the essence both of market economy and the economic science as such. In addition to Weber's four types of actions this gives in reality a fifth : *means rational actions*. This is well known from todays focus on market economical measures in "sustainable" transport policies, measures in the form of CO2-taxes, arrangements for sale and exchange of CO2-quotas, ever more extensive road pricing, etc. Etzioni stresses that this preoccupation with means, through a process known as *goal displacement* or *suppression*, tends to lead to primacy of means over aims. Normative values serve as an antidote to goal displacement because they rule out certain categories of means (which undermine aims) or excessive preoccupation with means or efficiency, to the neglect of other values (Etzioni, 1991, p. 109).

Etzioni's moderate deonthology can be termed *normative intentionality*. It establishes a framework for value rational actions without leading to voluntarism. Normative intentionality encompasses four steps : 1. Critical discourse, 2. Planning, 3. Implementation, 4. Reflection. The last includes arrangements for surveillance, evaluation and revision. The critical discourse includes discussion of conceptual structures, identification of values, discussion of basic issues and problems and identification of major characteristics (Lafferty, 1996). My works on *sustainable mobility* should be understood within this context of normative intentionality. The prime focus of this Ph.d. thesis is however – as emphasized in the introduction to this chapter - on the first step, the critical discourse. I have claimed that it is crucial to include in this the discourse on environmental ethics within the tradition of ecophilosophy.

8.8. References

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