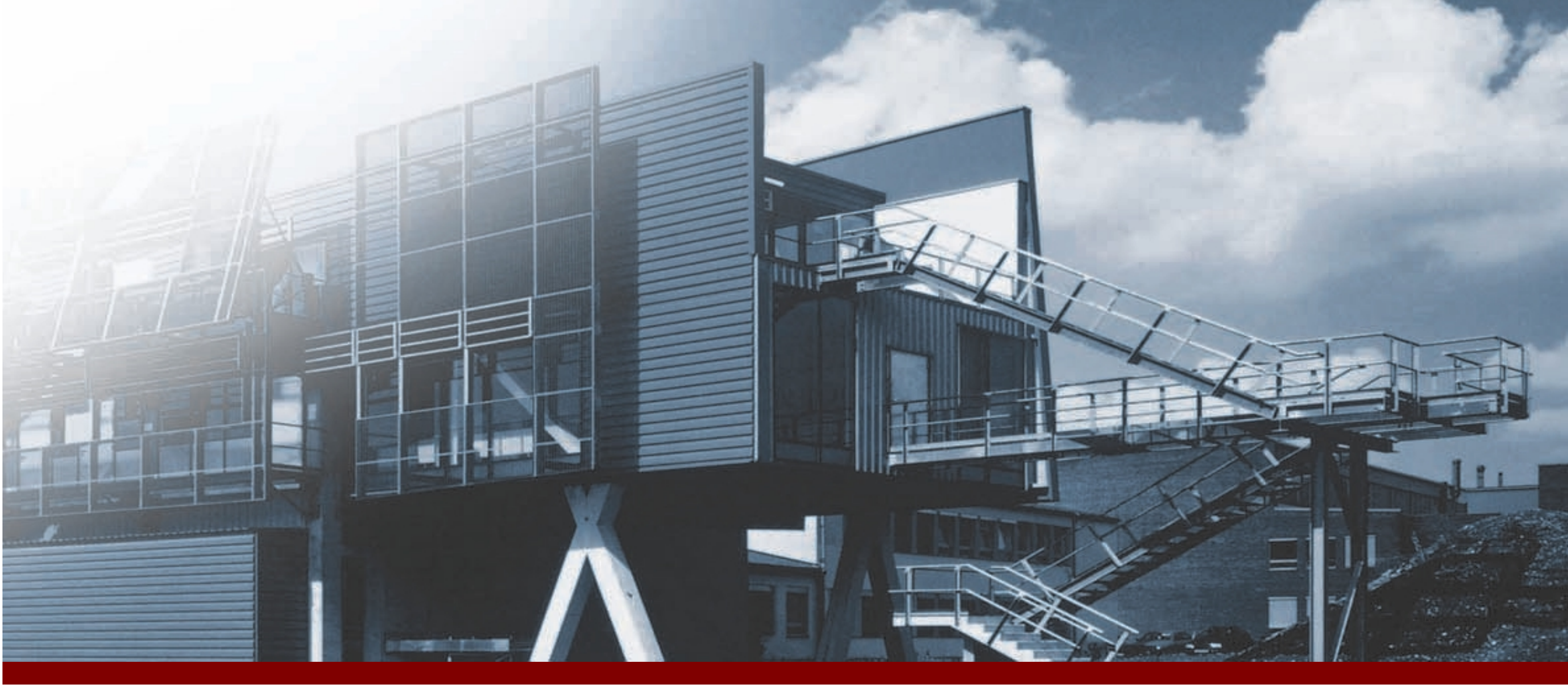

Environmental Behaviour and Quality of Life: Ecological, sociological, psychological and communicational indicators of sustainability

EUROCONFERENCE

Quality of Life - Sustainability - Environmental Changes

PROCEEDINGS

EVENT 1

OEFZS--S-0089/1

Training and Mobility of Researchers

AUSTRIAN RESEARCH CENTERS

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Bundesministerium für Verkehr, Innovation und Technologie

Geschäftsfeld Regionalforschung
GESCHÄFTSBEREICH SYSTEMFORSCHUNG TECHNIK-WIRTSCHAFT-UMWELT
Österreichisches Forschungszentrum Seibersdorf Gesellschaft m.b.H.
A-2444 Seibersdorf
Telefon: ++43 (2254) 780-3886, FAX: ++43 (2254) 780-3888, Email: eva.buchinger@arcs.ac.at

Table of Contents

PARTICIPANT PAPERS

LIST OF PARTICIPANTS

Preface

Preface

Sustainable development is presently one of the most challenging topics on political as well as economic and scientific levels. Nevertheless, sustainability is still – to some extent – a fuzzy concept. To deal with the very different aspects of sustainability and especially to get insights into possibilities and barriers of economic, policy, individual etc. actions, interdisciplinary as well as transdisciplinary research is necessary. According to that, the main objective of the Euroconference series "Quality of Life – Sustainability – Environmental Changes" was the international, interdisciplinary and transdisciplinary exchange of views of scientists, stakeholders, policy-makers, and NGOs about the alternatives of sustainable development in Europe. Special attention was given to the comparison and evaluation of different available systems of indicators, societal exchange processes, and strategies of intervention. Building on the disciplinary state-of-the-art, the interdisciplinary approach combined with the transdisciplinary approach represented the innovative nature of the Euroconference and allowed the discussion of alternatives to realise sustainable development considering ecological, societal and economic conditions of sustainability.

The Euroconference series was organised within the "Training and Mobility of Researchers (TMR) Programme" (4^{th} Framework Programme) and sponsored by the European Commission, by the Austrian Ministry of Science and by the Austrian Research Centers Seibersdorf.

Concerning the organisers – the Austrian Research Centers Seibersdorf -as main contractor in cooperation with the University of Vienna and Eco Counselling Europe (NGO) - the Euroconference originated from the national research initiative "Austrian Landscape Research" (Ministry of Science). As one part of it, Eva Buchinger was managing the four years, 20 researchers, seven scientific-disciplines and citizen-participation comprising project "Quality of life and environmentally friendly behaviour: Harmony and controversy in day-to-day life in an landscape", which was finalised December 1999. Rainer Maderthaner was responsible for all psychology-related questions within this project. (See the keynotes R. Maderthaner in volume 1 and E. Buchinger in volume 3.) As another part of the "Landscape"-programme, Christian Schrefel was promoting the implementation of Agenda 21 within the project "Research on cultural landscapes and Agenda 21". (See for the scientific background of this project the keynote of D. Francescata volume 2 and the contribution of C. Schrefel and P. Wagner volume 3.)

The three events of the Euroconference series were characterised by a discussion- and exchange oriented atmosphere. Participants from the academic, industrial, political, and non-governmental spheres contributed and exchanged scientific knowledge, practical experience, personal views, etc. As part of the TMR Programme, qualification of young researchers from less favoured regions was one of the key issue.

The present publication consists of three volumes, including the keynotes and selected participant contributions[1].

Event 1: Environmental behaviour and quality of life: Ecological, sociological and communicational indicators of sustainability. Stadtschlaining, Province of Burgenland/Austria, May 6-9, 1999 (Vol. 1).

Event 2: Exchange processes: Societal, institutional, and political determinants guiding environmental behaviour and processing environmental knowledge within society. Rust, Province of Burgenland/Austria, October 16-19, 1999 (Vol. 2).

Event 3: Present and future measures to achieve sustainability on international and local levels. Stadtschlaining, Province of Burgenland/Austria, April 27-30, 2000 (Vol. 3).

The scientific team wish to thank all persons and organisations who have given their support to make the Euroconference as well as the proceedings possible. Special thanks are due to Ingrid Divis for outstanding secretarial and administrative assistance, Silvia Steinbrunner for Internet services and to Thomas Roediger-Schluga for editing the papers and processing the manuscript.

Seibersdorf, September 2000

Eva Buchinger (Austrian Research Centers Seibersdorf)

Rainer Maderthaner (University of Vienna)

Christian Schrefel (Eco Counselling Europe)

Petra Wagner (Austrian Research Centers Seibersdorf)

[1] With respect to formal criteria, the contributions are only partly standardised. Several keynote speakers have not submitted a finalised paper; their contributions have been collected in the section "Keynote Lectures – Didactic Materials".

Quality of Life
Sustainability
Environmental Changes

Event 1: **Stadtschlaining / Austria**
May 6 - 9, 1999

Programme

Thursday 6 May 1999	
18:00 - 21:00	**Welcome Reception, Registration**
Friday 7 May 1999	
8:30 - 9:30	**Registration**
9:30 – 10:00	**Welcome Address** by J. Fröhlich (Austrian Research Centers Seibersdorf) **Opening** by R. Maderthaner (University of Vienna)
10:00 - 12:30	**Plenary Session 1 : Sustainability Indicator Research** Chaired by E. Buchinger (Austrian Research Centers Seibersdorf)
	Keynotes by F. Schmidt-Bleek (Factor 10 Institute, Wuppertal Institute) The MIPS concept: Bridging ecological, economic and social dimensions with sustainability indicators T. Ruddy (Consultant) Sustainable development indicators and politics in Anglo-American countries J. Ott (Erasmus University Rotterdam) Happy life expectancy: A comprehensive measure of quality-of-life in nations T. Whiston (University of Roskilde) Environmental consciousness and the challenges and barriers to communicating environmental knowledge/indicators
14:00 - 15:00	**Working Groups** Discussion of Plenary 1 keynotes (contradictions, synthesis) and preparation of statements/questions for Plenary 2
15:00 - 16:30	**Plenary 2: Discussion** Keynote speakers together with Working Groups Chaired by E. Buchinger (Austrian Research Centers Seibersdorf)
17:00 - 18:30	**Working Groups** Formulation of statements/conclusions and production of posters

Saturday 8 May 1999	
9:00 - 10:15	**Plenary 3: Systematisation of Indicators Research** Chaired by R. Maderthaner (University of Vienna)
	Keynotes by J. Fletcher (OECD Paris) Using the PSR model for developing sustainable indicators I. Guinomet (EUROSTAT LU) Eurostat´s tools for the development of indicators of sustainable development
10:30 - 12:30	**Working Groups** Discussion of Plenary 3 keynotes considering prior discussions/results and finalising of posters
14:00 - 18:00	**Plenary 4: Discussion** Keynote speakers together with Working Groups Poster Presentation of Working Groups Chaired by R. Maderthaner (University of Vienna)
Sunday 9 May 1999	
8:30 - 10:30	**Plenary 5: Panel Discussion: Practical Benefit of Indicators** Chaired by E. Buchinger (Austrian Research Centers Seibersdorf)
	M. Piringer (Global 2000), S. Gerhold (Austrian Central Statistical Office), Keynote Speakers
11:00 - 13:00	**Plenary 6: Lessons Learned**

TMR
Training and Mobility of Researchers

bm:wv

AUSTRIAN RESEARCH CENTERS

Keynote Lectures

Keynote Papers

Quality of Life – Sustainability – Environmental Changes

Rainer Maderthaner

One of the most important political and societal problem of nowadays is how to improve and secure the quality of life of mankind while living within the carrying capacity of the environment and without compromising the long term human, economical, and ecological capital of the future. For answering this basic question it could be very useful to try and find corresponding conceptual frameworks on the concepts of quality of life, sustainability and environmental changes. The following thematic contribution should help to find an orientation for discussing the relevant topics of sustainable development on local and global level, and refers to the relevant keynotes of the Euroconference.

Main Topics of the Conference

With respect to the general subject of the sustainable development of social, economical and environmental systems the following topics have been discussed more or less extensively during the three events of the Euroconference (http://euroconfql.arcs.at/):

- Selection of indicators and data sources (driving forces, pressures, states, responses)
- Integrated environmental assessment methodologies
- Horizontal measures and their effects (economic and market-related mechanisms, eco-labeling, environmental auditing, public information and education, energy efficiency, financial support mechanisms)
- Methods of public information and education (access to information, scenarios, and social learning)
- Conditions of social acceptance of environmental and economic measures
- Relations between environmental, economic and societal systems
- Impacts of local, regional and global change on human factors (industrial development, quality of life, human health, societal equity, teleworking etc.)
- Broadening the range of environmental, societal and economic instruments (effectiveness of measures, shared responsibility)
- Communication systems and mass media processes
- relevant legislative measures

Many national and international programmes and projects has dealt already with the listed topics or with similar areas of research until now (see Appendix 1). The innovative aspect of this very conference should be the transdisciplinary approach, which without any doubt will have striking influence on the research processes of universities in the future.

Methodological Orientation: Transdisciplinarity

Many environmental, economical and societal problems of nowadays can not be solved by disciplinary research alone but have to be analysed by interdisciplinary research too. Moreover for the definition of the problems of the “real” world it is necessary to include application experts of scientific knowledge, such as practitioners, stakeholders, policy maker, NGOs and regional decision makers. That means we have to turn into transdisciplinary research (e.g. Mittelstraß, 1992; Jaeger & Scheringer, 1998) by which problem orientation in generating scientific models (practice, everyday problems) is dominating and scientific interaction between scientists at the one hands and laymen (as “real world” experts) at the other hand is demanded. By transdisciplinarity it is possible to overcome the barriers between scientists and the other societal actors with regard to there different perspectives, languages, goals and interests (see also Dürrenberger, 1997). Many examples and methods of this new scientific approach are published in the Proceedings of “International Transdisciplinarity Conference” which has occurred on February 2000 in Zurich (http://www.snf.ch/transdisciplinarity/).

Crucial Concepts of the Conference

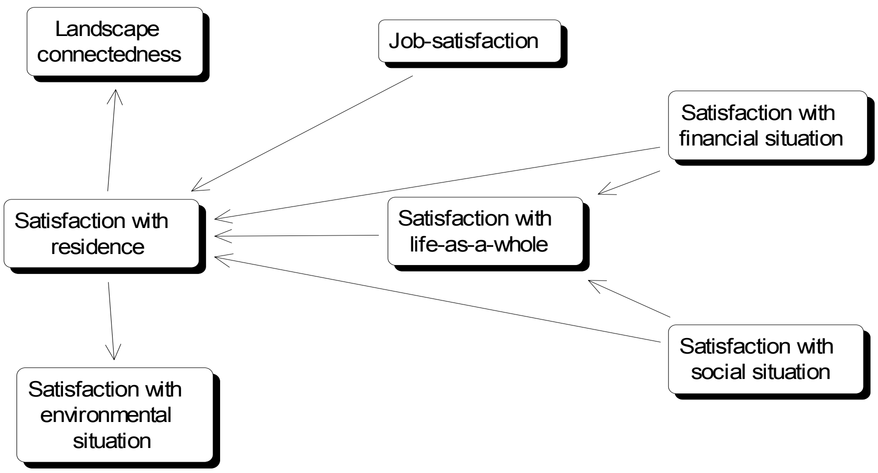
Quality of Life

Within the Fifth (EC) RTD Framework Programme (1998-2002) one of the thematic programmes is “Quality of Life and Management of Living Resources”. This programme “aims to unlock the resources of the living world and improve the quality of life. To achieve this, the links between discovery, production and end-use must be consolidated. The needs of society and the requirements of the consumer are paramount and research must lead to quantifiable future wealth and job creation, while respecting the principles of sustainable development” (http://www.cordis.lu/life/). Some important criteria for quality of life have been worked out by the Independent Commission on Population and Quality of Life in the publication “Caring for the Future. Making the Next Decades Provide a Life Worth Living” (Independent Commission on Population and Quality of Life, 1996).

Regarding the scientific research of the quality of life very often only the “objective” aspects of this concept has been considered and the “subjective” aspects has been widely neglected. This can be noticed by inspecting the key actions of the programme “Quality of Life and Management of Living Resources” which take up the concepts of food, nutrition, diseases, agriculture, and so on, but not the subjective problem domains of satisfying needs and social or psychic factors of well-being. So we can speak about the “neglected psychosocial and behavioural aspects in environmental policy-making” (see keynote by R. Kaufmann-Hayos). The problems of sociological and psychological research on quality of life are stressed quit extensively by Ruut Veenhoven (1988, 1991, 1995) and also the role of satisfaction in the conceptions of social welfare (see also the keynotes by Eva Buchinger, ARCS, and by Jan Ott, Erasmus University Rotterdam). The special triggers and causes for happiness and well-being are dealt extensively by Argyle (1987).

Results of empirical investigations often show statistical dependence between subjective factors of quality of life, therefore it is sometimes possible to rank the quality of life indices regarding to their existential priority. This should be demonstrated by an illustration of a result of the project "Quality of Life and Environmental Behaviour - Every Day Consensus and Conflicts" (Buchinger et al., 1999) already cited before (Fig. 1): The social and the financial conditions of people seem to be very important for the general assessment of quality of life, and the later one itself is determining the satisfaction with the residence and the natural environment.

Fig. 1: The main influence on the appraisal of satisfaction with "life-as-a-whole" stems from the satisfaction with the financial situation as well as the satisfaction with the social situation, and satisfaction with residence on its part depends on job satisfaction and on general satisfaction (Maderthaner & Szynkariuk, 1999).



With regard to the measurement problems of satisfaction research we have to face with multidimensionality (e.g. with respect to certain life-domains) of inventories, with the differentiation of affective and cognitive assessment components of well-being, with many biases of questioning (e.g. "desirability bias", actual well-being of the respondents), and with statistical difficulties too (e.g. complexity reduction, reliability and validity of the questionnaires).

Sustainability

Problem of Definition

Arthur L. Dahl (1997, p. 69) pointed out, that there can be found "dozens, if not hundreds, of definitions of sustainable development" in respective publications. Moreover, the definition depends

- on the sizes of the described systems (global, transboundary, regional, national, local scale),
- on the selected target sectors (energy, transport, industry, agriculture, forestry, tourism), and
- on the scientific or professional perspective of the defining person.

In accordance with the "European Community programme of policy and action in relation to the environment and sustainable development" (Fifth Environmental Action Programme, 5 EAP) the sustainable development path has to be reached by management of resources, mobility management, and management of production/services sectors, but no precise description of the concept has yet been attempted (Commission of the European Communities, 1993, "Towards sustainability"). The same applies for the update to the 1992 report on the state of the environment ("Environment in the European Union") by the European Environment Agency (EEA), where with respect to this topic it is merely mentioned that "without accelerated policies, pressures on the environment will continue to exceed human health standards and the often limited carrying capacity of the environment" (European Environment Agency, 1995).

To get a comprehensive approach measuring progress of sustainable development using indicators we need to consider some characteristics of this subject (Dahl, 1997, p. 70 - 77):

1. "Sustainability is fundamentally a question of balance maintained over time".
2. Sustainability is "inherently a value-laden concept, in that it implies responsibility for both present and future generations".
3. The scale of assessing sustainability ranges from the family to global society and includes therefore several nested functional units and levels of organisations.
4. There are at least three dimensions of sustainability, which interrelate with each other: The environmental, the economic, and the societal dimension.

Although there is no single definition of sustainability which is accepted by most scientists or public actors, one can find enough similarities between the different versions of definitions to be able to work with and understand each other. Some examples should illustrate this assertion:

- Sustainable development is development that meets the needs of the present without compromising the ability of future! ("Brundtland report: Our Common Future"; World Commission on Environment and Development, 1987).
- Improving the quality of human life while living within the carrying capacity of supporting ecosystems (IUCN/UNEP/WWF: Caring for the Earth, 1991).
- Sustainable production and consumption is the use of goods and services that respond to basic needs and bring a better quality of life, while minimising the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardise the needs of future generations (International Institute for Sustainable Development (IISD), Symposion, 1994).
- "Improving the quality of human life while living within the long term capacity of the natural, human, social, and built community capital upon which that life depends" or quit short "... continuing without lessening" (Maureen Hart, Environmental Data Analyst: Lecture at the U.S. Embassy Vienna, Oct 14, 1999).

In most relevant documents on sustainability in spite of precise definitions concrete recommendations for measures have been preferred. So perhaps we have to ask, what characteristics are usually associated with sustainable development or what criteria for evaluating sustainability we have to consider respectively?

Features of Systems

Before we can put forward relevant criteria for sustainability, we have to become clear about the kind of the systems to be described or evaluated and what features of the selected systems are the most important ones. At least four attributes of systems are relevant for sustainability analysis (see e.g. Bossel, 1992):

1. Size of systems: With regard to the size of the systems we can often find different scales of assessment. So for instance a global, a national, a regional, and a local sustainability can be differentiated. But what kind of interactions between the systems or subsystems we have to consider? Do we know enough about hidden or indirect effects of human or other impacts? Because of so many structural perspectives the size of the examined systems has not only to be adjusted to the functional constraints within the system but also to the purpose of the description. For there are so many options of structuring system the comparability of system simulation results is often very restricted.

2. Time scale of development: Sustainability analysis has to include not only the structure but also the dynamic of human or natural systems. The dynamic of systems which includes time lags, feed back loops, and long-term effects must also be accounted by the evaluation process. For instance, how many future generations are affected by the ecocide of the present generation? This questions are closely related with the problem of the so-called "inter-generational equity" and the well known difficulty to estimate the amount of remaining natural resources.

3. Dimensions of assessment: There are at least three system dimensions which commonly interrelate with each other, namely the environmental, the social, and the economic dimension. In accordance with an economic notion the distinction between “natural”, “human” and “economic capital” has been introduced. The Commission on Sustainable Development (CSD) discriminates additionally to the environmental, social, and economic aspects of a country also the institutional ones. It might be necessary to take into account more than four aspects for developing efficient models of sustainability. For instance until now the psychological, social and communicational processes has been neglected to a large extent, as have been pointed out by the keynotes of Ruth Kaufmann-Hayoz (University of Bern) and Thomas G. Whiston (University of Roskilde).

4. Goals of sustainable development: Sustainability is not only a value-laden concept which often implies different goals but also there are different ways of reaching these goals. All societal actors involved in public decisions, such as policy makers, shareholders, business men, scientists and citizens have specific attitudes, habits, lifestyles, moral principles and ideological positions which control the individual behaviour. That means that we are confronted with quite different interpretations of basic needs, goals, prosperity, health, and in general, quality of life (see Schäfer, 1992; Max-Neef, 1991). So it sometimes seems to be more a political decision than a scientific one if we assess the future development of regions or local communities. It is fair to keep in mind that exchanging views about sustainability means also - more or less - an ideological competition about the preferred way of life.

Principles of Sustainability

An international group of practitioners and researchers from fife continents have met in November 1996 in Bellagio (Italy) for developing new ways of assessing sustainability. They have proposed a collection of principles of sustainability which “are intended for use in starting and improving assessment activities of community groups, non-government organisations, corporations, national governments, and international institutions” (http://iisdl.iisd.ca/measure/2.htm;14.5.1999):

1. Guiding vision and goals
2. Holistic perspective
3. Essential elements (equity, biodiversity, human well-being, economic development, ...)
4. Adequate scope
5. Practical focus
6. Openness
7. Effective communication
8. Broad participation
9. Ongoing assessment
10. Institutional capacity

Another checklist of principles of sustainability, more specialised for the scope of agglomerations, leads "Towards a Local Sustainability Profile - European Common Indicators" by which appropriate indicators should be selected (http://www.sustainable-cities.org/indicators/direct.htm; 20.2.1999):

1. Equality and social inclusion
2. Local governance/empowerment/democracy
3. Local/global Relationship
4. Local economy
5. Environment protection
6. Cultural heritage/quality of the built environment

As already cited, in the sense of Maureen Hart "sustainable means continuing without lessening". "and a 'sustainable community' seeks to maintain and improve the economic, environmental and social characteristics of an area so its members can continue to lead healthy, productive, enjoyable lives there" (http://www.sunjectmatters.com/indicators/HTMLSrc/Sustainability.html).

Environmental Changes

Indicators

In 1987, already the World Commission on Environment and Development ("Brundtland Commission") demanded new methods for assessing progress toward sustainable development. Since the UN Conference on Environment and Development (UNCED) in Rio de Janeiro in June 1992 it was apparent, that there is an urgent need for indicators of sustainable development (ISD). The 40 chapters of Agenda 21 (http://www.agrar.de/agenda/) demonstrates the relevant aspects of environmental sustainability and help to communicate environmental problems at public and scientific level, referring for instance to poverty, demographic dynamics, human health, human settlement, consumption patterns, financial resources, fragile ecosystems, deforestation, biotechnology, protection of the atmosphere an so on.

In 1995 the UN Commission on Sustainable Development (CSD) presented a work programme for sustainability indicators, by which 134 economic, social, environmental and institutional indicators has been proposed. This set of indicators has been tested by 22 pilot countries (Austria, Belgium, Brazil, China, Czech Republic, Costa Rica, ...) until the end of 1999, afterwards the working list has been modified and completed. The aim of the CSD is to "have an agreed set of indicators available for all countries to use by the year 2001" (http://www.un.org/esa/sustdef/isd.htm). Some very useful side-effects of this process are the promotion of the national debate on sustainable development and the promotion of the dialogue between all relevant actors.

An overview about the "practical benefits of indicators for different stakeholders" has given Catherine Rubbens, who also has been a member of the Commission on Sustainable Development (CSD). Thomas Ruddy has had a lecture about the political relevance of indicators in Anglo-American countries, and the keynote of Friedrich Schmidt-Bleek (Factor 10 Institute, Wuppertal Institute) has dealt with the MIPS (*M*aterial *I*nput *p*er Unit *S*ervice) concept, the "rucksack factors" and the necessity of de-materialisation in the future by an average factor of 10.

With regard to the climate change problem "the Cardiff European Council (June 1998) asked the Commission and the Council to focus more on integration and develop indicators to help monitor progress and make the issues more understandable for citizens" (Commission of the European Communities, 1999)

Models

There exists a lot of models describing economic, social or environmental structures and dynamics. For our purpose they can be divided in models of classification (e.g. indicator models), models of accounting (e.g. gross national product), and models of explanation or prognostic models respectively (e.g. World 3).

One of the most influential environmental indicator model stems from the OECD (1994), in which 30 classes of indicators (OECD Core Set) are differentiated and integrated in the so-called *Pressure-State-Response (PSR)* framework (Linster, 1997). It is stressed here that the most basic criteria of this indicators design are policy relevance, analytical soundness, and measurability. Pressure includes all the human activities (e.g. energy, transport, agriculture) damaging the environment, state means the conditions of the environment and the natural resources, and response describes mainly the individual, collective and societal actions (1) "to prevent human-induced negative impacts on the environment", (2) to "halt or reverse environmental damage", and (3) to "preserve or conserve nature and natural resources" (OECD, 1994, p. 12). This concept was also described detailed by the keynote of Jill Fletcher (OECD).

A modification of the PSR framework of the OECD presented Corvalan, Kjellström and Briggs (1997) with respect to health. The *DPSEEA framework* consists of the already known concepts *driving forces* (D), *pressures* (P), *state* (S) and is supplemented by *exposure* (E), *effects* (E) and *actions* (A). Exposure means the kind of personal contact to some environmental hazards (e.g. inhalation, ingestion), the effects refer to the various diseases and actions are the curative, preventive and protective interventions.

Another model of indicators initiated by the UN Commission on Sustainable Development (CSD) is the *Driving Force-State-Response* (*DSR*) framework. The objective of this work programme is "to make indicators of sustainable development accessible to decision-makers at the national level by defining them, elucidating their methodologies and providing training and other capacity-building initiatives" (Mortensen, 1997). The conceptual framework is quite similar to the PSR framework with the exception of the first component, which is broadened from the environmental pressures to the driving forces, to include not only negative but also positive impacts on environment. The most important criteria for selecting indicators are described by Mortensen (1997): The indicators should be national in scale, understandable, available, realisable, conceptually well-founded, limited in number, relevant to Agenda 21, representative of national consensus, and of course relevant to indicate changes in sustainability. Because the DSR framework takes into account social, economic, environmental and institutional aspects of sustainable development it considers the most important facets of this subject.

The European Commission also has given a high priority to the designing of indicators of sustainable development. One important area of research is the Environmental Pressure Indices programme (European Commission & Eurostat, 1999; see also http://esl.jrc.it/envind/), which is maintained by 30 projects categorised in 3 modules. The first module is user-oriented, and the indicators are selected by panels of experts (about 200), whereby more than 1000 indicators resulted, which have to be reduced to a number of 25-30 for each of the 10 problem areas considered (air pollution, climate change, loss of biodiversity, marine environment and coastal zones, ozone layer depletion, resource depletion, dispersion of toxic substances, urban environmental problems, waste and water pollution, and water resources). The second and the third module concentrates more on physical, economical, and sectoral indicators. Another attempt of the EC refers to the adaptation of the UN framework of ISD for Europe which resulted in the meantime in the Pilot Eurostat Working List of Indicators of Sustainable Development consisting of 47 indicators (see also Guinomet, Sensi, Jesinghaus & Parker, 1997).

Among scientists and indicator experts the *DPSIR* model (driving forces, pressure, state, impact, response) has been widely accepted for structuring environmental information and describing the effort of sustainable development (European Commission and Eurostat, 1999) which is also the methodological basis of the mentioned Environmental Pressure Indices programme. Regarding the information management and the data collection Eurostat concentrates on driving forces, pressure, and response while the European Environment Agency (EEA) focuses on state and impact. A detailed description of the DPSIR model has been given by the keynote of Isabelle Guinomet (Eurostat).

The *Sustainable Development Indicators (SDI)* Group in USA raised a framework, in which endowments and current outputs/results of the economic, environmental, and social areas were differentiated. Endowments include built capital, natural resources, environmental systems, community organisations, and education systems, whereas current outputs/results are defined as goods, services and experiences of the human population (characterising standard of living and quality of life). The links between the endowments and the current outputs constitute the processes (decision making, driving forces).

Some modern trends in indicators research come from systems analysis and cybernetics. Bossel (1997a, 1997b, 1998) for instance proposes an indicator model in which the selection of indicators is based on so-called *orientors* (in German: Leitwerte) and their possibilities of satisfaction. The total system (human-environment-system) is divided in subsystems for which the satisfaction of 7 orientors have to be evaluated (existence, psychological needs, effectiveness, freedom of action, security, adaptability and coexistence). By this systemanalytical framework the hierarchy and the inter-linkages between the environmental, economic and societal processes are emphasised. In this context, the relation between sustainable development and human needs have to be considered. According to this subject, Max-Neef (1991) proposed a classification of human needs, which can had been used for comparing the quality of life in several countries (subsistence, protection, affection, understanding, participation, idleness, creation, identity, and freedom).

Another systems-oriented approach is the global integrated assessment model *TARGETS* (*T*ool to *A*ssess *R*egional and *G*lobal *E*nvironmental and Health *T*argets for *S*ustainability) which has been developed by Rotmans (1998) from the National Institute of Public Health and Environmental Protection (RIVM). It should help to analyse the "linkages among social and economic processes, biophysical processes, effects on ecosystems and humans" (Rotmans, 1998, p. 421). The methodological basis of this model is the PSIR approach ("vertical dimension") which is completed by submodels of human and environmental systems ("horizontal dimension") for each PSIR instance: 1. Population and health model, 2. Energy/economics/resources model, 3. Biophysics model, 4. Land/soils model, and 5. Water model.

One of the most famous, most discussed and probably most misunderstood computer model was that of Meadows and co-workers (1972, 1992), by which we should be informed about the worldwide trends in several sectors of development. Since this time many other models have been proposed, and many of them were of no relevance for practice. One of the newest *system dynamics model* has been developed in the last years by universities of Great Britain, Spain and Finland with coordination by the Wuppertal Institute. The keynote of Friedrich Hinterberger (Wuppertal Institute) and the contribution of Macolm Slesser (University of Edinburgh) demonstrated the so-called SuE model, which simulates the energy and resource flows within the European Union.

Models of accounting are for instance the algorithms of *gross national product* (GNP), the *Index of Sustainable Welfare* (ISEW), and the different modes of *green budgeting* (See van Dieren, 1995). The models of the this type were created to explain the dynamic of economic, societal and environmental structures and to predict their future development.

Measures

The "Community committed itself to developing a strategy on sustainable development by 2002" but this cannot be reached only with environment measures but it is also "necessary to strengthen the integration of environmental requirements into sectoral policies, which can contribute to addressing them at their origins in the economic forces which shape our society" and further "Future progress towards an improved environment and more generally sustainable development, including social and economic concerns, will require a more integrated approach to policy making" (Commission of the European Communities, 1999). The homepage of the European Union illustrates some areas of ongoing integration of environmental policies into Union policies: Employment, energy, agriculture, single market, industry, urban environment, and so on (http://europa.eu.int/scadplus/leg/en/).

Very often demanded but seldom realised is the statement within the Commission Working Document (Commission of the European Communities, 1999, p. 6) that "more focus should be put on addressing the origin of problems rather than seeking to abate the effects often with end of pipe solutions”. This would mean that we must not only stress on political, economic, technical, and legislative strategies but also more on psychological and communicational measures.

Referring to the possible categories of interventions for sustainable development fife approaches of actions can be roughly distinguished:

- Psychological, pedagogical and communicational measures (environmental consciousness, environmental education, environmental campaigns, public access to information etc.)
- Regional and local initiatives (Local Agenga 21, citizens' action groups etc.). See the keynote by Donata Francescato (University “La Sapienza”, Rome) on her method of “Community Diagnosis”, and the moderated workshop organised by Christian Schrefel (EcoCounseling Europe) and Petra Wagner (ARCS) on sustainable regional development in case of biomass in a small community of Austria. As successful example of such initiatives the project "Cultural Landscape and Agenda 21" (Cornelia Ehmayer, Christian Schrefel) also could be taken.
- Marcet based and governmental instruments (environmental taxes, Environmental Assessments, Eco-Management and Audit Scheme, EMAS, etc.)
- Scientific research and communication (EU framework programmes, LIFE etc.)
- Political and legislative actions (Action Programmes of the European Community, legislative frameworks of the countries; see also the keynotes of Peter Leroy, University of Ninmegen, Valentine Herman, ICL Belgium, and I. Graenitz, G.L.O.B.E)

By reviewing the Fifth Environmental Action Programme which was produced as the response of the European community to the 1992 Rio Earth summit and planning the Sixth Environmental Action Programme (http://europa.eu.int/comm/environment/) the Commission emphasised “new and open management culture and practices, more dialogue and transparency” and has given some examples respectively:

- Intensifying research on the impact of socio-economic activities on environment
- Implementation of the Strategic Environmental Assessment (SEA; for some details see also http://europa.eu.int/comm/environment/eia/)
- Improving economic evaluation (e.g. hidden environmental costs, cost-effectiveness)
- Development of indicators for better objectivity of environmental diagnosis processes and improvement of scientific and practical communication
- By the Eco-Management and Audit Scheme (EMAS) the voluntary participation of companies and enterprises should be facilitated, the traditional “command and controll” approach should be supplemented by self-regulation (see keynote by Heinz K. Prammer, University of Linz, and http://europa.eu.int/comm/environment/emas/)

In the previous cited document of the Commission also the “involvement of citizens and stakeholders” and the principle of “shared responsibility” is highlighted. “Experience shows us that when citizens act, policies start to change for the better. If we want to change behaviour, citizens should be well informed and empowered” (Communication from the Commission, 2000, p. 24). And as one facet of the new impetus of the European Community to achieve sustainability the increasing of public awareness of environmental problems has been stated, implying “improving access to information, integrating the concept of sustainable development in Community education and training programmes, evaluating and disseminating the results of Community policy" (http://europa.eu.int/scadplus/leg/en/lvb/).

Referring to the psychological, educational and communicational problems of sustainable development at the Austrian Euroconference several keynotes and workshops have been organised: Eva Buchinger (ARCS) has dealt quality of life and public measures to gain citizen support for sustainability, Gaetano Borrelli (Italian National Agency for New Technologies, Energy and Environment) has stressed the difficulties to disseminate environmental information by mass media, Ruth Kaufmann-Hayos (University of Bern) has given a lecture on collaborative agreements and social marketing instruments, and Paola Rizzi Universitario die Architettura di Venezia) and Willy Kriz (University of Munich) did organise a workshop on "Environmental Education and Training of Systems-Competence with Gaming/Simulation".

"Today, the Union is far from achieving its broader objective of sustainable development as reflected in the Amsterdam Treaty. The task now facing us is how we can give substance to this commitment. In essence it requires a change in the way we define economic, social and environmental objectives to that they become complementary and jointly contribute to sustainability" (Communication from the Commission, 2000, p. 25)

Appendix 1

Relation of the Conference to Other Respective Programmes or Projects

PROGRAMMES

- Human Dimensions of Environmental Change Research Programme (HDECRP)
- CSD Work Programme on Indicators of Sustainable Development (UN Commission on Sustainable Development, CSD)
- Environment, Science and Society programme (European Science Foundation)
- Global Resource Information Database (GRID) (United Nations Environment Programme - UNEP)
- Harmonisation of Environmental Measurement (HEM) (United Nations Environment Programme - UNEP)
- The International Human Dimensions Programme on Global Environmental Change (IHDP) (International Social Science Council -ISCC)
- International Geosphere-Biosphere Program
- Urban lifestyles, Sustainability and Integrated Environmental Assessment (ULYSSES)
- Climate and Environment in Alpine Regions (CLEAR)
- Austrian Research Initiative: Sustainable Development of Cultural Landscapes and Regions - in German "Kulturlandschaftsforschung" (KLF, http://www.klf.at)

PROJECTS

- The Measurement and Achievement of Sustainable Development (ENV 1C)
- The Socio-economics of the Transition to Ecological Sustainability (INTAS)
- Ethical Quality Adjusted Life Years (QALY): Investigation of Ethical Implications of Measures of Quality of Life Applicable to a Range of Diseases and Health States for in the Allocation of Resources in Prevention, Diagnosis (BIOMED 1)
- Software Scenario Models for Quality of Life in Information Society (ESPRIT 2)
- Biomarkers of Exposure and Effect in Relation to Quality of Life and Human Risk Assessment (FAIR)
- Local Indicators to Monitor Urban Sustainability (LIFE 2)
- Operational Indicators for Progress Towards Sustainability (ENV 1C)
- The social shaping of the EC framework programme. A network for a gender study of the quality of life dimension (HCM)
- The quality of life gap between East and West: exploring men's and women's health-related strategies in structural change (INTAS)
- The spatial configuration of peripheral settlements in Santiago de Chile: the implications of physical consolidation for the quality of urban life (ISC C)
- The Children's City: Demonstrative actions for sustainable development for the urban environment with children as catalysers of community participation and as parameters to measure the quality of life for everyone (LIFE 2)
- Sustainability Through Ecological Economics (ENV 1C)
- The Social Management of Environmental Change (ENV 1C)
- Instruments for Sustainable Regional Development (ENV 2C)
- Sustainability, Locality and Democracy: Community Identity in the Sustainability Transition (ENV 2C)
- Quality of life and environmental behaviour: Harmony and controversy in a day-to-day life in an landscape (BMWV)
- Research on cultural landscapes and Agenda 21 (Eco-Counselling Austria, especially the working group "17 and 4"; http://www.17und4.at)

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The MIPS-Concept

Bridging Ecological, Economic, and Social Dimensions with Sustainability Indicators'

F. Schmidt-Bleek

Abstract

The present throughput economy will yield to a customised economy, in which custom-tailored services are more important than mass products, and access to services more important than ownership of goods. In the customised economy, the natural resources land, energy, and materials will be largely replaced by knowledge, know-how, and know-who in the process of providing wealth to people.

In this paper, ecological indicators are presented which can be used to quantify the resource productivity of products, services, systems, and performances. Together with Factor 10 they form a framework which allows the operationalisation of the sustainability concept. The indicators presented fit well into the economic realities of the customised service economy.

Key Words:

Sustainability, Indicators, Resource Productivity, MIPS, Factor 10.

The Throughput Economies Of The Past

On the average, up to 90 % of the biomass harvested as well as more than 90 % of the natural abiotic (non-renewable) materials disturbed by machines in their natural settings are wasted on the way to making products available to the end-user. From this perspective, humankind has hardly any supply problems. Surprisingly, we seem to be serious when calling this dismal situation "high tech", "high chem", and "eco- something or other". The products of the future will disturb and consume less natural resources, they will require a higher input of know-how, and will outsell present goods on all markets.

Classical environmental protection remains a superficial answer to the ecological crisis. It typically works at the end-of-the-pipe and implies additional costs in money and resources. This still allows businesses and politicians to argue conveniently that economies need to prosper in the first place in order to afford environmental protection at all 1.2

As long as "to prosper" means to maintain per capita consumption rates of resources similar to the ones prevailing in our throughput economies of the west to date, the pollution control strategy remains profoundly unecological as well as uneconomic.

It is not accidental therefore, that classical pollution control measures failed to be internationally harmonised at a meaningful level - as demonstrated recently again by the almost complete lack of success during the United Nations meetings in Kyoto, 1997, and Buenos Aires, 1998 devoted to curbing the emission of CO2 and some other gases relevant to climatic changes. Even the United States have pronounced that they cannot afford their share to help saving the earth in this fashion.

Small wonder, therefore, that twenty five years of costly pollution control efforts have not prevented environmental deterioration from increasing on a global scale. Only that now toxic industrial emissions and effluents are found more in the poorer countries, while they used to be characteristic of the "the North" twenty-five years ago.

The wealth of the industrialised countries is based to a considerable degree upon man-induced material flows that occur in the Third World, as for instance natural timber, overburdens from mining mineral resources, and the use of water resources for the production of agricultural products and aluminium. To satisfy Germany«s thirst for orange juice, four times as much land would have to be devoted to orange production as is now being occupied by fruit trees in Germany.

As things stand, the orange trees for stilling Germany«s thirst grow mostly in Brazil, some 10000 kilometres away. Ca. 25 % of the people harvesting the oranges are less than 14 years old at an average monthly salary of 70 Euro. 1 kg oranges sells for ca. 0.03 Euro in Brazil, the litre of orange juice in Germany for 0.6 and up to 2 Euro. Thousands of children die each year in Brazil from chemicals« poisoning while harvesting agro-products .

The Root Cause Of The Ecological Instability

Irreversible disturbances of ecological equilibria are caused directly by technical interference with environmental resources in situ, irrespective of how much material wealth is produced with the masses translocated from their natural settings, and irrespective of how much and what kind of emissions and effluents are generated (Schmidt-Bleek, 1993).

80 tons of non-renewable natural resources are devoted every year to maintain the material wealth of Americans and Europeans. The non-OECD countries have far less per capita consumptions at this time.

Of course, the more resources are put into an economy the more has to come out of it in form of emissions, effluents, and wastes. Traditional environmental policies were - and still are - largely geared to take care of these waste streams in one way or another, normally with public funds. For reasons of costs, not all outputs could be considered for this artificial tail end economy, so the term pollution was invented to sort out a minute part of the waste streams and the so-called environmental technology was developed to do the job. Huge additional natural resources were invested for that purpose. The catalytic converter is a typical example. Close to 3 tons of non-renewable resources are invested for its construction.

The impact of all this ecological disruption is increasing, and is beginning to be reflected in economic terms. For example, there is an increase in the number and severity of natural catastrophes such as storms, floods and droughts, to which the insurance market is responding by sharply raising premiums. Central America will take many years to recover from the devastating hurricane Mitch in early November, 1998. The United States has lost some 50 % of its topsoil by erosion, virtually all of it during this century. In the Ruhr valley, some 70 000 hectares of land have subsided due to former deepmining of coal, with the consequence that waters have to be pumped around the clock forever to keep this area from flooding. Millions of people could otherwise lose their homes.

Toward a Customised Economy

A radical reduction of the material throughput in "advanced countries" is imperative during the coming decades, while end use satisfaction as it exists today in these countries must be maintained - or even improved. In this sense, the industrialised nations are the real "development countries". Their goal is a consumer customised service economy, in which all products and services consume the least possible natural resources - from cradle to grave. Together with Lehner I have coined this future economy a "customised economy". In a forthcoming book we describe the government, business and the environmental side of the story (Lehner, Schmidt-Bleek, 1999),.

In order to reliably achieve the necessary dematerialization, decision makers in politics and business, but also the consumers, need valid, understandable, and internationally compatible indicators about the relative resource intensity of goods and services, because one can hardly manage that which cannot be measured and compared (Schmidt-Bleek, 1999/2).

National accounts must also change. They must reveal the consumption of natural materials - including their ecological rucksacks - that are invested on a yearly basis in order to create wealth and provide security for people (FSO 1995).

But this is not enough. While the improvement of the technical eco-efficiency is imperative for approaching a sustainable economy, even the most extreme dematerialization of material artefacts alone will not suffice á la longue. Rebound (boomerang-) effects must be avoided: As history shows, technical advances in investing less resources per unit wealth have traditionally been "eaten up" by increasing consumption. A change in the traditional development of consumption patterns is urgently called for: a revision of use - offering new forms of satisfaction, well being, and prosperity.

All Stakeholders Have Roles To Play

Dematerialization can be looked upon as a strategy in a process of consumers, producers, retailers, scientists, NGO's, and government, each with their own concerns and responsibilities, each with specific roles to play in initiating and managing the process of change (Leo Jansen, TNO Delft).

The required radical improvement of resource productivity must span the whole spectrum of objects serving peoples« needs ("service delivery machines"), starting from simple items all the way to complex technological systems: from the propeller of a ship to propulsion, from the propulsion to the ship as a whole, from a single ship to the complex transportation system. Ultimately, it is the dematerialization of whole economies, measured in terms of the total material flow (TMF), that signals failure or success on the way to sustainability.

The achievement of a target to dematerialise society by a factor 10 or more requires intensive changes in culture, (institutional) structure as well as technology:

culture, legitimating nature and volume of societal needs to be fulfilled, expressed in consumption patterns dependant on ease and status (sufficiency),

- structure, the economic and institutional organisation to fulfil legitimated needs (effectiveness),
- technology, providing the technical means by which needs are (to be) fulfilled (efficiency, productivity).

These three elements characterise development of society in a strong mutual interaction and interdependence. The "acceptability" and viability of environmentally efficient technical means is directly connected to the economic and institutional conditions (structure) and to the demands of society (culture). In this context, it should be well understood that these conditions and demands are not static at all: At best, they can be adjusted by wise changes of economic policies, accounting procedures, and business approaches. However, they may also change radically as a result of environmental or political shock episodes.

Factor 10

In 1992, I proposed to halve the global natural material disturbed yearly by technology in order to move decisively toward sustainability. It should be noted that this is an absolute (albeit only estimated) target for lowering the yearly totality of natural resources disturbed in their original settings. Therefore, showing the material input per unit of GDP as a measure for dematerialization is bound to be misleading (Schmidt-Bleek, 1983/1).

Since western style wealth, generated at present for less than 20 % people of the world, consumes in excess of 80 % of the natural resources disturbed and harvested globally, the "rich of this world" will have to invent ways to generate their wealth with some 10 % (or a factor of 10 less) of their present consumption in order to let the "poorer" nations claim their fair share of resources - and still halve the world-wide total flow of natural resources.

In the future, western style processes, products, buildings, infrastructures, and services would therefore need to be dematerialised by an average factor of 10 (compared to present conditions) in order to move reliably toward sustainability. With increasing world population - or increasing numbers of people living by themselves in any society - the factor 10 would have to grow, too (Schmidt-Blek, 1993).

Austria wrote the Factor 10 goal into her Environment Plan already in 1995. In 1994, UNEP-IE and the Business Council of Sustainable Development suggested a factor 20 as a goal for sustainability. In 1997, the European environment ministers supported factors 10 as a strategic goal. Dozens of visits in medium and small sized industries in central Europe have produced convincing evidence that factors of 3 to 8 increase in resource productivity for products can be routinely achieved already today by making better choices of materials (that is by giving preference to materials with smaller ecological rucksacks than had been previously embodied in their products), and utilising a wide variety of options for reducing waste, packaging and transportation intensities 3. To increase the dematerialization further, the utility of the products can be raised in many cases, their longevity improved, as well as cascading uses and recycling options foreseen when designing new products.

Measuring Complex Realities

When attempting to develop measures for the environmental performance - or the ecological stress potential - of economic units such as firms, regions, and households, or of products, infrastructures or services, one important thing to keep in mind is that there are always very large numbers involved. Some 6 billion people participate in the world market, at least 20 million small and medium sized enterprises exist world-wide today, some 5 to 6 million different products are traded internationally (changing in nature and composition at a rapid rate), and there are some 180 countries with differing climates, resource bases, as well as political, historical, and cultural realities - all living within, and depending entirely upon a single system: the planet earth.

When attempting to develop indicators for the ecological stress potential of processes, goods or services, one should keep this diversity in mind, particularly in view of the fact that the economy runs on a single common indicator, the price of goods and services. And prices are not derived from scientific principles. Often they do not even make economic sense. Yet they serve obviously very well on a world-wide basis.

It is therefore clear that purely scientific approaches "to enrich" the present price structure for goods and services with environmental information, or to develop indicators for public and private policy setting will likely fail. The fewer indicators one needs to portray the essence of the (un)ecological nature of policies, processes, goods, services and the economy as a whole, and the better such indicators can be incorporated into existing economic models, the better the chances to shift the overall economic performance of individuals, firms, enterprises, regions, countries and the world economy as a whole in the direction of improving ecological sustainability.

In a recent paper, the European Environment Agency has proposed a set of 9 indicators: Inputs raw-material intensity, intensity of gross inland energy consumption, land-use intensity, and the intensity of water consumption; Outputs: (impact/pollutants): greenhouse potential, acidification potential, ozone depletion potential, (hazardous) waste, and chemicals (EEA, 1998). The EEA notes: "There is clearly an element of "double-counting" in accounting for both, input of materials and output of pollutants. However, it is not possible at this stage to focus just on either material inputs or pollutants in order to monitor progress towards sustainability: and "double-counting" is at least erring on the side of caution."

Conditions For Ecological Indicators

When attempting to develop indicators for describing the ecological stress potential of goods and services, of individuals, firms, enterprises, regions, countries and the world economy as a whole, such measures should meet the following conditions:

Conditions for Ecological Indicators

1. They must be simple, yet reflecting essential environmental stress factors. They must be scientifically defensible, albeit not scientifically complete;
2. They should be based on characteristics that are common to all processes, goods and services;
3. The selected characteristics should be straightforwardly measurable or calculable, irrespective of geographic locations;
4. Obtaining results with these measures should be cost-effective and timely;
5. The measures should permit the transparent and reproducible estimation of environmental stress potentials of all conceivable plans, processes, goods and services from cradle to grave;
6. Their use should always yield directionally safe answers;
7. They should form a bridge to economic models;
8. They should be acceptable and usable on all levels: locally, regionally and globally.

Source: Schmidt-Bleek, 1993

MIPS, Rucksacks, Service Delivers Machines, LCA, S/MI, COPS, TMF, FIPS, and TOPS

As outlined in Agenda 21 of the UNCED in Rio de Janeiro in 1992, there is a need for indicators of sustainability. Some national and international bodies as well as scientific institutions have since begun work on this subject (Adriaanse, 1993). The European Environment Agency in Copenhagen has recently moved proactively in this area (EEA, 1998), based, in part, on the work of the Factor 10 Club.

In 1992, I proposed the Material (including energy) Intensity Per unit Service (utility or function) - the MIPS - as a robust initial measure for estimating the ecological stress potential of goods and services from cradle to grave. With this indicator, one can operationalise the concept of sustainability on the economic micro-level and meso level, provided one takes additionally into consideration the available information on the specific eco-toxicity of materials involved. Simultaneously, I proposed Factor 10 as an initial overall target for increasing the resource productivity of western economies. This includes factor 4 and others which were proposed subsequently.

MIPS is computed

in material input per total unit of services delivered by the product over its entire useful life span (Resource extraction, manufacturing, transport, packaging, operating, re-use, re-cycling, and re-manufacturing are accounted for, and so is the final waste disposal). The total MI which is carried by a finished product is called its ecological rucksack.

The MIPS includes material along with energy inputs by counting the material fluxes associated with energy inputs. For electricity or solar heat inputs, the system-wide material intensity per unit energy input is taken as MI value.

Computing only the energy use for products or services can lead to serious errors when estimating the environmental impact potential associated with them. For instance, when assessing the MIPS of identical quantities of electricity delivered to the grid on a system-wide basis, German brown coal turns out to be ca. 50 times as material (plus energy) intensive as windpowered or natural gas burning systems, and some 8 times as material (plus energy) intensive as those using hard coal or photo voltaic cells. Another example is the aluminium car of a major European producer. Whereas the energy-only calculation shows that this car becomes more "ecological" than its steel cousin after some 140 000 km, more then 600 000 km must be driven before the lighter car begins to show its better resource productivity on a per kilometre basis (Schmidt-Bleek, 1998).

The value for S in MIPS is the total number of units of service (utility) delivered by the product during its life time, or the expected total number of service units that the product might supply during its life time (in the MIPS-concept, products are "service delivers machines" "Dienstleistungserfüllungsmaschinen" in German). The S-number is usually larger than that which is implied by the warranty on products.

It is evident that MIPS could be used as the entry point (or "base set") for a step-system approach in the process of eco-balancing products and services, based on LCA«s.

MIPS - which could be called eco-intensity - is the inverse of S / MI, the measure of resource productivity. Both include the ecological rucksacks of all materials - from cradle to grave.

The resource productivity can be improved by either lowering MI for a given S , as well as by increasing S with a fixed quantity of resources. Both changes can be achieved through technological as well as managerial/societal changes/innovations. For example, by increasing the longevity of goods, or by leasing rather than selling a product, and by sharing buildings, infrastructures, vehicles or machines can the total number of service units be improved dramatically, without a corresponding increase in the total input of natural raw materials. By following the request of hotel owners to utilise towels more than once ("to be nice to the environment"), guest can increase the resource productivity of providing towels without loss of convenience or hygiene by factors 2 or 3, and saving money (for the hotel owner) in the process.

The principal natural resources which are utilised by humankind to generate wealth are: material, energy, and land. MIPS is insofar incomplete, as it represents only material and energy intensities. Dr. Christa Liedtke at the Wuppertal Institute continues to work out the details for FIPS, the quantity of land (surface) used pro unit service. Factor 10 applies here in the sense that industrialised countries have to reduce their covering of land for technical purposes by at least by a Factor 10 as quickly as possible.

MIPS is the natural resource equivalent of COPS, the costs per unit service, the actual price of a haircut for instance, the costs of a withdrawal from an automatic bank, or the price for a flight ticket.

On the national or regional (macro) level, the Total Material Flow (TMF) approach - derived from the MIPS-Concept in my Deparment at the Wuppertal Institut - serves a similar purpose (Bringezu, 1996). The Factor 10 goal applies to TMF in particular, as it represents the integral total of all individual material flows on the micro level.

Ultimately, the ecological quality of goods and services could probably best be represented by the sum of three terms that would all have to cover the total life span of products:

MIPS = the Material (incl. Energy) Input per unit service

FIPS = the surface (F for "Fläche", a German word for surface area) coverage per unit service,

and by

TOPS = the eco-toxic exposure equivalent per unit service

It will be interesting to observe whether eco-toxicologists can ever agree on a simple and robust term (or a very few such terms, for instance addressing biotic and abiotic systems separately), that could serve as initial and rough indicator(s) for the eco-toxic intensity (TOPS) of different materials and goods.

Once more: Ecological Rucksacks

The ecological rucksack is defined as:

the total quantity (in kg) of natural material (M) that is disturbed in its natural setting and thus considered the total input (I) in order to generate a product - counted from the cradle to the point when the product is ready for use - minus the weight (in kg) of the product itself (Schmidt-Bleek, 1993).

The sum total of natural materials utilised (in kg) to make one kg of technical base (raw or starting) materials available (e.g. wood, iron, aluminium, copper, cement) is expressed as MI, called the "rucksack factor" of base materials (Schmidt-Bleek, 1998).

At the Wuppertal Institute, five different rucksacks were defined to describe the overall natural resource intensity of products. They correspond to the 5 environmental spheres that have been traditionally distinguished in environmental sciences and policies: water, air, soil, renewable biomass, and non-renewable (abiotic) materials. Factor 10 is applicable to all

On the average, industrial products carry non-renewable rucksacks that are about 30 times their own weight. This means that only about 5 % of the non-renewable natural material disturbed in the ecosphere typically end up in a technically useful form. In the case of a PC, the ecological (abiotic) rucksack weighs at least 200 kg per kg of product. This number calls seriously into question the expectation that modern communication can eo ipso contribute to a noticeable dematerialization of life styles.

For base materials (such as iron, plastic or copper), the MI values (rucksack factors) represent a new kind of material property. These factors allow the comparison of technical starting materials as regards their resource intensities and thus allow the computation of the rucksack of products, so long as the material compositions of these products are known (Schmidt-Bleek, 1998).

At the Wupperal Institute, MI values (rucksack factors) were assessed for a large variety of materials that make up industrial products. For the time being, they should be considered as preliminary average figures. Within the time and resources available it was not possible to compute specific source and process numbers for all base materials. Nevertheless, they allow the design of dematerialised products in many instances and permit important conclusions to be drawn very fast when comparing the resource intensity of products (Schmidt-Bleek, 1998). They are available on the internet: http//www.wupperinst.org/Projekte/mipsonline.

Typical approximate MI values (rucksack factors) for non-renewable resources) of base materials are as follows:

round wood = 1.2

glass = 2

plastics = 2 - 7

steel = 7

paper = 15

aluminium = 85

copper = 500

Platinum = 500 000

The Factor 10 Institute and the Factor 10 Consulting Network are proposing to establish centres for producing and distributing regularly validated MI factors. For the moment, MI factors are available on Internet from the Wuppertal Institute (Dr. Christa Liedtke) (http://www.wupperinst.org/projekte/mipsonline) and in several books (Schmidt-Bleek 1998). These lists also contain the rucksack factors for recycled materials which normally are considerably smaller (lighter) than those for virgin materials.

Defining Eco-Efficient and Eco-Intelligent Things

In recent literature, the term eco-efficient appears more and more frequently. This word was coined by Frank Bosshart, assistant to Stephan Schmidheyni during the preparations of the Business Council For Sustainable Development before the 1992 UNCED (United Nations Conference on Environment and Development) meeting in Rio. It is a term referring to both, economy and ecology: "Eco-efficiency is reached by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the earth's estimated carrying capacity" (Business Council for Sustainable Development, 1992).

Eco-efficiency is therefore a concept for improving the ecological character of production related activities while maintaining/improving their profitability.

More recently, a plethora of different definitions has been assigned to eco-efficiency, making orientation rather difficult. However, the term has found a wide acceptance, perhaps in part because it allows wide interpretations. One could say that it is an operational concept which implies the use of less nature for producing more output under profitable conditions and which serves people. It provides no measure for gaining sustainability. But the MIPS- and the Factor 10 concepts are entirely compatible with it. The MIPS-concept provides a framework for quantifying essential parts of eco-effciency, it addresses the consumption side of the economy, and the Factor 10 provides a goal against which one may determine how much effort is still needed in industrialised societies to approach sustainable conditions (Schmidt-Bleek 1998).

One is not really comparing efficiencies when considering the respective resource productivities - or toxicities and eco-toxicities - of goods. Efficiency increases normally refer to the output improvement of existing machines and processes at fixed inputs. Such improvements rarely surpass a few percentage points. Historically, less than 1 % per year has been achieved in the average. Improvements in the order of factor 2 would therefore tend to take some 50 years to accomplish.

The resource productivity can follow the path of progress that was achieved by the development of labour productivity: Labour productivity did not rise by any significant increase of labour efficiency improvements. The typical traditional shoe-maker or tailor could not possibly increase his or her speed of work more than 10 or 20 % with the old tools. It was the application of more and more intelligent machines replacing hand-craft that allowed "labour productivity" to rise sharply (in reality, of course, human labour was increasingly replaced by machines). In a similar way, energy and material productivity can be increased far beyond the technical potential of efficiency increases of current technological systems. As indicated before, the way toward decisive ecological improvements must start with the question "what is the desired utility?", followed by whatever new and old technical solutions can be employed with an overall minimum of natural resources.

As the originally defined term eco-efficiency also refers exclusively to the production sector of the economy, potentially important adjustments in consumption and society as a whole are not addressed. And thirdly, this term does not consider the importance of minimising the use of space, the "consumption" of surface area of the earth (the third important natural resource that we need for wealth production in - addition to energy and material).

For these reasons, one might wish to use the term eco-intelligent when referring to systems, goods, services, utilities, consumption, and processes that are more promising than others as regards reaching sustainability, while providing wealth to all people..

Eco-intelligent goods are:

Competitively priced services and products (objects, tools, machines, buildings and infrastructures) that yield maximum possible utility - in terms of individual customers preferences - for the longest possible time with a minimum of natural material, energy, surface coverage and dispersion of toxic materials - from cradle to grave.

Among resource productivity experts, eco-intelligent goods are usually referred to as "low-mips".

Five Rules For Eco-intelligent Products

1. The number of service units obtainable from products ("service delivery machines") must be as high as possible during their entire useful life. Built-in obsolescence must stop.
2. The life-long material input into processes, products, and services must be as low as possible.
3. The life-long energy inputs into processes, products, and services must be as low as possible.
4. The land use (surface coverage) per unit service must be as low as possible, from cradle to grave.
5. The dispersion of toxins must be minimal.

Source: Schmidt-Bleek

Eco-intelligent production systems are:

Competitively priced technical and organisational procedures for producing products and services, conducted with the help of eco-intelligent goods, while minimising the consumption of natural material, energy, surface coverage, the generation of wastes, and the dispersion of toxic or eco-toxic materials

Eco-intelligent economies are:

market systems within political boundaries, providing a maximum of wealth to all their people by providing them with eco-intelligent goods that were produced with eco-intelligent production systems.

Eco-intelligent consumption is:

the use of eco-intelligent goods within the confines of the overall sustainable availability of natural resources.

The Total Material Flow Concept for Eco-Benchmarking Countries

On the macro-economic level, resource productivity refers to the aggregate quantity of natural resources consumed to provide housing, rail transport, medical care, higher education, or for generating exports etc. for a given number of people (and/or within certain geographical or political boundaries), for a period of time (normally one year, as this corresponds to the traditional frameworks of national accounts). In short, on a macro-economic level resource productivity refers to the task of providing material welfare to people.

The Total Material Input (TMI), or Total Material Flow (TMF) may be regarded as a highly aggregated indicator that relates to the global environmental pressure associated with the physical basis of an economy (Bringezu, 1996).

The Factor 10 Concept applies in particular at this level: On the average, industrialised countries are expected to reduce the per capita consumption tenfold within one generation. The average Factor 10 for decreasing the resource consumption in industrialised countries could be differentiated on the basis of national performances, once sufficient information on the TMF of countries was available.

The sum total resource consumption for a country can be assessed by aggregating all resources that were imported, generated within the borders, minus those exported (including all ecological rucksacks) during the course of one year.

The Wuppertal Institute has developed - in co-operation with the German Federal Statistical Office - an overall material flow account that comprises physical mass balance. It consists of:

the domestic extraction from the environment,

- the domestic deposition and release to the environment,
- the imports,
- the exports.

The major points of information for Germany in the year 1991 can be stated as follows:

1. The throughput of water dominates the account (some 600 tons per capita-year).
2. The domestic input of abiotic (= non-renewable) raw materials exceeds the input of biotic (= renewable) inputs by a factor of about 50 (based on dry weight of the plant biomass from cultivation) (some 80 tons abiotic material per capita-year).
3. A tremendous part of the abiotic raw material input remains unused.
4. The input of biotic raw materials from cultivation is associated with an amount of erosion that exceeds the dry weight of the raw materials. Renewable inputs cannot be regarded as "free" with respect to environmental pressure (impacts).
5. On the output side the CO2 emissions into air amounts to about 1 billion tons. This is more than one third of all waste disposal (excluding incineration) and corresponds to about 13 tons per capita in Germany.

Stefan Bringezu and co-workers have also computed the resource intensity of the 58 sectors of the German economy and inter alias concluded, that the sector building and dwelling consumes between 25 and 30 % of the total non-renewable material flux. On the basis of such information, focused plans for national dematerialization policies could be developed (Schmidt-Bleek, 1998).

This approach can also be applied to integrate social and economic aspects into the analysis: e.g. one can study the relationship between employment vs. material intensity in regions, or in economic sectors; or one can shed light upon the interrelations between subsidies and economic sectors.

More recently, the World Resources Institute has published a joint study, based on the Wuppertal methodology, in which the national resource performances of Germany, the United States, Japan, and the Netherlands were reported and compared (World Resources Institute, 1997). It is interesting to note that the material welfare of Japanese citizens is being provided with about half the non-renewable resources consumption per capita compared to the United States. This, too, is a clear indication that consuming natural resources can be decoupled from generating welfare.

Once the TMFs of countries are known, one cannot only establish a ranking among them in terms of their per capita consumption of natural raw materials, but one can also compute the "true" factor of required dematerialization for each country, as measured against the need for a global reduction of natural raw material fluxes by a factor of 2 and the need for international equity. The Factor 10 which we recommend for industrialised countries as an average yardstick could thus be differentiated and adjusted on a yearly basis.

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USING THE PRESSURE-STATE-RESPONSE MODEL TO DEVELOP INDICATORS OF SUSTAINABILITY

OECD FRAMEWORK FOR ENVIRONMENTAL INDICATORS

Paper prepared by Jill Fletcher

For further information, please contact Ms. Myriam Linster

Contact:	OECD Environment Directorate – State of the Environment Division
	2, rue André Pascal - 75775 Paris Cédex 16
	tel.: [33]-1-45 24 97 44 / fax.: [33]-1-45 24 78 76
	e-mail: myriam.linster@oecd.org
	jill.fletcher@oecd.org
	internet: http://www.oecd.org/env/soe/

ABSTRACT

The OECD has been active in the field of environmental information for about 20 years, with regular publications on the state of the environment (1979, 1985, 1991), environmental data (since 1984, biennial since 1985) and environmental indicators (since 1991). Initially efforts were concentrated towards producing a first generation of environmental data and establishing state of the environment reports. This was further consolidated and enhanced during the 1980s, when state of the environment reporting became more and more frequent at national and international levels, and environmental data collection was reinforced. More recently, information strategies moved in the direction of environmental indicators and measurement of environmental performance. The Pressure State Response (PSR) model has been used in a large part of this work as it provides a means of selecting and organising data/indicators in a way useful for decision-makers and the public. By highlighting the relationships between the environment and economic dimensions of sustainable development, it also helps policy-makers design policies that address problems at the appropriate level. There is now a further need to extend the PSR framework to cover the environmental/social interface of sustainable development in order to better track the course towards a sustainable future.

OECD APPROACH TO DEVELOPING ENVIRONMENTAL INDICATORS

INTRODUCTION

This paper outlines the approach that has been taken and framework that has been used by the OECD to develop environmental indicators. In particular it sets out:

- Demand for environmental indicators
- Several types of indicators
- The OECD approach
- Uses of environmental indicators
- A common framework
- Using the PSR model in OECD work
- Other frameworks and models
- Conclusions
- Future work

DEMAND FOR ENVIRONMENTAL INDICATORS

The importance of environmental policies and related reporting has steadily increased in OECD countries over the last 25 years. This has largely been a result of:

- public awareness of environmental issues, their international aspects, and how they are related to economic and social issues; and
- concern about whether development is environmentally sustainable.

There is now a further need to monitor and assess environmental conditions and trends in order to increase countries' accountability and their capacity to evaluate how well they are meeting their domestic objectives and international commitments. In this context, environmental indicators are cost-effective and valuable tools.

SEVERAL TYPES OF INDICATORS

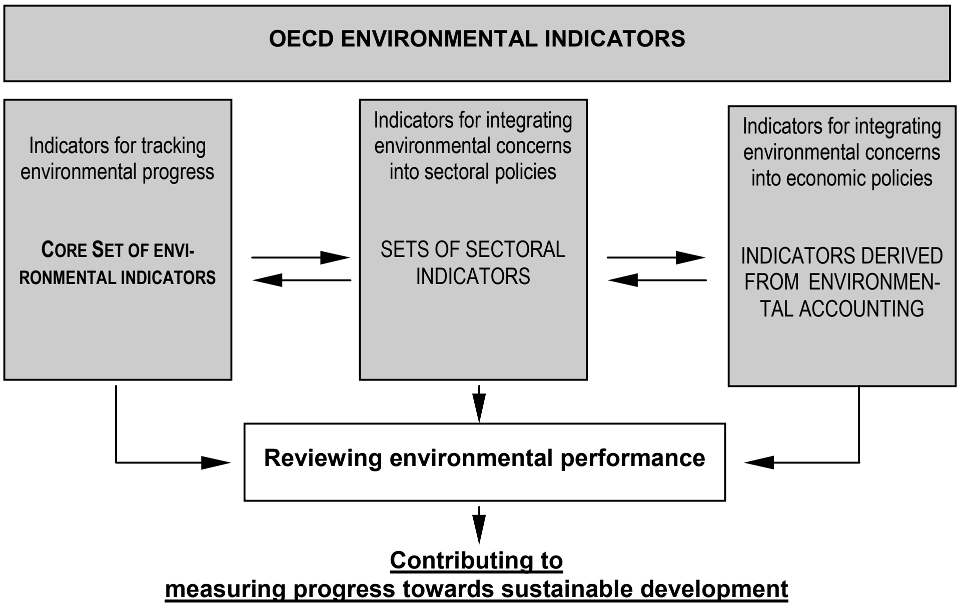
The OECD environmental indicator programme recognises that there is no universal set of indicators and that in practice several sets exist, corresponding to specific purposes and audiences. Indicators can be used, both at the international and national level, in state of the environment reporting, to measure environmental performance and also to report on progress towards sustainable development. They can further be used at national level in planning and clarifying policy objectives, and setting priorities.

The OECD work focuses principally on indicators to be used in national, international and global decision making, yet the approach may also be used to develop indicators at subnational or ecosystem levels.

The OECD initiated its programme on environmental indicators in 1989. Work[1] includes several types of environmental indicators, each corresponding to a specific purpose and framework:

- the OECD Core Set of environmental indicators, to keep track of environmental progress;
- several sets of sectoral indicators, to promote integration of environmental concerns into sectoral policy making: transport-environment indicators, energy-environment indicators, agri-environmental indicators[2], as well as sustainable consumption indicators;
- indicators derived from environmental accounting, to promote both integration of environmental concerns into economic policies and sustainable use and management of natural resources.

All these indicator sets are closely related to each other, the OECD Core Set being a synthesis and representing a minimum set common to OECD countries and common to equivalent sets of indicators; i.e. the most important sectoral indicators are part of the Core Set, as are major indicators derived from resource accounting.



APPROACH

In developing harmonised international environmental indicators, OECD countries adopted a pragmatic approach, which led in particular to:

- agreement on a common conceptual framework, based on a common understanding of concepts and definitions and on the (PSR) model
- identification of criteria to help in selecting indicators and validating their choice: all indicators are reviewed according to their policy relevance, analytical soundness and measurability;
- identification and definition of indicators (including an assessment of their measurability);
- the measurement and publication of these indicators

[1] *Like other work on environmental information and reporting, the work on environmental indicators is led by the OECD Group on the State of the Environment.*

[2] *Work led by the Joint Working Party of the Agriculture Committee and the Environmental Policy Committee.*

- provision of guidance for the use of indicators (stressing that indicators are only one tool and have to be interpreted in context)
- the use of indicators in the OECD's analytical work and Environmental Performance Reviews (EPRs).

Building on experience in environmental information and reporting and on strong support from Member countries, results of this work, and in particular its conceptual framework, have in turn influenced similar activities by a number of countries and international organisations (e.g. the UNCSD, with its work on sustainable development indicators).

Inset 1 **Criteria for selecting environmental indicators**

As indicators are used for various purposes, it is necessary to define general criteria for selecting indicators. Three basic criteria are used in OECD work: policy relevance and utility for users, analytical soundness, and measurability.*

POLICY RELEVANCE

An environmental indicator should:

- provide a representative picture of environmental conditions, pressures on the environment or society's responses;
- be simple, easy to interpret and able to show trends over time;
- be responsive to changes in the environment and related human activities;
- provide a basis for international comparisons;
- be either national in scope or applicable to regional environmental issues of national significance;
- have a threshold or reference value against which to compare it, so that users can assess the significance of the values associated with it.

ANALYTICAL SOUNDNESS

An environmental indicator should:

- be theoretically well founded in technical and scientific terms;
- be based on international standards and international consensus about its validity;
- lend itself to being linked to economic models, forecasting and information systems.

MEASURABILITY

The data required to support the indicator should be:

- readily available or made available at a reasonable cost/benefit ratio;
- adequately documented and of known quality;
- updated at regular intervals in accordance with reliable procedures.

These criteria describe the "ideal" indicator; not all of them will be met in practice.

USES

Those indicators from the OECD core set and the sectoral indicators for which internationally comparable data exist are regularly published and used in current OECD work, particularly in OECD EPRs. In the EPRs, environmental indicators are used throughout the various chapters and annexes to support and illustrate the analysis made. They are present in the form of tables and graphics (line and bar graphs, pie charts), and are complemented with lists (laws and regulations, economic instruments, conventions), organigrammes (institutional set-up), and maps. They are a valuable way to monitor the integration of economic and environmental decision making, to analyse environmental policies and to gauge the results. Beyond their immediate application in OECD EPRs, these indicators also contribute to the broader objective of *reporting on sustainable development.*

A COMMON FRAMEWORK

Frameworks have an important role in organising data and information and guiding in the selection of indicators needed to answer certain questions. By considering issues in a systematic way, they ensure that important considerations have not been overlooked. In particular, an indicators framework/model provides an overview for considering environmental or sustainable development problems and the associated interconnections between them in ways which are useful to decision makers and the public. Furthermore by enabling policy makers and the public to understand the interconnections between different issues they can help to identify, design and implement policies that address problems at the appropriate levels.

Although frameworks and models are essential tools for developing and selecting indicators they have their limitations. They can be too rigid in their analysis of issues and interactions and therefore they need to be used as one tool and in a flexible way with additional information supporting or supplementing them. Furthermore there is not necessarily a unique model that can be used for all purposes e.g. the OECD uses the PSR analytical framework for its work on the core set of environmental indicators and the sectoral indicators but it also uses accounting frameworks to develop indicators on the use of natural resources and environmental expenditure. A number of analytical frameworks for varying purposes and different audiences are often needed to develop and organise sets of indicators.

THE PSR MODEL

The PSR framework was initially proposed by Tony Friend and David Rapport for the purpose of analysing the interactions between environmental pressures, the state of the environment and environmental responses. OECD has applied an adapted version of the framework, since the 1970's, to its work on environmental reporting. The relevance and usefulness of the PSR model was reevaluated in 1989/1990 when OECD initiated its work on environmental indicators. In developing the Core set of environmental indicators, OECD countries agreed that the PSR model was a robust and useful framework and should continue to be used in OECD's work on environmental data and indicators.

The PSR model is based on the concept of causality: human activities exert pressures on the environment and change its quality and quantity of natural resources ("state"). Society responds to these changes through environmental, general economic and sectoral responses ("societal responses").

Pressures

- Environmental pressures relate to pressures from human activities exerted on the environment, including natural resources. "Pressures" cover underlying or indirect pressures, which act as driving forces for environmental issues (i.e. the activity itself and trends of environmental significance), as well as proximate or direct pressures (i.e. the use of resources and the discharge of pollutants and waste materials). Indicators of environmental pressures are closely related to production and consumption patterns; they often reflect emission or resource use intensities, along with related trends and changes over a given period. They can be used to show progress in decoupling economic activities from related environmental pressures. They can also be used to show progress in meeting national objectives and international commitments (e.g. emission reduction targets).

State

- Environmental conditions relate to the quality of the environment and the related effects or impacts, and the quality and quantity of natural resources. They cover ecosystems and natural environment conditions as well as quality of life and human health aspects. As such they reflect the ultimate objective of environmental policies. Indicators of environmental conditions are designed to give an overview of the situation (the state) concerning the environment and its development over time. Examples of indicators of environmental conditions are: concentration of pollutants in environmental media, exceedance of critical loads, population exposure to certain levels of pollution or degraded environmental quality, the status of wildlife and of natural resource stocks. In practice, measuring environmental conditions can be difficult or very costly. Therefore, environmental pressures are often measured instead as a substitute.

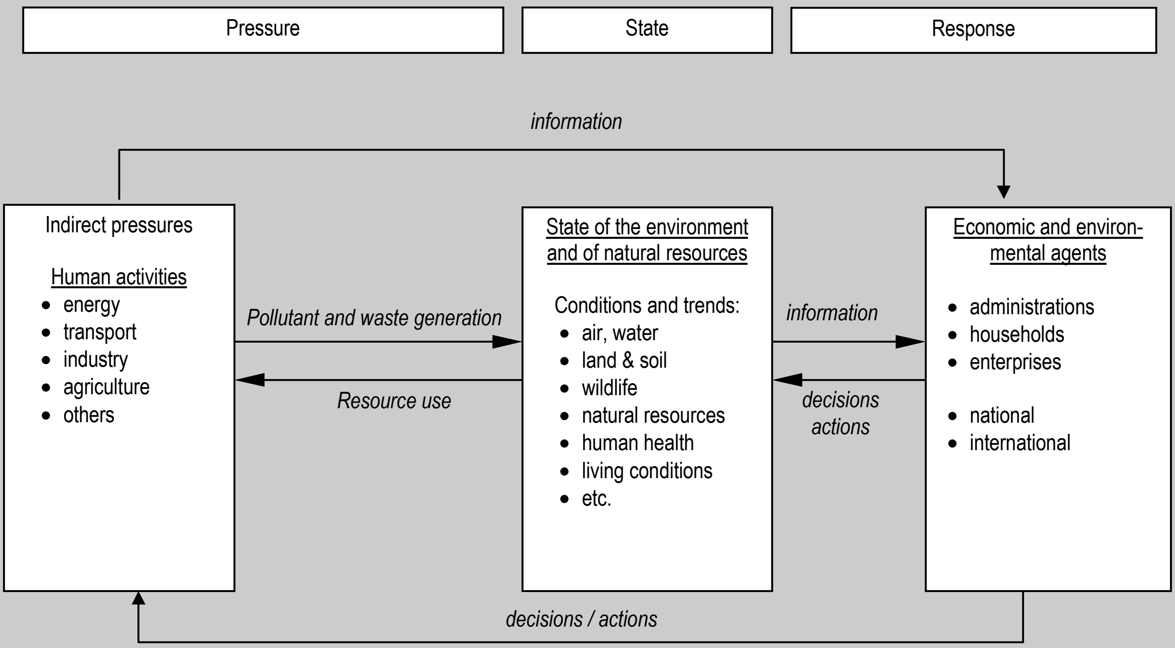
Response

- Societal responses show the extent to which society responds to environmental concerns through environmental, general economic and sectoral policies and through changes in awareness and behaviour. They refer to individual and collective actions and reactions that are intended to:
  - mitigate, adapt to or prevent human-induced negative effects on the environment;
  - halt or reverse environmental damage already inflicted;
  - preserve and conserve nature and natural resources.

  Examples of indicators of societal responses are environmental expenditure, environment-related taxes and subsidies, price structures, market shares of environmentally friendly goods and services, pollution abatement rates, waste recycling rates. In practice, indicators mostly relate to abatement and control measures; those showing preventive and integrative measures and actions are more difficult to obtain.

Inset 2 **The Pressure - State – Response (PSR) Model**

The PSR model considers that: human activities exert pressures on the environment and affect its quality and the quantity of natural resources ("state"); society responds to these changes through environmental, general economic and sectoral policies and through changes in awareness and behaviour ("societal response"). The PSR model has the advantage of highlighting these links, and helping decision-makers and the public see environmental and other issues as interconnected (although this should not obscure the view of more complex relationships in ecosystems, and in environment-economy and environment-social interactions).



Depending on the purpose for which the PSR model is to be used, it can easily be adjusted to account for greater details or for specific features. Examples of adjusted versions are the Driving force – State – Response (DSR) model used by the UNCSD in its work on sustainable development indicators, the framework used for OECD sectoral indicators and the Driving force – Pressure - State – Impact – Response (DPSIR) model used by the European Environment Agency.

USING THE PSR MODEL IN OECD WORK

In a large part of its work on environmental information and reporting the OECD uses the PSR model. In particular, it helps to structure the OECD core set of environmental indicators and the sets of sectoral indicators.

OECD CORE SET OF ENVIRONMENTAL INDICATORS

A major part of the OECD's work is devoted to developing a Core Set of environmental indicators This is a commonly agreed upon set of indicators for OECD countries and for international use, published regularly. It provides a first step in tracking environmental progress and the factors involved in it, and is a major tool for measuring environmental performance. Characteristics of the Core Set are that:

- it is of limited size (around 50 core indicators);
- it covers a broad range of environmental issues;
- it reflects an approach common to a majority of OECD countries.

It includes core indicators common to the majority of OECD countries and common to different sets of indicators serving different purposes.

The conceptual framework to develop the OECD core set of environmental indicators is based on two structural elements. First, it uses the PSR model to provide a classification into indicators of environmental pressures, indicators of environmental conditions and indicators of societal responses.

Secondly, it uses a number of environmental issues which reflect major environmental concerns in OECD countries. For each issue, indicators of environmental pressures, conditions and societal responses have been defined (Inset 3).

These issues depend on changing and sometimes conflicting perceptions and the list is therefore not necessarily final or exhaustive. In fact, it is flexible and new issues can be incorporated or old ones abandoned according to their environmental relevance.

Thirdly, the possibility of disaggregating major indicators at sectoral level is considered. Data availability permitting, this is one tool for analysing environmental pressures exerted by different economic sectors and distinguishing government responses from those of the business sector or private households. Indicators at the sectoral level could be useful in reviewing the integration of environmental and sectoral policies and monitoring resource use and emission intensities in the various economic sectors. Indicators at sectoral level also facilitate the link with economic information systems and models.

Inset 3 **Structure of OECD Indicators Core Set by Environmental Issue**

Major issues	PRESSURE **Indicators of environmental pressures**	STATE **Indicators of environmental conditions**	RESPONSE **Indicators of societal responses**
1. Climate change **2. Ozone layer depletion** **3. Eutrophication** **4. Acidification** **5. Toxic contamination** **6. Urban environmental quality** **7. Biodiversity** **8. Cultural landscapes** **9. Waste**			
10. Water resources **11. Forest resources** **12. Fish resources** **13. Soil degradation (desertification, erosion)**			
14. Socio-economic, sectoral and background indicators			

Broadly speaking, the first nine issues relate to the use of the environment's "sink capacity", dealing with issues of environmental quality, whereas the other issues relate to the environment's "source capacity", focusing on the quantity aspects of natural resources.

Not all indicators can be directly associated with a specific environmental issue. Some reflect background variables and driving forces, such as population growth and economic growth; others deal with selected sectoral trends and patterns of environmental significance, or factors such as economy-wide environmental expenditure and public opinion. An additional category of indicators has therefore been introduced in the framework. This category also provides an opportunity to further integrate indicators from sectoral sets into the OECD Core Set.

THE OECD SETS OF SECTORAL INDICATORS

OECD has been developing sets of 'sectoral' indicators to better integrate environmental concerns into sectoral policies. The objective is to develop a "toolkit" for sectoral decision-makers which should facilitate the integration of environmental concerns into sectoral policy-making. While limited to a specific sector and its interactions with the environment, these indicators are usually developed in larger numbers than the core set. Sectoral indicators are not restricted to environmental indicators per se. They also describe the sector itself and sectoral trends of environmental significance, as well as related economic and policy considerations, placed in a context of sustainable development. Together with environmental indicators (e.g. pollutant emissions) they may include economic indicators (e.g. sectoral output, prices and taxes, subsidies) and selected social indicators.

The conceptual framework adopted for sectoral indicators is derived from the PSR model but has been adjusted to account for the specifics of the respective sectors. It categorises indicators into those that reflect:

- sectoral trends and patterns of environmental significance (i.e. indirect pressures and/or related driving forces);
- interactions between the sector and the environment, including positive and negative effects of sectoral activity on the environment (i.e. direct pressures, such as pollutant releases and resource use, and related effects and resulting environmental conditions, such as ambient concentrations of pollutants and population exposure), as well as effects of environmental changes on sectoral activity;

- economic linkages between the sector and the environment, as well as policy considerations. This category includes environmental damage and environmental expenditure, economic and fiscal instruments, and trade issues.

Inset 4 **Framework* of OECD sets of sectoral indicators**

Sectoral trends and patterns of environmental significance	Interactions with the environment	Economic and policy aspects
Indirect pressures and driving forces	Sector related: • Resource use • Pollutant & waste generation • Risk and safety issues • Related effects and resulting environmental conditions • Selected direct responses	Sector related: • Environmental damage • Environmental expenditure • Taxation and subsidies • Price structures • Trade aspects

** derived from the PSR model.*

This framework is applied by the OECD to the transport and energy sectors. A set of sectoral indicators is also being developed for the agricultural sector[3]. This framework is also used to structure OECD's work on sustainable consumption indicators.

OTHER USES OF THE PSR MODEL

The PSR framework is also used by OECD in its regular EPRs to structure chapters on pollution, on resource management and on integration of the environment into specific sectors of the economy.

OTHER FRAMEWORKS AND MODELS

Although the PSR model is flexible and capable of being adapted according to its use, it is not unique. Other frameworks may need to be considered for different purposes and audiences and used either alongside the PSR model or in its place. For example the OECD uses a different framework for its work on environmental accounting. Other frameworks also exist to identify, develop and communicate indicators or composite indicators of sustainable development e.g. World Bank indicators, Human Development Index (HDI), Index of Sustainable Economic Welfare

ACCOUNTING FRAMEWORKS

Accounting frameworks are generally based on the national accounts approach. The OECD uses accounting frameworks in its work on environmental accounting from which a number of indicators are derived. The work focuses on physical natural resource accounts as a tool for sustainable management of natural resources, as well as on expenditure for pollution abatement and control and other environmental measures. In addition, the OECD participates in international work on environmental accounting and acts as a forum for exchanges of experiences in this field. (Inset 5)

To progress towards a common methodology, the OECD reviewed different approaches of OECD Member countries in the field of natural resource accounting (NRA). This work resulted in the establishment of OECD pilot accounts on forests and water. The basic methodology

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[3] 🕮 *OECD (1993, and forthcoming), Indicators for the Integration of Environmental Concerns into Transport Policies.*

🕮 *OECD (1993), Indicators for the Integration of Environmental Concerns into Energy Policies*

🕮 *OECD (1997), Environmental Indicators for Agriculture*

🕮 *OECD (forthcoming), Sustainable consumption indicators* used in the pilot accounts is simple and provides a guide to countries that are developing natural resource accounts. The format was set up to provide a tool for decision-makers.

The pilot accounts propose physical input-output tables tracing the production, transformation and use of each resource throughout the economy. This provides an analytical tool with which to assess the impact of sectoral economic activity on the resource. Basic flow relations from these accounts form the input for calculating indicators of sustainable use of natural resource quantities. Examples of such indicators are: intensity of use of forest resources and intensity of use of water resources.

The OECD has also pursued work on pollution abatement and control (PAC) expenditure for a number of years. The data are derived from environmental expenditure accounts. They are published regularly and supplement economic information from national accounts. Indicators which are developed from this work reflect the level of PAC expenditure compared with GDP, as well as the structure of such expenditure per environmental domain and per source sector.

Inset 5 **Environmental accounting: definitions and concepts**

Environmental accounting can be defined as the systematic description of interactions between the environment and the economy by means of an accounting framework. There is no unique model for environmental accounting; approaches vary according to purpose.

Approach	**Environmental categories taken into account**	**Characteristics**
Adjustment of national economic accounts	Valuation of: ♦ Environmental damages ♦ Environmental services ♦ Stock of natural capital	Modifies SNA framework and boundaries
Satellite accounts	Valuation of: ♦ Environmental damages ♦ Environmental services ♦ Stock of natural capital ♦ Environmental expenditure Corresponding physical flows and stocks	Complements SNA without modifying it General coherence with SNA
Natural resource and environment accounts	♦ Physical flows and stocks of natural resources ♦ Physical and monetary flows associated with anthropogenic exploitation of natural resources	Independent from and complementary to SNA

Accounting frameworks prove to be useful in developing indicators that measure asset stocks and changes including natural and human capital stock[4]. They are also a powerful tool for structuring statistical data in an accounting logic and for linking economic, social and environmental data in both physical and monetary terms.

[4] *Pearce and colleagues distinguish between "weak sustainability" where growth in human capital can be substituted for natural capital (as long as critical ecosystems are maintained) and "strong sustainability" where growth in human capital can not come at the expense of remaining total natural capital. The principal issues faced by economists and ecologists working in this area are determining measures of critical natural data and compiling data for all forms of capital. Also some economists argue that we should be improving our measures of income rather than capital because real income is a better measure of sustainability.*

WORLD BANK INDICATORS

The environmental indicators, published by the World Bank in 1995, focus on the applicability of indicators in policy development. They are sorted according to the PSR model but provide additional information:

- Social, economic and institutional criteria are included
- Indicators are linked where possible to sustainability targets. These indicators are called "performance indicators".
- The concept of "wealth of nations" is evaluated. This extends the definition of wealth to include human capital, man made capital, natural capital and social capital.

COMPOSITE INDICATORS

The UN Development Programme UNDP has developed a Human Development Index which indicates progress or decline in human development. The HDI combines indicators of health (life expectancy), education (literacy and years of schooling) and economic welfare (per capita income) into a single measure. This index does not, however, incorporate the environmental dimension of sustainable development although this amendment has been proposed. Another application takes household consumption expenditure as a point of departure and adjusts it for a range of "positive" and "negative" factors of economic, environmental and social nature to derive Indicators of Sustainable Economic Welfare (ISEWs). However controversies are raised about the choice of component indicators and their relative importance within an overall index.

CONCLUSIONS

A number of national and international organisations have found that the PSR framework is a very useful way to develop indicators and state of the environment reporting. It has proved valuable in highlighting the cause effect relationships between human activities and environmental and social conditions. As such it helps decisions makers and the public see that environmental, economic and social issues are interconnected, and also helps policy makers to design policies that address the key problems at the appropriate level. It therefore provides a means of selecting and organising indicators in a way which is useful for decision-makers and the public. It also has the following advantages. It is:

- one of the easiest frameworks to understand and use
- neutral as it only shows where linkages exist rather than whether they have negative or positive impacts
- a flexible model which can be adjusted easily to account for greater details, for specific features, different audiences and purposes e.g. capable of being used at different spatial scales
- widely recognised
- a model which ensures important considerations have not been overlooked by analysing issues in a consistent way.

Despite its many advantages, discussions of the PSR model have generally revealed the following weaknesses.

- ♦ Because of its simplicity, the PSR model tends to suggest linear relationships in the human activity - environment interaction and does not reflect the more complex relationships in ecosystems and in environment - economy interactions.
- ♦ The PSR model was developed to highlight environment and economic relationships. The links between the environment and the social or the social and economic dimensions of sustainable development are thus not adequately covered

These weaknesses are not, however, perceived as major obstacles and do not outweigh the many strengths of the model. But when trying to use the PSR model to structure the development of indicators of sustainability, these weaknesses need to be given further consideration.

The PSR model was initially developed to provide a framework for environmental reporting and indicators. There is now a growing demand to develop indicators of sustainability at the international scale, and thus, also an increased need to adapt the PSR model to incorporate the environment, economic and social dimensions of sustainable development. The PSR model already covers two key aspects of sustainable development: relationships between the environment and the economy, and sets of indicators which allow the integration of economic and environmental concerns for particular sectors within a country. It, however, needs to be extended to better cover the social dimension of sustainable development. This may simply mean adapting the current PSR model. On the other hand it could require the development of an additional framework to be used alongside the PSR which solely examines the environment/social interface or alternatively a new framework to replace the PSR model which covers all three strands of sustainable development. Either way, the OECD will be considering the frameworks that are currently being used at the international, national and sub-national levels to develop indicators of sustainable development.

FUTURE WORK

As part of its programme on sustainable development, the OECD is working, together with other relevant international organisations, on indicators to measure progress towards sustainable development. A conference is planned to take place in Rome at the end of the year to discuss the progress made in this area. In addition, further work is being done by the OECD to broaden its core set of environmental indicators to include environmental/social aspects for the second cycle of EPRs.

Progress is also needed in:

- improving the quality and comparability of existing indicators;
- linking the indicators more closely to established goals and commitments;
- further integrating environmental and sectoral indicator sets in a broader set of sustainable development indicators.

This necessitates:

- greater policy relevance and increased quality and timeliness of basic data sets, as well as a
- closer link between environmental data and existing economic and social information systems.

EUROSTATs Tools for the Development of Indicators of Sustainable Development

&

The Relationships Between Indicators of Sustainable Development

Isabelle Guinomet

Summary

The growing concern of European citizens for the quality of their environment underlines the need for an environmental information system which helps to measure progress towards a sustainable society. At political level, Cardiff and Vienna summits requested the development of indicators for measuring the effectiveness of the integration of environmental concerns into different sector policies.

Therefore, in a first phase in 1996, the Statistical Office of the European Communities (Eurostat) developed a first set of indicators of sustainable development (ISD) following the UN CSD methodology and framework of the United Nations Commission on Sustainable Development[1]. This first work presented 47 indicators for the EU Member States among the 132 proposed by the Blue book[2]. This first publication should be updated in 2000.

In a second phase the environmental unit of Eurostat developed a set of 60 indicators giving an overview of the pressure of human activities on our environment in ten policy fields. They cover well-known problems such as air pollution, climate change and also more difficult ones: biodiversity or dispersion of toxic substances. The first results of the report: "Towards environmental pressure indicators for the EU"[3] are very dependent on data availability.

Last but not least Eurostat takes part in the debate on methods to produce relationships between indicators. Various international works have proposed linkages or aggregation methods[4]. If the production of synthetic indices allow to weight various pressures and to aggregate them into a single index, linkages propose more sophisticated models aiming at synthesising the different component necessary to the measurement of a problem. The current debate search to define advantages and weaknesses of such methods.

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[1] Indicators of sustainable development, European Commission 1996, ISBN 92-827-9827-5, also available in French, German and Spanish.
[2] Indicators of Sustainable Development Framework and methodologies, United Nations, New York, August 1996 ISBN 92-1-104470-7, also available in French and Spanish and on the UN CSD web site: http://www.un.org/esa/sustdev/isd.htm.
[3] Towards environmental pressure indicators for the EU, Eurostat, 1999
[4] Please refer to the report: "The relationships between indicators of sustainable development, An overview of selected studies", United Nations and Eurostat, Isabelle Guinomet, 5th UN CSD Expert group on ISD.

Eurostat works

Eurostat[5] is one of the Directorates-General of the Commission of the European Communities; its tasks aim at meeting the growing demand for statistical information.
It is Eurostat's job to provide official statistics and to ensure a common statistical language within the EU, providing the European Union with a high-quality, harmonised statistical information service, offering the best possible guarantees of completeness and reliability.

From statistics to indicators

To obtain data of quality Eurostat works is organised through different steps: collection of the data, storage of the data in databases, dissemination of the information thanks to printed or electronic publications.

Data collection

Eurostat collects its data from the National Statistical Institutes of the countries concerned. All data are checked by Eurostat, compiled in the required form and, where applicable, harmonised with European Statistical System standards.

Statistical data collected, harmonised and referenced by Eurostat are disseminated as electronic products and computerised media, printed publications or databases. They are regularly updated and are divided into 9 major statistical themes:

- Theme 1 : General statistics
- Theme 2 : Economy and finance
- Theme 3 : Population and social conditions
- Theme 4 : Energy and industry
- Theme 5 : Agriculture, forestry and fisheries
- Theme 6 : External trade
- Theme 7 : Distributive trade, services and transport
- Theme 8 : Environment
- Theme 9 : Research and development

Eurostat databases

Currently, Eurostat offers you a thematic selection of databases that are constantly added to, updated and harmonised. They include:

- New Cronos, which contains some 70 million items of statistical data on Member States of the European Union, and, in many cases, on their main non-European economic partners.
- Comext, "external trade database" : for data on imports and exports by EU countries in both value and volume terms.
- REGIO, containing all Member States' socio-economic data, with regional breakdown.
- Eurofarm, statistical data based on the Union surveys on the structure of agricultural holdings.
- GISCO, database that combines statistical information and geo-referenced data, allowing each item of data to be related to its environment.

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[5] **Eurostat** Statistical Office of the European Communities .Jean Monnet Building, Rue Alcide De Gasperi, **L-2920 Luxembourg**
Tél.: (+352) 4301-34567
Fax: (+352) 4301-32594
E-Mail: info.desk@eurostat.cec.be

Over databases are developed for producers purposes but are not accessible to public. ENVSTAT[6] is an example of a multidimensional database developed by the environmental unit of Eurostat. The data stored in such a database can easily be updated and this allow the consistency of the work within the unit.

Eurostat offers users a Data Shop service. The Eurostat Data Shops network is open to the public for any information on Eurostat databases, their respective data or access possibilities, as well as any specific statistical search.

Eurostat printed publications

Eurostat disseminates its statistics in two forms:
- statistical documents
- publications

The former is directed mainly at the specialist. Usually they deal with a limited topic by way of tables and a brief commentary. In many cases, the information in the document is released in advance to the international media through press releases.
Publications provide a more general public with well-presented data accompanied by commentary.

Eurostat electronic products

Some statistical data from the Eurostat databases are published in CD-ROM format, such as:
- The Comext CD-Rom : 10,000 product headings, the detailed "geonomenclature" of 200 countries, all the previous year's data broken down by month, quarter, year... the main statistics on the external trade of EU member countries and their major partners.
- The Eurostat yearbook '95 CD-Rom : from 1983 to 1993, the main socio-economic statistics of each EU Member State and a comparison with their economic partners.
- Panorama of European Union Industry CD-Rom : more than 15,000 chronological series, from 1982 to 1992, profile of Europe's 500 largest private companies, all the significant trends of the 25 major industrial sectors in Europe.
- Eurofarm CD-Rom : a specialist database on agricultural, wine-growing and fruit-growing holdings, Eurofarm contains the results of surveys conducted in 1975, 1979/80, 1983, 1985 and 1987 by each of the 15 member countries of the European Union. From household incomes to prices and other production figures.

Production of Indicators

Eurostat work on indicators is highly connected to statistical work. This more complex information aims at presenting a trend in order to analyse a situation. Eurostat presents such indicators on its Internet site[7].
Indicators taking into consideration the evolution of the environment and indicators of sustainable development benefit of co-ordinated works at international, European and national levels. Although little differences might be observed (for example in the choice of a general framework: DSR for UN CSD; PSR for OECD, DPSIR for the EEA) objectives are similar and good co-operation is undertaken to develop lists of core set indicators or headline indicators.

The terminology in discussions on environmental indicators is not always absolutely clear but basic definitions can be given:

[6] Please refer to Annex 1.
[7] Please refer to Annex 2 for an example.

- **Data** are figures that need further processing (e.g. aggregation to national level, adjustment for season, climate, economic cycles etc.), before they can be called **statistics**.

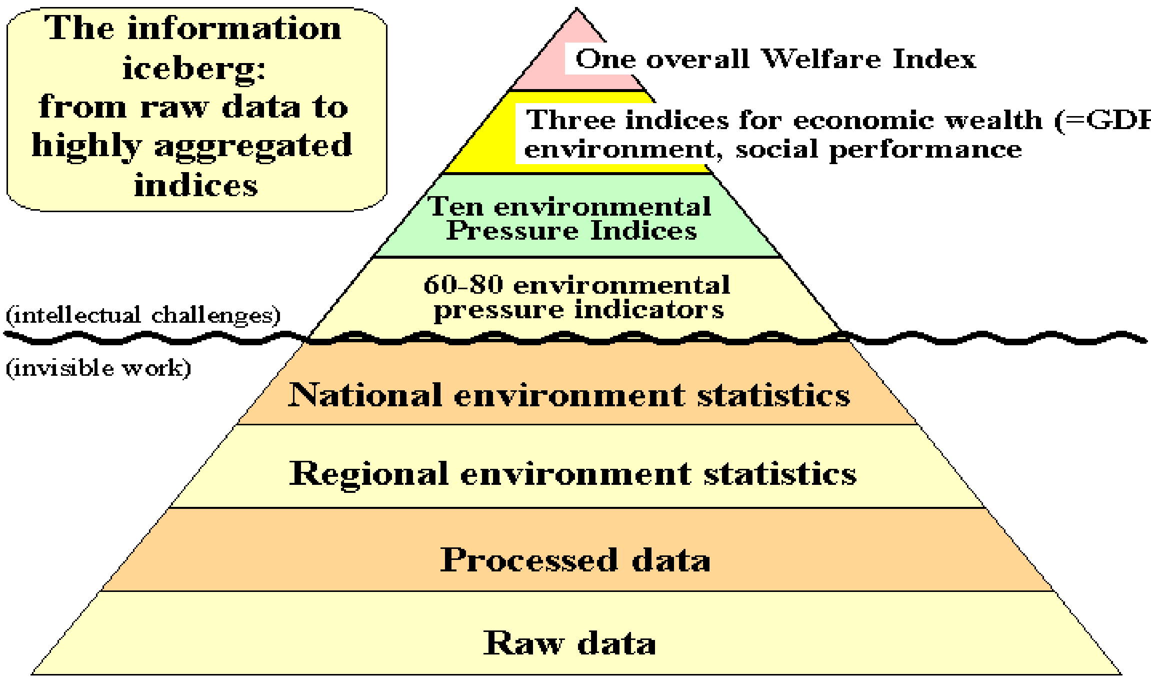
- In principle, **statistics** coming from official sources (the national Statistical Services, Eurostat, OECD or the European Environment Agency) enjoy more confidence than **academic figures** obtained from specific studies. Users assume that official figures have been produced with standardised definitions and reflect "mainstream thinking", and they know that, on the other hand, scientists may produce a wide range of results depending on differences in basic assumptions and definitions.

- **Statistics** are figures describing real phenomena according to an exact definition. In practice, statistics often need interpretation, and sometimes they have footnotes attached which explain why the figures as such are correct but may not look plausible at first sight. **Indicators**, in contrast, should send correct *messages* without a need for further interpretation. Indicators may require adjustments, e.g. for seasonally or climate and often they are related to interesting reference variables, e.g. CO_2 emissions *per capita,* fertiliser use *per ha of arable land*.

- Especially for a complex policy area like environment, detailed **reports** (e.g. the EEA's Dobris Assessment, World Resources) are an indispensable tool for experts. Statistical figures are often embedded in the text and serve as the basis for an in-depth discussion of policy priorities and options. In contrast, pure **indicators** are "executive summaries" addressed to non-experts who want to get a quick impression of basic trends without the need for further interpretation.

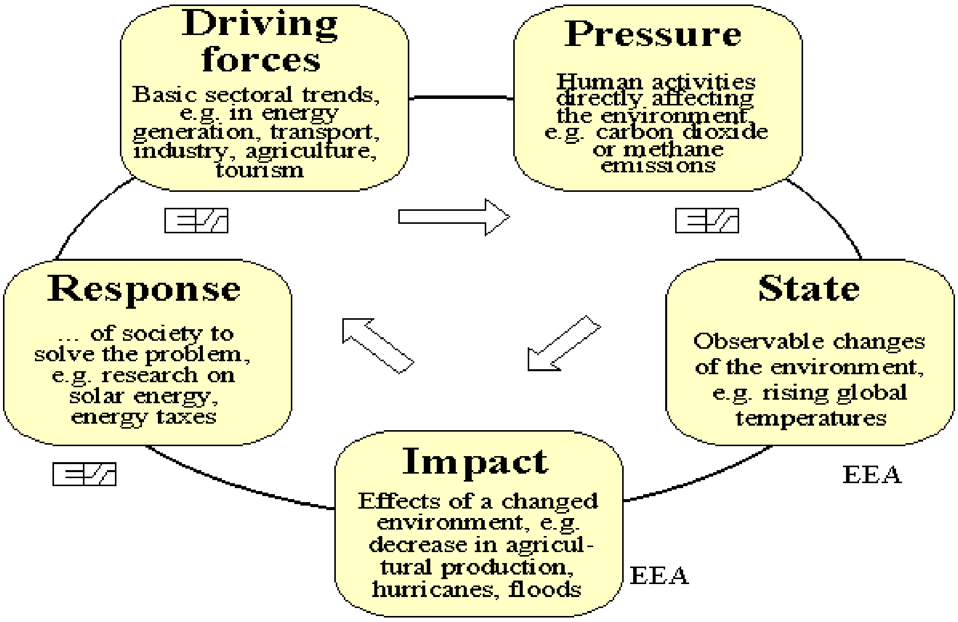
- *T*he term "index" is sometime used for indicators related to a baseline year ("Index 1990=100"). In the context of environmental indicators, however, " **index**" means an **aggregation of indicators with similar impacts.** For example, greenhouse gas emissions such as CO_2, methane, nitrous oxide, CFCs could be condensed into one greenhouse gas index showing the total contribution to *Climate Change* caused by these gases (based on the common unit *Greenhouse Warming Potentials*). Main purpose of such aggregations is to communicate detailed information to an audience that requires condensed, "simplified" information.

Most of the efforts needed for producing good indicators and indices happen "under the surface".



The framework

The European Commission has chosen a general framework DPSIR for the integration of environmental considerations into policies and actions within the principal economic sectors in Europe. This framework is developed by the EEA (European Environmental Agency)



Driving forces, such as population and economic growth, urbanisation and agricultural intensification, results in emissions of pollutants and other **pressures** which affect the **state** of the environment and in turn, may **impact** on human health, other life forms and the physical environment itself. **Responses** may address the driving forces themselves as well as seeking to reduce their effects or improve the state of the environment.

Eurostat focuses on Driving force (e.g. sectoral trends), Pressure and Response indicators, and on linking such indicators to standard socio-economic statistics. Complementary to this effort, the European Environment Agency (EEA) concentrates on state and impact indicators, and on a comprehensive description of the full PSR chain

In the Blue book of the UN CSD, 132 methodology sheets set out the definition, the methodological framework and the significance of each of the indicator. Within the four categories Economic, Social, Environmental and Institutional, three types of indicators are differentiated:
- Driving forces, which represent human activities, processes and patterns having an impact on the environment;
- State indicators, providing a snapshot of an existing situation,
- Response indicators, which outline measures.

Core sets of indicators

The example of the UN CSD list

Different **core sets of indicators** have been developed by several institutions the might be called core sets of indicators (UN CSD list) or headlines indicators (EUROSTAT, OECD).

In terms of sustainable development the UN CSD list is a reference currently tested by several testing countries in the world. The ultimate goal of that list is to present to UN member states a list of common indicators among them they can pick up those that can be produced and are relevant the country.

The 5th Environmental Action Plan of the European Community states that "as a matter of priority, improved information on the state of the environment, appropriated indicators and tolerance capacities must be made available to policy makers in order to better define sustainable development parameters." In that context as a full member of the United Nations, the Commission participated to the implementation of phase II of the work programme of the CSD (test of the list of indicators). This collaborative effort was followed up by Eurostat and by the European Environmental Agency. The criteria applied in selecting the indicators presented were availability of data for a sufficient number of European Union Member States and relevance in the European context.

Annex 3 presents the list of indicators proposed by the CSD. Among this list 47 indicators were selected for the publication "Indicators of Sustainable Development, A pilot study following the methodology of the UN CSD". The study comprises 9 economic indicators, 14 social indicators, 21 environmental indicators and 2 institutional ones. The report does not attempt to take into account the work done at Eurostat on integrating economic and environmental indicators and on developing satellite accounts.

This study demonstrated by its structure the extent to which the measurement of sustainable development involves inter-sectoral reflection. Therefore indicators of sustainable development are a major communication tool for the measure of sustainable development and a second Eurostat's publication on indicators of sustainable development will be available in 2000.

Set of 60 pressure indicators: Eurostat Pressure indices project

An other Eurostat project: the Pressure indices project uses a unique approach to identifying the most relevant indicators to give a comprehensive description of the most important human activities that have a negative impact on the environment. Instead of the usual approach of asking politicians which indicators they want for policy purposes, the decision was taken to ask the scientific and environmental community to identify the most important issues[8] for each of the 10 following policy fields:

- *air pollution,*
- *climate change,*
- *loss of biodiversity,*
- *marine environment and coastal zones,*
- *ozone layer depletion,*
- *resources depletion,*
- *dispersion of toxic substances,*
- *urban environmental problems,*
- *waste,*
- *Water pollution and water resources*.

Depending on how this debate develops, a possible further development of this work could be the aggregation of the 60 indicators into 10 indices, one for each policy field, allowing a better comparison with economic indices such as GDP.

[8] For a more detailed description of the selection process, please consult the project web site set up by the project team: http://e-m-a-i-l.nu/tepi/.

From indicators to index: the debate of the relationships between indicators of sustainable development

International organisations and researchers give special attention to the comparison of different available systems of indicators helping to measure how sustainable is our development. Models of explanation are developed by linkages or aggregation of indicators.

In October 1998, UN CSD launched a study co-sponsored by Eurostat aiming, describing and analysing the work undertaken in recent years by a number of organisations at both international and national level on the linkages between indicators of sustainable development as well as possible ways to aggregate them.

The report "The relationships between indicators of sustainable development, An overview of selected studies[9]" was written for the purposes of the 5th UN CSD Expert group meeting on Indicators of sustainable development. It presents an overview of summaries and analyses of a number of studies published in recent years by selected organisations at both international and national level on:

- the linkages between indicators of sustainable development
- The possible ways to aggregate indicators or to integrate them geographically.

The goal of the overview is to examine possible approaches that would be applicable to the current set of UN CSD indicators. It will serve as input for developing strategic options for the conduct of phase III of the implementation plan for the work programme on indicators of sustainable development of the CSD.

At the present stage, the document is a first draft to be further examined by the Expert Group on Indicators as well as a peer review group established for that purpose.

Methodology followed

In order to facilitate the reading of the abstracts, the studies the have been analysed along the following lines:

- a description of the major features according to a standardised structure;
- where relevant a summary graphic presentation of the relationship proposed and/or the list of indicators chosen followed by a comparison to the UN CSD indicator list;
- A first effort to analyse[10] current strengths and weaknesses with a conclusion box highlighting the main elements that can be taken into account for recommendations.

A structure for the abstracts has been elaborated together with the UN CSD secretariat. The objective is not only to provide a format for the presentation of the studies but also to permit the identification of features that could be used on the UN CSD list of indicators to build linkages and/or aggregation.

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[9] Electronic copies can be request to Birgitte Bryld, UN CSD: Bryld@un.org

[10] The writer of this overview bears all the responsibility for the analysis

Structure of the abstracts

The **first part** of this structure identifies basic facts
- the **study's title and authors identification**
- to whom the results are addressed (main users of the results)
- who has supported the project
- who has been involved to develop the model or the indices

The second **part** presents **the main features of the studies**
- **type** (linkages, aggregations or geographical integration)
- the scale of the linkages or aggregation (vertical & horizontal)
- How linkages / aggregation are made (e.g. narrative or mathematical, model based, etc.)
- the kind of features linked or aggregated

The third **part** details the results obtained up to now
- whether the model and/or the indices have been **tested**
- the set of indicators including, when possible, the list of indicators in common with the UN CSD list
- the conceptual framework (Driving Forces, State, Impact, Response or another framework)
- the data sources

In order to find the features that could be useful for the phase III of the UNCSD work on indicators a draft analysis is also presented following a common structure.

Structure of the analysis part

The feasibility in terms of number and availability of necessary data and distance to the current CSD list:
- Which indicators can be obtained both directly and cost effectively and are appropriate at different scales (data sources, relevance at world level or at other geographical scope).
- Stability of measurements over time (length of the proposed time series, use of standardised measurements),
- “Meaningfulness” of the indicator over time, and whether inter-temporal comparison within a country is possible.
- How easy is the interpretation of the indicator (comparison to target or references values, quality of trends observed).

The feasibility in terms of complexity of model used
- Relevance/explanatory power of the linkages/aggregations proposed

The feasibility in terms of running and development cost:
- Limited number of indicators that are adaptable to future developments.
- Quality of the documentation allowing easy development of the indicators.
- Robustness of the results.
- Accessibility of the results, especially for communication to a non-specialised audience

Conclusions: Under this heading summarising comments are given.
- Positive points, controversial aspects trying to grasp critical elements that could make it difficult to use the approach for the CSD work or elements that facilitates the inclusion in the CSD work. This is the most subjective part of the overview, which suffers, as mentioned in the foreword, of the lack of time necessary to go more in-depth in the methodologies of the studies.

Ex Ante typology of possible relationships between indicators

In order to analyse the different studies it was necessary to define what is meant by linkages, aggregation and geographical integration. Indeed, these are complex concepts and they can have many different meanings. Furthermore, in some cases the borderlines are very narrow between linkages and aggregation and between linkages and what would be called breakdowns in statistical terminology. The following typology is not meant to be scientific and exhaustive but was developed in order to classify the studies in a way as simple as possible. It aimed at building a common language for the abstracts and to improve the communication between experts that will discuss the present overview.

The typology presented below is fairly simple and was intentionally kept short. Indeed, further details could have been introduced to describe the extent of the relationships: all indicators linked together or only by sub-systems, these sub-systems being either by environmental problems (e.g. ozone depletion) or by type of environmental resource (e.g. water) or by economic or socio-economic functions or sub-systems (e.g. household consumption, sustainability of cities).

The framework used to create the links is also an important element to differentiate the models proposed (e.g. driving forces, State, Response developed by UN CSD; Driving Forces, Pressure, State, Impact, Response used by the European Environmental Agency; modular frameworks; and other original framework). The framework could serve as an additional feature in the typology.

In the field of aggregation, the dimensions along which the aggregation is performed (along vertical lines i.e. starting from the more detailed geographical or micro-economic levels or cutting across domains, environmental problems or economic activities i.e. what is usually referred to as horizontal lines). These elements are in fact described in the abstracts and could serve to produce an ex-post typology as a further step to this report.

A. Linkages

A.1 Narrative linkages

Narrative linkages describe verbally or with graphs the relationship between indicators either within a framework or for the integration of policy concerns. This is the simplest level of linkages' presentation that can prove to be very useful for checking and presenting an indicator set.

Narrative linkages within a framework

Several studies dealing with linkages of indicators present the indicators within a framework relating the indicators to each other. Such studies base their analysis on the DPSR framework or on another original framework.

Narrative linkages for the integration of policies concerns

Narrative linkages for the integration of policies concerns describe the relationships between indicators according to major policy concerns.

Narrative linkages for the achievement of goals

After defining levels of sustainability to be reached (target values or sustainability goals or references), such studies present indicator trends compared to goals.

A.2 Correlation models

Correlation models track the correlation between 2 or more variables. Based on correlation coefficients computed between all or groups of indicators in the framework. They are used to determine whether correlation is for example:

- Positive, negative or neutral
- Strong or weak
- Immediate or time delayed

For simple 2 variables correlation models a high positive correlation coefficient indicates that the variables move together in the same direction. High negative correlation indicates that the variables move in opposite directions. Small values (or zero) indicate that the variables are not directly related.
For multivariate correlation models pair-wise analysis are used to isolate potential linkages. Multivariate analysis allows isolating the effects of a single variable while other variables remain constant, linear regression is used for analysing the results.

A.3 Environmental accounting approaches

Environmental accounting is the description, within an accounting framework, of interactions between environment and economy.
Input-output models represent these approaches. They provide a potential for linking physical and monetary information. Input-output models add together goods having a market value and goods that are not considered in "traditional economic accounting" either because they have no market value (waste) or because their value is not known (natural resource not traded) or because they have a non measurable negative value (atmospheric pollution, waste water), these are usually called externalities. There are accounts based on physical quantities and accounts based on monetarisation of externalities.

Physical natural resources and environmental accounts

These models refer to quantities of material inputs (with or without water and air according to authors) used by human activities of a defined economy.
Domestically obtained and imported material inputs can be considered. The output-side, which is not always studied[11] considers exported goods, solid wastes (including the goods domestically consumed), sewage sludge; wastes from raw material extraction (such as overburden), air emissions and waste water. Changes in stocks are estimated to present balances.

Satellite accounts

Satellite accounts are extensions of the System of National Accounts (SA using the same structure as the SNA). They expand the analytical capacity of national accounts by providing on the flow side estimation of air and/or waste quantity emissions linked to economic activities (including households activities) and on the assets side by providing a valuation of natural resources available on a defined territory (including sub-soil assets).

[11] Models based only on material inputs to the economy are the following :

TMR (Total Material Requirement) : is the sum of the total material input plus indirect or hidden material flows, including deliberate landscape alterations. TMR is the best overall estimate for the potential environmental impact associated with natural resource extraction and use.

DMI (Direct Material Input) : corresponds to the flow of natural resource commodities that enter the industrial economy for further processing.
Some models also estimate the ecological rucksacks: the weight of soil, rock and wastes removed or created during extraction and processing of raw materials. The raw materials extraction often occurs outside the country of final consumption and it's a way to estimate the burden imposed on other countries.

Adjusted National accounts or monetary valuation

This accounting approach aims at integrating the value of natural resource depletion and environmental degradation in order to calculate an adjusted GDP. It is usually referred to as green accounting and is described in the System of integrated Environmental and Economic Accounting (SEEA) methodological framework. SEEA treats the depletion of natural resources as costs and introduce them into the production of accounts at imputed market value

A.4 Complex system modelling

Such models are based on more or less complex systems of simultaneous equations. They reflect a priori expected relationships between economic and environmental phenomena. Indicators are used as proxies of the actual phenomena. Coefficients are calculated using econometrics. Non-linear relationships can also be estimated.

A.5 Scenario analysis

Scenario analyses are hypothetical sequences of events constructed for the purpose of focusing attention on causal processes and decision points. They correspond to description of alternative futures by model analysis, possibly based on different views of how the world works. The role of the scenario analysis is to examine different perspectives on the past and present. In thus, scenarios allow examining different possible policy strategies.

A.6 Gaming modelling

Such models are based on game theory. They usually involve simulation models for the functioning of pretty limited systems such as cities, farms, etc.

A.7 Other linkage concepts

There exist other concepts, such as those described below, aiming at summarising (in a non-linear way) a range of effects to give synthetic information directly usable for management of certain environmental resources or problems.

Carrying -capacity: is defined by scientists as being the maximum population of a given specie that can be retrieved in order to maintain the stock stable according to its renewing capacity. This allows assessment of issues of resources exploitation (e.g.: maximum sustainable yield of fish stocks) or pollution (e.g. local acid deposition).

Ecological footprints: In order to illustrate the unequal world-wide distribution in per capita land use, the ecological footprints measure the area of land used by a given group of people with a specific standard of living to get its resources (materials, land and water) and to assimilate its waste wherever that land may be located.

Eco-efficiency: is a management strategy based on quantitative input-output measures which seeks to maximise the productivity of energy and material inputs in order to reduce resource consumption and pollution/waste per unit of output, and to generate cost savings and competitive advantage.

B. Aggregations

Aggregation mostly implies the use of the 2 following techniques and methodology:

- Common measurement systems allowing an intuitive aggregation by addition obtained either directly due to the nature of the indicators or using conversion factors.
- Weighting methods used either to attribute weights to variables measured with the same unit or to aggregate indexes computed from heterogeneous variables.

B.1 Direct financial assessment of damage

This approach is based on the willingness to pay or to accept to pay by estimating the economic damages of the environmental degradation (pollution, waste production, etc.)

B.2 Conversion factors

In order to allow indicators to be added together, conversion factors are used in order to put the different indicators into the same unit of measurement. The conversion factors are usually based on scientific measurements and experiences (e.g. IPCC protocol).

B.3 Performances scale

The performances scale aims at evaluating how good or bad an index position is on a subjective scale defined by experts. The "best" or "good" is defined at one end of the scale, and "worst" or "bad" at the other end. The position of the index can then be plotted on the resulting scale.

B.4 Expert assessments and public opinion polls

These methods use expert assessments or public opinion polls to define the weights of different elements contributing to a phenomenon and these weights are used to make an aggregation to a summarising indicator or index. In the case of weights defined by expert assessments, the experts are asked to rank the indicators according to their relative importance in relation to a defined problem. There are environmental domains where the consensus among experts on how to judge the relative contribution of a physical indicator to an overall problem is quite strong (by using Greenhouse warming potentials or Ozone depletion potentials for example), but this is not the case for most of the domains.

Weights defined by public opinion pools are easy to collect. Most of the selected issues are already on the political agenda and described by the media. The focus of the opinion tools is more the notion of “concern” of the people. They are usually expensive and time consuming to implement, but at the same time highly useful.

B.5 Sustainability levels

This method measures the need for political intervention and the urgency of a problem. The urgency is high if the goal is far to be reached, low if the goal is reached. Like in the case of performance scale the method measures a distance to a target. Weights are based on the distance between an indicator and the sustainability target to be reached. As the distance is in most of the cases not really measurable it is also subjectively evaluated and can greatly vary whether the evaluator is a policy maker that wants to minimise policy expenditure or a scientist who wants to persuade policy makers to do something.

C. Geographical integration

Geographical integration is in between linkages and aggregation. Statisticians would call this intuitive integration. However, the indicators needed might not be the same at all geographical levels and it is important to keep coherence between all geographical levels (vertical scales).
Reports using that kind of integration present the 2 following approaches:

- The first one consists in using Geographical Information Systems (GIS) to map indices produced according to one or the other aggregation method. The map obtained is usually a good illustration but the interpretation of the results depends on the aggregation method used to produce the index.

- The second consists in plotting several indicators on the same map to try and evidence relationships between the indicators. The method requires a presentation of the reasons for the indicator selection.

Conclusions

General remarks

About the selected studies

The short time frame for the overview has made it necessary to keep the list to a realistic number of studies, but numerous interesting works are undertaken by other organisations and it would be meaningful to take stocks of their results. In particular, it seems that there exist many studies on aggregation or linkages for specific national purposes and/or regarding specific environmental problems or economic activities. Some are very advanced and are used to guide policies and practical management of resources. A review of these would probably bring very interesting examples but this would require an enormous work (the annex 1 presents other examples of ongoing works on relationships between indicators).

The selection process of the studies might have introduced a methodological bias because the Members of the UN CSD Expert Group have suggested the studies to include and they tend to quote each other. This shows a certain degree of "close group thinking" and it is difficult to assess whether the list is a sufficient panel of studies.

Many studies are presenting interesting and innovative ideas. However, the documents studied often did not give enough information for a full understanding of the methodology behind the proposed linkages or aggregation. It is often difficult to judge whether these documents are short abstracts or if the methodologies are not yet developed. The first conclusion that stems out from the studies reviewed is that there is still a lot of work to be done:

- Many methodologies still seem to be in development and therefore only broad lines are described
- The indicators to be used are not always identified.
- Studies presenting examples computed on real data are scarce.

About the linkages and aggregation described

It seems easier to aggregate indicators than to create linkages. This is probably due to the lack of data, which creates a bottleneck, and prevents simulation work. (Data are absolutely necessary for linkage building except in the case of narrative linkages).

In the field of linkages, two approaches have began to produce: the complex system modelling *(Selection and modelling of Sustainability indicators for the Fraser River Basin, Final report & Technical supplement, Statistic Canada, From static to dynamic indicators of sustainable development: example of economy-energy-environment link)* and satellite accounts *(What's in NAMEA? Recent results for the Netherlands)*. These approaches can be used on sub-systems like a river basin or the energy cycle or on one part of a problem like the air emissions due to a certain number of economic activities. Because they are limited in scope, they seem easier to conduct first because the models are less complex and second because the areas can be chosen according to the quality and data availability.

In the field of aggregation, several studies are quite advanced like the *Living planet report, WWFI* and *the Wellbeing of Nations, Prescott-Allen*. This is probably due to the fact that the aggregation method chosen does not require complicated statistical computations, they correspond to simple weighting procedures used to obtain indices or to plot data on a performance scale. The most time and resource consuming as well as controversial part is to get the weighting coefficients. An easy solution for simulation work is to use equal weights.

Concerning the geographical integration of the indicators, the methodologies seem to fall short of precision. Several indicators are presented together on a map, but the reasons why these indicators have been chosen are not clear from the documents reviewed. Although the map analysis is generally straightforward they are not always presented in the available reports and it is therefore difficult to see the results obtained. These models need a high data quality and availability in order to present "meaningful" maps that can be analysed into a specific context.

About the Ex Ante typology

The typology proved to be usable even though the classification of the different studies reviewed can be discussed in cases where several approaches are mixed. Environmental accounting approaches are typically in that case because they are based on an accounting framework that allows aggregation (especially in the case of monetary valuation) but that also allows linkages through the use of accounting equations and derivation techniques (a change in one variable produces a proportional change in the variables part of the same equation).

Conclusions on studies on linkages

What are the main advantages of linkages?

The principal objective of linkages is to provide a tool to carry sensitivity analysis that can directly lead to policy measures: by showing the link between several indicators it is possible to quantify what is going to happen when a variable is modified. And indeed, in the studies analysed, those that are advanced enough seem very promising in that type of concrete use (complex modelling).

Another interest of approaches based on linkages is their flexibility: the models can be fully adapted to the problem to be studied and to the local or specific conditions. New elements can always be introduced when the conditions are changing. The models can also be split in several modules that can be estimated separately.

Studies on linkages are also able to present complex information in a meaningful way. Such systems can be used to understand the total pressure created by the final demand for all kinds of products. They may facilitate to people the understanding of how their actions can influence the environment and/or help policy makers to foresee the effects of economic activities and policy measures. These systems can also be used to understand the total pressure created by the final demand for all kinds of products.
For this type of use, it may not always be necessary to go as far as estimating the linkage coefficients (and this is the case of narrative linkages). Indeed, the verbal description of the linkages is sufficient to create a set of categories that are worded and ordered in a way supposed to be self explanatory on the linkages foreseen (e. g. driving forces, impact, response). These categories are used to classify the indicators. The more detailed and refined the categories are the more informative they are concerning the underlying linkages (see IFEN study).

When data is available, standard statistical techniques can be performed at a minimum cost and these techniques usually allow using substitute series to a wide extent.

What are the main disadvantages of linkages?

From a scientific point of view, the conceptual models behind the linkages have to be demonstrated by running statistical procedures and checking the robustness of the coefficients obtained. Apart in the case of complex modelling (for a limited scope) there seems to be no approaches that have estimated coefficients and therefore the models presented have not yet be demonstrated Stricto Sensus. The results are that the scientific community has still not been able to elaborate a consensus model for assessing sustainable development.

Interpretation can be difficult in the case of complex modelling, requiring a certain level of expertise in the area.

Even if the models can be adapted to the data availability and quality there is a need for a minimum set of data to test the links and in many areas such a minimum set does not exist.

The major disadvantage of linkages however is that the complexity increases very rapidly if one tries to integrate many elements and therefore the models become difficult to manage and understand.

What to consider?

At the moment it seems that linkages cannot be used on a very broad scale to build management tools and sensitivity analysis tools. The conceptual difficulties are important and there are many controversies on the model to choose to build a general/global description of sustainable development. However on restricted scopes certain models have proved to be working and are used as powerful simulation and management tool.

Narrative linkages are approaches that help elaborate and present indicator lists under categories that are put in an order that suggests interactions or cause/effect relationships and this presentation is supposed to be self explanatory on the linkages.

Correlation models are a good tool to screen a data set and to reduce redundancies.

SUMMARY TABLE FOR LINKAGES STRONG AND WEAK POINTS		
Type	**Strong**	**Weak**
Narrative linkages	Studies proposing narrative linkages present lists of indicators according to a framework, which is more or less justified by theoretical or empirical elements and can be further structured in policy concerns. These analyses usually describe trends observed and try to establish linkages between the indicators which are sequentially put together in the framework. Narrative linkages can be used as a basis for the selection of an indicator set.	They do not present linkage coefficients.
Correlation models	The usefulness of the correlation models is that they allow: - Establishing linear links between phenomena	A disadvantage of the correlation model is they need a certain amount of data to produce reliable results and therefore can-

	- Screening out poor data - Identifying an efficient indicator set through removing redundant indicators	not be used on very few indicators or very short time series.
Environmental accounting approaches General	Satellite economic accounts can be used to assess some environmental problems due to production and consumption patterns especially by input-output modelling. The input-output models allow running different scenarios, but are constrained by linear functions and fix technology.	Their usefulness might be limited because of inadequate or suppressed data. Environmental accounting approaches are appealing because they are linked to the dominant economic presentation of human activities. They are however at the same time bound by this presentation. Furthermore, they require a training and experience in economics to interpret the results.
Adjusted national accounts in monetary terms	SEEA intends to present environmental expenditures as a part of the costs necessary to counterbalance the negative impacts of economic growth. SEEA allows the calculation of environmentally adjusted macro-economic aggregates. Users can choose among different methodological approaches according to their priorities.	The limitation of monetary valuations such as the SEEA is that it deals only with certain assets and cannot really monetarise aspects linked to the subjective feeling of people regarding the quality of the environment.
Complex system modelling	Such models present several advantages: They reflect the existence of loops that occur in a system and can model its dynamic; -they provide a framework for specifying qualitative relationships between indicators; - they allow non-linear relationships to be specified for the entire systems; - policy variables or institutional arrangements can be included in the variables of the model Complex system models can be used to monitor specific policies and to elaborate scenarios. These models can be designed at any scale.	The complex system models are not too reliable when the database is small or poor because the coefficients obtained are not statistically significant. The complex modelling systems have a tendency to become over complex. To try to model the entire system can add to the complexity without adding necessarily to understanding.

Conclusions on studies on aggregation

<u>What are the main advantages of aggregation?</u>

Aggregation models do not need to conceptualise relationships, they assume that the different elements contribute to a phenomenon proportionately to a defined weight (explicit or implicit in the case of indicators expressed in a common measurement system).

By using indexes (no unit data), they allow putting together non-homogenous elements.

They allow creating as many aggregated indexes as necessary and therefore they are very flexible.

They allow synthesising much information in a very simple way and do not require sophisticated statistical techniques.

Their major advantage is their communication power to non-specialists. They can be disseminated to the public and to policy makers in the same way as other quantitative economic or social information. When they are accepted and when the public get used to them the interpretation of the changes can be taught.

What are the main disadvantages of aggregation?

The major problem is the choice of weights. When aggregation models are not based on proved and quantified relationships they are considered controversial.
Weights obtain through experts or public surveys are costly.

Aggregation models are also a simplification of reality, which does not allow defining concrete simulation or management tools.

Aggregated indexes are often looked at as "black boxes" and create certain mistrust in the public.

What to consider?

Aggregations models are suitable for presenting lists of indicators in a synthetic way They permit to disseminate comprehensive information to a wide variety of publics. Some models may be developed within a fairly short time frame. At the same time they may produce many controversies.

Tables of the different method to gather weights for aggregation

Type	Method	Comment
Conversion factors	Scientific experiences	Can be done only on limited number of variables. Toxicity has to be taken into account
Performance scale	Subjective choice of the assessment	The choice can be made by the author or by experts
Expert assessments and public opinion polls	Nomination of experts Public opinion polls	A survey needs to be conducted to define the weight. The method is straightforward and less controversial than the performance scale.
Sustainability levels	Sustainability levels are used as a basis for the weighting	The indexation method is complex because components of each index need to be expressed under an equivalent unit before to be aggregated. Requires specific training.

SUMMARY TABLE FOR AGGREGATIONS STRONG AND WEAK POINTS		
Type	**Strong**	**Weak**
Conversion factors	The indices are user-friendly and allow the analysis of human development at the international, regional, national levels. The tool is usually used at international level for comparisons between countries among the world. These indices require basic mathematical knowledge and statistical data sets.	Requires to aggregate indicators having different measurement units, and therefore to create units equivalent that are sometimes not used by the scientific community. Non-quantifiable dimensions can not be taken into account by the tool.
Performance scale	Can be used at national, regional and global Very easy tool to understand, people without specific statistical experience can interpret the results.	The assessment of the performance scale is subjective and controversial.
Experts assessment	Can be used at national, regional and global depending on data availability. Portray a situation by theme or policy fields.	The weighting coefficients used are subject to : - the choice of the valuation method and the selection of themes or policy fields - the choice of stakeholders. The quality and the consistency of their responses to surveys are determining for good results. In the examples proposed by the overview the method do not succeed presenting the index either because of the lack of good quality data or the need to continue the methodological reflection.
Sustainability levels	Based on comparisons to sustainability levels. The indicators described make it possible to compare emissions that were incompatible before.	Need to define how are chosen the sustainability level either according to country policy or to international agreements. Complexity of the aggregations proposed.

Conclusions on studies on geographical integration

<u>What are the main advantages of geographical integration?</u>

The major advantage of such approaches is their ability to show in a fast and simple way information for different geographical territories.

By an adequate cross mapping of data, relationships (cause/effects, similarities, and oppositions) can be seen without any sophisticated technique.

What are the main disadvantages of geographical integration?

The difficulty of such approaches resides in the need for many good quality data.

Such approaches can also be misleading because non-relevant links could be identified just by coincidence or because other not presented variables plays an explanatory role in a more complex model.

What to consider?

SUMMARY TABLE FOR GEOGRAPHICAL INTEGRATION STRONG AND WEAK POINTS		
Type	**Strong**	**Weak**
Geographical information systems (GIS)	Compilation of different information levels onto a map to provide an overview of dynamic links existing between indicators, if data are available the methodology is straightforward Can be used at any vertical scale. GIS to provide a sound basis for the decision making process and its follow up.	In the selected studies the methodology do not explain how to select the indicators to be presented together on a map .

Recommendations

The three types of approaches (linkages, aggregation, and geographical integration) are necessary steps in the advancement of indicator work. The different studies have their advantages and draw-backs. As nearly no studies are enough advanced yet it is difficult to decide to follow one way rather than another.
For the three types of approaches the data situation is a severe bottleneck to the progress and to the actual production of quantitative results. The current list of CSD indicators represents a good choice of what is available. Efforts should be dedicated to improve the database necessary for the computation of these indicators.
The objectives of the approaches are fairly different: providing a tool for sensitivity analysis and concrete management of environmental problems and resources in the case of linkages. Summa-rising, analysing and disseminating complex information are the main objectives of the two others. These different goals should be recognised and discussed to see which are the most important features in the context of the UN CSD and also the priorities. Once goals are clarified it has to be decided whether the present conceptual framework (DSR) is kept or need to be adapted. It is clear that certain linkage approaches (especially environmental accounting) are based on different frame-works and cannot be applied to the current UN CSD list.

Annexe 1: ENVSTAT database - the multi-dimensional solution

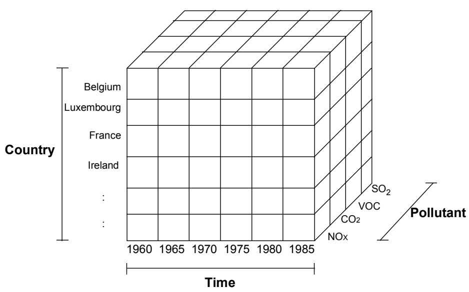
For further information please contact:
Ulrich Wieland, BECH 4/611, Bâtiment BECH, Eurostat F3, L-2920 Luxembourg.
Fax:+352 4301 37316 E-mail: Ulrich.wieland@eurostat.cec.be

ENVSTAT is a system developed by Eurostat to address the developing field of environmental statistics. To explain and qualify a rapidly growing stock of environmental statistics the system organises these statistics into multi-dimensional arrays and provides sophisticated meta-data management facilities. Any multi-dimensional table may then be generated from these arrays using an easy and intuitive drag-and-drop windows interface.

The main features of the system are:
User interface: a Microsoft windows interface to an Oracle database.
Flexibility: any multi-dimensional table may be generated using a choice of nomenclatures
Footnotes: footnotes may be attached to data. As statistics are retrieved, the relevant footnotes are retrieved
Derivation: mathematical formulae may be stored and used to automatically calculate new statistics whenever data are retrieved from the database
Properties: each statistic possesses a number of properties. As new statistics are calculated, their properties are also calculated.
Excel interaction: data may be easily moved to and from Excel using an Excel Reader.

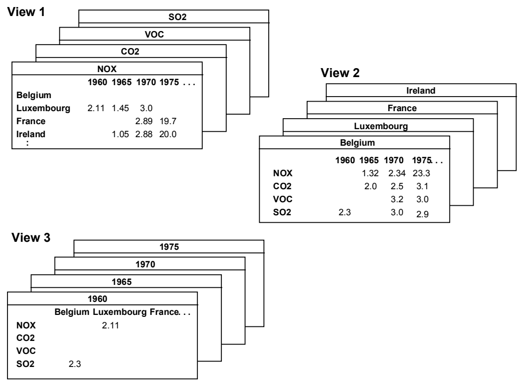
The multi-dimensional model
In the multi-dimensional model statistics are organised into a series of multi-dimensional arrays, or *matrices*. Each matrix is defined by a number of *dimensions*, and a set of labels in that dimension, termed *ordinates.* For illustration the figure below represents a three-dimensional matrix with the dimensions Country, Time and Pollutant:

Statistical Matrix



In this example, Time, Country and Pollutant are termed dimensions. Belgium, Luxembourg, France, Ireland etc. are termed ordinates in the dimension Country. Likewise, 1960, 1965 ... 1985 are ordinates in the dimension Time; NO_X, CO_2, VOC, SO_X are ordinates in the dimension Pollutant. Note that time is treated the same as other dimensions.
The value of storing data in multi-dimensional matrices is that it can be subsequently retrieved in a number of ways. In the example above, the data can be retrieved in three ways or views:

Differing Views of a Matrix



Although the example above used a three dimensional matrix, the system manages matrices of any number of dimensions. This is a unique feature of the ENVSTAT system.

Classifications
The system hierarchically structures the ordinates of each dimension into one or more *classifications*. An ordinate may belong to any number of such hierarchies or classifications.
"Annual" and "CN8" (Combined Nomenclature) are examples of classifications. The system manages and presents views of matrices according to classifications - so for example tables showing all years since 1970, each decade since 1950 or only recent years may be generated.

Differing Classifications

Annual

NOX	1960	1961	1962	1963	...
Belgium					
Luxembourg	2.11	1.45	3.0		
France			2.89	19.7	
Ireland		1.05	2.88	20.0	
:					

5 yearly

NOX	1960	1965	1970	1975	...
Belgium					
Luxembourg	2.11	1.45	3.0		
France			2.89	19.7	
Ireland		1.05	2.88	20.0	
:					

Decades

NOX	1960	1970	1980	1990	...
Belgium					
Luxembourg	2.11	1.45	3.0		
France			2.89	19.7	
Ireland		1.05	2.88	20.0	
:					

When a nomenclature is revised, ordinates may be carried over into the new nomenclature. Tables thus generated with the new nomenclature then contain data from the old. This again is a unique feature of the ENVSTAT system.

Meta-data

The system holds:

- the units statistics are expressed in
- definitions
- footnotes
- properties
- derivation formulae
- presentation format

Units

The units (Kg, Km/h etc.) that statistics are expressed in are defined across one (and only one) dimension for each matrix. The units may be the same across that dimension, or may vary from ordinate to ordinate.

Definitions

For each ordinate, the system may hold a definition of the concept that ordinate represents.

Footnotes

Footnotes are held in three languages, (English, French and German) attached to data in the matrix. A footnote may be attached to any number of statistics. A statistic may have any number of footnotes attached to it.

Properties

Each statistic possesses a number of properties: whether it is provisional, derived, confidential, significant, verified, estimated, and/or reliable.

Derivation

The system holds a number of derivation formula. Whenever the database is consulted, these formulae are used to automatically calculate new statistics. The properties of statistics so derived are simultaneously calculated.

Presentation

The system also manages presentation formats (width, precision etc.) and whenever a statistic is altered, the system records the previous value, the user that updated it, and the date of the change.

A technical feature of the system is that “not available” values are not stored in either the windows application, nor the oracle database. Thus, very large, but very sparse matrices may be held and treated by the system.

The system currently manages some 50 arrays comprising approx. 240,000 time series. Around one further array is added each month.

The generic nature of the multi-dimensional model make the system equally applicable to a wide range of domains.

Future development

The system is still under development and subject to design changes. Future enhancements will include: an OLE facility, connection to the Internet, extension to footnote management facilities, an interface to a modelling package, graphing and mapping facilities and extension to the calculation facilities.

Annexe 2: EU - indicators

On line data for the following indicators are presented on the Web page:
http://europa.eu.int/en/comm/eurostat/serven/part3/indic.htm

Economic and Monetary Union convergence criteria
Harmonised indices of consumer prices
General government deficit
General government gross debt
Nominal long-term interest rates
Participation in the Exchange Rate Mechanism (ERM)
Theme 1: General statistics
Population
Population density
Activity rate
Harmonised unemployment rates
Gross domestic product at market prices
GDP per inhabitant
Exchange rate 1 ECU =...
Consumer prices indices: General Index 1985=100
Theme 3: Population and social conditions
Crude birth rate
Proportion of live births outside marriage
Life expectancy at birth
Infant mortality
Crude marriage rate
Divorces
Asylum applications
Theme 4: Energy and industry
Index of industrial production (excluding construction)
Crude oil and petroleum products - Consumption
Theme 5: Agriculture, forestry and fisheries
Total area - Utilised agricultural area - Arable land
Theme 6: External trade
Total trade balance
Total exports
Total imports
Intra-EU trade balances
Extra-EU trade balances
Theme 7: Distributive trade services and transports
Number of credit institutions
Number of main telephone lines
Gross value-added at factor costs by branch
First registration of private and commercial cars
Theme 8: Environment
Carbon dioxide emissions
Use of pesticides
Pollution abatement and control expenditure
Theme 9: Research and development
R&D personnel as % of labour force
R&D expenditures in % of GAP

The Eurostat Data Shops[1] network is there to help you with any request for information.

[1] Eurostat Statistical Office of the European Communities, Jean Monnet Building, Rue Alcide De Gasperi, L-2920 Luxembourg Tél.: (+352) 4301-34567, Fax: (+352) 4301-32594, E-Mail: info.desk@eurostat.cec.be

Annex 3: List of Indicators of Sustainable Development

CHAPTERS OF AGENDA 21	DRIVING FORCE INDICATORS	STATE INDICATORS	RESPONSE INDICATORS
CATEGORY: SOCIAL			
Chapter 3: Combating poverty	-Unemployment rate	-Head count index of poverty -Poverty gap index -Squared poverty gap index -Gini index of income inequality -Ratio of average female wage to male wage	
Chapter 5: Demographic dynamics and sustainability	-Population growth rate -Net migration rate -Total fertility rate	-Population density	
Chapter 36: Promoting education, public awareness and training	-Rate of change of school-age population -Primary school enrolment ratio (gross and net) -Secondary school enrolment ratio (gross and net) -Adult literacy rate	-Children reaching grade 5 of primary education -School life expectancy -Difference between male and female school enrolment ratios -Women per hundred men in the labour force	-GDP spent on education
Chapter 6: Protecting and promoting human health		-Basic sanitation: Percent of population with adequate excreta disposal facilities -Access to safe drinking water -Life expectancy at birth -Adequate birth weight -Infant mortality rate -Maternal mortality rate -Nutritional status of children	-Immunisation against infectious childhood diseases -Contraceptive prevalence -Proportion of potentially hazardous chemicals monitored in food -National health expenditure devoted to local health care -Total national health expenditure related to GNP
Chapter 7: Promoting sustainable human settlement development	-Rate of growth of urban population -Per capita consumption of fossil fuel by motor vehicle transport -Human and economic loss due to natural disasters	-Percent of population in urban areas -Area and population of urban formal and informal settlements -Floor area per person -House price to income ratio	-Infrastructure expenditure per capita
CATEGORY: ECONOMIC			
Chapter 2: International cooperation to accelerate sustainable development in countries and related domestic policies	-GDP per capita -Net investment share in GDP -Sum of exports and imports as a percent of GDP	-Environmentally adjusted Net Domestic Product -Share of manufactured goods in total merchandise exports	
Chapter 4: Changing consumption patterns	-Annual energy consumption -Share of natural-resource intensive industries in manufacturing value-added	-Proven mineral reserves -Proven fossil fuel energy reserves -Lifetime of proven energy reserves -Intensity of material use -Share of manufacturing value-added in GDP -Share of consumption of renewable energy resources	

Chapter 33: Financial resources and mechanisms	-Net resources transfer / GNP -Total ODA given or received as a percentage of GNP	-Debt / GNP -Debt service / export	-Environmental protection expenditures as a percent of GDP -Amount of new or additional funding for sustainable development
Chapter 34: Transfer of environmentally sound technology, co-operation and capacity-building	-Capital goods imports -Foreign direct investments	-Share of environmentally sound capital goods imports	-Technical co-operation grants
CATEGORY: ENVIRONMENTAL			
Chapter 18: Protection of the quality and supply of freshwater resources	-Annual withdrawals of ground and surface water -Domestic consumption of water per capita	-Groundwater reserves -Concentration of faecal coliform in freshwater -Biochemical oxygen demand in water bodies	-Waste-water treatment coverage -Density of hydrological networks
Chapter 17: Protection of the oceans, all kinds of seas and coastal areas	-Population growth in coastal areas -Discharges of oil into coastal waters -Releases of nitrogen and phosphorus to coastal waters	-Maximum sustained yield for fisheries -Algae index	
Chapter 10: Integrated approach to the planning and management of land resources	-Land use change	-Changes in land condition	-Decentralised local-level natural resource management
Chapter 12: Managing fragile ecosystems: combating desertification and drought	-Population living below poverty line in dryland areas	-National monthly rainfall index -Satellite derived vegetation index -Land affected by desertification	
Chapter 13: Managing fragile ecosystems: sustainable mountain development	-Population change in mountain areas	-Sustainable use of natural resources in mountain areas -Welfare of mountain populations	
Chapter 14: Promoting sustainable agriculture and rural development	-Use of agricultural pesticides -Use of fertilisers -Irrigation percent of arable land -Energy use in agriculture	-Arable land per capita -Area affected by salinisation and waterlogging	-Agricultural education
Chapter 11: Combating deforestation	-Wood harvesting intensity	-Forest area change	-Managed forest area ratio -Protected forest area as a percent of total forest area
Chapter 15: Conservation of biological diversity		-Threatened species as a percent of total native species	-Protected area as a percent of total area
Chapter 16: Environmentally sound management of biotechnology			-R & D expenditure for biotechnology -Existence of national biosafety regulations or guidelines
Chapter 9: Protection of the atmosphere	-Emissions of greenhouse gasses -Emissions of sulphur oxides -Emissions on nitrogen oxides -Consumption of ozone depleting substances	-Ambient concentrations of pollutants in urban areas	-Expenditure on air pollution abatement

Chapter 21: Environmentally sound management of solid wastes and sewage-related issues	-Generation of industrial and municipal solid waste -Household waste disposed per capita		-Expenditure on waste management -Waste recycling and reuse -Municipal waste disposal
Chapter 19: Environmentally sound management of toxic chemicals Chapter 20: Environmentally sound management of hazardous wastes Chapter 22: Safe and environmentally sound management of radioactive wastes	-Generation of hazardous wastes -Imports and exports of hazardous wastes -Generation of radioactive wastes	-Chemically induced acute poisonings -Area of land contaminated by hazardous wastes	-Number of chemicals banned or severely restricted -Expenditure on hazardous waste treatment
CATEGORY: INSTITUTIONAL			
Chapter 8: Integrating environment and development in decision-making Chapter 35: Science for sustainable development Chapter 37: National mechanisms and international cooperation for capacity-building in developing countries Chapter 38: International institutional arrangements Chapter 39: International legal instruments and mechanisms		-Potential scientists and engineers per million population	-Sustainable development strategies -Programme of integrated environmental and economic accounting -Mandated Environmental Impact Assessment -National councils for sustainable development -Scientists and engineers engaged in R & D per million population -Expenditure on R & D as a percent of GDP -Ratification of global agreements -Implementation of ratified global agreements
Chapter 40: Information for decision-making Chapter 23-32: Strengthening the role of major groups		-Main telephone lines per 100 inhabitants -Access to information	-Programmes for national environmental statistics -Representation of major groups in national councils for sustainable development -Representatives of ethnic minorities and indigenous people in national councils for sustainable development -Contribution of NGOs to sustainable development

Keynote Lectures

Didactic Materials

Sustainable Development Indicators and their Use in British, German and North American Climate Policy

Thomas Ruddy

Abstract

The trend toward sustainable development indicators (SDIs) is a predominantly academic discussion among an elite with only limited meaning to voters. This paper covers the theory of how consensus-building is supposed to work in civil society and looks at different types of indicators and indicator frameworks that are available as tools for this process. Gradually SDIs are taking on more real-world relevance in the field of climate policy. Therefore the instructive case of Great Britain is taken, where the political roles of the executive and legislative bodies in climate policy have recently been redefined and commented upon by NGOs in an exemplary consultation process. Great Britain's strategy to reduce carbon dioxide emissions is compared with Germany's eco-tax. Both are based on burden-sharing among sectors of society.

Tax technicalities such as carbon content are explained, and strategy issues looked into such as that of reducing emissions by nuclear versus renewables. On the macroeconomic level, aspects such as decoupling CO2 from GDP and international negotiation aspects such as the relative difficulty of the Kyoto as versus the Montreal Protocol are made clear. After a look at two options for internalising negative externalities by means of taxation or certificates, these are recognised as two approaches to the much-sought-after theory providing a micro-macro link.

Introduction

[+ Scenario]

In the Seventies the growth paradigm began to break down that had set in after World War II. "Green" economists from many nations, realising that gross domestic product (GDP) was misleading, debated on a host of alternative progress indicators proposed at first to supplant, then to replace conventional systems of national accounts. In 1971 the Club of Rome pointed out that the "Limits to Growth" were being reached. A new paradigm, sustainable development, was devised in the mid-Eighties by the Brundtland Commission and presented to a wider public at the Earth Summit in Rio in 1992. Had until then conventional progress indicators been **de**scriptive of what was happening at the time, sustainable development indicators (SDI) were to become **pre**scriptive, anticipating what society wanted from the future. SDIs were to be embedded into a framework or indicator set, establishing linkages among them. A nation could declare the framework as its sustainability strategy. Agenda 21 and a new Commission on Sustainable Development CSD were set up to initiate such processes in civil society and governments world-wide.

Relevance to climate policy

Not until five years after Rio, though, did one sustainable development indicator emerge through the Kyoto Protocol in 1997 that is now advancing more rapidly in significance than the others, because it has an application in *Realpolitik*: the quantities of so-called greenhouse gases emitted by nations' fossil-fuel based economies. The OECD has concluded that climate change is one of the indicator areas most likely to be really used by policymakers. Already now a Greenhouse Gas Inventory is legally required to meet a nation's commitments under the UN Framework Convention on Climate Change (UNFCCC).

But which climate indicator?

Global Warming Potential (GWP)

This is "the index used to translate the level of ***emissions*** of various gases into a common measure in order to compare the relative ***radiative forcing*** of different gases without directly calculating the changes in atmospheric concentrations. GWPs are calculated as the ratio of the ***radiative forcing*** that would result from the emissions of one kilogram of a ***greenhouse gas*** to that from emission of one kilogram of ***carbon dioxide*** over a period of time (usually 100 years)". The World Resources Institute in Washington DC, though, has proposed an interesting improvement in the "metrics" or indicator method used: the quantity of carbon **accumulated** in the atmosphere is the real object of interest, not annual emissions. Compared with the conventional view, WRI would put more blame on the industrialised countries, but sees greater potential for remediation in the developing ones.

[Slide 2]

The treaty of Amsterdam, signed by the European Union's 15 member states in October 1997, made sustainable development into a central policy goal for the EU. The Dutch currently have the lead in European sustainable development initiatives, theirs having existed since 1989. The Dutch government is also notable for its environmental covenants with business and its National Environmental Policy Plan (NEPP or NMP in Dutch) (according to this basic book available from me in Burgenland edited by Dieren, Wouter van: Taking Nature into Account, 1995, New York, NY: Springer Verlag, p.94).

Germany has hesitated to develop a sustainable development initiative, proceeding schizophrenically with the Sustainable Germany study commissioned in 1995 by Friends of the Earth (FOE) - Germany and the Catholic charity Miseorer, on the one hand. Not until two years later did the Federal Bureau for Environmental Protection under its right-of-centre coalition government produce "Nachhaltiges Deutschland". Finally in 1999, the new Red-Green coalition government is going ahead with an official, national sustainability strategy. One of its first obstacles is the trade-off inherent in simultaneously reducing CO2 emissions and decommissioning nuclear power plants, a problem that non-EU member Sweden is also facing.

[Slide 3]

The political process in Great Britain

Right after Labour's take-over in the 1997 elections, the United Kingdom set about developing a bold sustainability agenda, beginning with its auditing of government policies for their environmental impacts and providing for extensive consultation with stakeholder groups. The BBC reported how "it was Labour that advocated 'integration' of environmental aspects into all areas of government. [Labour wanted to]:

- Establish a parliamentary Environmental Audit Committee to scrutinise the environmental impact of government policy across all departments.
- Present an annual sustainable development plan to Parliament. [and]
- Publish new indicators of national economic performance, incorporating environmental factors, alongside more traditional measures such as GDP."

The U.K.'s Department of the Environment, Transport and the Regions DETR wanted a strategy that would be suited for comparisons at the local, national and global levels. Here is an example starting with the local, or firm, level:

> "..Many of the "pressure" indicators, for example, relating to emissions of a particular pollutant, or amounts of waste generated, could be calculated for an industry sector or even an individual site or plant level."
>
> "Similarly at the international level, there may develop over time a consensus about a set of indicators which it would be sensible for all countries to report on a common basis, while countries will also want to develop indicators for national use which reflect their own particular situation and priorities. The Government hopes through this report to contribute to the development of not only national, but also international and local indicators."

[Slide 4]

Early on, Prime-Minister Tony Blair stated his support for a democratic process known as the stakeholder model to be used with U.K. voters, i.e. in civil society.

What is civil society?

"That personal sphere of citizen activity not to be infringed upon either by the state or commercial interests, although a market economy is a prerequisite for citizens to acquire the personal means to maintain their independent sphere." Hegel included the economy as part of civil society, but it has not been included by Talcot Parsons or others [as documented on the Website].

What is a multi-stakeholder process?

"A stakeholder in an organisation is any group or individual who can affect, or is affected by, the achievement of the organisation's objectives" stated R. Edward Freeman in 1984, Prof. of business ethics at the University of Virginia Business School. He still asks today in the course outline on his website: "Do businesses have a moral obligation that goes beyond maximising shareholder wealth? What exactly is involved in the obligation to maximise shareholder wealth? What about externalities? [to be dealt with later] What about other stakeholders, such as community, suppliers, customers and employees? "

Other applications of stakeholder theory:

- The new **Global Reporting Initiative (GRI)** is introducing sustainable development indicators (SDI) into corporate environmental reporting (CER) at its 1999 conference in London.
- Stakeholder theory is also applied to corporate governance by the "communitarian" Amitai Etzioni [on his Home Page].
- Stakeholder theory is applied to the mediation of disputes over undesirable environmental facilities like incinerators Not In My Back Yard.

The U.K. invited stakeholder groups such as NGOs to come in for consultation. Friends of the Earth (FOE UK) demanded that that periodic monitoring of progress be put in place in the form of audits by a committee and reports to Parliament. FOE UK has published its critical views on the government's indicator programme. One of FOE's major points is targets:

"We consider that it is inadequate to consider developing sustainability indicators without targets. Some indicators can be useful without associated targets, by indicating whether change is in the right direction. These directional indicators can partially help overcome the inertia amongst policy makers and the public to recognise the scale and urgency of the challenge of sustainable development, but only 'distance-to target' indicators can convey whether change is of the right rate or magnitude. Such indicators and associated targets are urgently needed. The strategy should set targets in place, along with appropriate indicators and mechanisms to monitor progress and to ensure effective reviews of policies and practices where progress is inadequate. Monitoring of progress against such targets is likely to require new data gathering. This should not be treated as a reason to reject particular types of indicator or target".

Furthermore, FOE calls for expanding the idea of the exemplary Environmental Audit Committee into a Sustainability Audit Committee, and challenges the Government "to give it resources and powers appropriate to the task of ensuring that all policy reviews and initiatives reflect the Government's objectives of sustainable development".

In Part 2 of FOE's response to Government's invitation to consultation, FOE criticises the use of GDP as "headline indicator". "Alternative aggregated measures of welfare need to be taken from academic circles and debated more widely - this is how they can be improved."

Keeping progress measurable

[Slide 5]

One other demand of NGOs to the Blair cabinet was that government not only declare a sustainability strategy and develop SDIs to describe the physical parameters involved. Instead, FOE insisted, government should also set targets and use performance indicators showing the distance remaining until the targets would be reached and the rate of progress toward them. (This is akin to the percentage strip that progressively fills up across a computer screen during installation of a new program or as downloads complete.)

[Slide 6]

Moreover, as Germany and Sweden are discovering, SDIs need a framework establishing linkages with other policy areas. Reduction of CO2 emissions needs to be co-ordinated with new measures promoting renewables or conserving energy to compensate for the decommissioning of nuclear plants, which are CO2-free.

Sustainable Germany

Let us look therefore, ladies and gentlemen, at how the "performance" type of indicator demanded by FOE shows progress toward a target. The data I have available is from the Sustainable Germany study, which shows how Germany has addressed its Global Reduction Commitment.

[Slide 7] shows the history for Germany. You see the highest curve of CO2 emissions while Business As Usual (BAU) continues. Stage 1 of the eco-tax sets in 1999, taking the emissions curve downward. From the standpoint of 2000, then, one should be able to report -- once results confirm the tax's effectiveness -- that 'Over the last year we have reversed the trend and are halfway towards reaching the trajectory called "Global Reduction Goal." By the Year 2002 with the aid of Stage 2 we will be on target.'"

[Slide 8] shows the detail. Notice how the double-crossed area bends the curve of emissions below Business As Usual in two stages.

As in Germany, the U.K. strategy is also culminating in new plans for an energy tax. Chancellor-of-the-Exchequer Gordon Brown announced plans "to tax the business use of gas, electricity and oil to raise an estimated Sterling 7bn and help Britain to meet its targets for reducing greenhouse gases." The tax forms part of "the Chancellor's 'green' strategy agreed with John Prescott, the Deputy Prime Minister." Soon thereafter, predictably,

> "Britain's big energy users warned John Prescott that the new climate change tax could cause serious harm to their businesses. Representatives from sectors such as steel, paper and chemicals, told Mr Prescott that even a 50 per cent discount in the energy tax would hit their competitiveness....The government intends the tax to be revenue neutral and to compensate companies through a cut in employers' national insurance contributions."

The political input process includes policy advice from economists, who can indeed predict quite accurately the results to be expected from the overall strategy upon which an energy or CO2 tax is to be based. However it is society and its voters, not economists, who must reach a consensus on the contributions that individual sectors should make to the success of the overall strategy. Then their representatives, the policymakers, can forge an appropriate scheme. Likewise the trade-off between CO2-induced global warming versus radioactive waste disposal is part of society's definition of what it considers sustainable development, and consequently what it needs as indicators.

[Slide 9] 'Burden-sharing' - UNEP, a college and a pension fund have tried to facilitate acceptance of the energy tax by aiding in converting data in terms of litres of fuels to CO2.

The UK's plans to shift Sterling 7bn from energy consumption to relieve employment taxes from April 2001 may be comparable to Germany's shift of roughly Sterling 3bn from April 1999 as it is planned to be expanded in two later stages.

[Slide 10] compares the magnitude of the revenue transferred from energy use to employee insurance schemes in each of these countries.

Tax technicalities

[Slide 11] shows the carbon content of major fuels. A CO2 tax is based on this indicator; an energy or BTU tax is based on energy content.

[Slide 12] shows the decoupling of CO2 emissions from GDP in Germany.

[Slide 13] shows the difficulty of reaching international consensus on CO2 emission reduction (the Kyoto Challenge) because the respective indicator is only weakly decoupled from GDP, as opposed to the relatively strong decoupling of CFC emissions from GDP in principle (the encouraging precedent of the easy Montreal Protocol).

Efficiency indicators

Efficiency indicators measure more complex relationships than do performance indicators.

[Slide 6]

They measure productivity, or relate welfare to resource consumption, or CO2 emissions to dollars spent. Eco-efficiency, for instance, is a concept that can be implemented in microeconomic applications as advocated by the World Business Council on Sustainable Development WBCSD, as we see in ...

[Slide 14]. "Reporting Trends and Improvements"

As we've seen, national governments that accept obligations under international protocols face the problem of how to pass on the obligation to their emitters, i.e. their citizens and businesses.

Macroeconomists point to taxes as one option of internalising what they call the negative externality, or damage, caused by CO2 emissions.

Externalities

[Slide 15] shows the principle of externalities, or those damages "external to", and therefore not reflected in, market pricing. How should they be "accounted for?" A tax might be used to artificially raise the price of a barrel of oil, thus discouraging the citizen on the left from sending damaging emissions to the citizen on the right. Government thus can internalise the damage, or discourage it from being applied indiscriminately to others, who fall back on the state for medical assistance. It is then said to "make the polluter pay."

Tradeable permits

Option #2 involves property rights, which are represented by tradeable certificates. This system permits only limited emission for which the damaged party is compensated. It works best over large areas such as whole nations or regions of emitters having wide variations in the cost of abatement. Its effectiveness has been proven in the case of the SO2 emissions from power plants in the Mid-west of the United States, which used to cause acid rain in the East. It is being considered for wide-spread use under the Kyoto Protocol's mechanisms.

The micro-macro link

[Slide 16] shows two options for a micro-macro link that helps national governments pass on the obligation to their emitters. Traditionally the macro indicator GDP was derived or "aggregated" from lower- level micro data assembled by a nation's firms. What is to be done, though, with the modern-day sustainability strategies that have no lower level to refer to?

Germany has chosen to levy an ecological tax, but other EU "Member States, such as Spain, are still critical and challenge the general assumption that an ecological tax will help reducing CO2 emissions.... Others which have been reluctant in the past, like the UK, have accepted the general idea" (Sascha Mueller-Kraenner, Heinrich-Boell Foundation, Washington D.C. Office, personal communication, April 1,1999).

Thus, maximum climate-change abatement efficiency is demanded by Canada and the United States from any climate treaty such as the Kyoto Protocol. Macroeconomists generally concur that emissions trading would increase the efficiency of climate change mitigation measures. So-called 'win-win' opportunities are being sought first, which would bring the greatest CO2 emissions reduction at the lowest cost. Unlike the indicator term GWP used in the Kyoto Protocol as a ratio, the indicator actually found to be practical in the market for emissions trading is called a "carbon dioxide equivalent". "'Offsets' are carbon credits that allow companies to discount their production of greenhouse gases. A price range of $US 5-10 [applies to a ton of] carbon dioxide equivalent - the unit of the emerging trade in greenhouse gases."

Canada

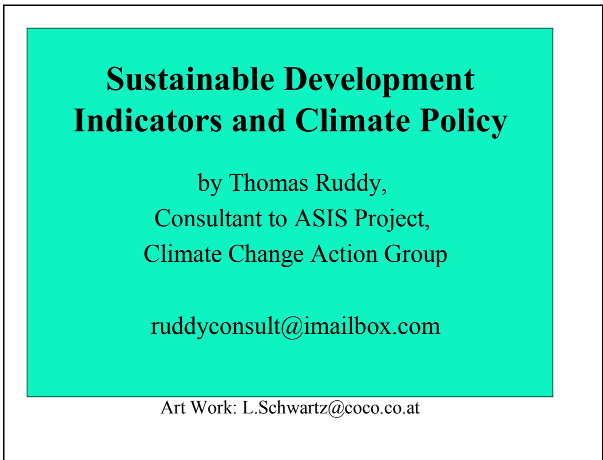
Canada has called together a National Round Table on the Environment and the Economy, NRTEE, to define a new approach to assess progress toward sustainable development (acknowledgments to Stephan Barg and Alan Willis).

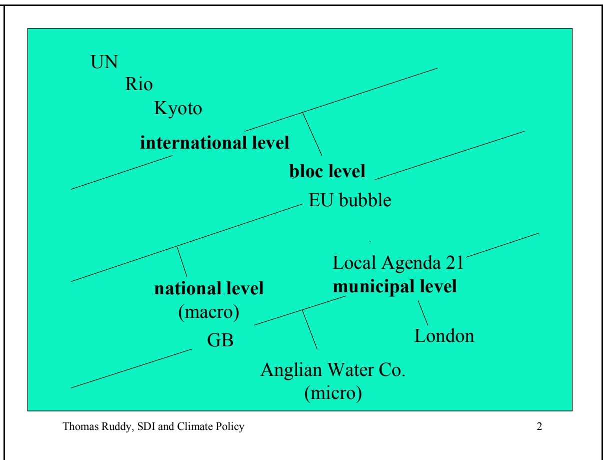
CO2 emission is an indicator that is needed acutely in the quest for sustainable development. It would, however, be oversimplified if taken to serve as the sole headline indicator of sustainable development, as it leaves out intergenerational issues such as radioactive waste disposal. At the other extreme, one finds such complexity in sustainability that many indicators would be required to describe it adequately. The Kyoto Protocol's Clean Development Mechanism (CDM) needs a set of SDIs in order to identify the condition that justifies the awarding of emission credits; this lack of clarity in the treaty is regarded by many as an unduly risky loophole. The CDM would be infinitely easier to administer if SDI were defined. That, however, has not yet been accomplished on any national level, much less internationally.

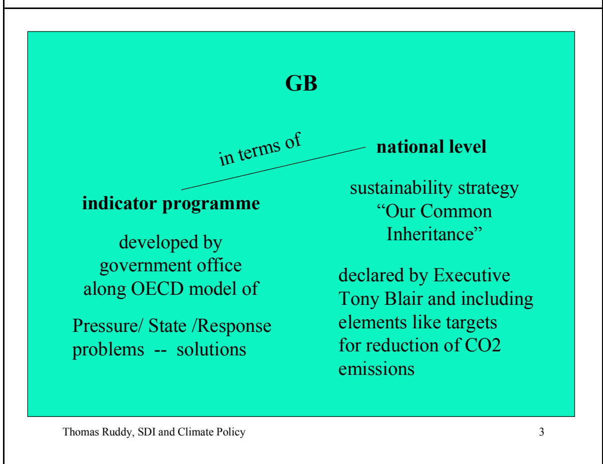
References

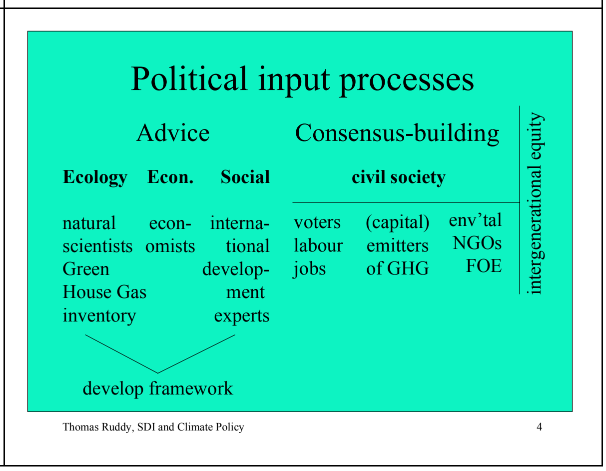
Lit.refs on: http://ourworld.compuserve.com/homepages/thomasruddy/hotlist.htm

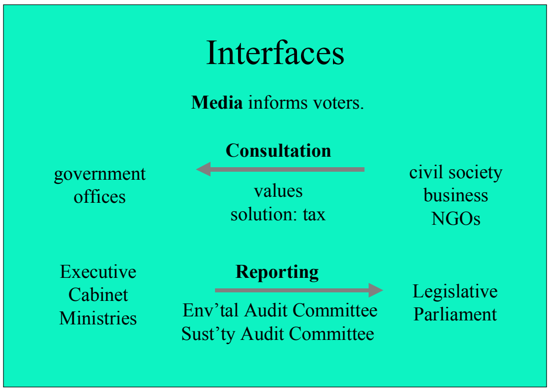
Annex - Slides











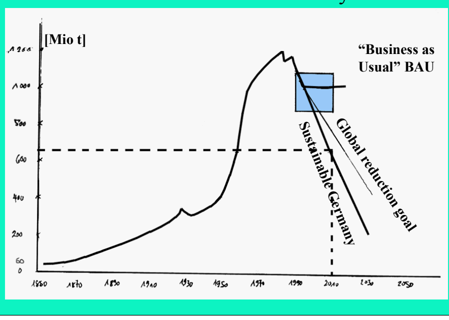
Thomas Ruddy, SDI and Climate Policy 5

Three indicator types

- Simple indicator measures parameter.
- Performance indicator **relates** parameter...
  - **to** a direction (better or worse)
  - **to** a target (in quantity / time)
- Efficiency indicator relates output / input:
  - eco-efficiency (welfare / resource consumption)
  - climate change abate eff. (CO_2 emiss. / $ spent)

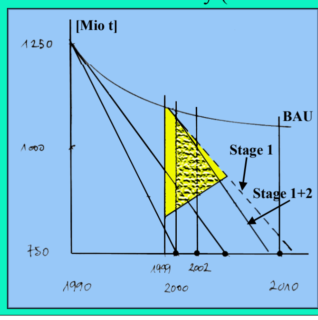
Thomas Ruddy, SDI and Climate Policy 6

CO2 emissions in Germany



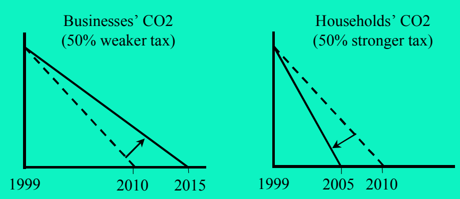
Thomas Ruddy, SDI and Climate Policy 7

CO2 emissions in Germany (Area of detail)



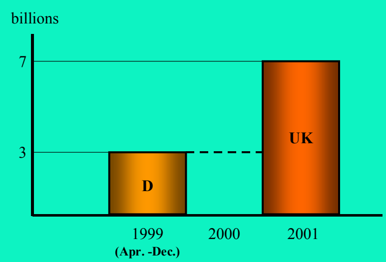
Thomas Ruddy, SDI and Climate Policy 8

Burden-Sharing



Thomas Ruddy, SDI and Climate Policy 9

Revenue transferred from energy use to employee insurance schemes



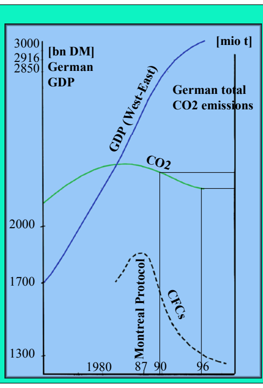
Thomas Ruddy, SDI and Climate Policy 10

(Area of Detail)

Weak delinking of CO2 emissions from GDP

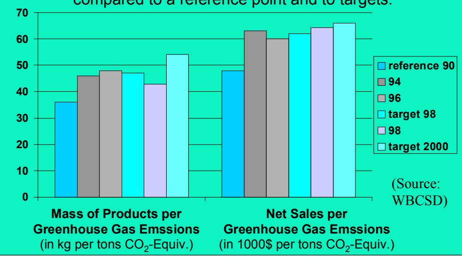
Strong delinking (independence) of CFCs from GDP

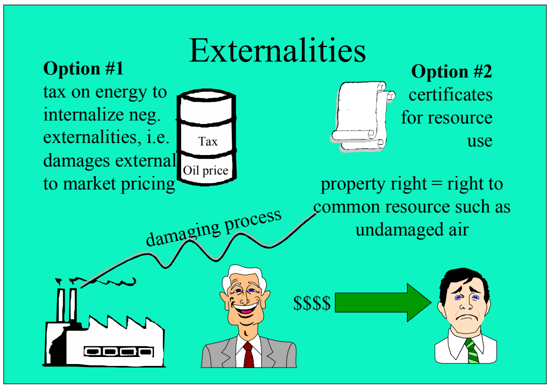
(Source: Stat. Office, VDEW)



Reporting Trends and Improvements

Example of improvements over time, and achievements compared to a reference point and to targets:





Possible micro-macro links

- **Option #1**: energy tax (adv.: truthful prices)
- Reach consensus on sector burdens, exemptions.
- Assemble database of emission sources.
- Levy energy tax.

- **Option #2**: certificates (adv.: exact limits, exploits efficiencies)
- Assign property rights.
- Issue certificates.
- Open trading.

Environmental Consciousness and the Challenges and Barriers to Communicating Environmental Knowledge/Indicators

Thomas G. Whiston

ABSTRACT

This paper discusses the level of environmental consciousness which presently exists and the role that environmental knowledge and indicators play in influencing that consciousness (and vice versa).

It is argued that whilst many environmental indicators help considerably in attenuating environmental consciousness nevertheless the vast majority of such indicators only address the "symptoms" of environmental degradation. Deeper and wider indicators are required if the environmental consciousness is to be improved and raised and in so doing encourage the population at large to more fully appreciate the global interactive nature of the *environmental problematique*.

In that sense, the term "environment" is not a residual, but an entity which incorporates attitudes, values, institutions, economics, science and technology, and ideology.

Environmental indicators should reflect that holism and their interactive dependencies. However there is much resistance to this … and many remaining challenges.

Introduction

There is no shortage of data, information (which is not the same thing)concerning environmental problems and challenges. If anything there may be too much information from which the general public, the educator, the environmental agency, industry, commerce, the politician, the would-be-policy-maker has to select. This presents its own problems of organisation, collation and selection and assimilation. In collating and organising environmental knowledge/indicators then the intended *audience* should be kept uppermost in mind. Whilst in terms of selection and assimilation then the *source* of data/information should be carefully considered and judged by the reader, the "assimilator".

For unlike the physical and natural sciences, data can be highly selective, if not biased. Thus the data presented by an auto-manufacturer (" … the exhaust fumes emitted by the car … are purer than the air entering into the carburettor … ") may well give a different picture to that provided by an environmental agency data sheet … or different again from an even more aggressive NGO.

The school teacher taking an environmental class; the politician considering impending legislation; the international "global environmental statesman" (if we concede for a moment that such an individual exists); the automobile or power-station designer … . all of these require differing levels of complexity and depth of commentary when trying to absorb "environmental knowledge", "environmental indicators".

Also there now exists a multitude of media-dimensions: computer networks, data banks; CD- ROMs; texts; videos; newspaper and journal articles (both popular and specialised); environmental agency broadsheets and texts; monographs or whatever … from which to chose. Thus, as I indicated, the problem may be more of information-overload (too much data) rather than a paucity of data or information from which to chose. This was not so a few decades earlier when environmentalists were struggling to assemble their information regarding the environment, ecology, systems interaction. . at local, regional, national, international and global levels. The amount of **data** we now possess is gargantuan, though still not exhaustive. Thus there are still disputations regarding (say) the extent to which, the rate at which, desertification is advancing … and its causes; there is still disputation regarding whether or not global warming is "real" (which is not the same thing as disputation regarding the "greenhouse effect". . which cannot be denied); we are still ignorant regarding the risk implications of GMOs … Thus data has to be qualified by argument and interpretation.

Nevertheless, despite argument and disputation, very few societal actors would now deny that the world faces major environmental problems in numerous spheres: water pollution; agricultural misuse; soil erosion; loss of fauna and flora; atmospheric pollution; urban decay; toxic wastes; irrational patterns of energy and transport usage; recycling needs; life-cycle accountability and life cycle accountancy needs; third world despoliation; global warming; ozone depletion; numerous physical and social aspects of both urban and rural life style. Thus most people – the general public, politicians, industrialists … all recognise *to some degree* that there is a major "environmental problem" which necessitates regulations, legislation, better design of products and systems, energy conservation, better use of materials, preservation of fauna and flora, more careful attention to food additives, animal husbandry and related agricultural techniques. Similarly, such major "issues" as relate to BSE or GMO initiatives herald a new wave of concern. To state all of this implies, as we all know, that "environmentalism" is very much on the political agenda and part of the "public realm of consciousness" … much more so than was the case in earlier decades when the likes of Rachel Carson or John Muir or Meadows and Meadows of this world were signalling a wide range of environmental concerns.

Where then lies the problem? Is there insufficient environmental awareness and consciousness? Are there significant challenges and barriers to the communication of environmental knowledge or indicators? If so what form do such challenges take, what forms of obstacles and barriers exist? Are the barriers and obstacles of a valueative, an attitudinal nature? An institutional nature? An ideological nature? It is those questions which we address here.

The communication of environmental problems

First, I would make the point that that with respect to 'communication' which is aimed at improving environmental consciousness or awareness there are *two* tasks : one is to *provide information*, data, of the best possible form and of the greatest scientific legitimacy; the other task is, essentially, one of propaganda – it is to *persuade* people of the necessity of change. Those two tasks obviously interlink (persuasion is more easy if the data is sufficient, solid and impressive) but that second task of 'persuasion' is by far the more difficult. This is because persuasion implies a 'change of attitude and of value'. But why should people change, and according to whose logic or perview? And to what degree?

It is with respect to the latter (to what degree) that we encounter a formidable problem. This is because the environmentalist himself or herself may (does) have mixed feelings as to what is "societally necessary" or even "obtainable" … and hence to what degree he should attempt to persuade, propagandise or cajole his audience. We readily encounter this problem (which is essentially one of a 'dimension of radicalness') when we consider or compare the data/work (say) of a Meadows (Limits to Growth) or a Rawls (Intergenerational equity) or a Friends of the Earth publication or a text from the State of the World archives, or a contemporary UN or UNESCO publication, or a Department of Environment data sheet. For if you read one document then data may well be provided which would suggest that Western society should abandon reliance upon the private automobile, whilst if you read another less radical document you will be presented with data which suggests that "satisfactory environmental indicators" will be achieved by reliance upon three-way catalytic converters to improve fuel emissions perhaps coupled with improved fuel efficiency.

Meanwhile the low price of automobile fuel (in a normalised inflation-corrected sense), plus the intention of such countries or regions as China and Latin America to rapidly expand their car fleets … will ensure that any temporary qualitative gains made by incremental technological innovation will be more than offset by quantitative growth in the global car-pool. And since the global atmosphere knows no boundaries to carbon dioxide, or nitrous oxides, or unburnt hydrocarbons … then a true global indicator of environmental degradation would give a different picture to that of localised West European or North American gains. Such an analysis would of course move the 'debate', the 'environmental debate' towards issues of technological diffusion rates, technological substitution rates, needs for new forms of North-South co-operation, new trade patterns, new economic frameworks, more pro-active Rand D, international environmental agencies which encourage such R and D etc . Thus one would then be entering a new era and a new arena as to *what is understood by environmental consciousness* (and hence what the nature of challenges or barriers to the communication of 'environmental knowledge or indicators'. . really is).

What I am saying here is that if the major task of the communication of the environmental challenge is to persuade, then one must consider carefully what it is that one is attempting to persuade – and why. This in turn will determine the scale of communicational challenge, the forms of data collection which comprise the indicators and the nature of appropriate indicators (economic, social and physical), the forms of understanding and awareness which one wishes to encourage.

Such an approach or analysis will also reveal, or at least illustrate or highlight, where there is insufficient environmental awareness; or an apathy; or a condition of benign acceptance of environmental progress reflecting an unwarranted complacency. . unmerited by the actual state of affairs.

Thus the public-at-large, or the politician, or an environmental agency, or the corporate representatives of an industrial sector, may well feel that if X% improvement of the quality of drinking water, or Y% improvement in the condition of sewage disposal on the coast line, or Z% improvement in CO, HC or NOx levels in the urban region is obtained, or K% reduction in Pb-emissions, or T% improvement in the recycling of materials is obtained such that 95% of the body weight of an ELV pertains … . . then all is well … . and "sustainability" … the environmentalists El Dorado … is well on target. Viz. that we are going in the right direction at a satisfactory speed …

But at a deeper level of global analysis, with a much richer data-bank of information which is of an economic, demographic and socio-economic-technological *interactive* nature … then this may well indicate the more fundamental nature of the environmental problem. And in so doing thereby reveal a misplaced complacency which requires on the part of everyone a deeper, fuller, environmental awareness.

But that would then reveal new much more *challenging challenges* with regard to the need of policy changes, life style changes, industrial and commercial changes … and fundamental changes in the mechanisms and framework which presently guides and controls the global environment.

Indeed the main challenge would undoubtedly be for the public at large, and the involved politician, and the dedicated environmental agency … to recognise and act upon with a sufficient scale of commitment to the problems and form of the global interactive nature of the "environmental problem". This of course has been the essential message of many earlier and contemporary global studies : ranging (say) from the seminal Brandt Commission studies through to the more recent EU study "Global perspective 2010 – tasks for science and technology". In all such studies the message is essentially the same: the *global* i*nteractive* nature of the *global* environmental problem; the fact that the physical environmental problem to which so many attend is rooted in an *attitudinal, valueative, institutional and ideological framework* … . . and that the real challenges, the real communicational challenges and barriers relate to, and must address, these deeper levels which underpin everything. Environmental indicators which merely tabulate the symptoms of a disease, important though they are, are insufficient. The need is to dig much deeper into causes, not just symptoms, and in tabulating 'causes' to indicate the dynamics and interactions of the causation. For example, it may be that incremental 'band-aid' technological innovation with respect to automobile design and production actually *accentuates* the related environmental problem by extending the societal life or adherence to a transport system which in its present form may 'kill' large areas of the planet. The requirement then is to provide deeper, more meaningful environmental indicators … beyond (say) emission statistics.

Or, yet again, with respect say, to civil applications of nuclear energy … improved design (and hence safety/risk relating to a nuclear power station) does little to solve the nuclear waste problem The requirement then would be not only to provide safety statistics, safety indicators … but rather the amount of money, scientific manpower … which is addressing the waste disposal problem. I am not aware of such statistics or a dynamic, temporal-change tabulation of that need.

In that sense lack of societal imagination, insight, may be a barrier … and a challenge (sometimes addressed by the more radical NGOs, but not always).

But if we do address more fundamental 'valueative, institutional and ideological frameworks' in formulating our environmental knowledge and indicators then this raises equally fundamental economic and world trade questions. It raises educational and scientific-capability questions. For example, it implies that because of the importance of indigenous scientific and technological capability in *developing countries* (as a means to improving the physical environment) that socio-economic indicators relating the development of such human resources and capabilities may be of more relevance than indices of the quality of land, sea, water, air or soil or forests in such countries. This is an *additionality* requirement however. The base statistics are invaluable to focus our attention on need … but they must be supplemented by the "mechanism" statistics … which reflect the ways in which environmental problems both emerge and may be tackled more effectively. We should constantly remember with respect to our reference to developing countries that they account for over two-thirds of the world's population, … . the environmental dimension is therefore enormous both in its own right and in a global interactive sense.

Similarly social indicators relating to "dualism", to economic dependency ratios, to demographic factors are of critical importance to an understanding of the environmental problem and future pressures. . thus our net has to widen as does our level of understanding.

In short the challenge regarding the communication of environmental knowledge/indicators is to move constantly beyond the 'surface', symptom, indicators towards deeper social, economic and attitudinal indicators. But that challenge has to be coupled with the equally difficult conceptual and psychological or valueative challenge of constantly explaining to both public and politician (or stated more accurately. . the political process) the nature and form of that global environmental interaction.

This therefore requires not only tables of statistics, piecemeal histograms of (say) CO_2 emissions per person per country; or ozone depletion rates by year; or a pie-chart of CO_2 sources relating to transport; or annual rates of pesticide use; or indices of water clarity or number of prohibited bathing areas; or tonnage of nitrogen per unit area of land mass; or lists of mammals, birds, plants, lichens or butterflies "red-listed" for extinction; or household consumption indicators … Whilst these statistics are useful indicators … that is all they are … indicators. What is equally and urgently required, for example, is data on the effects of international pricing on trade; the rate of diffusion of new technologies; the legislative and economic barriers to knowledge diffusion and how this changes over time; details of S and T development and again rates of diffusion; R and D statistics, not of a an aggregate form but detailing environmental research etc.

All of that has to be viewed in global terms which emphasises North-South interactions; the more so since the consumer policies of the North carry enormous environmental implications for the South. . which in turn feed back onto the North (or will do in a few years or decades time). This sort of data or socio-environmental indicator I will refer to as *Second Order Environmental Indicators* in order to distinguish then from the *First-Order "symptom " data*. There is also need of *Third –order socio-political, valueative data* relating to values, laws, legislation (and their influence, effectiveness, failure points, obsacles and barriers … and the underlying rate of change). With all of that data, those different levels of indices, or knowledge, or indicators we can then be in a better position to see and understand where we are going and where we are not going … and how fast or slow and with what implications or potential catastrophes. Viz. what barriers remain, what challenges lie ahead.

Resistance and barriers

By and large industry and commerce does not 'resist' environmental legislation or regulation. On the contrary whilst it sometimes fights a rear-guard action campaign it also does much to set the environmental agenda. Indeed industry often assists in setting those regulations … advising what is feasible or practicable with present day technologies (this is naturally both a strength and a weakness – and the form and degree of involvement and collaboration varies a great deal from country to country). Industry becomes involved in so-called voluntary agreements; in adjusting Rand D budgets to comply with new regulatory requirements. Often its main concern is not so much the "absolute value" of a particular environmental legislative requirement rather than the uncertainty of the timing of the legislation and the form that it will take.

Similarly, the public do not resist (say) the recycling of paper, of bottles or automobiles. They are prepared to pay for catalysts on their cars or for better more environmentally-friendly packaging. They are, in the main, prepared to pay a little more, but not that much more, on their energy bills if SO2 scrubbers are fitted to electricity power generating stations, or if a fuel tax is introduced to encourage conservation of energy. But such legislative limits and the reactions to those limits are at the margin and are socially incremental. If, however, a more fundamental understanding of the global environmental problem, in both its spatial, geo-economic and temporal senses, was actively used as a guideline for legislation and if this impinged upon the public and industrialist's psyche or consciousness … and if with that understanding … . if it was more deeply appreciated what this would imply in terms of (say) the true environmental cost of commodities, of raw materials, of open-cast mining, of single export crop economies (in terms of the costs of environmental degradation). . in Third world countries; or the true challenge to introduce mass transit systems which might displace reliance on the automobile; or the true need of entirely new agricultural systems which do not rely on energy-intensity or chemical-intensity or animal-farming-factory techniques … . then one would almost certainly encounter individual, public, industrial, economic and political barriers on a scale which would dwarf and resist any fundamental policy change. It is then that one would encounter the real nature of vested interest, of personal self-interested welfare … and indifference to the wider global environmental challenge.

To radically change (or call for change) in employment habits, consumer trends, mass production reliance, international market structures – which have taken nearly three hundred years to assemble – is a gargantuan, if not impossible task. Yet it is what the "environmental consciousness" of many well informed environmental experts or specialists call for, or argue for, in relation to planetary survival.

If we accept their perspective, then the real challenge is to seek effective means of transmitting that environmental awareness of the informed specialist to the public at large, to the politician and to the industrialist. This implies that we constantly aim to seek out, indicators and interactive arguments – the second-order and third-order indicators referred to earlier , since single piece-meal indicators are not adequate in that respect, as a means of going well beyond the more parochial task envisaged by most environmental agencies.

It is not difficult to see that in relation to that scenario, that whilst on the part of the general public there is much environmental awareness there is insufficient understanding or acceptance (the same applies to the public's appointed leaders … the politicians) of the true nature of the global problematique. There are many obvious reasons for the lack of acceptance … hedonism and localised short-term self-interest play a big role … and outweighs any deeper morality: Rawls is not on the political agenda; Hirsch's social limits to growth is not part of the public psyche … short term self interest dominates.

In terms of an 'improved understanding', this raises very big challenges with respect to both formal and informal education at all levels: schools, colleges, universities. It carries implications for the media and for all forms of publication. It carries implications for the ways in which industry and government converse with each other. It carries implications for the economic, political agenda. It carries implications with regard to Rand D (in both its public and private arenas). It carries implications for the technological trajectories which we might seek and it carries implications for the remit of environmental agencies and NGOs. It carries, above all, implications for North-South relations and future development paths.

Above all it implies that the term "environmental awareness" is not seen as something 'without' … . a way of thought to be tacked onto the main agenda of life. . some form of attending to unwanted externalities; not something which is a marginal issue, an "after-issue" … but rather as *the central factor*.

Environment is not an "issue". It is life itself. Life is the environment and the environment is life. In terms of awareness, therefore, as we move into the 21st Century the need is not to intellectually compartmentalise such terms as economy – technology – science – life styles –the physical surroundings and attachments of life … . but to view all of this as an interactive, interdependent entity. This is not to resort to some form of Gaia philosophy, rather it is to recognise that a true, legitimate, meaningful environmental awareness emerges which seeks to link attitudes, values, social structures, economic systems … with technology, commerce, industry, transport, energy generation, housing, agricultural systems, water … and to place all of this deeper understanding and awareness in the framework of the global economy which determines much of our environmental demise. The whole "twentieth century entity" is captured in that deeper framework *and hence indicators have also to capture that deeper rationale.*

In recent years some attempts have been made to derive analytic frameworks, indices and measures of the global condition and its future pressures - but much remains to be done. It requires a multi-disciplinary and interdisciplinary effort on a very large scale. It implies the need of enormous data collection and analytic power. As a society we have that ability – and in some quarters the understanding or at least an embryo of understanding, in both an analytic and integrative sense. It is in no sense an impossible task , but it is a very necessary task.

Competing ideologies, competing views, competing challenges

There are, not surprisingly, several competing perspectives as to the seriousness of the global and regional "*environmental problematique*". Not all would agree that the planet is threatened and increasingly threatened with environmental demise. For instance President Reagan, some time ago now, considered that " … we have cracked the environmental problem. . " . Deregulation in many forms ensued. It is not known what environmental indicators influenced or derived from that perspective.

Lady Thatcher when Prime Minister of the U. K. took a similar view and apparently considered that radical environmentalists were some form of 'enemy within' … but later changed her views and came to accept the environmental issue as a major global challenge.

Table 1 below suggests that we can in no way succumb to complacency. As indicated in Table 1 we have lost the equivalent of one India, one China … there are not that many Indias or Chinas left.

Table 1: Planetary degradation despite environmental protection efforts of national governments over the past twenty years.

Population growth	Since 1979, 1600 million people have been added to the world's population (more than inhabited the planet in 1900)
Loss of fauna and flora	Thousands of plant and animal species which we shared the planet with in 1970 no longer exist.
Forest loss	Since 1970 the world has lost in excess of 200 million hectares of tree cover (equivalent to an area the size of the US east of the Mississippi river).
Increasing deserts	Deserts have expanded by 120 million hectares, claiming more land than is currently planted to crops in China.
Soil erosion	The world's farmers have lost an estimated 480 billion tons of topsoil (equivalent to that in the cropped land of India).
Proliferation of cars	The total 'world car park' is estimated to double by the first decade of the next century.

Source: Whiston T. G. in *Outlook on Agriculture,* Vol. 22, No. 4, 251-256.

Similarly there are competing views as to "remedy". Those of the technical fix school of thought (e.g. the late Hermann Kahns of this world … and many technologists) have considerable faith in science and technology to solve everything … and they produce indicators and agenda to fit into that viewpoint. Devotees of that school of thought have faith in biotechnology, genetic engineering, GMOs, low energy catalysis, nuclear-fusion technology, alternative energy systems … as the main route(s) to global salvation. Others see population control, through the wide application of birth control programmes as a major indices of environmental improvement. Malthus, neo-Malthusians, technical fix perspectives, socio-economic adjustment, environmental equilibrists … there is no limit in competing interpretations and subsequent recommendations. All are based on their own selective use of indicants in one form or another.

In all of this, indeed in all cases, one of the important requirements is to derive socio-environmental statistics (as well as social forecasts) as to the likely future trajectories which we *might* expect. But as argued earlier those statistics, those indicators, must be compiled with deeper concern, deeper environmental concern, awareness and comprehension. That deeper analysis needs to consider not only the physicalities of life but also the implications, as best as can be foreseen, of both policy change or technological breakthrough and the linkage of technology with societal parameters in many forms (viz. the second-order indicants referred to earlier).

Consider, for example, the possibility of excessively cheap energy produced , say, by an environmentally friendly route (solar energy with high conversion ratios). This would most likely imply that if the energy was so cheap, then as the energy cost component of industrial production reduced then greater mass production of goods and services (and hence sales) would ensue. This in turn would carry environmental penalties in other areas …

Similarly , biotechnology and GMOs may solve many things, but they open up new corridors of risk which may in the end floor mankind completely. All of this demands detailed debate, detailed public awareness and understanding, open and thorough indicators at many levels of discourse (viz. first, second and third level indicators).

But here we see another form of difficulty and challenge (though C. P. Snow pointed to much of its form in his two cultures perspective and analysis wherein he distinguished between the two cultures of the scientist and humanist or politician). It is the problem of 'specialised knowledge' and 'public understanding'. The media can play an important role in bridging the gap between specialised knowledge and wider public understanding (if supplied with clear scientific knowledge and appropriate indicators) of science and technology issues. But there is a limit to that translation problem. Non-scientists (and politicians, despite the use of select committees) can pretend that they fully understand the implications of (say) DNA-modification, GMOs, nuclear waste problems … but there is invariably a level of trust involved (and hence risk taking) which is not easily assuaged. Much effort (though not enough) presently goes into the "public understanding of science" … but there are limits to what can be done. Thus many non-specialists *believed* the neo-Malthusian message of Meadows and Meadows regarding the planetary limits to growth … and that book sold *millions* of copies.

Subsequent detailed critique (e.g. Such texts as: *Thinking about the future: a critique of limits to growth; World futures :the great debate; The uses and abuses of forecasting*)emerged. . but sold in their limited market … perhaps a few thousand copies. Public debate, therefore, can be somewhat skewed … and competing perspectives do not always operate on a level playing field.

In earlier days the nuclear lobby was extremely powerful (which it still is) and the voices of dissent were often drowned. The present day auto-lobby is exceedingly powerful and natural public tendency plus enormous advertising (compare in the press the ratio of space given to auto advertisements to those of environmental critique … it is probably of the order or 1000:1. . itself a useful second order indicant) which thereby drowns environmental critique … or at least relegates it to the margin. The "radical" is therefore tamed. The same can apply to environmental agencies (who often supply statistics and environmental indicators) – they can be "captured" or "neutered" thereby serving governments which are often a surrogate for commerce.

All of this implies that "environmental awareness" requires the most open public involvement fed by sets of indicators, discourse and analysis that is as full and extensive as possible. It also implies that environmental agencies (and their informational counterparts) are proactive rather than reactive.

To some degree NGOs, publicly funded environment bodies (e.g. The Friends of the Earth; Greenpeace etc.) provide a valuable alternative information source … but even that is not enough.

Nearly fifty years ago Rachel Carson achieved much with one single book. A century ago John Muir single-handedly was instrumental in saving much of the countryside of North America. It does not always, therefore, have to be an organisation … with masses of data. .

Fifty years ago President Eisenhower pointed to the dangers of the "military-industrial complex" and its effects upon freedom. In environmental terms we might now refer to the 'socio-corporate complex' which controls much information and most of science and technology. Here again we see the need of an enlightenment of environmental debate in the most fundamental terms … and new indicators of concern.

Conclusion

Thus what we have suggested here is that there exists much "environmental awareness" and numerous data and indicators but their 'reach' is insufficient. More depth regarding what indicators attempt to capture must be considered. We have referred to these as second and third order indicators. They go beyond the physical to the valueative, the social, the economic realms. Special vested interests should be supplemented by wider, more meaningful data banks and environmental indicators should go well beyond representation of "symptoms". That way there is the possibility, if not the actuality, of a fuller environmental consciousness.

In a text entitled *'Organisation theory'* (ed. O. E. Williamson) which was written to commemorate the pioneering work of Cheester I. Barnard, Barbara Levitt and James March wrote:

"This volume honours a book by Barnard (1938), *The Functions of the Executive*, which has had an enduring influence. The book contains the seeds of several of the more important developments in organisation theory over the past fifty years … . In effect, Barnard distinguished conflict systems from co-operative systems. A conflict system is one in which individuals have objectives that are not jointly consistent. It organises through exchanges and other interactions among strategic actors. A co-operative system is one in which individuals act rationally in the name of a common objective. The problem of organising was seen as one of transforming a conflict(political)system into a co-operative (rational) system.

Barnard recognised that such a transformation was a non trivial problem … Barnards analysis of this problem of organising anticipated much of the contemporary theories of organisations. *In particular he emphasised that co-operative rationality presumed knowledge, and he saw the limits of organisation in* securing *and attending to information* (my emphasis). Thus, he is correctly seen as a forerunner of those parts of organisation theory that emphasise the cognitive limits of information processing in organisations. Even more, he anticipated the complications of conflict. He saw the significance of strategic action on the part of the self-interested actors in organisations and the difficulty of discovering and negotiating jointly satisfactory sets of exchanges and agreements"

This has much resonance with some of the problems which I have indicated earlier – resolution of differing views of the public, of commerce and of environmentalists; the problem of cognitive limits to information overload; the problems of reconciling the needs and interests of "North" and "South" in environmental, social and economic terms. The need for conflict resolution and the role of knowledge in that resolution. In an earlier paper entitled "*Knowledge and Sustainable Development: towards the furtherance of a global communication system*" (in *Information Society* ed. K. Gill) I indicated that information is not simply a task of just considering the 'sender' and the 'receiver' (of say environmental indicators or knowledge) but is a much, much more complicated process where many forms of information distortion can ensue (see Figure 1 below).

Figure 1: Stages of sophistication in understanding the communication process

(1) Sender --------→ Receiver

(2) Sender --- Channel capacity ----- Receiver

(3) Sender ---- Channel capacity ---- Receiver

/

Noise

(4) Sender --- Encoding process --- Channel capacity --- Decoding process --- Receiver

/

Noise

(5) Collection of information — Encoding Process — Channel Capacity — Receiver — Decoding Process ---
--- Diffusion of message.

(6) Intentions of Sender — Collecting of information --- Encoding Process — Channel capacity ---
--- Message to numerous receivers.

(Adapted from Whiston 1996 Knowledge and Sustainable Devlopment: towards the furtherance of a global communication system).

Now, in relation to the decoding and encoding of information in a global setting, the problem is many times worse and involves many actors (see Figure 2 below)

Figure 2: Global communication for sustainable development: factors influencing knowledge and technology transfer.

The NORTH

- knowledge embedded in organisational structure and social relationships
- the relative location of knowledge in the public and private sectors
- Sand T primarily defined by the North's needs
- Lack of volition to communicate
- IPR

ENCODING

- the influence of tacit knowledge
- the problem of translating tacit knowledge from one culture to another

COMMUNICATION CHANNEL (N. B TWO WAY REQUIRED)

- the role of international technology and knowledge transfer agencies
- the role of collaborative international S&T
- the exchange of scientists, engineers, policy makers in an international setting
- the need of common global concern and mutually dependent economic, commercial
- and technological policies
- public channelled; private channels influencing information transmission

SOUTH

RECEPTION (DECODING)

- Indigenous capability
- Relevance and irrelevance of education systems
- Local learning institutions and networking
- Self serving bureaucracies
- indigenous infrastructure
- tacit knowledge decoding problems

INTERNAL DIFFUSION

- indigenous infrastructure
- networking
- timescale of learning

Source: adapted from Whiston 1996.

If we are to achieve global 'sustainable development' (which implies much radical change in science, technology, life styles) then more effective knowledge and technology transfer is a requirement *sine qua non*. Conflict(political) of 'North' and 'South', in the sense of economic competition, has to become Barnard's co-operative (rational) system. This implies that the knowledge, understanding, information that is *sought* by and *generated* by appropriate, deep, meaningful, environmental indicators … be more fully achieved than is presently so.

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The Danger of Continuing Economic Growth in Rich Nations: Ecological Costs With Diminishing Returns on Quality of Life

Jan Ott

Economic growth is usually assumed to contribute to the quality of life. One objection to this assumption is that the costs of economic growth, in terms of depletion of natural resources and pollution, are underestimated. These costs are often "external" in the sense that they are not expressed in prices. But there is a more fundamental objection. If quality of life is measured in terms of subjective wellbeing or happiness, it appears that the contribution of extra wealth is diminishing if certain levels have been reached. Other factors, like certain types of freedom in economic, political and personal affairs, have a more constant effect on the quality of life. In rich countries people should therefore be critical about the general value of growth and should try to develop more specific values or purposes in life. For example the development of poor countries, protecting ecological sustainability and improving certain types of freedom.

In order to stimulate such a change in attitudes it's important to take two steps:

1. Accept explicitly, like utilitarians do, subjective wellbeing or happiness as an important value within the context of the quality of of life. This is a normative and therefore arbitrary choice that requires some elucidation. There is no need to make this an exclusive or unconditional choice. While supporting happiness as an important value one can still support other values like freedom, religiousness or health. A well-known issue in utilitarian discussion is whether one may make people happy if this requires limiting their freedom. This might be an academic discussion since freedom and happiness show positive correlations. But if it's more than an academic discussion one might agree that happiness is important but that the pursuit of happiness never justifies any limitation of individual freedom. Once happiness is accepted as an important value one evident next question is: "whose happiness?". The least controversial answer is: "happiness of people in general" and this includes not only the contemporary world-population but also the next generations. Accepting happiness as a value implies therefore that one protects conditions for happiness for next generations and this requires attention for ecological sustainability.
2. If one considers happiness as an important value one must try to measure or assess happiness, and differences in happiness, to understand what factors determine happiness. Understanding these factors can help to develop policies that maximise happiness. This is an important step. Many people, including politicians and policymakers, accept implicitly happiness as an important value and even consider "quality of life" to be more or less as equivalent to happiness. But they fail to assess happiness and the underlying factors. Instead they work with implicit assumptions about the effect of certain factors on the quality of life. Factors like wealth, employment, educa-

tion, equality and social security are accepted as indicators for quality of life. But the effect of such factors on happiness shouldn't be taken for granted. These factors are potential input for the quality of life but their actual effect must be assessed by empirical research.

As Ruut Veenhoven and other scientists have demonstrated it's possible, notwithstanding several methodological problems, to assess happiness and to explain the results. This includes the possibility to assess the average happiness in nations. This average happiness and the average length-of-life indicate how well people actually flourish. By multiplying the average happiness in nations on a 0-1 scale with registration based estimates of length-of-life Veenhoven constructs an indicator for the apparent quality of life: the "Happy Life-Expectancy" (HLE). This HLE can be interpreted as the number of years the average citizen in a nation lives happily at a certain time. A theoretical justification can be found in the first part of Veenhovens article "Happy Life-Expectancy, a comprehensive measure of quality-of-life in nations", page 1-24; published in Social Indicators Research, 1996, Vol. 39, 1-58.

Once we have HLE-scores for a sufficient number of nations we can identify factors that help to explain differences. The contribution of extra economic wealth (real GDP per capita) to HLE-scores appears to diminish after certain levels of wealth are reached. This diminishing returns of economic growth constitute a strong argument to be more critical about economic growth in rich nations and the ecological costs that go with it. Formulated in a positive manner: these diminishing returns create room to choose alternative goals, like development in poor countries, sustainability and certain types of freedom.

Appendix: HAPPY LIFE-EXPECTANCY

A comprehensive measure of quality-of-life in nations[1]

Ruut Veenhoven[2]

A longer version of this article has been published in Social Indicators Research, 1996, Vol. 39, 1-58.

Abstract

One of the aims of social indicator research is to develop a comprehensive measure of quality-of-life in nations that is analogous to GNP in economic indicator research. For that purpose, several multi dimensional indexes have been proposed. In addition to economic performance, these also acknowledge the nation's success in matters like schooling and social equality. The most current indicator of this type is the 'Human Development Index'. In this approach QOL is measured by input; the degree to which society provides conditions deemed beneficial. The basic problem is that one never knows to what extent the cherished provisions are really good for people.

An alternative is measuring QOL in nations by output, and consider how well people actually flourish in the country. This 'apparent' QOL can be measured by the degree to which citizens live long and happily. This conception is operationalised by combining registration based estimates of length-of-life, with survey data on subjective appreciation-of-life. Life-expectancy in years is multiplied by average happiness on a 0-1 scale. The product is named 'Happy Life-Expectancy' (HLE), and can be interpreted as the number of years the average citizen in a country lives happily at a certain time.

HLE was assessed in 48 nations in the early 1990's. It appears to be highest in north-west European nations (about 60) and lowest in Africa (below 35).

HLE scores are systematically higher in nations that are most affluent, free, equal, educated, and harmonious. Together, these country-characteristics explain 70% of the statistical variance in HLE. Yet HLE is not significantly related to unemployment, state welfare and income equality, nor to religiousness and trust in institutions. HLE does not differ either with military dominance and population pressure.

The conclusion is that HLE qualifies as the envisioned comprehensive social indicator. It has both clear substantive meaning (happy life-years) and a theoretical significance (ultimate output measure). HLE differenti-

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[1] This paper was prepared during my stay at the Wissenschafts Zentrum fhr Sozialwissenschaft Berlin, Germany. An earlier version was presented at the International Conference on Quality-of-Life at the University of Northern British Columbia, Prince George, Canada, August 1996.

[2] The study reported in this paper is part of a broader research program on cross-national differences in quality of life at Erasmus University. Other investigators are Joop Ehrhardt, Pietrika Okma, Piet Ouweneel and Peggy Schyns. Anton Kunst added also to this paper by his valuable comments.

ates well. Its correlations fit most assumptions about required input, but also challenge some. The indicator is likely to have political appeal.

INTRODUCTION

In the first half of this century, quality-of-life in nations was largely measured by the material level of living. The higher that level in a country, the better the life of its citizens was presumed to be. As such, quality-of-life was measured by GNP related measures, currently by 'real' GDP per head.

This materialistic conception of QOL was never unquestioned, but criticism long remained marginal. Yet in the 1960's, the opinion climate changed. Saturation levels were reached and the ecological limits of economic growth came in view. This gave rise to a call for broader indicators of quality-of-life, which materialised in the so called 'Social Indicator' movement. The name of 'social' indicators signifies that the mere economic performance does not suffice.

From its beginning, one of the aims of Social Indicators Research was to develop a social equivalent to the economist's GNP. Several measures have been proposed since.

Current measures of Quality-of-Life in nations

Though social indicators research arose from discontent with economic indicators, most alternative measures do involve material 'level of living'. They add further criteria. The new social indicators of quality-of-life differ in the criteria which they add and how many. Exhibit 1 provides an illustrative overview. Similar indicators of this kind have been proposed by Drenowski (1974), Liu (1977), Mootz (1990), Slottje (1991) and Kacapyr (1996), to mention a few.

As yet, none of these indicators reached acceptance comparable to GNP, neither in the realm of politics, nor in the scientific world. The Human Development Index is still the most accepted one in this class, but it is also the least different.

Problems with these measures

The reason for this lack of success is not only found in the continued dominance of materialist views, but also in several weaknesses of this generation of indicators.

Arbitrary selection

The most evident weakness is the selection of aspects of QOL. There is difference in number of aspects and in content of aspects involved.

As we can see in exhibit 1, the Human Development Index suffices with 3 aspects, whereas the Index of Social Progress involves 11. Estes tried to include as much information as available in national statistics. Yet is more better? Should we include all things ever associated with QOL? Obviously inclusiveness goes at the cost of substantive meaning.

Exhibit 1: Some current measures of quality-of-life in nations

Criteria for QOL in nations	Examples of QOL indexes			
	Index of Social Progress (ISP) (Estes 1984)	Index of well-being (Kacapyr 1996)	Quality-of-life index (Narrol 1984)	Human Development Index (HDI) (UNPD 1995)
Economic affluence	x	x		x
State welfare	x		x	
Education	x		x	x
Public health	x		x	x
Social equality	x			(x)[3]
Peacefulness	x	x	x	
Physical habitability	x	x		
Social stability	x		x	
Cultural diversity	x		x	
Lifestyle		x		

Yet selection requires choice, and choice for one aspect or another is difficult to argument. The example of divorce may illustrate the problem. Divorce-rate is part of the indexes of Naroll and Estes, but does not figure in the other indexes. Should it be included? Divorce is clearly no fun and has several negative consequences for affected children and society. Yet dissolution of unsuccessful marriages has advantages as well, particularly in highly individualised societies.

Arbitrary weights

Next to the question whether divorce rate should be counted positive or negative, there is the question whether it is more or less important that other items in the index. For instance: is divorce-rate more important than murder-rate, or less important than GNP?.

Still another problem is that relative importance is mostly not the same everywhere. As suggested, the effects of divorce may be more positive in highly individualised societies. That means that its weight should in fact be variable.

Current indexes do not acknowledge such complications. They simply count items either positive or negative, and give items the same weight, irrespective of the situation of the nation. In the Human Development Index for instance, schooling counts equally strong as GNP.

3.The Human Development Index is also available in a version with gender equality included, called 'Gender-sensitive HDI). See Human Development Report 1992 table 1.3.

Limited universal relevance of items

This brings us a more fundamental problem: Most items do not have the same significance across culture and time.

Some of the items in current QOL-indexes seem to be valued everywhere. For instance 'economic prosperity' and 'high life-expectancy', though even on these matters there is difference in degree of adherence. However, on many further points disagreement prevails. For example on women's rights. Several countries see that as a sign of decay (like divorce) rather than as quality-of-life.

One can discount that problem by saying that value-free measurement of QOL is not possible, and admit that one measures the quality of the world's countries by current Western values. Yet, the political use of the indicator is clearly limited by such disagreements.

Yet another problem is that most of the items tend to loose significance over time. This is for instance the case with 'education', which seems subject to the law of diminishing utility. Schooling for everybody is clearly better than mass-illiteracy, but should we call the quality-of-life in a society better if 50% of its citizens receives university education rather than 15%? Possibly over-education can even reduce the quality-of-life. Likewise, gains in economic affluence become less relevant when society becomes more affluent. In fact, items appear on the QOL-list if they are problematic at some point in history, and should therefore be omitted if no longer pressing.

One can dispose of the problem by saying that present day indicators suit present day problems. Still it is preferable to have an indicator that allows comparison over time. How else can we judge whether QOL improves or not?

No clear meaning of sum-scores

GDP per head has a clear substantive meaning. It indicates the amount of goods and services the average citizen can purchase. The indicator may labour some technical imperfections, but it is at least clear as to what it is about.

That is not the case with current 'social' indexes of QOL. The sum-scores reflect the degree to which different notions about the good society are met, but not which notions precisely. They reflect mixed quali<u>ties</u> rather than one quali<u>ty</u>. In other words: these measures provide a 'quality profile', but not 'inclusive value'.

Some of the indexes are in fact more specific and equate quality-of-life more or less with 'modernity'. They measure in fact the degree to which characteristics of dominant Western society are present in a nation. This may be apt when the aim is to monitor how the nation is doing in catching up. Yet it is misleading to call that 'quality-of-life'. Modernisation should not be equated with the good life. One of the very reasons for QOL-measurement is checking whether 'social progress' leads us to a better life.

Mixing up quality <u>of</u> society, with quality-of-life <u>in</u> society

Most indexes claim to tap how well people live in the country. Labels like 'quality-of-life' and 'well-being' suggest that the focus is on individuals. Items like life-expectancy are indeed indicative of individual thriving. Yet this is less clear with items such as economic affluence or cultural similarity. These things can be seen as good for people, but also as desirable for society. Statements on that matter are typically ambiguous. Still there is a problem; What is good for people is not always desirable for society, and vice versa.

Mixing up means and ends

The most fundamental problem with this generation of QOL-indicators is that they involve criteria of a different order. They do not distinguish between means and ends, nor between societal input and societal output. This can be illustrated with the two items that are part of most indexes: 'economic affluence' and 'life-expectancy'.

Economic affluence can hardly be seen as an end in itself. Command over goods and services may be instrumental in creating a good life, but does not constitute the good life itself. On the other hand, life-expectancy is typically an endvalue. We want to life long because we value life in itself.

In the same vein, supply with goods and services can be seen as a societal 'input', and life-expectancy as 'output'. In the following paragraphs I will argue that quality-of-life in a notion can better measured by output than by input.

Shovelling means and ends on one heap is not only theoretically unsatisfactory, but also reduces the political relevance of these measures. Policy-makers must know two things: to what extent instrumental policy-aims are realised, and whether success in that contributes to higher goals. Sum-scores that mix up these matters do not inform about either. The label of 'quality-of-life' bears the suggestion that some final end is indicated. Yet in practice the items in the indexes are issues on the political agenda. As such these measures say more about advancement in the course taken than about the merits of that heading.

CONCEPTIONS OF QUALITY-OF-LIFE IN NATIONS

The core of the problem with these measures lies at the conceptual level. If we are not clear about what we mean with QOL, we will never have sensible measures of it. Let us therefore consider the various notions involved.

A first thing then is to distinguish between quality *of* nations and quality-of-life *in* nations. In other words: between conceptions of the 'good society' and conceptions of the 'good life'. These notions are related, and even overlap to some extent. Yet they are not the same.

Quality of nations

Current standards for the quality of nations can be summarised in four clusters: 1) stability-criteria, 2) productivity-criteria, 3) ideal-criteria and 4) criteria of habitability. The latter is also referred to as 'quality-of-life in nations.

System-stability

Standards of the good society concern first of all the presence of a stable social fabric. Without society there can be no good society. Applied to nations, this criterion requires that there is order and continuity in the country. In this respect, the quality of many new African nations is currently judged poor.

It is clear that every nation at least needs some stability. Once past a minimum level, preference for more stability or less is a matter of taste. In present day Western societies, conservatives complain about the fast pace of change, while modernists see too much continuity.

The criterion of stability has many aspects (e.g. predictability, constancy) and can be applied on various subsystems (e.g. political system, kinship system). Hence a nation may be stable in some respects, but not in others. This is one of the reasons why there are no comprehensive measures of social stability in nations.

Productivity

Nations are also judged by their yields. In the current discourse the emphasis is on economic productivity. The greater the quantity, quality and variety of the goods and services it generates, the better the country. In this respect East Asian countries are seen to do well, while Western nations are seen to loose their edge. Economic productivity of nations is typically measured by GNP.

Though mostly used for market products, the criterion can also be applied to non-market services, such as family support for the aged on the basis of normative reciprocity. Non-monetary productivity is not reflected by calculations of GNP, and only partly by estimates of 'real' GDP.

In a longer view, the productivity criterion is also applied to inventions, not only technical and scientific discoveries, but also innovations in arts and in social organisation. In this respect we think more of early Greek civilisation than of the Viking's productivity. This latter kind of productivity is not well reflected in GNP either.

Ideal-expression

Another class of criteria concerns the degree to which a nation realises certain values. Early writings on the Good Society emphasised individual lifestyle values, such as 'bravery', 'modesty' and religious 'devotion'. The quality of a society was deemed higher, the more it emphasised such values, and the more its members actually lived accordingly. This view is still dominant in present day 'fundamentalist' thinking. Modern notions focus more on social organisation. Nations are currently judged by the degree to which they allow 'political freedom', respect 'civil rights' and realise 'social equality'.

In this genre, there are as many criteria as there are ideologies. Though innumerable in principle, the actual variation in values endorsed is limited. Present day world-society witnesses a growing ideological consensus around Humanist values (Naroll 1984: Ch. 2.) In fact, there is a strong movement to canonise such values as 'Universal Human Rights'. Some of these notions of quality have been made measurable. In the following paragraphs we meet with indicators of nation-performance with respect to freedom, justice and equality.

Liveability

The last category of criteria concerns the nation's quality as a habitat. 'Liveability' or 'habitability' of a country is also referred to as 'quality-of-life *in* the nation'[4].

Concept 'Liveability' of a nation can be defined as *the degree to which its provisions and requirements fit with the needs and capacities of its citizens*. A nation is not well liveable if, for instance, it fails to meet minimal needs for food, safety and contacts. It is also unliveable if its structure is too complex to handle for most citizens, or if its morals require the impossible.

Human needs and capacities are to a great extent given by nature. Socialisation typically modifies and cultivates parts of our innate possibilities. There are thus limits to human adaptability, which societies cannot ignore. Where bio-physiological needs are concerned this is rather evident. Any society must provide 'food' and 'shelter'. The existence of bio-psychological needs is less obvious, but no less true. Societies must also provide a sense of 'security', 'identity' and 'meaning'.

To some extent societies can mould their members to their provisions. A society that provides little security can socialise to psychological hardiness, and therefore be still reasonably liveable for its members. Such compensation through socialisation is not an automatism however; unsafe societies tend to breed vulnerable people.

Social evolution does not guarantee that all societies are highly liveable. Extremely unliveable societies probably tend to extinction; either because their members die out, or because they desert. However, societies that provide only poor liveability do not always have fewer survival chances. Low liveability can instigate wars of conquest, or mobilise economic effort. Badly liveable societies can therefore become dominant. Critics of modernity claim that is typically the case with present day nation states. Yet there are also anthropological reports of 'primitive' societies that are badly liveable (Edgerton, 1992).

Difference with other quality concepts The criterion of quality-of-life *in* the nation (liveability) overlaps to some extent with the earlier mentioned criteria of quality *of* the nation. Good life for its citizens requires at least some order and continuity in the nation, a minimum of productivity and some congruence between ideal and reality. For that reason, the two quality concepts are often equated.

Yet, a nation can fail to provide a good life to its citizens in spite of high performance on the other quality criteria. In some nations, social stability is enforced by brute repression. Such nations are typically not very liveable. This was the case with former East-European nations. Likewise, highly productive societies can wear their members out. Several social critics see that happen in Japan and the USA (e.g. Schor, 1991). Lastly, the demands implied in some ideals seem to exceed human possibilities. This is illustrated in the failure of 19th century utopian 'communes'. It appeared hard to live with the ideals one lived up to. In the present century the Russian and Chinese revolutions even more spectacularly demonstrated that ideology can be unliveable.

4.The phrase 'quality-of-life in nations' has a somewhat broader connotation than 'liveability of nations' or 'habitability of the nations'. The latter expressions refer primarily to a fit with the needs of inhabitants. The former expression also denotes moral and esthetical qualities of the citizens' life. As such it is closer to conceptions of 'ideal quality' of society (mentioned third). Here, the term 'quality-of-life in nations' is used in the limited meaning of 'liveability' of nations.

Quality-of-life <u>in</u> nations

Quality-of-life *in* nations was specified as liveability of nations. Liveability of a nation was defined as the *fit* of its provisions and requirements to needs and capacities of its citizens. That match cannot be observed as such: the degree to which it exists must be derived from observations of other things. There are two ways to estimate quality-of-life in a nation.

Measurement approaches

One way is to assess the presence of preconditions deemed likely to produce a fit. This involves assumptions about fit-likeliness of living conditions. The focus in this approach is on societal *input.*

The other way is to observe how people actually flourish in the nation, and attribute good functioning to good fit. The focus is than on societal *output*.

An analogy may illustrate the matter: the case of 'fertility' of the soil. If we want to know whether some piece of land is well suited for growing grain ('liveable for grain'), we can estimate the input that soil provides or consider the output it has yielded earlier.

In the input approach, we consider the structure of the soil, its percentage of moisture, the minerals it contains, etc. Because we know fairly well what grain needs and to what conditions it can adapt, we can then estimate the fit reasonably well, that is: predict how well grain will grow on that soil.

In the output approach we consider the harvest; either by retrieving information on earlier crops or by trying. We then look at the quantity and quality of the grain harvested.

Through the ages, fertility of land has been established by finding through experience (output). Only fairly recently did we gather sufficient knowledge on a limited number of plants to specify their necessary living conditions in advance (input).

The living conditions of grain can now be specified reasonably well. Needs and capacities of that species are rather clear cut and have been discovered by controlled experimentation. The necessary living conditions for humans can less easily be specified. Not only is the human organism more complicated and many-sided than grain is, but also are humans much more adaptable. In fact, a major biological specialisation of the human species is its unspecialism, combined with a capacity for learning. Therefore, the possible variation in liveable societies for humans is greater than the possible variation in fruitful soils for grain. Controlled experimentation is hardly possible with humans and human societies. Hence it is also more difficult to discover basic human needs and capacities.

Let us keep these problems in mind and now consider current estimates of quality-of-life in nations.

Input approach: 'presumed' quality-of-life

As we have seen in the introductory paragraph, most measures of quality-of-life in nations assess presence of conditions such as material affluence, schooling, political freedom and social equality. The common assumption is that more of such conditions fits human nature better than less. There are at least two problems with this approach:

The first problem is that the assumed fit is highly questionable in most cases. Consider the example of economic affluence: Does a rich society provide a better fit with individual needs and capacities than a not so rich society? Though people typically 'want' to improve their material standard of living, it is doubtful that they really 'need' to. It is also uncertain whether a rich society challenges human capacities more optimally than one not so rich. In fact, the human species has developed in material conditions that would be judged as poor by present day standards.

The second problem in this approach is the assumption that more of such conditions always denote better quality-of-life. Let us consider the case of social stability. A minimum level of stability is certainly required, too much change frustrates needs for safety and overcharges adaptive capacities. However, a society without any change is not likely to fit either: it will frustrate the need for novelty and leave adaptive capacities under-utilised.

An evident way to avoid these problems is to depart from a well established theory about human needs and capacities and to specify the social conditions that are required to fit with these. This is called the *basic need approach*. Though better in principle, it has brought us little further.

A first problem on this track is that there is no well established theory about human needs and capacities. There is much speculation on this matter, some of which is rather plausible, but little empirical proof. Methodologically, it is extremely difficult to demonstrate what people 'really' need and can.

The currently most cited theory is Maslow's (1964) need hierarchy. According to this theory the most pressing need in human life is to overcome some basic deficiencies: first organic deficiencies such as hunger, and next socio-psychological needs like safety, belonging and esteem. Beyond these 'deficiency needs', 'growth needs' would prevail. That means that people need meaningful challenges that fit their capacities and involve ongoing development.

At the level of deficiency needs, this theory allows some specification of necessary living conditions. The gratification of organic needs requires that there is a production system that provides 'food' and 'shelter'. Required minimum levels can be fairly well specified in this case. Things become more difficult where the socio-psychological needs are concerned. There is much variation in the way societies provide 'safety', 'belongingness' and 'esteem', and it is difficult to define minima or compare performance. What is for instance the minimum required degree of belongingness? Are these needs better gratified in the traditional stem family than in the modern nuclear family? Things become even more complicated where 'growth needs' are concerned, which concern the use and development of capacities. These needs are too varied to allow the specification of satisfiers. At best one can say that gratification of such needs requires a considerable degree of 'freedom' and 'variety' in society (Veenhoven 1996b). Again it is hardly possible to indicate minimum and maximum levels.

In fact, current input indicators have little scientific ground. The assumptions about the good life rather root in bad experience and in ideology. Present QOL indicators typically reflect Western remembrance of poverty and inequality. Positively they reflect Western Enlightend creed.

Output approach: 'apparent' quality-of-life

By lack of a theory from which we can deduct necessary living conditions, we must therefore resort to the other approach and assess inductively what societal conditions appear to be liveable. The question is than how liveability manifests itself.

Exhibit 2: Indicators of liveability: summary scheme

unobserved concept	**QUALITY-OF LIFE IN NATION (or liveability of nation)** **fit between provisions and requirements of society and needs and capacities of citizens**		
	INPUT-indicators:		OUTPUT-indicators
observable manifestations	Presence of conditions deemed likely to fit with citizens' needs and capacities, such as:		Flourishing of citizens as apparent in average:
	• economic affluence: e.g. GNP		• good health - physical - mental
	• political freedom e.g. legal rights		• positive appraisal of life
	• social equality e.g. income equality		
	• access to knowledge e.g. literacy rate		
	• etc.		
comprehensive indicators	various sum-scores: e.g. HDI e.g. ISP		Happy Life-Expectancy

The flourishing of plants or animals in a given ecological environment is usually measured by their functioning as apparent in growth, adequacy of behaviour and absence of disease. Successful procreation is also seen as a sign of good functioning.

Can the flourishing of humans in a social environment be measured by the same criteria? To some extent yes. Human thriving also manifests physically, particularly in good health and a long life. Therefore, we can induce the quality-of-life in a nation from the *health* of its citizens.

The flourishing of humans involves more than biological functioning alone. Unlike plants and animals, humans can reflect on themselves and their situation. The fit between their needs and capacities with the provisions and requirements of society is therefore also reflected in their judgements. As such we can also infer quality-of-life in a nation from the citizen's *appraisals* of life.

The two approaches to the measurement of quality-of-life in nations are summarised in exhibit 2. In the next paragraphs we shall consider the manifestations of apparent quality in more detail. First we shall review current measures of 'health' and 'appraisal', and then propose a new measure that combines both.

CURRENT INDICATORS OF APPARENT QUALITY-OF-LIFE IN NATIONS

Inferring quality-of-life from 'health' and 'appraisal of life' is less easy than it seems. What do these terms mean precisely? Can these matters be measured, in principle and in practice? In this paragraph I will review current indicators and their usefulness for this purpose. The review is summarised in exhibit 3. It will appear that only a few indicators qualify.

Measures of 'health' in nations

As in the case of plants and animals, the flourishing of humans can be judged by their bio-physiological functioning; in other words by their 'health'. We cannot say that somebody lives well if s/he is weak, impaired or ill and certainly not if s/he is dead. The concept of health covers biological functioning at large. Specific health concepts concern specific aspects of human functioning.

Measures of physical health

The analogy with flourishing of plants applies best where mere bio-physiological functioning is concerned, also called 'physical health'. Physical health of organisms can be defined in two ways: firstly by absence of disease or impairment, secondly by signs of good functioning, such as energy or resilience. The former aspect of bio-physiological functioning is referred to as 'negative health', the latter as 'positive health'. The less negative and the more positive the physical health of citizens, the more liveable the country apparently is.

Negative health can be measured by the incidence and severity of impairments and disease. That sounds again easier than it is. Medical statistics say more about medical consumption than about illness. The available figures on illness are typically limited to 'incidence' and do not inform us about 'severity'. Moreover, medical statistics typically concern 'specific' health defects and mostly allow no view on the 'overall' health situation in a country. Some attempts have been made to characterise overall health in nations, but unfortunately these are as yet not sufficiently standardised to allow international comparison.

Positive health can be measured by performance tests and by subjective reports about feelings of health. The latter indicators typically concern overall health. In several Western nations periodical health surveys monitor health feelings. Though the items used are quite diverse, some do allow international comparison in a sizeable number of nations. At this moment the best source is the subjective health item in the World Value Survey.

Life-expectancy The citizen's health can also be measured by their longevity. The number of years people live is assessed on the basis of civil registration. This is no problem for the generations that have passed away. For the living we must do with estimates. Life-expectancy is estimated on the basis of observed survival rates in age-cohorts. Obviously, life-expectancy differs by age. Average length of life in a country is commonly expressed in 'life-expectancy' at birth.

The quality of data on life-expectancy is quite good. Most present day nations have fairly reliable mortality statistics. These statistics show considerable differences between present day nation states. Life-expectancy is currently lowest in Upper Volta (about 30) and highest in Japan (79.5). Because mortality statistics cover considerable time periods, they also show progress and decline: for instance a drop in life-expectancy in the former second world (communist) countries in the 1970's, and a rise in first world nations (UN 1995).

Healthy life-expectancy Long living is not necessarily healthy living. Life-expectancy may be high in a nation' but average health low. Extra years may be bought at the cost of a lot of illness. Therefore, health in nations is measured by the average number of years people live free from chronic illness (Robine & Ritchie, 1991).

Healthy life-expectancy has been measured in different ways. As yet, there is little comparable nation data on this matter.

Measures of mental health

Instead of focusing on 'bio-physiological' functioning, one can also consider the adequacy of 'socio-psychological' functioning. This is what commonly is referred to as 'mental health'. When used in the context of liveability, the reasoning is that the better a society fits with human needs and possibilities, the less it drives its members mad.

There is nothing wrong with this idea, but there are great problems in its operationalisation. It is not easy to establish who is mentally 'ill' or not. Cross national comparison is hampered by differences in manifestations of psychological disturbance, as well as in definition and registration. This limits the use of this indicator to countries which are culturally very similar.

Comparable national data on this matter are scarce, and limited in fact to the Western world. The data that is available concern 'negative' mental health: that is incidence of psychological disturbances. As in the case of physical health, most figures are on curation rather than on disturbance as such. Again morbidity statistics do not reflect 'overall' mental health, but the incidence of specific syndromes such as depression, anxiety and stress. A good review of data and their limitations can be found in Murphy (1982).

As in the case of physical health, the best indicators of overall mental health in a given country come from survey studies. Most health surveys inquire about psychological complaints and compute sum scores on the basis of these. Unfortunately, there is as yet too little uniformity in the data for meaningful comparison between countries.

Measures of 'life appraisal' in nations

Next to mere 'functioning', the thriving of humans can also be inferred from their 'appraisals'. Humans can apprehend their situation. Like other higher animals (but unlike plants) they experience affects. These affective appraisals are highly indicative for the quality-of-life. The very biological function of these faculties is to lead the organism to the best suited conditions[5]. Positive affect is generally indicative of good adaptation. Contrary to other animals humans are also able to appraise their situation cognitively. Positive judgement of life is generally indicative of good adaptation as well.

The degree to which inhabitants of a nation appraise their life positively can be assessed in different ways: indirectly by inferring from their behaviours and directly by asking how they feel about their life. For long social scientists have preferred the former method. By now it is clear that only the latter is viable for this purpose.

Behavioural manifestations of malaise

Traditionally, the quality-of-life in a nation was measured by the incidence of behaviours deemed indicative of despair. The more such behaviours observed, the less liveable the country was supposed to be.

This approach does not require that people are fully aware of their malaise. Behavioural reactions can be affect driven or subconscious. Therefore, similar indicators are used for estimating well-being in animals. Aggression and self infliction are often mentioned as indicative of despair in captive animals. Among wild animals migration can sometimes be seen as a manifestation of discomfort in their earlier habitat.

Despair

Quality of life in nations has been measured by various manifestations of despair: mostly deviant behaviours such as use of drugs, aggression and excessive risk-taking, but also non-offensive behaviours such as religious retreat. The problem with this approach is that these behaviours are at best partly linked to liveability of society, and probably not equally much in all societies at all times.

Still, there is little doubt that *suicide* mostly signifies great personal despair. Hence suicide rates are often used as an indicator of quality-of-life in nations. This tradition dates back to Durkheim (1897). In this vein, the continuous rise of suicide in Western nations in the 20th century has been interpreted as showing that modernisation reduced the quality-of-life.

There is probably some truth in the idea that low liveability gives itself away in high suicide rates. Yet it is also clear that the incidence of suicide depends on many other things as well. In traditional societies such as Japan, suicide was in some situations a moral obligation. In present day Western society, suicide rates may rise because it is no longer taboo and because medical technology postpones natural death. It is also possible that modern people are less willing to endure suffering. As in the case of other despair behaviours, these effects are not equally great in all societies at all times.

Nevertheless, suicide is often used assess quality of life in nations. This is probably due to the fact that suicide is well documented. In most countries this cause of death has been systematically registered since long. Though the accuracy of registration varies somewhat between countries and through time, the data seem well comparable. The best available statistics are prepared by the World

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[5].For a discussion of the adaptive functions affect see Morris (1992). Affect and cognition developed only in species that can choose how to live and where. The faculties would be of little use for plants.

Health Organisation (WHO 1987). The data show sizeable differences. Around 1980 mortality by suicide was greatest in Hungary (" 460 per million) and lowest in the Philippines (" 9 per million).

Protest and desert

The quality-of-life in nations is also seen to reflect in protest-behaviours, in purposive political action (protest demonstrations, protest voting, etc) as well as in undirected rioting. In this line, the student revolts of the 1960's have been interpreted as showing declining quality-of-life in modern nations. Here again the problem is that these behaviours do not necessarily reflect personal dissatisfaction with life. One can be quite happy, but still be concerned about social injustice. Studies on participants in the 1960's student rebellion illustrate that point (Keniston 1968). In fact, personal satisfaction may even facilitate engagement in social issues. Still another thing is that protests are typically concerned with specific aspects of society, and are therefore not very indicative of overall satisfaction with life. It is not easy to compare the incidence of protests and mass support across nations. The available figures seem to say more about registration than reality.

Emigration seems more indicative of quality-of-life in the nation. The decision to leave the country involves an overall evaluation of life in it, and that evaluation is likely to be negative; leaving hearth and home is not easy. In this vein, Ziegler & Britton (1981) showed that living conditions in emigration countries are typically poor. Yet, emigration may say more about opportunity to settle abroad than about the quality-of-life in the country. Also, expectations about a better life elsewhere do not necessarily mean that the quality-of-life in one's home country is poor. Further, emigration is not always due to dissatisfaction with life. Part of the migrants seek new horizons for positive reasons, and often migration comes about more or less unintendedly by involvement in love or work. Migration is a well documented phenomenon, and the figures are fairly comparable across nations.

Self reported appraisals

Though higher animals have the faculty of experience, they are typically unable to reflect on that experience and communicate it. We humans can. We can appraise how we feel about life and can communicate the estimate. Therefore, human appraisals can in principle be assessed by interrogation.

Research has shown this is practically possible as well. Though self reports could be distorted in various ways, present interrogation techniques seem to measure it reasonably valid and reliable. On that basis a survey research tradition established since the 1960's.

Like in the earlier tradition of measuring quality-of-life by behavioural manifestations of malaise, the research on self reported appraisal started with despondencies as well. In the course of time emphasis shifted from specific patterns of experienced 'ill-being' to global subjective 'well-being'[6].

Experienced ill-beings

In the sociological literature the concept of 'alienation' is commonly mentioned as state of ill-being that indicates poor quality-of-life. In Social Psychology and Social-Medicine the concepts like 'anxiety', 'stress' and 'depression' are more common. Tough currently used, these indicators are too specific to characterise the degree to which people thrive encompassingly. The concepts denote only negative experience, and not positive experience. Yet in this context it is the balance of positive and negative experience that counts. Moreover, the concepts concern specific kinds of mental discomfort, rather than overall suffering.

Alienation is seen as something that results from a lack of fit between ways of life provided by a society and human potentials. That condition is believed to manifest in individual feelings of powerlessness and meaninglessness. There are many variations in this theme, some of which come close to conceptions of mental health.

The incidence of subjective alienation in a society can be measured by means of surveys. Several questionnaires have been developed for that purpose. The currently most used is the Seeman Alienation Scale (Seeman, 1975). A major limitation of all these measures is that they do not involve a general judgement of life, but rather describe dissatisfaction in a cluster of life-aspects. Therefore, it is better not to use them for assessing overall quality-of-life.

In spite of much theorising about alienation and society, there are hardly any comparative data. Even if we might want to judge liveability of nations by the alienation of its citizens, we simply cannot.

Anxiety, depression and stress Above, these phenomena were already mentioned as manifestations of mental health. In that context, the concepts denoted impairment in the first place. In this context, the emphasis is on discomfort.

Like alienation, these mental states are seen as outcomes of poor fit between individual and society. Depression is commonly explained by lack of meaningful tasks and relationships, while anxiety and stress are often mentioned as a results of too high social demands. Though there is probably some truth in that, we should realise that these discomforts can also occur in an otherwise good life. For instance, life in a dynamic nation may yield much satisfaction, though at the cost of some anxiety.

Prevalence of these kinds of mental ill-being is mostly assessed by survey research. There is a wealth of questionnaires on these matters, some of which are reported to have good psychometric qualities. Still, there is doubt about the comparability of such scores across time and culture. Report of such discomforts may be somewhat higher where they are more recognised and accepted. For instance, the slight rise in depression reported in the USA (Lane 1996) could be due to greater awareness of mental ailments.

There is a lot of data on these matters of psychological ill-being. Yet the available data allow little opportunity for cross-national comparison. The few cross-national studies that did involve a sizeable number of nations is limited to specific groups, such as employees of students. So again, it is simply not possible to measure the liveability of nations in this way.

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[6].The difference between subjective 'ill-being' and 'well-being' was proposed by Headey & Wearing (1984)

Overall happiness

Assessing the appraisal of life in a nation requires that the total of experienced well-being is estimated. This sum of experience is denoted by the concept of 'happiness'. Happiness is a person's overall evaluation of his/her life as-a-whole.

Concept In this context it is worth distinguishing between judgements about 'society' and judgements about ones 'life in that society'. A society that is judged positively by its citizens is not necessarily a very liveable one. The judgement can concern aspects that are very prominent in public discourse, but have little relevance for the actual enjoyment of life. Also, basically dissatisfied people can still be positive about their society, because they are unaware of its shortcomings and attribute their misery to other matters. The degree to which people flourish in a society can thus best measured by how they evaluate their own life, in other words by their personal satisfaction.

Personal satisfaction judgements can concern 'aspects-of-life', or one's 'life-as-a-whole'. Satisfaction with specific aspects of life such as 'work', 'marriage' or 'governments' says little about the general liveability of a society. Most citizens may be satisfied with their work, but still be unhappy because their society offers little more. Also they can be satisfied with most aspects of life, but nevertheless judge their life-as-a-whole negatively; for instance because they miss something essential in it, i.e. 'freedom'. Still another complication is that aspects of life are not equally important in all societies at all times. 'Work' for instance is less central in most third world countries than in the homelands of the Protestant Ethic. For these reasons the focus on is here on '*overall' personal satisfaction*.

When we appraise how much we appreciate the life we live, we seem to use two sources of information, we estimate our typical affective experience to asses how well we feel generally (hedonic level of affect) and at the cognitive level we compare 'life as it is' with standards of 'how life should be' (contentment). The former affective source of information seems generally more important than the latter cognitive one (Veenhoven 1996a: 33-35). The word happiness is commonly used for these 'subtotals' as well as for the comprehensive appraisal. I use the terms 'overall' happiness or 'life-satisfaction' for the last judgement and refer to the affective and cognitive sub-appraisals as respectively 'hedonic level of affect' and 'contentment'. Elsewhere, these concepts are delineated in more detail (Veenhoven 1984: Ch. 2).

Measures All these variants of happiness can be measured by self-report. Various questions have been developed for that purpose. For a review of items and scales see Veenhoven (1984: ch4). The most commonly used item is the single question: "Taking all together, how happy would you say you are? Very happy, fairly happy, not too happy or not at all happy?" Another current question is how 'satisfied' one is with one's life-as-a-whole. Hedonic level is often measured by the ten item Affect Balance Scale (Bradburn 1969), which concerns occurrence of specific positive and negative affects in the past few weeks. This latter method seems best suited for cross-national comparison[7].

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[7].The Affect Balance Scale (ABS) has at least four advantages in a cross-national context. 1) ABS is less vulnerable for language differences than the single happiness- and satisfaction-items. Because ABS involves 10 items, possible distortions in translation and understanding are likely to neutralise each other. 2) ABS is also less vulnerable for desirability distortion, and therefore also less vulnerable for differential distortion of that kind. ABS inquires about recent affective experience, which a more tangible matter than general happiness and satisfaction. Also is admitting that one felt bad during the last few weeks less threatening than avowing oneself as unhappy. 4) ABS does not require acquaintance with concepts such as 'happiness' or satisfaction. Though single items on happiness do not appear to be vulnerable for these distortions either (Veenhoven 1993, chapter 5), use of ABS is still safer.

Since the 1970's, happiness serves as a core variable in 'Quality-of-Life' surveys in many developed nations. In the reports, happiness is often presented as an indicator of liveability, the happier the inhabitants are on average, the more liveable the nation or region is presumed to be.

There is now a growing body of data on average happiness in nations[8]. Presently there are comparable surveys in some fifty nations. The data are brought together in the World Database of Happiness.

Measuring happiness in nations

Though currently used, these measures are much criticised. Three main objections are raised, which all imply that self reports of happiness provide no good basis for estimating apparent liveability of nations. If true, these objections would be fatal to the new indicator proposed in this paper. Therefore I will now review that criticism in more detail. For more elaborate discussions of the measurement problems involved here see: Diener (1995), Headey & Wearing (1992) Saris & Veenhoven (in preparation), and Veenhoven (1993, 1996a).

Validity of happiness self reports

The first objection is that responses to questions about happiness do not adequately reflect how people really feel about their life. Several reasons have been suggested.

One of the misgivings is that most people have no opinion about their happiness. They would be more aware of how happy they are expected to be, and report that instead. Though this may happen incidentally, it appears not to be the rule. Most people know quite well whether or not they enjoy life. Eight out of ten Americans think of it every week. Responses on questions about happiness tend to be prompt. Non-response on these items is low; both absolutely (" 1%) and relatively to other attitudinal questions. `Don't know' responses are infrequent as well.

A related assertion is that respondents mix up how satisfied they actually are, with how satisfied other people think they are, given their life-situation. If so, people considered to be well off would typically report to be happy, and people regarded as disadvantaged should avow themselves unhappy. That pattern does occur, but it is not general. For instance, in The Netherlands good education is seen as required for a good life, but the best educated appear slightly less happy.

Another objection concerns the presence of systematic bias in responses. It is assumed that questions on happiness are interpreted correctly, but that the responses are often false. People who are actually dissatisfied with their life would answer that they are contented. Both ego-defence and social-desirability are said to cause such distortions. This bias is seen to manifest itself in over-report of happiness; most people claiming to be happy, and most perceiving themselves as happier than av-

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8. The first cross-national surveys involving items on satisfaction were initiated in the USA and effected by Gallup International. In 1948, nine western nations were surveyed (Buchanan & Cantril 1953). In 1960 and 1975 world-surveys were performed (Cantril 1965, Gallup 1975). These were once-only projects. Periodic quality-of-life surveys were held in most of the rich nations since the 1970's. Initially, these surveys provided little opportunity for cross-national comparison of satisfaction, because items differed too much. Over the years, the pool of comparable items has grown, both as a result of spontaneous consensus and deliberate effort to develop standard questions. In 1991, the International-Social-Survey-Program (ISSP) included the same set of questions on satisfaction in 12 nations. In the early 1980's the first World Value Survey (WVS1), took place in 22 nations. The standard questionnaire of that survey involves three items on happiness. In the early 1990's WVS2 was held in 43 nations. WVS 3 is planned to cover about 75 nations at the turn of the century.

erage. Another indication of bias is seen in the finding that psycho-somatic complaints are not uncommon among the happy. These observations are correct, but the findings allow other interpretations as well. Firstly, the fact that more people say to be happy does not imply over-report. It is quite possible that most people are truly satisfied with life. When living conditions are not too bad this is in fact quite probable. Secondly, there are also good reasons why most people think that they are more satisfied than average. One such reason is that we underestimate happiness of our fellow-man, because misery is more salient than prosperity. Thirdly, the occurrence of head-aches and worries among the satisfied does not prove response distortion. Life can be a sore trial some times, but still be satisfying on a balance. The proof of the pudding is in demonstrating the response distortion itself. Some clinical studies have tried to do so by comparing responses to single direct questions with ratings based on depth interviews and projective tests. The results are generally not much different from responses to single direct question posed by an anonymous interviewer.

Elsewhere the surmised flaws of self reported happiness have been checked in more detail. See Veenhoven (1984: chapter 3) and Headey & Wearing (1992: Ch. 3). None of them was corroborated as yet.

Significance of average happiness

The second objection is are that happiness does not reflect real quality of life. This objection has two variants: one variant holds that happiness is merely a matter of perceived advantage and the other that it is a mere matter of outlook.

Relative? The first variant holds that happiness judgements draw on comparison *within* the nation, and can therefore not meaningfully compared *across* nations. This view is based on the theory that happiness results from social comparison. Some often cited investigations claim support for this theory. Easterlin (1974) saw the theory proved by his observation that happiness is as high in poor countries as it is in rich countries. Brickman et al (1978) claim proof in their observation that lottery-winners are no more satisfied with life than paralysed accident victims. Elsewhere, I scrutinised these sensational claims (Veenhoven 1991, 1995). The results of that enquiry can be summarised as follows:

First of all, average happiness is clearly not the same in poor and rich nations. Neither are accident victims equally satisfied as lottery winners. The differences may be smaller than one might have thought, but they exist undeniably.

Some other implications of theory that happiness is relative failed an empirical test as well. One such implication is that changes in living-conditions, to the better or the worse, do not have a lasting effect on happiness. However, there is good evidence that we do not adjust to everything; for instance, we don't adjust to the misfortune of having a handicapped child or the loss of a partner.

Another implication is that earlier hardship favours later happiness. This hypothesis does not fit the date either. For example, survivors of the Holocaust were found to be less satisfied with life than Israelis of the same age who got off scot-free.

A last empirical check to be mentioned is the correlation with income. The theory that happiness is relative predicts a strong correlation in all countries, irrespective of their wealth. Income is a salient criterion for social comparison, and we compare typically with compatriots. Again, the prediction is not confirmed by the data. The correlation is high in poor countries but low in rich ones.

The theory that happiness is 'relative' assumes that happiness is a purely cognitive matter and does not acknowledge affective experience. It focuses on 'wants' and neglects 'needs'. Contrary to wants, needs are not relative. An alternative 'affective' theory is that we infer happiness from how we feel generally. If we feel fine, we gather that we must be satisfied. If we feel lousy most of the time we conclude we must be dissatisfied. Unlike conscious comparisons between ideal and reality, affects are largely unreasoned experiences, that probably signal the degree to which basic needs are met. The evidence for this theory is mounting. It denotes that happiness ratings reflect something universal, that can be meaningfully compared cross-culturally.

Folklore? A second variant of the insignificance objection is that happiness reflects the dominant view-on-life, rather than actual quality-of-life in a country. In this view, happiness-ratings reflect local 'folklore'. Comparing happiness reports would hence be equating apples and pears.

The theory of happiness behind this argument is cognitive as well. Happiness is seen as a judgement that depends on socially constructed frames of reference, which are supposed to be culturally unique. This relativistic theory found support in unexpected differences in average happiness between nations, such as low happiness in France and the high level in the USA. The idea was also nourished by the finding that average happiness remained at the same level in post-war USA, in spite of a doubling of the national income.

Elsewhere I put this theory to several tests (Veenhoven 1992b: 66-79, 1994, 1995). One implicated hypothesis is that differences in average happiness are unrelated to variation in objective quality of life. Five such differences were considered: economic affluence, social equality, political freedom and intellectual development. These nation-characteristics explained 78% of the differences in average happiness in a 28 nation set. Further, there are examples of change in average happiness following improvement and decline of quality-of-life in the country.

One also considered the residual variances in regression charts. If French national character would tend to understate happiness and the American way to overstatement, we can expect to find the French less happy than predicted on the basis of objective welfare and Americans more happy than their situation justifies. No such patterns appeared.

Still another test involved the analysis of happiness among migrants. If happiness reflects the quality of the conditions one lives in, the happiness of migrants in a country must be close to the level of autochthons. If happiness were a matter of socialised outlook, the happiness of migrants should be closer to the level in their motherland. The former prediction appeared true, the latter not.

Comparability of across countries

Methodological objections involve various claims about differential distortion in responses to questions about happiness. Several of these assertions have been tested empirically (Veenhoven 1993, 1996a). Again, the results are negative as yet.

The most common objection holds that differences in language hinder comparison. Words like `happiness' and `satisfaction' would not have the same connotations in different tongues. Questions using such terms would therefore measure slightly different matters. That hypothesis was checked by comparing the rank-orders produced by three kinds of questions on the overall appreciation of life-as-whole: a question about `happiness', a question about `satisfaction' with life and a question that invites to a rating between `best-' and `worst possible life'. The rank-orders appeared to be almost identical. Next, responses on questions on happiness and satisfaction in two bi-lingual countries were compared. This did not show linguistic bias either.

A second objection is that responses are to questions are distorted by social desirability, and that such biases differ across cultures. One of the manifestations would be more avowal of happiness in countries where happiness ranks high in the value-hierarchy. That latter claim was inspected by checking whether reported happiness is indeed higher in countries where hedonic values are most endorsed. This appeared not to be the case. As a second check, it was also inspected whether reports of general happiness deviate more from feelings in the past few weeks in these countries; the former measure being more vulnerable for desirability distortion than the latter. This appeared not to be the case either.

A third claim is that convention in communication distort the answers dissimilarly in different countries. For instance, collectivistic orientation would discourage `very' satisfied responses, because modest self-presentation is more appropriate within that cultural context.

This latter hypothesis was tested by comparing happiness in countries differing in value-collectivism, but found no effect in the predicted direction. The hypothesis failed several other tests as well.

A related claim holds that happiness is a typical Western concept. Unfamiliarity with it in non-western nations is said to involve several effects; responses would be more haphazard, and uncertainty would press to choice for middle categories on response scales, which results in relatively low average scores. If so, more `don't know' and `no answer' responses can be expected in non-western nations. However, that appeared not to be the case. The frequency of these responses is about 1% in all parts of the world.

All these claims imply that there will be little relationship between average happiness rating and real characteristics of the nations. Yet we have seen that country differences in economic prosperity, freedom, equality and schooling explained 78% of the differences in reported happiness.

Possibly, there are some other distortions. Time will learn. For the time being, it seems that self reports of overall happiness can de meaningfully compared across nations.

NEW SUMMARY-MEASURE OF APPARENT QUALITY-OF-LIFE IN NATIONS

In recapitulation, quality-of-life in nations is measured in two ways: 1) assumed QOL, by presence of conditions deemed beneficial, such as affluence, freedom, learning, etc (assumed QOL), and 2) by the degree to which citizens thrive, as manifested in their health and happiness (apparent QOL). We have seen encompassing measures of assumed quality-of-life, the multi dimensional indexes which we reviewed in the introductory paragraph. As yet, we did not meet with a comprehensive measure of apparent quality-of-life.

We have only seen an encompassing measure of the health indicator of apparent quality of life. That is: healthy life-expectancy, which combines absence of disease and longevity. The review did not reveal a measure which combines health and happiness. This paper proposes such combination, which provides an all-encompassing measure of apparent quality-of-life.

Notion of long and happy living

The 'apparent' liveability of a nation can be measured by the degree to which its citizens live long and happily. The longer and happier the citizens live, the better the provisions and requirements of society apparently fit with their needs and capacities.

An evident advantage to measuring quality-of-life by longevity alone is that the subjects' appraisal of life is acknowledged. People may live long, but not happily. For instance, in a repressive nation where healthy lifestyle is enforced, or where blind medical technology stretches life too long. Likewise, an advantage to measuring quality-of-life by happiness alone is that the length-of-life is taken into account. People may live happy in a culture of irresponsible hedonism, where they indulge in drugs and risky sensations, but they won't enjoy that life very long.

In fairy tales the happy end is commonly described by the phrase 'and they lived long and happily ever after'. This phrase reflects common conviction that the good life manifests in a long and happy life. In this conception, that individual level notion of quality-of-life is aggregated to the nation level. Instead of the fairy tales hero, we consider the average citizen.

Compared to most notions of 'assumed' quality-of-life the concept is relatively uncontroversial. Most people will agree that it is good to live long and happily. Not for nothing the fairy tales with that happy end are so popular.

Operationalisation in 'Happy-Life-Expectancy' (HLE)

Empirical assessment requires information on average length-of-life and on average appreciation-of-life in the country. As noted, this information is available from two sources: 1) civil registration of death, and 2) survey data on happiness. On the basis registrations of death we can estimate how long people live in a nation at a certain time. These data are of an 'objective' nature, only an outsider can assess how long one lived. Surveys allow an estimate of how happy people are on average. This data is of a 'subjective' kind. Only the oneself knows whether one is happy or not. Combined, these sources of information can tell us how long and happily people live in a country.

Analogous to 'healthy' life-expectancy, this combination can be labelled as 'happy life-expectancy'. In line with custom we will abbreviate to 'HLE'.

The idea of such an analogous measure was suggested by Anton Kunst, with whom I developed an earlier measure of happy life-expectancy (Kunst et al 1990).

Computation

'Healthy' life-expectancy is usually computed by detracting expected years in bad health from expected years of life, both estimates based on age specific information[9] computed by multiplying 'standard' life-expectancy in years with average happiness as expressed on a scale ranging from zero to one.

Formula: Happy life-expectancy = standard life-expectancy x 0-1 happiness

Examples Suppose that life-expectancy in a country is 50 years, and that the average score on a 0 to 10 step happiness scale is 5. Converted to a 0-1 scale, the happiness score is than 0,5. The product of 50 and 0,5 is 25. So happy life-expectancy in that country is 25 years. This example characterises most of the poor nations in the present day world.

If life-expectancy is 80 years and average happiness 8, happy life-expectancy is 64 years (80 x 0,8). This example characterises the most liveable nations in the present day world.

Range Theoretically, this indicator has a broad variation. Happy life-expectancy is zero if nobody can live in the country at all, and will be endless if society is ideal and its inhabitants immortal.

The practical range will be between about 20 and 75 years. Presently at least, life-expectancy at birth in nations varies between 30 and 80, whereas average happiness is seldom lower than 0,4 on a 0 to 1 scale and seldom higher than 0,8.

Happy life-expectancy will always be lower than standard life-expectancy. It can equal real length of life only if everybody is perfectly happy in the country (score 1 on scale 0 to 1). This is clearly not possible. The highest level of happiness ever observed is 0,8 (Iceland 1990), which is probably close to the maximum.

Interpretation

High happy life-expectancy means that citizens live both long and happily, low happy life-expectancy implies that the life of the average citizen is short and miserable. Medium values of happy life-expectancy in a country can mean three things: 1) both moderate length-of-life and moderate appreciation-of-life, 2) long but unhappy life, and 3) short but happy life. In this measure these three situations are treated alike.

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[9].So-called 'Sullivan method'. Firstly, life-expectancy at a certain age is estimated, by adding survival chances in each of the following years. These survival chances are the observed survival rates in death tables. e.g......?? Secondly, years in bad health are estimated on the basis of data on incidence of serious impairment in age categories. F.e. if survey data show that of the 80-years old 50% is in bad health, survivors to age 80 can expect to spend half of the year to their 81st birthday in bad health.

This method makes sense if the purpose is to estimate the healthy life-expectancy of a particular person at a certain age. Yet specification by age is not necessary if the purpose is to estimate general life-expectancy of the population.

Age specification is also more appropriate in the case of 'healthy' life-expectancy than in the case of 'happy' life-expectancy. Health does indeed deteriorate with increasing age, but happiness does not (Okma & Veenhoven).

Metaphorically, the scores can be interpreted as the number of happy years the nation affords its citizens.

Practical requirements

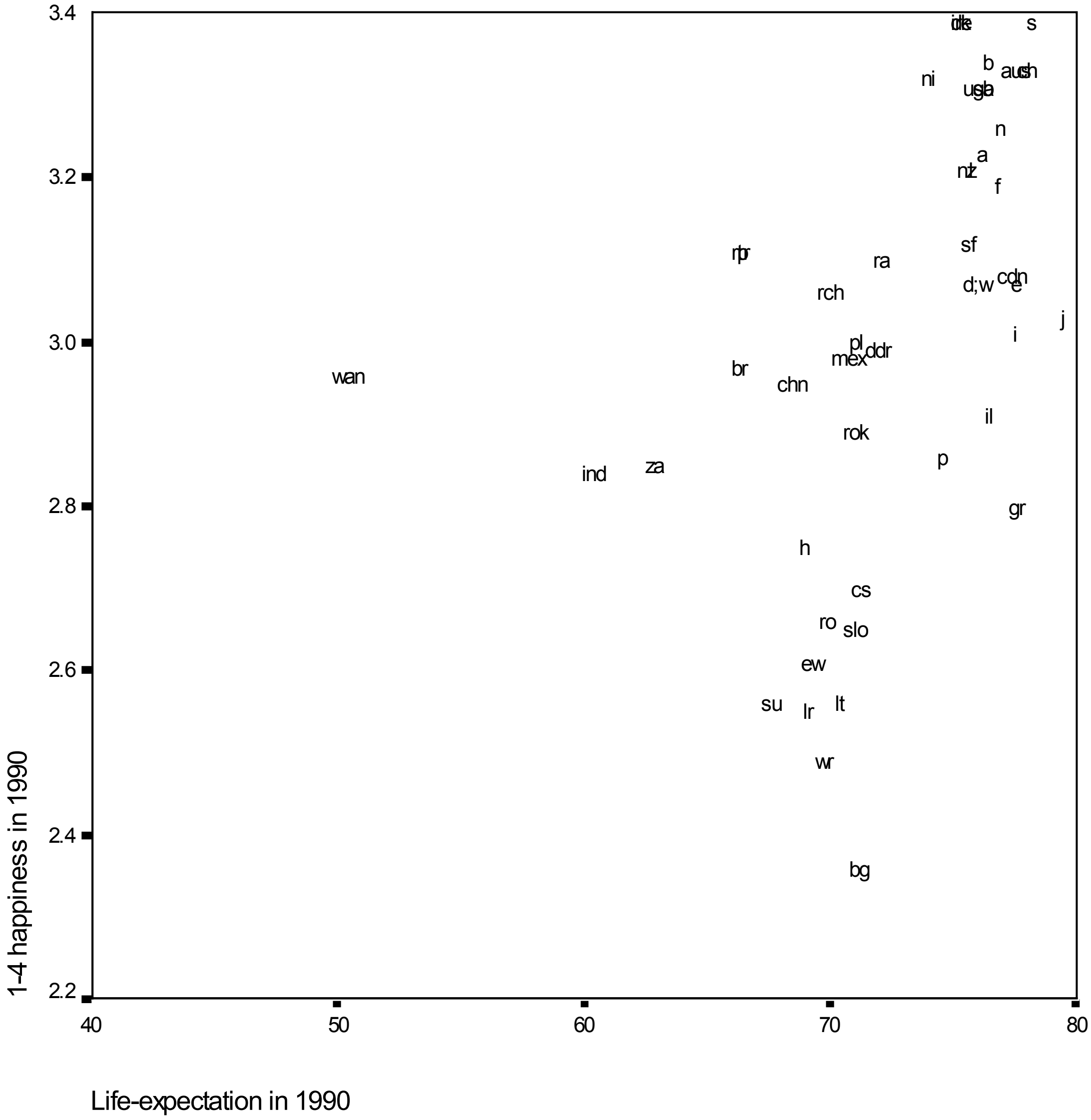
Actual measurement of HLE requires that data on both happiness and life-expectancy is available for a sufficient number of nations. Another condition is that these components involve distinct information.

Availability of data Availability is no problem for life-expectancy. This is known for all present day nations, and on a lot of countries there are also time-series which date back to more than a century (UNDY 1995).

Data on average happiness in nations is less abundant. Survey-research is relatively recent, and items on happiness appeared only until the 1970's. Still there are some 50 nations of which we know present happiness, and on a dozen we have time-series of one or more decades (World Database of Happiness). For the moment, that suffices for an exploration. In the coming decades happiness surveys will probably get established in most of the worlds nations.

Differentiation of components At the conceptual level there is a clear difference between life-expectancy and happiness, but does that difference appear at the empirical level as well? If life-expectancy and happiness coincide completely, we shall not get wiser by combining them.

Exhibit 3: Plot of average length-of-life by appreciation-of-life (in 48 nations early 1990's)



Data: Appendix 1

A look at the available data shows good differentiation. See exhibit 3. On the left, the case of Nigeria (WAN) demonstrates that low length-of-life can go together with reasonable appreciation-of-life. To the right below, the Eastern European nations illustrate that the reverse occurs as well. Right on top we see that the nations with the highest life-expectancy (typically the developed nations) differ considerably in average happiness.

Appendix 1

Table of life-expectancy, happiness and happy life-expectancy (in 48 nations early 1990's)

Nation		Average length of life *(in years)*	Average appre-ciation of life *(scale 0 to 1)*	Happy life expec-tancy *('happy years')*
code	name			
RA	Argentina	72,10	0,690*	49,75
AUS	Australia	77,60	0,767	59,49
A	Austria	76,20	0,733	55,88
WY	Belarus (White Russia)	69,80	0,487	33,97
B	Belgium	76,40	0,770	58,83
BR	Brazil	66,30	0,647	42,87
GB	Britain	76,20	0,760	57,91
BG	Bulgaria	71,20	0,443	31,57
CND	Canada	77,40	0,683	52,89
RCH	Chile	70,00	0,678*	47,37
CN	China	68,50	0,640*	43,84
CZ	Czecho Slovakia (former)	71,30	0,557	39,69
DK	Denmark	75,30	0,787	59,24
EW	Estonia	69,30	0,527	36,50
SF	Finland	75,70	0,697	52,74
F	France	76,90	0,720	55,37
D	Germany (former West)	76,00	0,680	51,68
DDR	Germany (former East)	72,00	0,653	47,04
G	Greece	77,60	0,590	45,78
H	Hungary	69,00	0,573	39,56
IS	Iceland	78,20	0,793	62,04
IND	India	60,40	0,603*	36,44
IRL	Ireland	75,30	0,787	59,24
IL	Israel	76,50	0,627	47,94
I	Italy	77,50	0,660	51,15

J	Japan	79,50	0,666	53,00
LR	Latvia	69,10	0,508	35,01
LT	Lithuania	70,40	0,497	35,90
L	Luxembourg	75,70	0,727	55,01
MEX	Mexico	70,80	0,650	46,02
NI	Northern Ireland	74,00	0,763	56,49
NZ	New Zealand	75,50	0,722	54,86
NL	Netherlands	77,40	0,797	61,66
WAN	Nigeria	50,40	0,643	32,42
N	Norway	76,90	0,743	57,16
RP	Philippines	66,30	0,693	45,97
PL	Poland	71,10	0,657	46,69
P	Portugal	74,60	0,610	45,51
RO	Romania	69,90	0,543	37,98
SU	Russia	67,60	0,510	34,48
ZA	South Africa	62,90	0,607	38,16
ROK	South Korea	71,10	0,620	44,08
SLO	Slovenia	71,00	0,540	38,34
SP	Spain	77,60	0,680	52,77
S	Sweden	78,20	0,787	61,52
CH	Switzerland	78,00	0,767	59,80
TR	Turkey	66,50	0,693*	46,11
US	United States of America	76,00	0,760	57,76

Life-expectancy: Data from UN Demographic Yearbook 1993

Happiness: Data from World Database of Happiness (update 1996), tables 1.1.1a and 1.1.1b

* Probably too high. Score based on samples in which poor rural population was under represented

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Sustainable Development Indicators from a NGO´s point of view

Markus Piringer

Prefatory I would like to say that this statement is discussing Sustainable Development Indicators from the perspective of a rather small environmental NGO. In our organisation about 20 persons are working constantly on environmental issues. The discussion on Sustainable Development Indicators does not play an important role within our every day work, although we are using indicators like Emission of CO_2, energy consumption, biodiversity etc. The point of view stated here does not cogently coincide with the opinion of other members of Friends of the Earth or other environmental organisations.

I would like to raise the question if further research on Sustainable Development indicators is really helpful.

The **problems caused by our present life-style and by our economy are quite clear.** They were also unequivocal identified within this workshop: One main problem is that people from the so called “Developed Countries” are consuming too much of the world’s resources. For example more than 50% of the world’s energy-consumption goes to the richest 17% of the world’s population. Most of the environmental damage is directly or indirectly linked to this waste of resources. The second main problem is that the differences between the “developed countries” and the so called “third world” are socially explosive.

Existing (simple) indicators sufficiently monitor these main problems

Examples: greenhouse gas emissions (per capita), changes in biodiversity, resource consumption (per capita), etc.

We do have political targets

Examples: Kyoto protocol for reduction of greenhouse gas emissions. Montreal protocol for reduction of ozone layer depleting substances. For the UN also the reduction of resources by the factor 10 in “developed countries” is a political target. Etc.

There are tools and measures existing how to achieve the targets

Examples: Higher taxes on resources and energy. Relieve the so called “third world” from their debts. Etc.

SO WHAT DO WE NEED FURTHER RESEARCH ON DEVELOPING MORE SOPHISTICATED INDICATOR-SYSTEMS FOR???

If we cannot monitor a change with the existing simple indicators, it is obvious that we are not getting ahead fast enough. On the other hand a complex system of indicators raises a lot of questions:

- Where are the indicator-systems developed? (in the “developed countries”)
- Who is deciding which indicators are influencing decision-making? (policy-makers)
- Who has access to the data? (There is a tendency to privatise statistical departments)
- Who can afford to monitor “sustainability data”? (the “developed countries”)
- Who can understand the indicator-systems and use them for argumentation? (Experts)
- Etc.

All these questions seem to lead to the result that complex indicator-systems are empowering the rich, powerful, well educated. They are developing the indicator-systems, they have access to data, they have knowledge how to use the data for their argumentation.

So from my point of view further research on indicators seems mainly a waste of time and money. While the OECD is creating indicator-frameworks, economy is creating facts. What we really need is political action.

The Environmental Indicator System of Statistics Austria

Susanne Gerhold

The Environmental Indicator System of Statistics Austria

In the early nineties the Department for Environmental Statistics started to establish a system of **Environmental Indicators for Austria**.

The main **principles** were

- to use **available** data only (in order to be able to start immediately)
- to create only **simple** (easily understandable) indicators
- to keep the data set **small** (to ensure an easy overview)
- to produce **time series** (i.e., no data on a single year only)
- to find indicators of **PRESSURES**, as well as of **STATE** and of **RESPONSE** (following the OECD approach)
- to focus work on **10 problem areas** (following the Pressure Indicator project of Eurostat)
- to create **sustainability indicators** (e.g. material flows)
- to accept **second best** data if the required information could not be produced (e.g. traffic amount instead of CO2 emissions).

Meanwhile, we have made the **experience** that – although in some fields **data are missing** – quite a **good overview** can be given on the situation of the main environmental problem areas, especially when we look at the development over a given period of time.

However, the difficulty does not only consist in missing data as the availability of **too large an amount of data concerning the same problem** may be confusing, as well. Therefore, data have to be reduced or aggregated to produce comprehensible information.

By now **the third updated edition** of environmental indicators for Austria has been **published**.

Since 2 years, the **Ministry for Environmental Affairs** (since April 2000, **Federal Ministry for Agriculture and Forestry, for the Environment and the Management of Water Resources**) has been responsible for the whole field of environmental indicators. Statistics Austria is willing to support the future work of the Ministry by the preparation of data and by offering methodological guidance.

What are environmental indicators useful for?

- First and foremost, environmental indicators give an **overview** of the situation in the various fields of problem;
- they enable the **observation of a development** over a given period of time;
- they are useful for finding out the **crucial problems** and the primary producers of pollutants;
- and, last but not least, they are useful for international **comparison** -

but

- in most cases, environmental indicators will be too rough to be used as the basis of any **concrete decision to be made in environmental policy.** Nevertheless, the big pool of environmental data will certainly be useful in various instances.

I would also like to point out that, because of technical improvements, early availability of data has become much easier. **Electronic media** are widespread and common, and therefore, the **need for prefabricated data has lost much of its importance.**

Practical constraints in the development of indicators: data availability, timeliness and costs

The provision of statistical data always depends on the **need for information** of policymakers and of the public.

The need for data, on the other hand, always depends on the public **awareness** of a problem.

Therefore, the availability of data on various environmental problems is determined by the public awareness of an environmental problem. And a statistical institution also requires sufficient time to consider, to plan and to carry out a survey and, finally, to provide the requested data.

For these reasons, there will always be a considerable **time-lag** between the first awareness of a problem and the final availability of the corresponding information.

The **financial burden** of a survey has to be taken into consideration, as well, and apparently this aspect will become even more significant in the future.

After all, we have to bear in mind that the **willingness of respondents** to fill in additional questionnaires continues to decrease steadily, a fact which also causes growing resistance among stakeholders against the support of new data collections.

All these circumstances show that caution should be exercised when **demanding new data**; we should never forget how long it takes until a new indicator is made available.

Participant Papers

Does Digital Technology in the Office Offer Environmental Benefits in Terms of Energy Consumption?

David Foley, Irina Maslennikova, Chris France

Abstract

Certain environmental burdens are associated with offices and the work carried out in offices. Energy utilisation is one of the most important environmental burdens connected to offices, alongside paper usage. Office equipment such as copiers, printers, faxes and scanners contribute to the energy consumption of an office. Digital technology is rapidly displacing traditional technology in office machines. Digital office machines are multifunctional, one machine is capable of printing, faxing, scanning and copying.

This paper will specifically compare the energy consumption of the two alternatives to answer the question: 'Will the substitution of one multifunctional device for four separate uni-purpose machines offer any environmental advantages?' The importance of energy consumption to business will also be discussed.

Introduction

Across the world many bodies concerned with environmental impact include a reduction in energy usage as a key step towards moving towards sustainable development. Bodies recommending this include: UN, OECD, UK DETR, Japanese Environment Agency, USA Dept of State and virtually all industrialised governments. (Golove & Schipper 1997, Owen 1997, Lenssen & Flavin 1996)

Energy usage is seen as an environmental issue due to the burning of fossil fuel, and the associated CO_2 emissions contributing to the Greenhouse effect. When considered globally, the scale of the problem is very daunting. Although this is already a major problem addressed by the Kyoto protocol it is more daunting when one translates Western levels of per capita greenhouse emissions to countries such as China and India. Gielen (1995) estimates that Western countries will need to reduce their CO_2 emission by 50-90% to stabilise atmospheric CO_2 concentrations if the development of countries such as India and China are considered. Such high reduction goals require new technologies and lifestyle adjustments according to Gielen.

Among the OECD countries, Japan has achieved one of the lowest energy intensities (as shown in the table below) and has been successful in reducing emissions of key air pollutants. A key policy in this success was a concentration on energy conservation (Fukasaku 1995). The Japanese efforts in this area stem from the supply scare experienced in the 1970s. Energy conservation was accorded a high priority as a means to secure national energy supplies. In 1979 the Japanese government passed the 'Energy Conservation Law'. This law operated on three levels:

6. Defining standards for energy conservation in factories, and large energy consuming facilities,
7. Adopting guidelines for energy conservation in buildings,
8. Developing criteria for increasing the efficiency of energy use in consumer products. (Fukasaku 1995)

This highlights the importance of product related energy efficiency in helping to achieve national targets for reduced energy consumption and lowered CO_2 emissions.

Table 1: Trends in GDP and energy intensity of major OECD countries (Fukasaku 1995)

	Energy intensity 1991 (toe/US$1000)	% change 1980-91 Energy intensity	GDP
Japan	0.2	-19.1	56.8
USA	0.4	-14.9	26.2
France	0.3	-3.5	26.2
Germany (west)	0.3	-20.3	27.9
Italy	0.2	-9.7	26.4
UK	0.3	-14.1	26.2
OECD	0.3	-14.5	31.3

In the USA the government proposed goals to reduce CO_2 emissions (Golove & Shipper 1997). Golove and Shipper also demonstrated that the savings made through increased efficiency in energy use were all offset by increased activity and energy use in all facets of American society: households, transport, industry and commerce. Efficiency improvements are no use if offset by increased consumption.

According to the United Nations publication 'Measuring changes in consumption and production patterns' approximately 36% of world primary energy is consumed by commercial and residential buildings (UN Dept of Economic and Social Affairs 1998). In industrialised countries these levels are substantially higher. Globally, the energy usage in residential buildings is roughly twice that of commercial buildings. The rate of growth in energy consumption in commercial buildings is faster than in residential. This is particularly true over the last two decades. The rate of growth in energy consumption for commercial buildings is 6.7% in developing countries and 2.6% in industrialised countries. (UN Dept of Economic and Social Affairs 1998)

Factors that have been identified as contributing to this increased consumption in commercial buildings include more: heating, computers, office equipment, air conditioning and other appliances. However the technical potential for energy efficiency improvements in commercial buildings is relatively high. Estimates for the USA vary from 27% to 48%, and in some European countries it ranges from 42% to 76%. This compares to developing countries where the potential has been estimated at ranging from 31% to 56%. (UNDPCSD 1997)

Energy consumption is an environmental indicator that permeates through all layers in society. It is equally useful at the International level, through national, regional, business and down to the individual level.

At the level of business it is useful for several reasons:

1. It is linked to the environment. Electricity is mainly produced from fossil fuels, which produce CO_2 when combusted, and contribute to the greenhouse effect. Also, perhaps more importantly, energy consumption is seen to be linked to environmental issues by Businesses' stakeholders.
2. It has an economic link. By conserving energy, the business is saving money. These multiple drivers, improving environmental performance and economic performance are extremely useful drivers of environmental achievement in the business community. Another example of this is material reuse.
3. It is easily measurable. Energy consumption is empirically measurable, and the measurements are widely understood by a variety of people.

All of these points add up to make the indicator a highly visible, widely used one. The indicator has resonance with Business and its stakeholders, and so acts as a useful indicator for business environmental performance.

Office equipment has been shown to be the second ranked contributor to office energy consumption after heating. (DETR 1998) Typically in the UK, 20% of office energy is used to run equipment such as printers, faxes and copiers. Of that 20% some two thirds is accounted for by Personal Computers (PCs) and monitors. (DETR 1998). Although in some offices document machines can utilise as much as 70% of the total energy. In the GB it has been estimated that inefficient use of office machines results in a $700 million loss per annum to business (Earth Ltd 1993), which highlights both the magnitude of wastefulness and the potential economic driver for a change in consumption patterns that would benefit the environment.

The total energy consumption that can be attributed to office equipment is made up of: (DETR 1998)

The energy consumed by the equipment

The energy needed to remove the waste heat produced by the equipment

In an air-conditioned office it can typically take as half as much energy again to remove the heat generated by office equipment as it takes to run the equipment, according to the UK DETR.

Numerous studies have shown that 70% of the environmental impact of office equipment occurs during the use phase – mainly in paper and its embodied energy content. (McIntyre 1999). Within copier machines the fuser role (which heats the toner to fix it to the paper) accounts for 70% of the average energy consumption (Kok 1998).

Haas *et al* (1998) highlight the importance of reducing energy consumption through efficiency. Their major conclusion was that with respect to appliances, efficiency is the most important slower of electricity consumption. They suggest that there are opportunities for substantial equipment efficiency improvements and further energy savings from appliances in the home and office.

Methodology

A comparison of the energy consumption of a digital multifunction device with an analogue copier, and also with a mixture of analogue machines providing the same service was made. The unit of comparison was one years use.

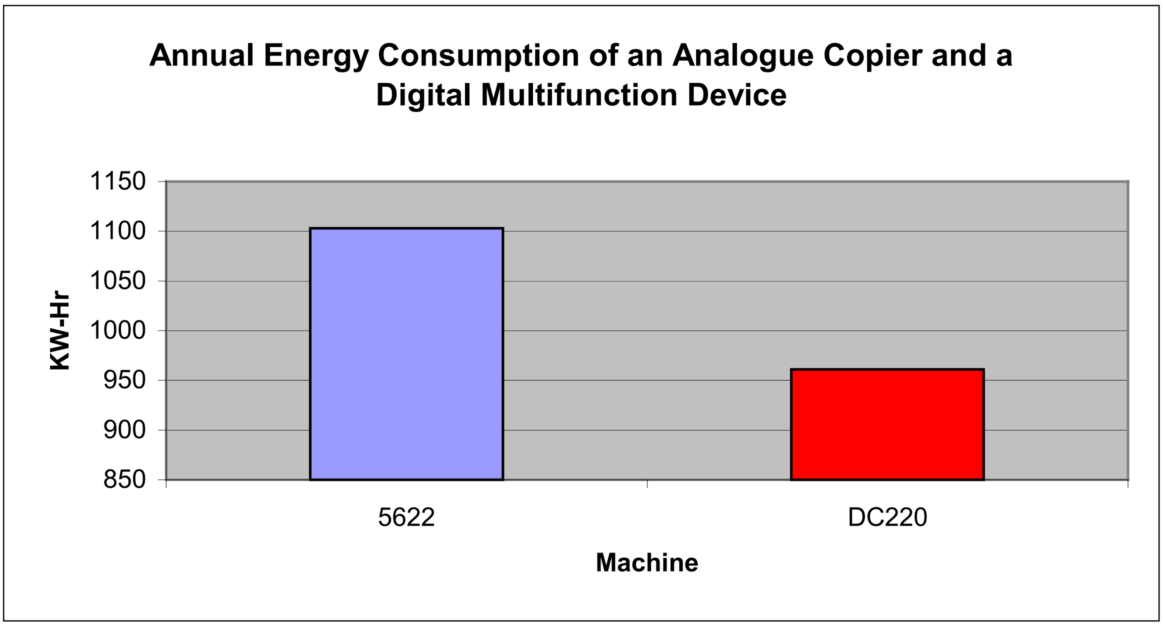
The machines were chosen to represent the same functionality, i.e. the speed of image production. All machines operated at around 20 pages per minute (ppm) (the variation was from 20 to 22 ppm).

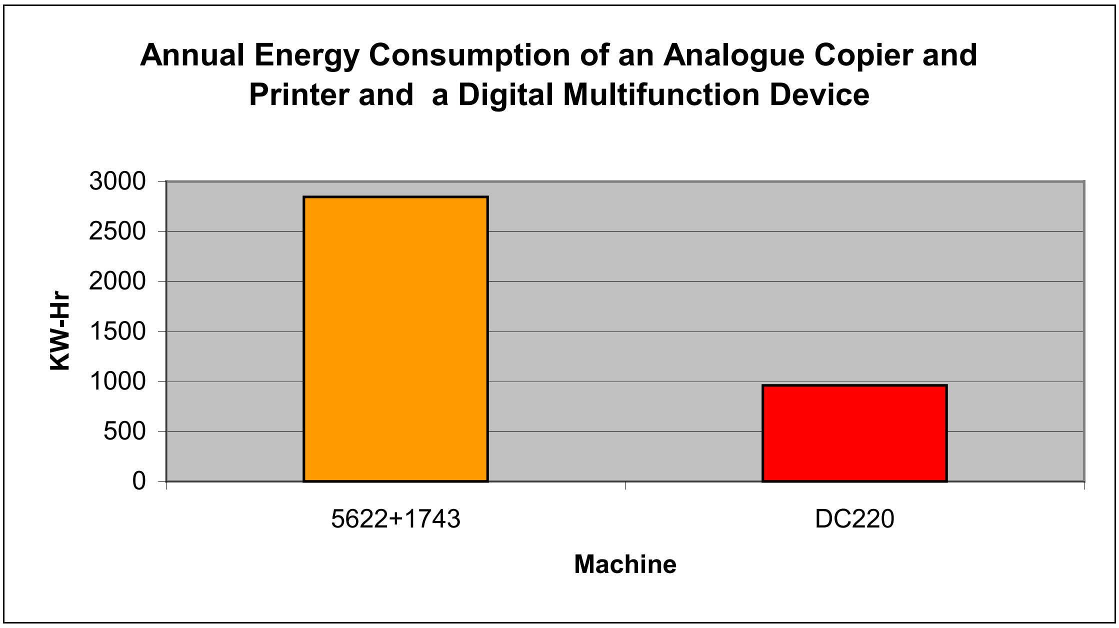
The testing of electricity consumption was carried out at Xerox Limited Technical centre, Welwyn Garden City. From the tests carried out the energy consumption was reported in kWhr.

These consumption tests were carried out for the various power modes in which the machines are designed to run. These modes are: run, standby, low power, sleep and off. The length of time that the machines would be in each mode per year were taken from product specification sheets, and then multiplied by the figures obtained from the tests for energy consumption.

Also tested was the heat output of the machines. This was carried out at XLTC as well. The results were expressed in British Thermal Units (BTUs) per hour. Then using the various number of hours that each machine was used in differing modes the annual heat production of the machine was calculated.

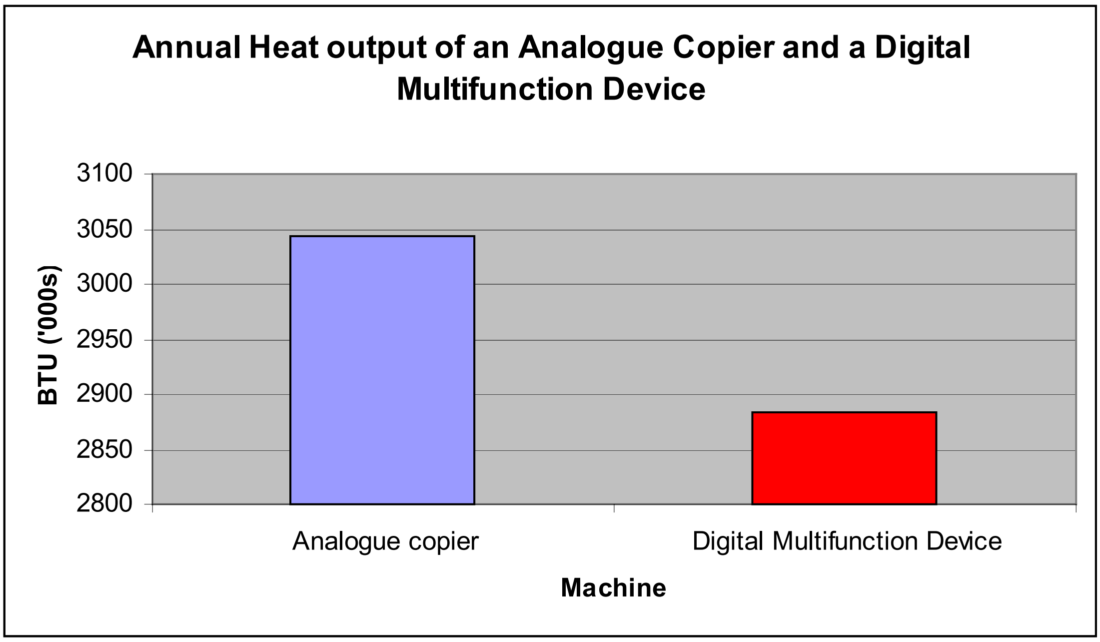
Results

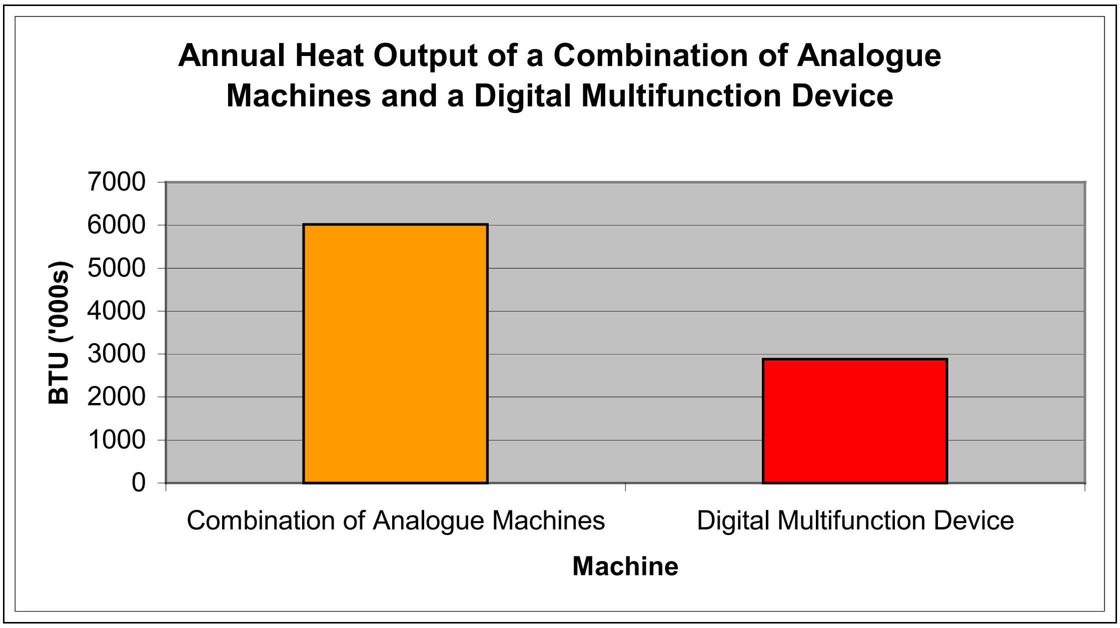




As can be seen from the above graphs the digital multifunction device demonstrates lower power usage than either the analogue copier or the combination of analogue machines that are displaced by the digital machine.

In the comparison with the combination of analogue machines the digital multifunction device has a 66% reduction in energy consumption over the course of a year. In the comparison with the analogue copier alone the digital machine shows a reduction of 13% in energy consumption over a one year period.





The above graphs show that the digital multifunction device produces less heat for the equivalent service than the combination of analogue products. In fact, it is less than half the heat emissions.

Conclusions

From the results shown Digital office machines offering an equivalent service are substantially more energy efficient than comparable analogue machines. The digital machine is slightly more efficient than a standalone copier, but considerably more efficient than a combination of analogue machines fulfilling the same function.

It can also be seen that the digital multifunction device is also more efficient in terms of heat emission. This has an effect on the energy consumption of the office as highlighted in previous sections. The energy required by the air-conditioning unit to cool the office is a considerable part of the office burden. Using a digital multifunction device in place of a combination of analogue devices would lower this impact as demonstrated by more than half.

The unit of service is an important issue in this study i.e. what is being delivered. The unit is one years work; copying, scanning, faxing and printing within the office. The digital machine is capable of delivering all of these services, whereas the analogue machines each fulfilled a separate role, hence the comparison of a combination of these products to simulate the displacement that is occurring in the office market.

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Towards Indicators of Sustainable Development

Teresa M. Mata, António A. A. Martins, Carlos V. Costa

Abstract

Sustainable Development Indicators (SDI) measure progress towards sustainable development in each region, helping people to make informed decisions about social, environmental and economic issues. They support governmental and non-governmental organisations, policy makers, businesses, citizens and households, allowing them to see the broader picture in a national and international scale. An indicator framework allows the development of a logically structured list of categories for which indicators would be sought. A framework can also conceptually represent the basic types of cause-and-effect relationships believed pertinent to the objectives of the indicator set. This approach reflects the belief that sustainable development can only be achieved through a broad understanding of the interactions among the economic, environmental and social aspects of human well being. A working draft framework on SDI should be designed with these lists and cause-and-effect relationships in mind. This paper does not intend to provide the basis for determining what types of indicators should be used, but examines the background to SDI including problems with their construction and outlines fundamental steps that should be followed to produce any list of them.

INTRODUCTION

There is much concern today over the ecological sustainability of human development. Sustainability is fundamentally a question of balance maintained over time, for example in a dynamic system like human society and it is thus something that cannot easily be scaled and measured. It may be more easily defined in practice as the lack of forces tending to upset equilibrium over time. The growing of the population and the resource consumption are drawing down stocks of natural resources and renewable productive potential. Simultaneously wastes are increasing with further damaging natural systems and essential life support processes. In order to minimise these pressures and impacts, SDI can be used in a precautionary approach to the management of such complex systems. However, many ecological processes are so complex and so poorly understood that is very difficult to derive indicators of ecological sustainability.

We all use indicators everyday to get a quick piece of summary information about something happening in the area of interest to us. That is the purpose of indicators: to give a quick, easy to understand view of the status of something we are interested in or necessary to make a decision about. Indicators help the public getting an idea of important trends without the need of being technical experts in each field. The effort must be directed towards the development of a framework and a set of experimental indicators to inform policy makers and the public on progress towards sustainable development. As Dahl (1995) notes if we want to produce effective indicators of sustainable development, we must agree on what we are trying to indicate and accomplish a working consensus on what we are trying to measure. It may therefore be more useful start by exploring the major dimensions of sustainability that need to be included and then formulate a working definition that helps us to focus on the form and content of indicators and indices.

A set of indicators of sustainable development present environmental, economic and social trends together. It can include the condition of the ecosystem, the natural resource base and the state of our society, institutions and communities. These are all valuable assets that we inherit from the past like endowments and pass on to our children and grandchildren. Measures of these endowments can increase awareness of the long-term effects of the production, consumption, investment and policy decisions we make today.

To develop SDI a framework is necessary to provide a logical structure for all components of the Earth system from the unique view of sustainable development. As with all aspects of SDI development, the choice of indicators, especially those reflecting human values, must emerge from a process that allows wide participation, large discussion of issues and achieves broad consensus. The all-inclusive nature of the framework ensures consideration of all the alternatives before selecting the most appropriate SDI for each country and the commitment of all parts. It must involve the participation of all stakeholders from regional to national levels (political, local agencies, non-government organisations, corporations, etc.). However, the specific indicators chosen for individual communities may be different from those selected at the national level. Nonetheless, information from the government and other national sources can be very helpful to communities in creating a useful set of indicators that will support good decisions about solving their more important problems.

Each community or region can benefit from identifying the economic, environmental and social issues that are important to all participants. This way they can take advantage of opportunities they identify, like greater efficiency to reduce pollution, improve profits or use of recycled materials to increase local jobs and reduce the volume of solid waste. A framework for indicators will help to identify categories and subcategories of indicators in a logically consistent manner. For many components of the framework, biophysical measures of quantities and qualities may prove appropriate. For other components, particularly those directly relevant to human well being, measures can be the values that humans place upon various phenomena. In many cases, both biophysical and value measures would be useful.

FRAMEWORK OF SUSTAINABLE DEVELOPMENT INDICATORS

Framework Elements

The elements of a SDI Framework implicitly match two objectives in the definition of sustainable development: meeting the needs of current generations and preserving the opportunities for future generations. These elements are the following:

Endowments: capabilities, assets and conditions inherited from previous generations and passed to the future generations. To manage for sustainable development we need information on our economic, environmental and social resources.

Outputs and results: are the goods, services and experiences resulting from using endowments and measure the success of the efforts to meet current needs.

Processes: are activities that draw upon various components of the endowments to produce results. It includes all biological, physical, economic and social processes. For example, "driving forces" are a subset of mechanisms that directly act upon endowments and "decision making" is a subset of processes that determine human actions.

Framework objectives

The two main objectives of SDI Framework are:

Provide a logical structure: One objective of a framework is to help develop terminology and taxonomy for categorising phenomena in a manner that facilitates the development of indicators and to select the set of indicators to develop. It will also provide a logical and understandable structure to organise, manage and distribute indicator data. It will help the SDI developers group to organise existing data and identify data gaps.

Identify relationships between components: The framework should provide a conceptual description of the various components and phenomena that are relevant to sustainable development. This conceptual description will help to communicate an understanding of the nature of sustainability and build a consensus on the set of indicators. A comprehensive, integrated framework will also help to promote cross-discipline research and communication.

Characteristics of the Framework

The SDI Framework is a structure that organises the elements of sustainable development and helps to see the whole picture. National policy must consider interests of many constituencies and balance economic, environmental and social concerns. The SDI Framework shows social, economic and environmental activities, clarifies relationships between areas, links current benefits to long term assets, identifies processes that affect future capabilities the most.

A framework should have several characteristics to make it useful in identifying and organising indicators:

Understandable: People from diverse disciplines should find the framework easy to understand and explain.

All-inclusive: All elements of a system should fit ensuring the consideration of all possible alternatives during the selection of Sustainable Development Indicators.

Scalable: The framework must be very general at its highest level, yet be expandable to greater detail.

Compatible: The framework should be compatible with other frameworks and concepts used in indicator development and sustainable development in general.

Internally consistent: The different elements within the framework should be consistent with each other.

Dynamic: Accounting over time of processes and trends. In a sustainable balance, the processes of maintenance, replacement and renewal must equal or exceed the processes of depreciation, degradation and loss. Integrated accounting over time should help to eliminate unrealistic assumptions about the future, by incorporating the real dynamics of possible rates of change and capacities of systems and resources, such as water resources, primary productivity, population characteristics, etc. One critical factor will be the energy throughput, including both renewable and non-renewable sources. The sum of dynamic indicators for the movements over time of all these dimensions of our total accounts will define the real sustainability.

Globally relevant: If they are to be globally relevant, indicators of sustainability must be designed to have sufficient flexibility in the analysis of common themes, dimensions or trends of sustainability while remaining culturally appropriate everywhere. Setting indicators involves value judgements that are inherently culture-bound. They should be capable of covering the full spectrum of interests in a global level.

Objective: For example, environmental indicators should have an objective scientific basis for setting targets or limits. Only science can define the criteria of environmental quality from which society can set its appropriate limit. However, on the social and economic side, limits or targets are much more value-laden and thus indicators cannot be absolute but must be relative to the society's concepts, goals and values.

MEASURING SUSTAINABLE DEVELOPMENT, PROBLEMS AND FUNDAMENTALS

Measurement of sustainable development is an essential prerequisite to promoting a sustainable society. During the 1990s there has been a boom in programmes with the aim of devising SDI. The Brundland report (WCED, 1987) gave us the benchmark definition that has been supplemented by the widely accepted but more precise definition given in the second World Conservation Strategy report (IUCN-WWF-UNE, 1991). However, no method of measuring sustainable development has gained a similar widespread level of support and considerable effort is currently focused in this area by governments, public local authorities, NGO and academics across a wide range of disciplines.

On an international scale indicators are used by organisations such as the Organisation of Economic Co-operation and Development (OECD) and the Worldwatch Institute. The United Nations Environmental Assessment Programme is reviewing indicators work and is attempting to harmonise approaches and encourage greater partner involvement (UNEAP, 1995). UNEAP is co-ordinating the SDI work of a number of supra-national bodies including the UN Development Programme, the UN Department of Policy Co-ordination and Sustainable Development, the UN Statistical Department, the Scientific Committee on Problems of the Environment, the World resources Institute and the World Bank. The principal reason for this indicators demand is the UN conference on Environment and Development (the Rio "Earth Summit"). This Summit stated that "indicators of sustainable development need to be developed to provide solid bases for decision making at all levels and to contribute to self regulating sustainability of integrated environmental and development systems" (UNCED, 1992). The European Community's 5th Environmental Action Programme "Towards Sustainability" also notes that "there is presently a serious lack of indicators and environmental assessment material" (CEC, 1993) and this has added to the demand for effective SDI.

Nationally, we are only beginning to address SDI to meet their commitments made under the Rio declaration. Sustainable community indicators attempt to look at different aspects of interaction, present information to the community and serve multiple uses. They organise and make information accessible to the public, identify action steps and clarify goals. Indicators serve as tools to measure progress and are one part of an effective community based process that defines and implements a specific course of action. For example, a resource indicator, such as the recycling activity in a local community, can reveal information such as the stability or variability of the community participation in collection programs, the quantities of resources diverted from landfills, what products are manufactured from secondary materials and to which markets. This information can support action to increase recycling rates, develop alternative markets for materials, affect policy and future planing and lead new goals.

At the regional and city scale, local authorities and NGO address local Agenda 21 commitments. The Tufts University Consortium for Regional Sustainability (CRS) published a report "Defining a Sustainable Community", which describes four characteristics of sustainable community: economic security, ecological integrity, quality of life and empowerment with responsibility. These characteristics provided the framework for a second project entitled "Sustainable Community Indicators", in which CRS identified a series of pathways and corresponding indicators that can measure progress toward community sustainability. These indicators were determined through literature reviews, interviews and consultations with other community indicator's projects. Then people with knowledge about the community evaluate them in order to test their relevance and practicability. The community engagement aspects should direct people to think through their project ideas to discover and understand the possible linkages, the short and long-term consequences and the likely results.

Despite the considerable attention devoted to SDI, no set has emerged with universal appeal and new SDI sets experience difficulty in gaining wide acceptance.

The need for indicators

A tremendous increase in the volume and availability of data and information on the social, economic and physical environments is a net result of the information technology revolution we are living. Policy makers must see through this deluge of data how they can do the best possible decisions. Unfortunately, valuable information from that mine of data is only being extracted at a very slow rate. Indicators are a simple way of substituting all the available information in order to support a decision making process. Zachary (1995) notes that indicators to be used by decision-makers need to be accessible and presented in a clear, concise format. This format must includes information about where the data was obtained, how it was interpreted, what it signifies for a sustainable community and how it relates to other indicators. It gives to the reader a snapshot of the range of issues covered, providing a straightforward discussion. Policy-makers can use indicators to identify where more information is needed before making decisions. Applying indicators to a specific project enables policy-makers to see how indicators can be implemented at a practical level.

Indicators are tools for information. Ott (1978) describes indicators in this way "ideally, an index or an indicator is a means devised to reduce a large quantity of data down to its simplest form, retaining essential meaning for the questions that are being asked. In short, an index is designed to simplify. In the process of simplification, of course, some information is lost. Hopefully, if the index is designed properly, the lost information will not seriously distort the answer to the question".

During the process of extracting information from the available data, distortions can occur due to gaps on it or in the simplifications necessary to perform the data analysis. This is particularly important in SDI development where significant data may not be available, with the need of using surrogate measures to replace them. Clearly, if SDI are to be a useful tool in the promotion of sustainable development they must be designed to minimise information distortion and losses and to provide the answers to the questions policy makers and public seek to answer.

Indicating and Designing Indicators of Sustainability

Organisations facing the task of promoting sustainability must have ways of measuring the progress towards that goal. The use of single figure aggregated indices, designed primarily for use at a national level are not suitable for citizens and decisions makers wishing to promote local sustainability. Therefore, a large amount of SDI sets was proposed, each comprising a large number of specific indicators, in an attempt to include all the dimensions (local to national to global) of the problem. Obviously the problem of compatibility between them arises and there is a danger that without the application of a common method, indicators will be produced in an ad hoc fashion without full consideration of key sustainable development principles or indicators characteristics.

We are dealing here with dynamic systems and our goal is progress towards sustainable development. By analogy with physics, the set of indicators must tell us in which direction we are going, towards or away from the goal and the speed of that movement as a vector. Such indicators will allow each country or region to define its owns goals and relate them to the indicators, whether is making progress towards them and at what rate. The objectives and targets can not be fixed in time as technological possibilities and social visions of change. A moving target modified from time to time, is the only valid option.

Since sustainability is itself difficult to define and most present indicators represent negative factors or pressures preventing sustainability, vector measures allow countries or regions to report their progress in the reduction of damaging activities, even if they have not yet defined their goals. The relative weight of the different indicators is other key issue in designing SDI. The weighting must be calculated according to the characteristics of each phenomenon. Each indicator in effect weights itself according to the significance of its impact.

Indicators could be developed not only as numbers and graphic representations, but also on scales and even colour codes that would make it easier to communicate them or map them to show distributions in space. Indicators could be scaled as a percentage ranging from 100 for full sustainability to 0 for non-sustainability. Another measure could be the number of years to achieve sustainability (for positive trends) or non-sustainability (for negative trends) around a central point where the vector changes direction at 10, 100 or 1000 years depending on the phenomenon. A standardised language or scale for indicators of sustainability could be used for any factor at any geographic scale at which indicators need to be determined and would communicate indicator results in a simple graphic fashion easier for non-specialists and the public to understand. Sustainability may be a complex concept, but this does not mean that indicators of sustainability cannot have an immediate direct meaning for everyone concerned.

Aggregated single indices are contentious in construction, are often poorly supported by the required data and are difficult to understand doing little to communicate sustainability issues to most people. A set of simpler SDI complements the use of the single aggregated index and is essential for promoting sustainable development at the local level. However another often finds indicators produced by one group unsatisfactory and to date, no common set of SDI has been widely implemented. The reasons for this are that firstly, the geographical diversity of cities, towns and countryside means that many groups seeking SDI find existing indicator sets inappropriate to their locality. Secondly, needs vary between groups of people (both indicator developers and users) so some indicators must be selected that are good reflections of local concerns and cultural diversity. However, it should be possible to identify a core set of SDI common to all localities that address global sustainability concerns. Thirdly, existing SDI are occasionally found unsuitable due to "technical" difficulties such as poor data availability. Finally and perhaps most seriously, sustainability principles are not consistently applied within all indicator programmes.

Designing a good indicator is difficult enough when the subject matter is well understood, but is particularly difficult in the case of SDI given the complex and multifaceted nature of sustainable development issues. Effective SDI can best be identified, by ensuring that personnel in organisations with the responsibility for their development are adequately briefed on sustainability issues and indicator characteristics. This process can be assisted, in part, by the application of a suitable SDI method able to guide developers through the process of indicator identification.

CONCLUSIONS

Indicators are useful in promoting sustainability if designed with care and used properly. Many existing sets of SDI have not been identified using an explicit methodology, making it difficult for other indicator developers to learn general lessons and sometimes they have been used to mislead and misinform. Due to geographical and cultural diversity and the varying needs of different user groups, there is likely to be a continued strong demand for SDI. It would be desirable to agree as far as possible on standard ways to express sustainability indicators to make them easily understandable and widely recognisable.

Our challenge is that indicators of sustainable development are being pushed by political demand despite the hesitancy of experts and scholars to tackle questions that involve human values and political processes as much as or more than scientific methodologies. The above reflections and proposals may suggests a satisfactory way forward. We must rise to the challenge and work to develop indicators that can themselves become the driving forces towards a truly sustainable society.

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Measuring Changes in Consumption and Production Patterns

Catherine Rubbens

Abstract

In the context of the implementation of the Work Programme on Indicators of Sustainable Development (WPISD) of the Commission on Sustainable Development (CSD), the Division for Sustainable Development of the United Nations Department of Economic and Social Affairs (DSD/DESA) has organised a project to select a preliminary core set of indicators for monitoring consumption and production patterns.

This paper includes (i) an introduction to the WPISD; (ii) an overview of activities related to the selection of the preliminary core set of indicators for consumption and production patterns; (iii) progress achieved in developing methodologies and in national testing of the indicators; (iv) preliminary reactions from partners; and (v) next steps for further development of the set.

The Work Programme on Indicators of Sustainable Development of the Commission on Sustainable Development

Indicators can help decision makers at various levels promote sustainable development. The importance of indicators for monitoring progress was recognised at the Earth Summit in Rio de Janeiro in 1992. Chapter 40 of Agenda 21, „Information for Decision-making" calls for the development of indicators of sustainable development.

In implementation of chapter 40 of Agenda 21, the WPISD was established at the third session of the Commission on Sustainable Development (CSD) in 1995 and is being co-ordinated by DSD. Through collaboration among international, governmental, and non-governmental organisations, the implementation of the WPISD has resulted in a working list of 134 indicators of sustainable development covering all of the forty chapters of Agenda 21. The overall objective of the work programme is to provide decision makers at the national level with indicators of sustainable development, and to agree on a workable set of indicators by the year 2001, through a process of feed-back and revision of the indicators.

The indicators are grouped in four major categories: social, economic, environmental, and institutional. These categories create the horizontal structure of a matrix in which the vertical structure is organised in categories called driving force, state, and response (DSR). In this framework, driving force indicators represent human activities that affect sustainable development, state indicators show the condition and status of sustainable development, and response indicators reflect policies and other societal responses to unsustainable development.

The use of the DSR framework does not mean that it is possible at this stage to identify causal relationships among driving force, state, and response indicators. The choice of the framework should rather be seen as a way to categorise the indicators so that they fit the needs of their producers and users.

For each of the 134 indicators, methodology sheets were developed by „lead agencies“ selected from the United Nations system and other intergovernmental and non-governmental organisations. The purpose of the methodology sheets is to provide agencies at the national level with information about the concept, significance, measurement and data sources for each indicator in order to facilitate data collection and analysis. The methodology sheets were published by the United Nations in October 1996, in „Indicators of Sustainable Development: Framework and Methodologies“.

Since 1996, the sustainable development indicators and methodology sheets are being tested on a voluntary basis by 22 countries in all regions of the world. Countries involved in this testing process have been requested to provide periodic reports on the testing phase to DSD. This testing process has been co-ordinated through a meeting in Belgium (1996), where the testing process was launched, and two follow-up meetings in the Czech Republic and Luxembourg (1998). Training for countries in the use of the indicators and methodology sheets was provided by DSD at regional workshops held in Thailand, Costa Rica, Ghana, and Barbados. DSD is currently in the process of implementing the WPISD further by developing additional technical co-operation activities in various countries.

DSD has also hosted five Expert Group Meetings on Indicators of Sustainable Development since the WPISD was launched. At these meetings, experts in the area of sustainable development indicators discuss the further implementation of the WPISD. Issues on the agenda include linkages and aggregation, harmonisation of international indicator initiatives, further development of the core set of indicators, revision of methodology sheets, experiences from the testing process, and technical co-operation activities.

More information about the implementation of the WPISD can be found on the website http://www.un.org/esa/sustdev/isd.htm.

A core set of indicators for monitoring changes in consumption and production patterns

Since the Earth Summit in Rio de Janeiro in 1992, discussions on consumption and production patterns have focused on trends in consumption and production and ways to influence these trends so that they become more sustainable. The topic, „changing consumption and production patterns“, considered in chapter 4 of Agenda 21, covers various resource and policy sectors and has linkages with other sustainable development issues, such as trade, finance, education, and technology transfer.

Changes in consumption and production patterns result from the choices of a wide variety of actors including business and industry, households, and governments. The challenges faced by policy makers concerned with sustainable consumption and production are to optimise resource use, to minimise negative environmental and social impacts of consumption and production, and to stimulate and facilitate trends towards more sustainable patterns.

The development and use of indicators for monitoring consumption and production patterns have become increasingly important in this policy making process. These indicators should reflect the „eco-efficiency" strategy, increasing the productivity of energy and material inputs in order to reduce resource consumption, pollution and waste per unit of output. They should monitor changes in the volume and intensity of resource use and the environmental effects thereof, and provide information about possible policies and other measures for achieving more sustainable consumption and production patterns. They should also allow for analysing consumer behaviour that impedes sustainable development, and ways to change such behaviour.

Though the WPISD process selected eight indicators for "Changing consumption and production patterns", it was recognised that further work was needed to address this issue in a comprehensive manner.

For the above reasons, DSD has organised a process to select a preliminary core set of indicators for changing consumption and production patterns. Consultations were organised among policy makers and other experts working on consumption and production patterns and indicators of sustainable development, and a Workshop was hosted by DSD in New York on 2-3 March 1998. The 1998 report "Measuring changes in consumption and production patterns" is the result of this consultative process.

The publication proposes a provisional core set of 17 indicators: 8 for the "Key resources", energy, materials, water, and land, and 9 for the "Consumption clusters", mobility, consumer goods and services, buildings and housekeeping, food, and recreation (see ANNEX).

The DSD is now in the process of identifying lead agencies to develop methodologies for these indicators, and generating interest among countries and organisations to improve the core set, to develop some of the indicators further, and to test these indicators at the national level.

Methodologies and preliminary testing results

Three of the selected indicators for changing consumption and production patterns are already part of the set of 134 Indicators of Sustainable Development, and methodology sheets for those indicators were developed previously. The United Nations Statistics Division has developed methodology sheets for the indicators „Annual energy consumption per capita" and „Share of renewable energy in total energy consumption". The United Nations Conference on Trade and Development (UNCTAD) has prepared the methodology sheet for the indicator „Intensity of material use".

In the testing process of the WPISD, Austria, France, South Africa, and Finland have provided preliminary testing results for the indicators „Annual energy consumption per capita" and „Share of renewable energy in total energy consumption". These indicators were already being used in most of those countries, and relatively complete data sets were available. The users were pleased with the information included in the methodology sheets. Among the above four countries, only Austria reported on the indicator „Intensity of material use“. Data availability did not seem to be a problem in Austria, and there were no particular problems in the use of the methodology sheet.

Several lead agencies have already developed methodology sheets for new indicators for changing consumption and production patterns. The Statistical Office of the European Communities (Eurostat) developed methodologies for „Energy prices“ and „Number of road vehicles“, and the World Resources Institute (WRI) has finalised the methodology sheet for the indicator „Total material requirement“. These methodology sheets are currently being circulated among experts.

The International Energy Agency has committed to the development of the methodology sheet for the indicator „Intensity of energy use“, the Food and Agricultural Organisation for „Land use change“, and Statistics Canada for „Market share of more sustainably produced goods and services“.

Potential lead agencies have been identified for the indicators „Distance travelled by mode of transport“, „Spending on recreation as share of disposable income“, „Time spent on leisure, paid and unpaid work, and travelling“, „Average household size“, and „Residential energy and water use per household“. However, formal commitments to the development of methodology sheets have not yet been received.

Further work is still needed for the development of the three indicators „Retail sales of selected goods per capita“, „Market share of more sustainably produced food“, and „Intensity of water use“.

The indicator „Retail sales of selected goods per capita“ could be expressed in terms of the number of units sold or in monetary (total expenditure) terms, and should include separate data on major consumer durables. Similarly to the alternative indicator „Per capita ownership of selected commodities per household“ the indicator is expected to be relevant to policy makers for projecting trends in household electricity use (in combination with indicators of energy efficiency of appliances). In addition, the indicator could provide a basis for estimating rates of disposal of household appliances (in combination with information regarding average length of product life).

More detailed information on major consumer goods would help policy makers in estimating expected energy and material throughput, as well as environmental effects from purchase, use, and disposal of durables. As a result, the indicators would help them to better target product, consumer, and waste policies.

Further studies on the indicator should identify approximately 10 consumer durables to be covered by the indicator (e.g. refrigerators, washing machines, dryers, TV’s, radios, VCRs, microwave ovens, computers), with an emphasis on products with large environmental impacts. The choice of these products should be based on a quantitative method such as input-output analysis. In light of policy relevance and data availability, consideration could be given to alternative indicators, such as „Per capita ownership of selected commodities“, or „Household consumption expenditures by type of good“.

As with the market share of more sustainably produced goods and services, the indicator „Market share of more sustainably produced food“ is expected to be useful as a measure of changes in consumer behaviour or consumer awareness, complementing attitude surveys, and allowing a comparison of expressed and actual behaviour. It could also be useful for policy makers to identify market constraints to the adoption of green consumer behaviour and in assessing trends in overall consumption.

It is difficult to base the methodology for this indicator on market shares of certified or labelled food products, since no harmonised definitions thereof exist at the international level. The selection of products included in the indicator should reflect the product life cycle impact and might have to be revised periodically, as some sustainably produced food products can reach very high levels of market penetration over time and hence cease to be „more“ sustainably produced.

The suggested approach for the development of this indicator is therefore to first discuss and develop several environmental criteria (e.g. pesticide and fertiliser use) and social criteria (e.g. the extent to which food is produced with child labour). In a second stage, on the basis of data availability, approximately 10 food categories should be proposed. The next step would be to include a matrix of products and criteria, indicating which criteria are applicable to which products. A threshold of environmental and social quality should then be developed for determining which food products could be considered environmentally and socially friendly. Finally, a proposal would have to be given as to how the criteria, product categories, and thresholds could be revised over time. In addition, data availability would have to be verified.

This year, the German Wuppertal Institute for Climate, Environment, and Energy has initiated a project on household consumption, with some initial suggestions for methodologies that could be used for the two „Market share“ indicators as well as the indicator „Retail sales of selected goods per capita“. It would be worthwhile to take this work into account in further developing these indicators.

The indicator „Intensity of water use“ should be developed for various sectors, and be expressed in cubic metres per unit of production, or in other units reflecting the ratio of inputs (of water) to outputs. Sectors that could be considered include agriculture, aquaculture, and several industrial sectors (e.g. pulp and paper, steel, and mining).

So far, several organisations and institutes have been working on components of this indicator. In the agricultural sector, indicators for efficiency of water use have been calculated for irrigation districts with different climatic and economic conditions, often providing a means of comparing performance within a single system over time. It could be interesting to consider whether it is feasible and useful to develop an indicator for the intensity (or efficiency) of water use in agriculture at the national level.

Preliminary reactions from partners

DSD has received several reactions on the structure of the core set as well as on specific selected indicators from environmental and statistical ministries, research institutes, and international organisations. Statistics Canada has been particularly helpful in providing comments.

Generally, there were positive reactions to the indicators proposed under „Key resources“, energy, materials, water, and land. The resource indicators were said to reflect the „heart“ of the discussion on sustainable consumption and production, since they aimed at monitoring resource flows associated with consumption and production activities.

Some „refinements“ of the indicators were proposed. It was argued that the indicator „Annual energy consumption per capita“ should be calculated for non-renewable energy sources, in order to focus more attention on unsustainable energy use. It was also suggested that the indicator „Energy prices“ should be measured in terms of international purchasing power parities.

Some felt that the indicator „Total Material Requirement“ had an important communicative value. However, concerns were raised about aggregating the materials included in the indicator. It was also argued that the varying environmental impacts of these material streams were not sufficiently taken into account. Similar problems related to aggregating all materials in one single indicator were associated with the indicator „Intensity of material use“.

Some reservations were expressed with regard to the policy relevance of the land use indicator. Land is different from other resources in that more intensive land use (e.g. greenhouses), as opposed to extensive land use (e.g. tomato fields), is not necessarily more sustainable. This makes it more difficult to draw conclusions on sustainablity from land use data.

Reactions were generally less supportive of the indicators selected under the „Consumption clusters“. Some of those were said to provide insufficient information on the contribution of consumption to material and energy flows, and were therefore not informative on changes in sustainability of consumption patterns over time.

For example, with regard to the indicator „Distance travelled per capita by mode of transport“, it was felt that what mattered more than the mode of travel was the polluting emissions associated with travel. Similarly, „Pollutant emissions per kilometre driven“ was proposed as an alternative to the indicator „Number of road vehicles“, in order to reflect the impact of vehicles on the environment more clearly.

„Retail sales of selected goods per capita“, „Average household size“, and „Spending on recreation as share of disposable income“ were also criticized as having unclear implications for sustainability, particularly in relation to materials and energy consumption.

Concerns were also raised about international comparability across countries. For example, the indicator „Number of road vehicles“ could be misleading in international comparisons, since it does not include considerations of fuel quality, level of maintenance, and age-stock and vehicle-type distribution of the car fleet.

It was also argued by some that the selected indicators should be linked more clearly to targets and benchmarks, in order to indicate to policy makers and the public whether the indicator should increase or decrease over time. The indicators „Average household size“ and „Time spent on leisure, paid and unpaid work, and travelling“ were not considered as optimal indicators from this point of view.

Concerns with regard to data availability were voiced particularly with regard to the two „Market share“ indicators, and the indicators „Distance travelled per capita by mode of transport“ and „Retail sales of selected goods per capita“.

It was suggested by some that the transport of goods should be emphasised more under „Mobility“. Some doubts were also expressed as to the relevance of a separate consumption cluster for recreation. It was suggested that recreation mobility could fit under the consumption cluster „Mobility", hotels and other infrastructure under „Buildings and housekeeping", and restaurants under „Food". Finally, as a general comment, it was argued that a clearer distinction should be made between consumption and production indicators, in order to facilitate targeting of different messages to different groups (i.e. consumers as opposed to producers).

Next steps

The selection of indicators is a continuous and consultative process, as reflected by the process described above. DSD will continue collaborating with partners in further improving the existing methodology sheets of the indicators for changing consumption and production patterns, and in developing methodologies for others.

It is not clear at this stage if all 17 indicators will be integrated into the broader WPISD programme. In some cases, alternatives might be preferable, in other cases data availability might be an insurmountable bottleneck. Moreover, the core set of 134 indicators is currently being modified. It is expected that ultimately the number of core indicators will be reduced, and that the indicators will be classified in accordance with major sustainable development themes. It is hard to predict, as this stage, how the indicators for sustainable consumption and production will fit into this new structure.

Meanwhile, DSD continues to welcome any comments and suggestions partners might have on the further development of the provisional core set of indicators for changing consumption and production patterns. The research community is considered as a particularly important partner in this respect.

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Core Set of Indicators for Changing Consumption and Production Patterns

KEY RESOURCES	
ENERGY	
1. Annual energy consumption per capita	Monitors energy consumption.
2. Intensity of energy use	Monitors energy use per unit of production/service (for selected sectors).
3. Share of renewable energy in total energy consumption	Monitors the development of renewable energy sources.
4. Energy prices	Monitors energy prices in relation to GDP and disposable income.
MATERIALS	
5. Total material requirement	Monitors total material throughput, including hidden or indirect material flows required for a national economy.
6. Intensity of material use	Monitors material use per unit of production/service (for selected sectors).
WATER	
7. Intensity of water use	Monitors water use per unit of production/service for selected sectors.
LAND	
8. Land use	Monitors land use (forestry, agriculture, settlements, infrastructure, and recreation).
CONSUMPTION CLUSTERS	

MOBILITY	
9. Distance travelled per capita by mode of transport	Monitors the use of different modes of transport (foot, bicycle, train, boat, car, bus, plane).
10. Number of road vehicles	Monitors the total number of vehicles (possibly by type and fuel efficiency).
CONSUMER GOODS AND SERVICES	
11. Retail sales of selected goods per capita	Monitors retail sales of goods (e.g. electronics, home-appliances, clothing).
12. Market share of more sustainably produced goods and services	Monitors social and environmental interest of consumers and producers.
BUILDINGS AND HOUSEKEEPING	
13. Residential energy and water use per household	Monitors total water and energy use in households due to consumer behaviour and housing design and construction.
14. Average household size	Monitors the number of persons per household.
FOOD	
15. Market share of more sustainably produced food	Monitors social and environmental interest of consumers and producers.
RECREATION	
16. Spending on recreation as share of disposable income	Monitors the demand for recreation activities.
17. Time spent on leisure, paid and unpaid work, and travelling	Monitors time-allocation and distribution, and reflects life-styles.

Economic Consequences of the Divergent Characteristics of Greenhouse Gases

Dirk Rübbelke

Abstract

Climate change is probably the most intensely discussed issue harming the sustainability of our global system. It is mainly caused by anthropogenic generation of greenhouse gases (GHGs) hindering long-wavy radiation (heat) to leave the atmosphere towards outer space.

An approach to solve this severe problem might be found in international environmental negotiations. These negotiations should yield an efficient result maximising the welfare of all parties. For this, the greenhouse gas abatement costs and benefits have to be determined. This paper demonstrates that the various greenhouse gases have different characteristics which influence the shape of cost and benefit functions of climate policies in different ways. Furthermore, - because of divergent emitter groups - negotiations of different greenhouse gases will yield different transaction costs.

Thus, to evaluate the efficiency of a climate policy design it is not sufficient to consider only one gas representing the whole group of greenhouse gases because the characteristics of these gases are heterogeneous.

I. Introduction - Evaluation Problems

Global warming on our planet is mainly due to a variety of greenhouse gases (GHGs). Major negative effects on the climate result from the emissions of the gases CO_2, CFCs and methane[1]. By reference to these three GHGs it will be demonstrated in the succeeding investigation that an evaluation of the efficiency of climate policies and the design of international climate negotiations is not possible in a proper way if only the characteristics of one gas like CO_2 are considered. This is mainly due to the fact that the characteristics of the variety of GHGs are heterogeneous and therefore, divergent abatement benefit and cost functions have to be applied in the development of international climate policy design. Furthermore, because of different emitter groups, transaction costs for negotiating emission reductions diverge for different gases.

[1] "[...] even though CO_2 represents 50-60% of total greenhouse effect gases resulting from human activity, climatic changes also depend on other gases: CFC for 15-20% of the total, methane for 15-20% of the total, [...]." Rotillon and Tazdaït (1996: 297).

II. Main Characteristics of Methane, CFCs and CO_2

CO_2, methane and CFCs originate from many different sources and are disposed to divergent sinks. They persist in the atmosphere for different periods of time and hinder heat radiation of different wave lengths to leave our global system before they are depleted.

Methane represents the main content of natural gas. Main sources of this gas can be distinguished between natural (e.g. wetlands, termites, oceans) and anthropogenic (e.g. rice fields, sewage treatment, burning of biomass) sources. The main sinks are the atmosphere and soil. Methane persists about 11 years in the atmosphere (Houghton 1997: 38).

CFCs are emitted only by anthropogenic sources e.g. by cooling systems and spray cans. They persist in the atmosphere for a long time: CFC 11 for about 60 years and CFC 12 for about 130 years (Bauer 1993: 27). When the Montreal Protocol, which established a limitation of CFC emissions, entered in force on 1 January 1989, the USA, Japan and the former USSR accounted for about half of the CFC emissions world-wide. The top 12 emitter countries accounted for about 78% of world wide emissions (Sandler and Sargent 1995: 154-156).

In the case of CO_2 two main categories of sources can be distinguished. First, industrial-based CO_2 emissions, where the main emitters are the USA, the former USSR, China, Japan and Germany (Sandler 1997: 102). Second, CO_2 emissions from land-use changes (tropical deforestation), where the major emitters are countries not belonging to the top group of industrial-based emitters (exceptions are Mexico and India). Thus, there are two emitter groups whose pollution is generated by mainly different sources. Per capita CO_2 emissions of the USA, the main industrial-based polluter, amount to 19.53 tonnes per year compared to 1.43 tonnes in Brazil, which ranks at the top in the group of the main emitters from tropical deforestation (Rodenburg, Tunstall and van Bolhuis 1995: 11-12). Main sinks are the atmosphere and the oceans (Gorshkov 1997: 168). The persistance of CO_2 in the atmosphere is about 120 years (Bauer 1993: 27).

III. Economic Approach

The emissions of GHGs harm the global common “atmosphere” and belong to the group of unidirectional global externalities. According to economic theory, in the case of such externalities the abatement level of a single country becomes optimal for this country where its marginal abatement costs equal its marginal abatement benefits (for every single GHG) given the abatement levels of all the other countries (Nash behaviour scenario).

However, playing Nash is not a (pareto-)efficient solution for the considered problem. “An efficient, comprehensive, climate policy should balance the cost of reducing emissions of each greenhouse gas (GHG) against the environmental costs of the emissions of the gas.” (Hoel and Isaksen 1995: 89). More precisely, countries have not to consider only their national abatement benefits. To achieve a pareto-efficient solution all countries have to take the benefits of their emission abatement for all the other countries into account. Thus, each country’s marginal abatement costs should equal the marginal abatement benefits - for every single GHG - for the world community as a whole (pareto-efficient solution). The pareto-efficient abatement level is larger than the Nash level and maximises net benefits for the whole world[2].

From a normative point of view, international negotiations on climate change should aim at maximising the welfare of all nations, that is, realizing the pareto-optimal level of abatement. As mentioned above, the marginal abatement cost and benefit functions of GHG emissions are crucial in determining this pareto-optimal level. Therefore, the focus of the succeeding investigation will be on the problems associated with the derivation of these functions for different GHGs.

IV. Primary and Secondary Benefits of Climate Change Policies

Since the sources of CO_2 emissions are well known and the calculations of emission quantities are easy to handle, mainly the abatement costs and benefits of this gas are discussed with regard to climate policies in economic literature[3]. Thus, a considered policy is judged to be efficient if the marginal costs of the policy are equal to the marginal benefits of the yielded CO_2 reduction. Here, the benefits from the CO_2 emission reductions represent the primary abatement benefits.

But the consideration of the primary abatement benefits seems to be incomplete, since secondary benefits of a policy are not taken into account. “Policies to reduce CO_2 emissions by reducing the burning of fossil fuels will also reduce other emissions. [...] It is well accepted that pollution from these other emissions,[...] are responsible for substantial external costs.” (Ekins 1996: 162). The avoidance of these external costs, apart from the external costs of CO_2 emissions themselves, represents secondary benefits. Empirical investigations support the relevance of these secondary benefits. Barker (1993: 9) has calculated that the burning of fossil fuels is not only responsible for the emission of CO_2, it is also responsible for 48% of the methane emissions in the UK. Thus, by a reduction of the use of fossil fuels there are not only benefits for the climate because of a reduction in CO_2, there is also a secondary benefit from the reduction of methane. Ekins (1996: 162) points out that the appearance of secondary effects is not atypical for industrial countries.

Accordingly, an important problem for the evaluation of the efficiency of climate policy design is due to the fact that the consideration of only primary benefits – which diverge for different gases[4] - will underestimate the benefits of abatement policies. This underestimation diverges for different GHGs because their marginal secondary benefits differ.

It can be concluded that only by a consideration of the marginal total benefits – the sum of primary and secondary benefits - a proper efficiency evaluation becomes possible.

The impact of primary and secondary benefits on the total benefit function and the optimal abatement level can be observed from the example of a measure to reduce the burning of fossil fuels in order to abate CO_2 emissions. If the evaluation of this policy does not consider secondary benefits

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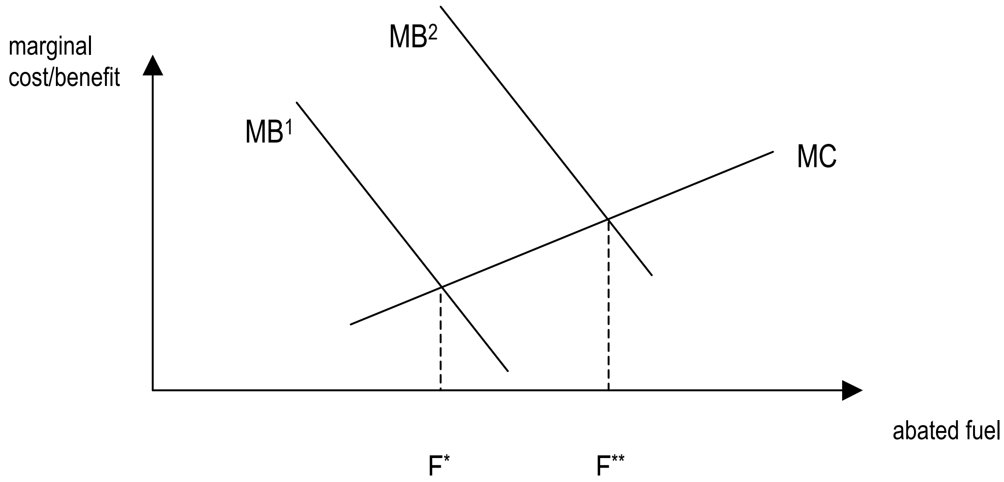
[2] A comparison of these concepts and numerical estimations for several countries can be found in: Hackl and Pruckner (1998).

[3] “To be able to enforce an agreement specifying emission levels from different countries, one must be able to monitor emissions from individual countries. This is probably not particularly difficult for CO_2 (through information on fossil fuel consumption), but considerably more difficult for e.g., methane.” Hoel and Isaksen (1995: 91).

[4] CFCs have a higher global warming potential than methane and methane’s global warming potential exceeds the potential of CO_2. See Bauer (1993: 28).

and only takes into account the direct positive effects from the yielded CO_2 emission decrease, the marginal benefit function is MB^1. If additional secondary benefits from the environmental policy are taken into account, the marginal benefit function MB^2 will be located above MB^1. The marginal costs function MC for a reduction of the burning of fuel is assumed to be given[5].

Figure 1: Marginal abatement benefit functions with and without consideration of secondary benefits[6].



As can be seen from Fig. 1, the equilibrium abatement level changes - by the consideration of the secondary benefits – from F^* to F^{**} (where $F^{**} > F^*$). Thus, the optimal abatement level F^{**} is higher than the abatement level F^*, where the relevant indicator was the positive (primary) effect of CO_2 reduction. Therefore, the abatement policy is less attractive if only the primary benefits are considered.

But secondary benefits of climate policies are difficult to quantify and may even reveal environmental benefits beyond the mitigation of the greenhouse effect. Foresting, for example, is a policy to bind CO_2 but might as well increase biodiversity. On the other hand a measure to mitigate climate change could yield negative secondary effects. The substitution of natural gas for coal and oil in the energy sector, for example, yields - on the one hand side - a decrease in CO_2 emissions[7], but leads - on the other hand side - to higher emissions of methane.

[5] For the sake of simplicity linear marginal cost and benefit functions are applied.

[6] Because of their high concentration in the atmosphere GHGs endanger the sustainability of our global system. High emission level of GHGs might have disastrous consequences for the life on our planet. By abating GHG emissions disastrous effects could be evaded. Thus, the marginal abatement benefit functions is assumed to have a quite steep slope in the relevant range.

[7] Coal emits roughly the double of the carbon dioxide in comparison to natural gas for an equal amount of energy. See Nakićenović (1994: 661).

V. Abatement Costs of Greenhouse Gases and Transaction Costs in Negotiations

Hazardous Pollutants and Divergent Marginal Cost Functions

In contrast to the international negotiations on CO_2 emissions the negotiations and policies on CFCs have been successful in recent years. One reason for this fact might be deduced from the different shapes of the abatement cost functions of the two GHGs[8].

Barrett (1990: 70-72) distinguishes two important categories of hazardous pollutants. He demonstrates for extremely hazardous pollutants with slowly increasing marginal abatement costs, that it is in the single country's interest to reduce these emissions unilaterally in an almost pareto-optimal way: The slope of the marginal abatement benefit curve is steep for extremely hazardous pollutants and the slope of the marginal abatement cost curve is small for pollutants with slowly increasing abatement costs. As we can see from the strongly simplifying depiction of Fig. 2a), the Nash optimal abatement level (determined by the intersection of OMC and OMB) and the pareto-optimal level (determined by the intersection of OMC and GMB) do not diverge very much in this case.

Figure 2a): Slowly increasing OMC

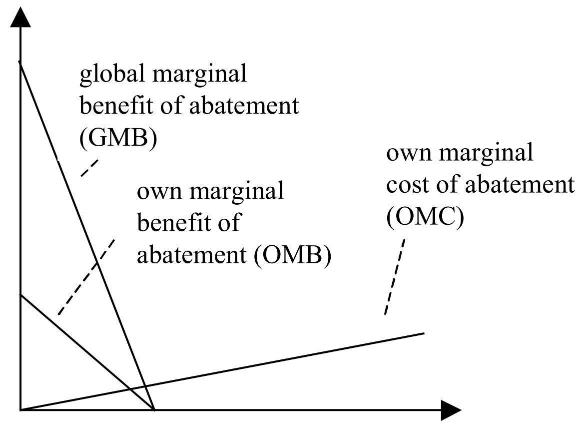
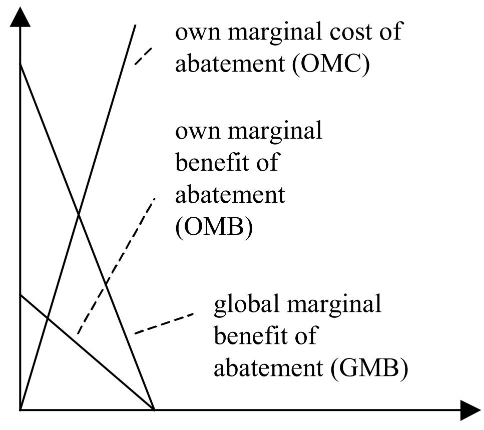


Figure 2b): Rapidly increasing OMC



These changes when the extremely hazardous pollutant is characterised by rapidly increasing abatement costs (thus, the marginal abatement cost function has a steep slope): Now, as we can see from Fig. 2b), the difference between the pareto-optimal and the Nash optimal abatement level is larger than in Fig. 2a)[9]. Obviously, national disincentives to abate emissions in a pareto-efficient way are larger in the case of rapidly increasing abatement costs.

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[8] A second reason is that the estimated abatement benefits of CFCs have increased compared to estimations in earlier years and thus, the incentives for higher efforts in CFC emission abatement became stronger. The new estimations assume that the protection of the ozone shield would save enormous costs associated with skin cancers (Sandler and Sargent 1995: 155-156).

[9] To make both cost scenarios comparable, the same steep marginal benefit functions are employed in the two figures.

On the basis of this general discussion of the different properties of hazardous pollutants' cost functions and their effects on the abatement outcome, the greenhouse gases CO_2 and CFCs will be considered successively.

Abatement Costs: CFCs versus CO_2

The Montreal Protocol aiming at the reduction of CFC emissions in order to save the ozone layer entered into force in 1989[10]. At the beginning reductions in production and consumption of hard CFCs by 50% had been agreed upon by 24 signatories (Barrett 1992**: 206-207). In the following years, this abatement level was renegotiated and increased up to a phase out by the year 1996 by the signatories (Goodstein 1999: 499-502; Houghton 1997: 39). This was possible because appropriate substitutes were at hand which even yielded additional economic gains in some cases[11]. Sandler (1997: 113) points out: "The rapid development of acceptable substitutes meant that producers had much to gain from a CFC ban and, therefore, did not put up any political opposition [...]"[12]. Thus, the marginal abatement cost function of CFCs can be assumed not to increase rapidly at all[13].

CO_2 emission reductions might be possible with low costs by realising efficiency gains especially in the energy sector. But with increasing efficiency the marginal costs of policies reducing CO_2 will grow rapidly. Costs of significant reductions are estimated to be high (Nordhaus 1991: 49; Sandler 1997: 100-101). Thus, policies which reduce CO_2 emissions substantially are more problematic, and therefore, more costly than substantial abatement policies for CFCs[14]. The marginal abatement cost function of CO_2 can be assumed to increase rapidly in the relevant range where significant abatement should take place.

Thus, countries would have smaller disincentives for pareto-optimal national reductions of CFCs than of CO_2 because the marginal abatement costs are increasing less rapidly in the CFC case. Therefore, a realisation of an international agreement aiming at efficient abatement of CO_2 emissions seems less probable[15].

Transaction Costs

Finally, it has to be considered that the group of main emitters of CFCs is much smaller and more homogeneous than it is the case for methane or CO_2[16]. The smaller the number of negotiating parties and the more homogeneous the main emitter group, the lower are the transaction costs of the

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[10] Thus, the main reason for the limitation of this greenhouse gas was not the problem of global warming.

[11] Adams (1997: 85) notes the case of electronics manufacturers which realised cost savings by the substitution of CFCs.

[12] Barrett (1992*: 83) refers to the role of strategic incentives of companies in the issue at hand, when he states that CFC generation "[...] is concentrated in only a few firms, and the ones that are developing substitutes have every incentive to want to market these widely; a world wide ban works in their favour".

[13] The two main substitutes HFC/HCFC are not unproblematic in respect to global warming because they also belong to the group of greenhouse gases (Sandler 1997: 113).

[14] For abatement costs of CO_2 and CFCs see Nordhaus (1994: 59-65).

[15] Because of the high marginal abatement costs in the relevant range the free rider incentives are larger in the CO_2 case.

[16] The large main emitter groups of industrial-based and tropical deforestation-based CO_2 consist of almost completely different countries. Methane is produced by a large group of emitters, too. The USA, Canada and Europe account only for about 30 percent of world-wide emissions. Contrarily, the ten major emitter countries of CFCs - at the time the Montreal Protocol entered in force – accounted for about 75 percent of global emissions in 1989. Almost all of these producers were industrialised countries (Sandler 1997: 112). China represents an exception of minor importance.

negotiation process. This is another reason, why international methane and CO_2 abatement negotiations are highly problematic.

VI. Conclusion

The problem of global warming is due to a variety of sources[17]. The focus in this article was on the three greenhouse gases CO_2, CFCs and methane. It was demonstrated that the characteristics of these GHGs are quite different. Furthermore, these characteristics have different influences on the shape of the marginal abatement cost and benefit functions and thus, on the outcome of negotiations.

Another issue under consideration was the composition of emitter groups. Different sizes of emitter groups and different levels of homogeneity yield divergent transaction costs of negotiations. The emitter groups of methane and CO_2 are quite large and heterogeneous. Thus, transaction costs of international methane and CO_2 negotiations are high.

It can be concluded that for the evaluation of an international climate negotiation design and the efficiency of a climate policy it is not sufficient to consider only one gas representing the whole group of GHGs because the characteristics of these gases are heterogeneous. Transaction costs of negotiations, primary and secondary benefits of abatement, substitution possibilities and abatement costs of all the different GHGs have to be considered in a proper evaluation of international climate policy design.

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[17] Some authors do not only consider greenhouse gases as the 'bads' causing climate change, they also consider the problem of accumulated heat as a 'bad' causing global warming. This point can be integrated by applying the thermodynamic 'entropy' concept. See Frondel, Oertel and Rübbelke (1999) and Rübbelke (1998).

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Viable Technologies and Sustainability: The Role of Natural Funds

Thomas Schulz

Introduction

Nicholas Georgescu-Roegen may be looked upon as one of the founders of ecological economics. But he did not deal explicitly with the concept of sustainability, the basic concept of ecological economics. On the contrary, his uncompromising critique of the steady state concept seems to imply that the only economy he could imagine to be sustained forever is the economy of hunters and gatherers. He has accused the proponents of the steady state that their "crucial error consists in not seeing that not only growth, but also a zero-growth state, nay, even a declining state which does not converge toward annihilation, cannot exist forever in a finite environment." (Georgescu-Roegen 1976, p. 23)

Nevertheless, as Gowdy/O'Hara (1997) have shown recently, the legacy of Nicholas Georgescu-Roegen contains a concept which could contribute to the debate on sustainability: the concept of "viable technologies".

The paper first introduces Georgescu-Roegen's concept of viable technologies and his analytical representation of the relationship between the economic process and the environment. Then it will be shown that the viability condition is not apt to ensure sustainability as well. Taking up an idea of Gowdy/O'Hara, in a next step the viability condition will be modified in order to get a condition of sustainability. This modification implies the introduction of a "fund of natural services". In a concluding chapter the limitation of this approach will be discussed briefly ending in the conclusion that Georgescu-Roegen's flow-fund model and his concept of viability can serve as a framework which allows to discuss ecological services indispensable for sustainability in a consistent way thereby stimulating the debate on sustainability indicators.

Viable Technologies

Georgescu-Roegen insisted that technologies must be evaluated in a comprehensive perspective in order to prove if they are "viable". A technology is viable if it not only enables us to do specific activities but also "... can maintain the corresponding material structure and necessarily the human species" (GR[1] 1984: 29). According to Georgescu-Roegen, in the history of mankind there were only two "promethean inventions" as he called them that resulted in viable technologies: the mastery of fire

[1] In citations the abbreviation GR will be used for Georgescu-Roegen.

and the heat engine.[2] These inventions firstly facilitate a qualitative energy conversion and therefore increase the availability of resources in a substantial manner. Secondly they lead to a chain reaction. Fire achieves the conversion of the chemical energy of combustible materials into caloric power and a chain reaction of burning any amount of whatever combustible material is available by a small flame. The heat engine achieves the conversion of caloric power into motor power and the chain reaction consists in the fact that with a heat engine and just a small amount of coal man is able to mine more coal and other minerals to produce more heat engines and so on (GR 1984).

It must be noted that viable technologies, as defined by Georgescu-Roegen, are dependent of a certain kind of fuel. As a consequence, even viable technologies are sustainable only in a mid-range perspective: as long as the fuels they are driven by are not depleted. But the concept of a viable technology can be broadened: "A technology ... is viable if and only if it can maintain the corresponding material structure which supports its resource and sink functions, and consequently support human activity indefinitely under current environmental conditions" (Gowdy/O'Hara 1997: 242). By proposing this "viability rule" Gowdy/O'Hara connect the idea of crucial functions provided by nature with Georgescu-Roegen's analytical representation of the production process. They enhance Georgescu-Roegen's flow/fund model by adding "all economic and ecological services of natural resources including their assimilative and absorptive capacities" (ibid.: 242) to the funds that have to be maintained.

The Flow/Fund Model of the Production Process

Georgescu-Roegen's model of the production process is based on the fundamental distinction between two kinds of factors of production: on the one hand there are flow elements, natural resources and intermediate products, that are acted upon transformed or produced by, on the other hand, the fund elements. The fund elements are the durable agents of production.[3] Whereas flow elements change qualitatively, the fund elements do not change (GR 1983) during the process. It is important to distinguish a fund from a stock: whereas a stock can be decumulated at an arbitrary rate, the "decumulation" of a fund - i.e. the use of the fund until it is worn out - is largely determined by its physical structure. A fund is not consumed, its services are used until it "breaks down". If an element is a flow or a fund depends on the duration of the process. The funds of production are the classical factors (Ricardian) land (L), labor power (H) and capital (K).

Georgescu-Roegen's simple representation of a reproducible or steady-state process is shown in Table 1 (GR 1984):

[2] The breeder reactor technique was also classified as promethean by Georgescu-Roegen, but he didn't advice its use because of the unsolved security problem connected with it (GR 1986).

[3] The fund elements can also be regarded as the "material scaffold" (GR 1979:1027) of the economic process.

Table 1: The Analytical Representation of a Reproducible Process

Factors	(A)	(B)
	Flows	
Inflows from nature	-r	-R(t)=rt
Inflows from other processes	-i	=-I(t)=it
Outflows of products	+q	=+Q(t)=qt
Outflows of waste	+w	=+W(t)=wt
	Funds	
Labour power	H	H(t)=Ht
All capital	K	K(t)=Kt
Ricardian land	L	L(t)=Lt

Since Table 1 represents a steady-state process the capacities of funds and the rates of flows which enter or leave the process are constant over time. These are given in column A. The rate of flows elements is measured in quantities per time and the capacities of funds are simply the size of the fund, for example the number of workers in the case of H. Column B shows the amounts of flow elements (measured in physical units) or the amounts of services contributed by the different funds (measured in size of fund x time) during a given time period respectively. To be reproducible, the process must not alter the funds and their ability to contribute services. Thus the assumption of Georgescu-Roegen was that there has to be a maintenance flow to keep the capital funds intact (GR 1971, Chapter IX, Section 5).

Based on the previous illustration of a reproducible process Georgescu-Roegen has given an analytical representation of the relation between a steady-state economy and its environment by identifying six subprocesses according to Table 2 (GR 1984: 27):

Table 2: The Relationship Between the Economic Process and the Environment

Elements	**(P_0)**	**(P_1)**	**(P_2)**	**(P_3)**	**(P_4)**	**(P_5)**
			Flow Coordinates			
CM	x_{00}	*	$-x_{02}$	$-x_{03}$	*	*
CE	$-x_{10}$	x_{11}	$-x_{12}$	$-x_{13}$	$-x_{14}$	$-x_{15}$
MK	$-x_{20}$	$-x_{21}$	x_{22}	$-x_{23}$	$-x_{24}$	$-x_{25}$
C	*	*	*	x_{33}	*	$-x_{35}$
RM	*	*	$-x_{42}$	$-x_{43}$	x_{44}	*
ES	*	$-e_1$	*	*	*	*
MS	$-M_0$	*	*	*	*	*
GJ	w_0	w_1	w_2	w_3	$-w_4$	w_5
DE	d_0	d_1	d_2	d_3	d_4	d_5
DM	s_0	s_1	s_2	s_3	s_4	s_5
R	r_0	r_1	r_2	r_3	r_4	r_5
			Fund Coordinates			
Capital fund	K_0	K_1	K_2	K_3	K_4	K_5
People	H_0	H_1	H_2	H_3	H_4	H_5
Ricardian land	L_0	L_1	L_2	L_3	L_4	L_5

The subprocesses can be described as following:

(P_0): transforms matter in situ, MS, into controlled matter, CM (mining sector);
(P_1): transforms energy in situ, ES, into controlled energy, CE (energy sector);
(P_2): produces maintenance capital, MK (capital goods sector);
(P_3): produces consumer goods, C (consumer goods sector);
(P_4): recycles the garbojunk, GJ[4] and supplies recycled matter, RM (recycling sector)
(P_5): maintains the population H (consumption sector)

P_0 and P_1 provide the basic resources matter and energy which circulate through every other sector. P_2 and P_3 represent production proper. P_4 represents the recycling sector and P_5 the sector of households[5] (GR 1977). As a consequence of the entropy law, in the course of all processes energy

[4] Garbojunk is Georgescu-Roegen's concept for recyclable waste like broken glass, old papers etc. It represents available although not useful matter in contrast to dissipated matter (DM) which is lost forever for human purposes.

[5] The fact that the consumption sector has no output except of waste shows according to Georgescu-Roegen that the true product of the economic process consists in an immaterial flux - the so called "enjoyment of life" (GR 1977).

and matter are dissipated, i.e. they are transformed from an available state into an unavailable state where they cannot be used for human purposes any longer. Thus each process produces not only the wanted output of goods but also an unwanted output of dissipated matter (DM) and dissipated energy (DE). Besides the already mentioned waste of recyclable matter (garbojunk), unrecyclable (dissipated) matter and thermal waste (dissipated energy), there is still another kind of waste listed by Georgescu-Roegen. This is the so called refuse (R). Refuse contains energy and matter in available form but nevertheless is useless because of technical or economic reasons. An example would be nuclear garbage.

Recalling Georgescu-Roegen's definition of viability, all subprocesses are required to maintain their material structure and the human species. The second condition is fulfilled if the whole population (H_5) can be maintained by the flows x_{i5} (and if the funds K_5 and L_5 are sufficient). The material structure of the economic process consists in the capital funds K_i, thus x_{22} must be large enough to replace the worn out capital funds K_i.

Thus the following conditions hold for a viable steady-state process (GR 1979: 1041):

$$\sum_{i=2}^{4} x_{0i} = x_{00};\quad \sum_{\substack{i=0\\ i\neq 1}}^{5} x_{1i} = x_{11};\quad \sum_{\substack{i=0\\ i\neq 2}}^{5} x_{2i} = x_{22};\quad x_{35} = x_{33};\quad \sum_{\substack{i=2\\ i\neq 4}}^{3} x_{4i} = x_{44};\quad \sum_{\substack{i=0\\ i\neq 4}}^{5} w_{i} = w_{4}.$$

The fund of natural services

The concept of a viable technology or a viable process as introduced by Nicholas Georgescu-Roegen is not yet apt to describe a sustainable process. Firstly, whether a viable technology is sustainable depends on the availability of the fuels which drive the technology. Although called viable by Georgescu-Roegen, the heat engine technology would come to an end if it ran out of fuels. Secondly, sustainability as understood by ecologists requires ecosystem functions to be kept intact. It seems that the definition of a viable technology - maintaining the material structure and the human species - does not allow to capture those ecosystem functions which are regarded as indispensable for a sustainable development. These functions are not taken into account in the first part of the definition since „material structure“ in Georgescu-Roegen's sense means solely the capital fund (GR 1983). The second part of the definition is too general to be a useful analytical tool. Consequently, redefining the fund structure is necessary.

In Georgescu-Roegen's model natural resources are solely represented as flows. The fund factor land is seen as mere space, it does not comprise any ecological functions on a given territory. This definition has been modified by Gowdy/O'Hara (1997). Their definition of land refers to "all economic, and ecological services of natural resources including their assimilative and absorptive capacities" (p. 242). Besides a flow of natural resources there is now established a fund of natural services.[6] This new fund element must supply indispensable ecosystem functions. The proposal of Gowdy/O'Hara is to focus first of all on "sink functions", i.e. the assimilative and absorptive capacities

6 This fund could be called natural capital but this is a concept surrounded by a lot of difficulties. See for example England (1998).

of ecosystems. The economic process is supported on the source side by natural input flows and resource functions and on the sink side by the assimilative and absorptive services of natural funds for the disposal of output flows of waste (DE, DM, and R in table 2). According to Gowdy/O'Hara a technology is viable "if and only if it can maintain the corresponding material structure which supports its resource and sink functions and consequently support human activity indefinitely under current environmental conditions" (p. 242). This "viability rule" ensures also sustainability of the economic process as a whole and is equivalent to another formulation:

An economic process is sustainable if it maintain its fund factors K (manmade capital), L (Ricardian land), N (fund of natural services), and H (people) indefinitely.[7]

This definition is a strong sustainability concept as far as it accounts for ecological stability or ecological resilience by the claim to keep essential ecosystem functions (N) intact. Also it assumes that the relationship between the fund factors K and N is complementary.

Discussion of the approach

The main contribution of a "Georgescu-Roegen style" flow-fund model with respect to sustainability is that it shows the importance of supporting services for long term reproducible production processes (Gowdy/O'Hara 1997). In addition to the maintenance of flows - a topic well established in economics - the viability of these processes according to Gowdy/O'Hara depends as well on the supporting services of natural funds which ensure the resource and sink functions of the process.[8]

From the flow-fund model a simple sustainability rule can be derived which states that all funds have to be kept intact. The difficulty consists in identifying the elements which should be subsumed under the fund of natural services, N.

A first problem arises with the concept of resource functions used by Gowdy/O'Hara (1997). It is not clear whether this concept refers to flows or funds or both. To be in line with Georgescu-Roegen's flow-fund model it is necessary to keep flow and fund elements discretely distinct.[9] The question is what natural resources belong to the fund N and what to the flow R? A fund is a material structure which supplies services while remaining unchanged. According to this definition non-renewable resources certainly do not belong to N, they are stocks which can be decumulated into flows. But what about renewable resources?

Organisms can be regarded as funds. But in this context it is advisable to choose species as units of funds because in principle species can reproduce themselves forever (Faber et. al. 1996). Consequently it is possible to subsume species under the natural fund N. But this immediately invokes the question which species are crucial for sustainability.

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[7] It is possible to omit the fund L, because by its definition as mere space it cannot be destroyed.

[8] As Gowdy/O'Hara (1997) have pointed out, in addition to supporting services of natural funds there is another kind of supporting services that are equally important for sustainability: the social supporting functions which contribute to keep the human working capacity - the fund H - intact.

[9] Otherwise there is the danger of double counting.

The simple sustainability rule is in line with the well-known management rule for sustainable resource use (see for example Pearce/Turner 1990):

1. Harvest rates of renewable resources should not exceed regeneration rates.
2. Waste emission should not exceed the relevant assimilative capacities of ecosystems.
3. Non-renewable resources should be exploited in a quasi-sustainable manner by limiting their rate of depletion to the rate of creation of renewable substitutes.

Rule 1 is fulfilled if species are included in the natural fund N. Rule 2 is fulfilled because sink functions have to be kept intact. Rule 3 is fulfilled because the (manmade) capital fund K has to be kept intact.[10]

To secure the survival of all species is a rule that might be too rigid as it does not leave much substitution opportunities. When taking opportunity costs into account it seems necessary to use both ecological and economic sustainability indicators (Rennings/Wiggering 1997). This implies to confine the fund N to really essential ecological services as the services of the ozone layer, the global water cycle or biodiversity. To make the sustainability rule "keeping the funds intact" operational it is necessary to rely on sustainability indicators which show whether this aim has been reached and to what extent. Both the key ecological services and the corresponding indicators have to be determined by interdisciplinary research.

Thus one conclusion of the discussion on the contributions of Georgescu-Roegen's flow-fund model and his concept of viability is that it can serve as a framework which allows to discuss ecological services indispensable for sustainability in a consistent way.

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[10] The fund of (manmade) capital K cannot be sustained indefinitely if depletable resources are not substituted by renewable ones.

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List of Participants

List of Participants

Speakers and Session Leaders

Buchinger, Eva	eva.buchinger@arcs.ac.at	Austrian Research Center Seibersdorf, Division Systems Resarch Technology-Economy-Environment, Department of Regional Studies, A-2444 Seibersdorf	phone ++43 2254 780 3886 fax ++43 2254 780 3888
Fletcher, Jill	Jill.Fletcher@doh.gsi.gov.uk	SD2e, Department of Health Room 444B, Skipton House, 80 London Road ,London, SE1 6LW	
Gerhold, Susanne	SGerhold@oestat.gv.at	Austrian Central Statistical Office, Hintere Zollamtsstr. 2b, A-1033 Vienna	phone ++43 1 71128 7235 fax ++43 1 711-27 7728
Guinomet, Isabelle	althea@pt.lu	EUROSTAT - Statistical Office of the EU, Unit of Environment, 21, Rue JP Koenig, L-1865 Luxembourg	phone ++352 22 59 31 fax
Maderthaner, Rainer	rainer.maderthaner@univie.ac.at	University of Vienna, Institute of Pdychology, Liebiggasse 5, A-1010 Vienna	phone ++43 1 4277 47823 fax ++43 1 4277 9478
Ott, Jan	opstalot@wxs.nl	Erasmus University Rotterdam, POB 1738, NL-3000 DR Rotter-dam, Netherlands	phone ++31 10 408 2101 fax ++31 10 408 9098
Piringer, Markus	markus.piringer@global2000.at	Global 2000 – Friends of the Earth Austria, Flurschützgasse 13, A-1120 Vienna	phone ++43 1 812 57 30 fax ++43 1 812 57 28
Ruddy, Thomas	ruddyconsult@imailbox.com	Consultant, Fr.-Zundelstr. 8, D-72074 Tübingen	phone ++49 7071 83490. fax ++49 7071 81697
Schmidt-Bleek, Friedrich	biofsb@aol.com	Factor10 Institute (President), La Rabassière, F-83660 Carnoules	phone ++33 4 94 33 24 58 fax ++33 612 175 837
Schrefel, Christian	Ecocounselling.Europe@nextra.at www.ecocounselling.org	Eco Counselling Europe, Mariahilferstr. 89, A-1060 Vienna	phone ++43 1 581 13 28 fax ++43 1 581 13 28-18
Whiston, Thomas G.	tgw@teksam.ruc.dk	Professor Environmental Regulation Roskilde University, Depart-ment of Environment, Technology and Social Studies, Univer-sitetsvej 1, P.O.Box 260, DK-4000 Roskilde	phone ++45 4674 2000 fax ++45 4674 3000

List of Participants

List of Participants

Adderley **Paul**	UK	Department of Environmental Science, University of Stirling	FK9 4LA Stirling	phone ++44 1786 467 861 fax ++44 1786 467 840	w.p.adderley@stir.ac.uk
Almeida **Susanna**	PT	Portuguese Research Reactor, Technological and Nuclear Institute	Estrada Nacional 10, apartado 21, P-2686-953 Sacavém	phone ++351 1 9550021 fax ++351 1 994 1039	ccosta@itn1.itn.pt
Alves **Maria Fatima**	PT	Department of Environment and Planning, Universitario de Santiago	Campus Universitario de Santiago, P-3810 Aveiro	phone ++351 34370 831 fax ++351 34 29290	malves@dao.ua.pt
Bauler **Tom**	LUX	Center for Economic and Social Studies on the Environment, Université Libre de Bruxelles	cp124, avenue Jeanne 44, B-1050 Brussels	phone ++32 2 650 3379 fax ++32 2 650 4691	tbauler@ulb.ac.be
Bartroli **Jordi**	ESP	Universitat de Girona, Faculty of Sciences, Dept. of Chemical Engineering	Campus Montilivi s/n, E-17071 Girona	phone ++34 972 41 8281 fax ++34 972 41 8150	jbartroli@lequia1.udg.es
Beal **James**	UK	Research Centre for Built and Human Environment, University of Salford	Bridgewater Building, M4 5WT, Salford	phone ++44 1642 711 348 fax ++44 1642 711 348	besamrt@beal.u-net.com
Broderick **Sheelagh**	IRL	Department of Sociology, Trinity College, Dublin & Cork, Environmental Alli	Trinity College, Dublin	phone ++3553 28 20604 fax ++353 28 20604	sheelagh@indigo.ie
Bruun **Henrik**	FIN	Human Ecology Section, Göteborg University	Box 700, S-40530 Göteborg	phone ++46 31 7734298 fax ++46 31 773 4933	henrik.bruun@ctv.gu.se
Burkle **Martha**	MEX	University of Sussex, SPRU –Science & Technology Policy Research	Mantell Building, BN1 9RF Brighton, UK	phone ++44 1273 686 758 fax ++44 1273 685 865	M.M.Burkle@sussex.ac.uk
Cabugueira **Manuel**	PT	Departamento de Eonomia, Universidade Portucalense	Rua Dr.Antonio Bernardino de Almeida 541, P-4200-072 Porto	phone ++351 2 557 0343 fax ++351 2 557 0280	mmc@upt.pt

List of Participants

Caraveli **Helen**	GR	Department of Economics, Athens University of Economics and Business	Patission 76/104 34, GR-10434 Athens	phone ++30 1 8232 902 fax ++30 1 8103 302	caraveli@atieb.gr
Dobre **Michelle**	FRA	Institut Francais de l'Environment, IFEN	61, boulevard Alexandre Martin, F-45958 Orleans	phone++33 2 38 797896 fax ++33 2 38 797870	michelle.dobre@ifen.fr
Egger-Steirer **Michaela**	AUT	Institut für Umwelt und Wirtschaft, Wirtschaftsuniversität Wien	Althanstraße, A-1090 Vienna	phone ++43 1 31336 4848 fax ++43 1 31336 709	eggstein@wu-wien.ac.at
Endlweber **Sonja**	AUT	Wirtschaftsuniversität Wien, Institut für Umweltökonomie	Augasse 2-6, A-1090 Vienna	phone ++43 2254 780 3816 fax ++43 2254 780 3888	sonja.endlweber@arcs.a.c.at
Fischer **Corinna**	GER	Forum Umwelt und Gesundheit, Deutsches Hygiene Museum	Lignerplatz 1, D-01069 Dresden	phone ++49 351 484 623 fax ++49 351 484 65	cfi@zedat.fu-berlin.de
Foley **David**	UK	Xerox Europe	Riverview, Oxford Road, Uxbridge, Middx, UB8 1HS, UK	phone +44 1895 845225 fax ++44 1895 845469	David.Foley@GBR.Xerox.com
Freire **Fausto**	PT	Dep.Eng. Mecanica - Polo II, University of Coimbra	Pinhal de Marrocos, P-3030 Coimbra	phone ++351 39 790739 fax ++351 39 790701	fausto.freire@mail.dem.uc.pt
Fritsche **Immo**	GER	Institut für Psychologie, Universität Magdeburg	PF 4120, D-4120 Magdeburg	phone ++49 391 67-14805 fax on demand	Immo.Fritsche@student.uni-magdeburg.de
Fromm **Elisabeth**	GER	Institute of Organic Farming, University of Agricultural Sciences	Gregor Mendel Str. 33, A-1180 Vienna	phone ++43 1 47654 3755 fax ++43 1 47654 3792	fromm@edv1.boku.ac.at
Goldblatt **David**	USA	Energy Analysis Research Group, Swiss Federal Institute of Technology (ETH)	ETH Zentrum ETL G22, CH-8092 Zürich	phone ++41 1 632 7520 fax ++41 1 632 1050	goldblat@eeh.ee.ethz.ch
Gross **Dieter**	GER	Union of German Teachers of Geography, VDSG Verband Deutscher Schulgeografen	Argentinische Allee 8c, D-14163 Berlin	phone ++49 30 80902656 fax ++49 30 80902657	dieter.gross@t-online.de
Hamza **Christine**	AUT	Regional Consulting	Schloßgasse 11, A-1050 Vienna	phone ++43 1 544 0780 50 fax ++43 1 548 4956	christine@regcon.co.at
Koeppen **Bernhard**	GER	Technische Universität-Chemnitz; Professur fuer Sozial- und Wirtschaft	Reichenhainer Str. 39, D-09107 Chemnitz	phone ++49 371 531 4057 fax ++49 371 531 4058	bernhard.koeppen@phil.tu-chemnitz.de
König **Friedericke**	AUT	Inst. of Process Engineering, Technical University-Graz	Inffeldgasse 25, A-78010 Graz	phone ++43 316 873 8422 fax ++43 316 873 8434	koenig@biote.nawi.tu-graz.ac.at

List of Participants

Lutz Juliana	AUT	Institute for Interdisciplinary Studies of Austria	Seidengasse 13, A-1070 Vi-enna	phone ++43 1 526 7501-21 fax ++43 1 523 5843	Juliana.lutz@univie.ac.at
Martins Maria	ESP	Universitat de Girona, Faculty of Sciences, Dept. of Chemical Engineering	Campus Montilivi s/n, E-17071 Girona	phone ++34 972 41 8281 fax ++34 972 41 8150	maria@lequia1.udg.es
Martins Antonio	PT	Chemical Engineering Department, Faculty of Engineering,Porto University	Rua dos Bragas, P-4099 Porto	phone ++351 2 3326154 fax ++351 2 2000808	amartins@americium.fe.up.pt
Mata Teresa	PT	Chemical Engineering Department, Faculty of Engineering,Porto University	Rua dos Bragas, P-4099 Porto	phone ++351 2 3326154 fax ++351 2 2000808	amartins@americium.fe.up.pt
Newburg Michael	USA	University of Colorado, Department of Anthro-pology	Bolder, CO 80304 Colorado, USA	phone ++1 303 938 8266 fax is phone	mnewburg@earthlink.net
Eduardo de Oliveira Fernan-des	PT	Faculdade de Engnharia, Universidade do Porto		phone: ++351 2 2007 455 fax: ++351 2 2052 476	eof@fe.up.pt
Oodit Deo	MAUR	Department of Economic and Social Affairs, United Nations	2, UN Plaza, DC2-2206, E44 St. 10017 New York, USA	phone ++1 212 963 4671 fax ++1 212 963 4260	oodit@un.org
Paternotte Valéry	BEL	Free University of Brussels, Service de Mathe-matiques de la Gestion	Bd. du Triomphfe, C.P. 210/01, B-1050 Brussels	phone ++32 2 650 5504 fax ++32 2 650 5970	vpaterno@smg.ulb.ac.be
Porta Sergio	IT	DPA - Dipartimento Progettazione Architettonica, Politecnico di Milano	Via Golgi 39, I-20133 Milano	phone ++39 522 451 657 fax ++39 522 439 336	sergio.porta@re.nettuno.it
Ramos Isabel	PT	University of Evora, Bioengineering and Land-scape Planning Dept.	Rua Romao Ramalho, 59, P-7000 Evora	phone ++351 66 744 616 fax ++351 66 744 968	iar@uevora.pt
Reiterer Markus	AUT	University of Vienna, Institute for International Law and International	Universitätsstr. 2, A-1090 Vi-enna	phone ++43 1 4277 353 04 fax ++43 1 4277 9353	markus.reiterer@univie.ac.at
Rübbelke Dirk	GER	Department of Economics, Technical University Chemnitz	Reichenhainerstr. 39, D-09107 Chemnitz	phone ++49 371 531 4212 fax ++49 371 531 3963	d.ruebbelke@wirtschaft.tu-chemnitz.de
Rubbens Catherine	USA	Department of Economis and Social Affairs,, Division for Sustainable Development, United Nations	2, UN Plaza, NY 10017 New York, USA	phone ++1 212 963 5243 fax ++1 212 963 4260	rubbens@un.org

List of Participants

Schartinger Doris	AUT	Wirtschaftsuniversität Wien, Institut für Wirtschafts- und Sozialegeographie	Augasse 2-6, A-1090 Vienna	phone ++43 2254 780 3867 fax ++43 2254 780 3888	doris.schartinger@arcs.ac.at
Schulz Thomas	GER	Technische Universität Chemnitz, Fakultät für Wirtschaftswissenschaften	Reichenhainer Str. 39, D-09107 Chemnitz	phone ++49 371 531 3971 fax ++49 371 531 4343	t.schulz@wirtschaft.tu-chemnitz.de
Siebenhüner Bernd	GER	Belfer Center for Science and International Affairs (BCSIA), Kennedy School of Government (KSG), Harvard University	79 JFK Street, Cambridge, MA 02138, USA	phone ++++1-617-496-0426 fax ++1-617-496-0606	Bernd_Siebenhuner@harvard.edu
Sortino Silvia	ITA	University of Palermo, Department of Botanical Sciences	Via Archirafi 39. I-90123 Palermo	phone ++39 091 682 6243 fax ++39 091 623 8203	sortinom@unipa.it-
Stoll Susanne	GER	Technical University Berlin, Institute of Landscape Development (Swiss federal Institute of Technology, People Environment Interaction Unit)	Franklinstr. 28/29, D-10587 Berlin (Haldenbachstr. 44, CH-6092 Zürich)	phone ++49 173 217 2651 fax ++49 30 314 0 (phone ++41 1 632 6301 fax ++41 1 632 1029)	stoll@uns.umnw.ethz.ch
Wallgren Christine	SWE	FOA/fmsForskningsgruppen för miljöstrategiska Studier	Box 2142, SE-10314 Stockholm	++46 8402 3816 fax ++46 8402 3801	wallgren@fms.ecology.su.se
Walsh-Daneshmandi Anne	IRL	Trinity College Dublin, Department of Psychology	College Green, D.2 Dublin	phone ++353 1 608 1886 fax ++353 1 671 2006	awalshda@tcd.ie
Wylie Judith	UK	The Questor Centre, The Queens University of Belfast	David Keir Building, Stranmillis Road, Bt9 5AG Belfast, North Ireland	phone ++44 1232 274575 fax ++44 1232 664 144	jw.wylie@qub.ac.uk