DIW Berlin

Messung von Nachhaltigkeit

DIW Workshop

3.-4. Juli 2003

Proceedings B ohne Wortprotokolle

Die Proceedings B wurden mit den Workshop-Teilnehmern abgestimmt.

CONTENT

1 Executive Summary

These proceedings document the results of the workshop on "Measuring Sustainability" which was held on July 3rd & 4th 2003. It was the third of a whole series of workshops that contribute to the research project on "Economics and Sustainable Development". This research project aims at surveying economic approaches to sustainable development in a wide context of related scientific disciplines. It attempts to make out promising lines of economic research that can bridge the gap between mainstream neoclassical economics and ecological economics. The project is conducted by the German Institute for Economic Research (DIW) and funded by the German Federal Ministry of Education and Research (BMBF) which is considering to fund a major research programme on „Sustainability and Economics".

This third workshop on measuring sustainability consisted of several expert presentations as well as a concluding discussion to identify pressing research needs. The outcome of the latter is an agenda for economic research with regard to sustainable development. In particular, the workshop participants recommended:

- Clarifying the limits of a scientific approach to sustainability
- Modelling the interactions between natural and socio-economic systems, among other things to derive prices for ecosystems
- Collecting physical data on pollution flows and stocks of pollutants
- Considering alternatives to weight-based aggregation in Material Flow Analysis
- Linking Material Flow Analysis and other physical accounting approaches
- Performing simulations, international comparisons and providing scenarios by means of Material Flow Analysis
- Linking the micro and macro level of analysis in Material Flow Analysis
- Developing a systematic sustainability indicator set on an expanded accounting system
- Developing modelling tools for an integrated analysis of sustainable development
- Studying the feasibility of modelling socio-economic aspects of sustainability
- Gathering consistent data about environmental, social and economic performace of firms and households

The preceding discussions on intergenerational justice were divided in four distinct sessions with the first concentrating on welfare-related approaches to measuring sustainability, the second on indicators derived from satellite accounts, the third on system analysis approaches and the fourth on measuring of social and environmental sustainability.

Prof. Karl-Göran Mäler gave his presentation on "Net Domestic Product, Wealth, and Social Well-Being" starting from a notion of sustainability that requires non-declining welfare over time. So far, most theoretical work in this field has been based on an optimal economy. Since most economies are non-optimal, however, it is necessary to develop a theory of sustainable development for arbitrary economies and, furthermore, to develop approaches to implement it. Social welfare is determined by the productive capacity in the economy, i.e. stocks of productive assets, technology, institutions and it has to be measured somehow. Theoretically, even in non-optimal economies wealth is the correct measure of sustainable development. Changes in wealth at constant prices measure changes in social welfare. In the same way, differences in wealth per capita measures differences in social welfare between countries. This theoretical work for sustainable development can be applied by estimating changes in capital stocks and by estimating accounting prices. The entire capital of a country consists of physical, human and natural capital whereas "social capital" is better seen as a resource allocation mechanism. Regarding exhaustible resources, exploration costs should be included but generally valued at an accounting price different from one in order to reflect the contribution to the stock of knowledge. As to human capital, Net Domestic Product should include the accounting value of the net change in the stock of human capital. Finally, ethical difficulties arise in determining the "optimal population" because of the comparison of potential individuals and real individuals.

The subsequent discussion covered topics such as further decomposition possibilities regarding the presented model, comparisons with hypothetical optimal paths, the applicability of the Tinbergen framework, the appropriate subject of analysis and the relevant geographical scale, the includability of physical measures and of uncertainty in terms of system behaviour into the approach, and, finally, the parallels between the presented approach and outdated development theory.

Dr. Frank Jöst presented his reflections on welfare-related indicators for sustainable development. The welfare theoretic approach relies on two fundamental welfare theorems and the maximisation of an intertemporal welfare function subject to the development of production possibilities, the stock of environmental goods and distributive goals. The advantages of this approach are that the intertemporal price system signals the intertemporal scarcity of all goods and resources and that prices have a clear-cut interpretation and allow one to solve the aggregation problem consistently. Its disadvantages are that the time horizon and the discount rate are not determined by scientific reasoning and that it requires perfect information or a probability distribution concerning future events. Further problems have to do with the existence, uniqueness and stability of the solution of intertemporal optimisation approaches, and finally, with the welfare economic approach and variable and endogenous population. As a recommendation, future work should clarify the limits of a scientific approach to sustainability, proceed in modelling the interactions between natural and socio-economic systems in order to derive prices for ecosystems and collect physical data on pollution flows and stocks of pollutants.

The following discussion included topics such as the price derivation for ecosystems independet from human valuing and their applicability to complex problems, existence and stability of intertemporal optimisation approaches, aggregation problems, the relation of intergenerational und intragenerational allocation, the consideration of ignorance, and the feasibility of an encompassing concept of sustainability.

Prof. Carsten Stahmer elaborated on different approaches of "greening the accounts". In the 1970s, researchers were more optimistic with regard to correcting Gross Domestic Product and extending it to a real measure of welfare. In this context, one general underlying question always is whose welfare exactly is to be measured. To answer this question, two distinct concepts have been developed in the Federal Statistical Office Germany with the first called "cost borne" and the second "cost caused" concept. The first asks in what way we are affected by environmental degradation anywhere whereas the second rather focusses on how our own behaviour does affect others. Here, welfare measuring is not the primary objective. Furthermore, our behaviour cannot simply be evaluated statically, but has to be seen in a dynamic context. Therefore, modelling approaches will become more and more important in the future.

The succeeding discussion was about external costs, the adequacy of normative elements in analysis provided by a statistical agency, the departure from a measure of welfare, the interaction between analysts and policy-makers, the future significance of "greening the accounts" and the role of modelling.

Opening the second session on indicators derived from satellite accounts, *Stefan Giljum* spoke about the possibilities and limits of Material Flow Accounting and analysis (MFA) for measuring sustainability. MFA helps to analyse the composition of the physical "metabolism" of societies and determining the physical „scale" of an economy. It relies on the basic assumption that all materials extracted or moved by humans exert a pressure on the environment. The strengths of MFA are that it represents a comprehensive approach, that its data organisation is compatible with the System of National Accounts, that it provides indicators on all levels of aggregation and, more specifically, that it provides macro indicators of total environmental pressure equivalent to GDP or employment. Its weaknesses include that it does not provide detailed information on environmental impacts, that qualitative aspects of materials are not considered, that big flows dominate aggregated indicators, and that there is no separation between production and consumption. Future research should consider alternatives to weight-based aggregation, sectoral disaggregation, linking MFA and other physical accounting approaches, scenarios and simulations, international comparisons, regional analyses and the linking of micro and macro levels.

The following discussion concentrated on the problem of aggregation in MFA, the role of MFA-derived indicators regarding the representation of "scale" and "carrying capacity", the compatibility of MFA and monetary accounting systems, the need for aggregated indicators to communicate problems of sustainable development, the disaggregation of MFA-indicators, normative assumptions underlying any aggregation scheme, and directional safety as a minimum requirement of indicators in general.

Dr. Karl Schoer gave a presentation about the state of development of the German Environmental Economic Accounts (GEEA) and the national strategy for sustainable development. Since sustainable development requires a holistic approach, there has to be a co-ordination of sector policies, simultaneous achievement of conflicting goals, and interlinkages between indicators. The national accounts and its satellite systems are the ideal framework to meet the data requirements for an integrated analysis. As far as Germany is concerned, a considerable proportion of the indicators for sustainable development is already embedded into the accounting data set. Concerning the relationship between different approaches, the physical flow and stocks accounts are the basis for monetary valuation required for welfare related approaches. Although GEEA can also provide indicators for diagnosis; its main area of application is modelling for diagnosis, forecasting, and policy formulation. In the accounting framework, international linkages can be established between imports and exports and the related environmental pressures by Input-output table-analysis. Future research should include developing a systematic sustainability indicator set based on an expanded accounting system and developing modelling tools for an integrated analysis of sustainable development.

The subsequent discussion covered issues such as the kind of modelling that may be supported by the BMBF, the range of analyses conducted by the Federal Statistical Office Germany and possible cooperations of the Office with research institutes, interlinkages between economic, environmental and social indicators, and the appropriateness of absolute indicators versus intensity indicators.

Opening the session on system analysis approaches, *Prof. Richard Tol* held his presentation on Integrated Assessment Models (IAMs) and sustainability. Integrated environmental assessment is policy-relevant multidisciplinary research on complex environmental issues which is supported by IAMs. Typically, IAMs combine parts of various disciplines in order to inform stakeholders through scenario analyses, multicriteria analysis, cost-benefit analysis, and cost-effectiveness analysis. Being used for long-term strategic policy advice, IAMs are suitable for identifying unsustainable paths of development, and assessing potential countermeasures. The current domain of development for integrated assessment ist climate change. In this context, strong sustainability requirements are always violated because regardless of human behaviour, the atmosphere will warm for a few more centuries, and consequently the sea will rise for a few more millennia. Therefore, regarding climate change, weak sustainability considerations are more interesting. As to the external costs of climate change, studies show that they range between $8 and $495 per ton of carbon for weak and strong sustainability respectively. In conclusion, IAMs give a view of the long-term developments of the coupled social-natural system, but a lot of natural and social effects have not been taken into account yet such as feedbacks of environmental change on development.

The following discussion centred on the adequacy of monetary valuation, feedback effects between environment and the economy, the role of equity weighting and discounting regarding different governmental policies, the problem of high damages with small probabilities, the integratability of Multicriteria Decision Aid, the time span that should be considered for prediction in economic models.

Dr. Felix Rauschmeyer hold his presentation on measuring sustainability by means of Multi-Criteria Decision Aid (MCDA). This entails three main difficulties related to the consideration of future generations, hierarchical dependencies, and the role of scientists. As to the first, future and present generations can be weighted equally or critical natural capital can be taken into account. Alternatively, representatives of future generations can take part in performing MCDA. Whatever approach is pursued, though, the interests of future generations remain uncertain. Second, there are uncertainties regarding the hierarchical dependencies of the natural, the social and the economic system. Third, since sustainability science has to be relevant for decision-making, it has to orientate to decision-makers' preferences and to the normative concept of sustainability. This is complicated by the uncertainty in values. MCDA differs from mono-criteria concepts not so much in its general approach, but as to how easily it can be integrated into an appropriate context of social decision-making. MCDA facilitates making the three main difficulties of scientific sustainability evaluations transparent.

The succeeding discussion focussed on possible differences with respect to the decision-makers' MCDA criteria and objective facts, opportunities to reveal the decision-makers' preferences to the public through MCDA, inconsistency in MCDA criteria regarding sustainable development, the robustness of MCDA results in terms of changes in aggregation weights and actors involved, and, finally, alternatives to stakeholder discussions for determining MCDA aggregation weights.

Prof. Carsten Stahmer opened the session on measuring social and economic sustainability and presented his thoughts regarding the social dimension. Concerning the scientific discourse about sustainable development, first, each discipline should work out its own concepts which could then be integrated. Regarding the role of GDP, it should not be seen as a sustainability indicator on its own because this would render discussions among disciplines more difficult. Instead, the value of GDP should result from other measures of sustainability. As to the economic dimension of sustainability, it should orientate not by the level of activity, but rather by certain structural and stability criteria. The social dimension, on the other hand, can be best measured by looking at gender relations, and more specifically, at mens' share of quality time spent with their family which currently is very low. Indicators of the social dimension generally have to include all kinds of activities, i.e. formal as well as informal work. This becomes even more important when considering the decreasing ability of the traditional formal work-based social security system to provide social security. Reseach should focus on studying the feasibility of modelling socio-economic aspects of sustainability to provide policy-relevant aid in decision-making.

The ensuing discussion covered related issues such as the role of scientists in the sustainability discourse with policy-makers, the way the discourse between different scientific disciplines should proceed, the question how far the economic dimension of sustainability can be separated from the other dimensions, the significance of productive, market-related formal work as opposed to informal work, the measurability of quantitative social aspects of sustainability, and the general problem with indicators regarding underlying assumptions and dependence on unstated background cycles.

Dr. Klaus Renning gave a presentation about environmental-economic indicators. Historically, after a first phase of "greening the accounts" in the 1970s, physical indicators became more widely used in the 90s. From the mid-90s on, there has been a trend towards 3-D-indicators. The use of one-dimensional indicators, whether monetary or physical, constitutes a problem since they are intransparent and undifferentiated, rely heavily on assumptions and lead to ideological discussions rather than solution-oriented approaches. 3-D indicators, on the other hand, tend to be over-complex and focus on certain concrete action fields. Here, key indicators are often chosen for reducing complexity. Generally, all 3 dimensions of sustainable development should be represented by distinct indicators with economic and social aspects primarily described through synergies and trade-offs. Since there are problems with the representativity of the currently available data, research should concentrate on gathering consistent data about environmental, social and economic performance of firms (sustainable production) and households (sustainable consumption).

The following discussion focussed on differences between ecological and mainstream economics, the future of ecological economics, and data requirements for assessing aspects of sustainable production on the firm level.

2 Introduction

The workshop "Measuring Sustainability" is part of a DIW research project on "Sustainability and Economics", which is funded by the German Federal Ministry of Education and Research (BMBF). This survey project consists of several workshops on economic and related sciences approaches to sustainable development and a questionnaire on "Economics and Sustainable Development". The first three workshops in 2003 are "Intergenerational Justice and Sustainability" (15th & 16th May), "International Institutions for Sustainability" (12th & 13th June), and "Measuring Sustainability" (3rd & 4th July).

The project is motivated by the observation of a scientific divide in economics. One indicator of this divide is the fact that the concept of sustainable development is still being ignored by many mainstream neoclassical economists. As an alternative line of research the merger-movement of "Ecological Economics" has formed. It investigates various aspects of sustainability and consists of many different scientific approaches, joined by their frontiers with mainstream neoclassical economics. Also, in general, the theoretical and methodological contribution of economics to sustainable development (SD) seems to need further elaboration. The survey project thus aims to identify both, pressing research needs and promising lines of economic research. It also aims to identify concepts that may bridge the gap between economic approaches (e.g. neoclassical economics, ecological economics, evolutionary economics) and provide a multi-dimensional mindset to overcome the current constellation of "schools of thought". The project is based on an integrative concept, which we have labelled "Sustainability Economics" (SE). The key features of the Sustainability Economics concept are:

a) A comprehensive approach encompassing the ecological, economic and social dimensions of sustainability,
b) the development of economic methods and concepts that deal with problems of sustainability,
c) a strengthening of policy-orientated economic approaches for sustainability,
d) an integration of sustainability concepts of general economics (such as sustainable finance) into the environmental economics SD debate,
e) and an identification of "bridges" between different economic "schools of thoughts" by means of studying integration and disintegration processes in general science and exploring venues of interdisciplinary approaches.

The survey is carried out through a series of workshops and a questionnaire on "Economics and Sustainable Development". These proceedings document the results of the third workshop on "Measuring Sustainability" which took place on July, 3-4, 2003.

The proceedings from all workshop of this research project including the questionnaire results will be published and made available at our website www.sustainableconomics.de in 2003 and 2004.

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4 Presentation by Prof. Karl-Göran Mäler

4.1 “Net Domestic Product, Wealth, and Social Well-Being”

4.1.1 Basic Agreement

- Sustainable development: development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- implies that we should sustain social welfare
- implies that we must give future generations at least the same ”productive capacity” as we are having today

4.1.2 Implications

- Welfare should not decrease over time
- Welfare determined by the productive capacity in the economy
- Productive capacity determined by
  - Stocks of productive assets
  - Technology
  - Institutions

4.1.3 Optimum Growth Models

- Most theoretical work on sustainable development based on an optimal economy
- No economy is optimal!
- Sustainability get its bite in non-optimal economies
- Necessary to develop the theory for arbitrary economies and
- Develop approaches to implement such a theory

4.1.4 Review of History

- 1976- M. Weitzman showed that with linear utility function, NNP is equal to the maximum sustainable consumption
- 1990- K.-G.Mäler and J. Hartwick (independently) generalizes to general utility functions

- Maximum Hamiltonian equals the maximum sustainable utility
- NNP defined as the linearized Hamiltonian

- NNP is not equal to maximum sustainable consumption unless close to a steady state (Dasgupta-Mäler 1991)
- 1993- D. Pearce and G. Atkinson introduce wealth as the proper indicator of sustainable develolpment
- 2001- Dasgupta and Mäler show theoretically that wealth is the correct measure of sustainable development, even in non-optimal economies
- 2003- Arrow, Dasgupta, and Mäler show how population changes should be included and develop the theory further.

4.1.5 Social Well-being

Koopmans' formulation:

$$V(t) = \int_t^\infty e^{-d(t-t)} U(C(t))dt$$

C is a vector of flows that affect utility. δ is the utility discount rate. V the value function or the social well-being, depends on the initial capital stocks and how these are used to produce investments and consumption in the future.

4.1.6 What is Consumption

- Consumption contains all those items that affect current well-being
- Thus, it contains
  - Consumption of goods and services
  - Labour supply
  - Flows of current environmental damages

4.1.7 Resource Allocation Mechanisms

Let K(t) be the vector of all stocks of resources at time t.

Let

$$\alpha(\tau, t, K_1(t), \ldots, K_m(t)) \; T \in [0, \infty]$$

be a mapping from the capital stocks at t into the flow of consumption and investments in all time periods after t. Then the social welfare is

$$V(K(t),\alpha) = \int_t^\infty e^{-\delta(\tau-t)} U(\alpha_\tau(K(t)))d\tau$$

4.1.8 Autonomous Allocation Resource Mechanisms

If the resource allocation mechanism can be written

$$\alpha(\tau-t, K_1(t), \ldots, K_m(t))$$

then the mechanism is autonomous, otherwise it is non-autonomous

4.1.9 Capital

- Capital
  - Physical real capital
  - Human capital
  - Natural capital
- What is social capital?
  - A resource allocation mechanism!

4.1.10 Accounting Prices

Define accounting prices with utility as numeraire for the initial capital stocks as the change in social welfare that would occur from a marginal change in the stocks, that is

$$\pi_i(t) = \frac{\partial V}{\partial K_i(t)}$$

This assumes that V is differentiable

4.1.11 Accounting Prices – Consumption as Numeraire

$$p_i(t) = \frac{\overline{p}_i(t)}{U_{C_1(t)}}$$

4.1.12 Hamiltonian

Define the current value Hamiltonian as

$$H = U(C(t)) + \sum_{i=1}^{m} p_i(t)\dot{K}_i(t)$$

Then one can show that

$$H = dV$$

4.1.13 Proof – Incomplete

$$\frac{dV}{dt} = \sum_j \frac{\partial V}{\partial K_j}\dot{K}_j = \sum_j p_j \dot{K}_j$$

$$\frac{dV}{dt} = d\int_t^{\infty} e^{-d(t-t)} U(C(t))dt - U(C(t)) =$$

$$= dV - U(C(t))$$

$$H = U(C(t)) + \sum_j p_j \dot{K}_j = H(t) = dV$$

4.1.14 Welfare Changes

- A change in social welfare can therefore be measured by the corresponding change in the Hamiltonian!
- However, the Hamiltonian is non-linear!
- It includes all consumer surpluses!
- We need a linear index!

4.1.15 Sustainable Development

Define sustainable development as a development in which

$$\frac{dV(t)}{dt} \geq 0$$

in all future time periods.

4.1.16 Sustainable Development

One can easily show that

$$\frac{1}{U_{C_1}} \frac{dV}{dt} = \sum_{j=1}^{m} p_j \frac{dK_j}{dt} + \frac{1}{U_{C_1}} \frac{\partial V}{\partial t}$$

Thus the development is sustainable if and only if the sum over all assets of the value of changes in capital stocks plus the drift term is non-negative.

If the mechanism is autonomous, the drift term is zero.

4.1.17 The Importance of Wealth

- Changes in wealth at constant prices measures changes in social welfare
- In the same way, wealth differences (or rather wealth per capita) measures differences in social welfare between countries

4.1.18 NNP and Change in Wealth

$$\Delta NDP = \sum_i q_i \Delta C_i + \sum_j p_j \Delta \dot{K}_j$$

$$\Delta NNP - \sum q_j \Delta C_j = \sum p_i \Delta \dot{K}_i$$

Genuine Savings

4.1.19 Changing the Numeraire

$$\frac{\dot{p}}{p} = \frac{\dot{\overline{p}}}{\overline{p}} - \frac{\dot{u}'}{u'} = d - \frac{u''c}{u'} \frac{\dot{c}}{c} - \frac{1}{p} \frac{\partial H}{\partial S} =$$

$$= d + hg - \frac{1}{p} p \frac{\partial \dot{S}}{\partial S} = r - \frac{\partial \dot{S}}{\partial S}$$

r the consumption rate of interest

$$\dot{p} = rp - p \frac{\partial \dot{S}}{\partial S}$$

4.1.20 Applications – Wealth

- Estimation of changes in capital stocks
  - Real, human made capital
  - Human capital
  - Natural capital
- Estimation of accounting prices
  - dynamics of ecosystems
  - depends on our predictions of the future
  - depends on the institutions

4.1.21 Depletion

$$H = U(wR - c(R)) + \overline{p}\dot{S}$$

w world market price

c(R) cost of producing R

$p\dot{S}$ the value of depletion of S

4.1.22 Optimal Use of the Resource

$\max_R$ H yields

$$U'(w - k'(R)) = \overline{p}$$
$$or$$
$$p = w - k'(R)$$

Net price method

4.1.23 Non-optimal Use of the Resource

Resource allocation mechanism:

$$R_\tau = R(\tau, t, S_t)$$

$$C_\tau = w_\tau R(\tau, t, S_t) - \kappa(R_\tau) \text{ and}$$

$$dC_t / dt = \frac{\partial C_t}{\partial S_t}\dot{S}_t + (w_t - k'(R_t))\frac{\partial R_t}{\partial t}$$

$$V_t = \int_t^\infty e^{-d\,(t-t)} U(C_t)\,dt$$

$$\frac{dV}{dt} = p_t \dot{S}_t + \int_t^\infty e^{-d(t-t)} U'(C_t)\, m(t,t)\,dt$$

First term genuine savings, second term the drift term. μ is an index of the extent the allocation resource allocation is non-autonomous

Suppose C is constant, then μ =0 and change in well-being measured by genuine savings.

Suppose R is constant. It follows that

$$m(t,t) = w_t R_t \frac{\frac{\partial w_t}{\partial t}}{w_t}$$

$$\int_t^\infty e^{-d(t-t)} m(t,t)\,dt = \overline{m}/d$$

$\overline{m}$ is the average expected capital gains on the world market

4.1.24 Exhaustible resources: Discoveries and Exploration

$$\dot{S} = D - R$$

- D is discovery of additions to the stock
- R is the exploitation of the stock
- E is the expenditures on exploration
- U = U(R), the utility function

$$D(t) = N(E(t), \int_{-\infty}^{t} E(t)\,dt, S(t))$$

$$Z(t) = \int_{-\infty}^{t} E(t)dt$$

$$\dot{Z} = E(t)$$

$$\dot{S} = N(E, Z, S) - R$$

$$H = U(wR - E) + p_Z E + p_S (N(E, Z, S) - R)$$

Therefore the NDP is defined from

$$\Delta NDP = \Delta C + p_Z \Delta E$$
$$+ p_S \Delta \dot{S}$$

Exploration costs should be included but valued at an accounting price which in general is different from one. This inclusion does reflect the contribution to the stock of knowledge.

Assume that $\delta N/\delta Z = 0$.

Then

$$NDP = C + p_S \dot{S}$$

Thus, exploration costs should not in this case be included in NDP.

4.1.25 Human Capital

- Y = f(TL) production function where T stock of human capital and L labour demand
- $dT/dt = \mu ET - \theta T$ where μ and θ are constants, and E education expenditures
- Y = C + E

$$H = U(C, L) + \bar{v}(mET - qT)$$

As C = Y - E, and $\Delta NDP = \Delta H / U'_C$

$$\Delta NDP = \Delta Y - \Delta E - w\Delta L + v^* dT/dt$$

- Net Domestic Product should not include the accounting value of labour demand

- Net Domestic Product should include the accounting value of the net change in the stock of human capital

4.1.26 Population Growth - Endogenous Growth

- demand for labour defined by
  - demand for child labour
  - need for old age security
  - need for social security
  - children as consumption goods
- Ethical difficulties in determining "optimal population"
  - comparability of potential individuals and real individuals

4.1.27 Exogenous Population Growth: Constant Returns to Scale

$dK/dt = f(K, L) - C$, where f is linearly homogenous

$c=C/L$

$k = K/L$

$L_\tau = L_\tau e^{n(\tau-t)}$

$dk/dt = f(k,1) - nk – c$

All equations in "intensity" variables and time autonomous.

4.1.28 Exogenous Population Growth

$$V_t = \frac{\int_t^{\infty} e^{-r(t-t)} L_t e^{n(t-t)} U(c_t)\,dt}{\int_t^{\infty} L_t e^{n(t-t)} e^{-r(t-t)}\,dt}$$

$$V = V(k_t, L_t)$$

$$p_t = \partial V / \partial k_t; \quad v_t = \partial V / \partial L_t$$

$$\frac{dV}{dt} = p_t \dot{k}_t + v_t \dot{L}_t$$

For some resource allocation mechanisms, $v_t=0$

4.1.29 Running Down Capital

	I/Y	n	GNP/N growth	dk/dt
Bangladesh	-0.013	2.3	1.0	-2.60
India	0.080	2.1	2.3	-0.01
Nepal	-0,024	2.4	1.0	-3.00
Pakistan	0.040	2.9	2.7	-1.90
Sub-Saharan Africa	-0.028	2.7	-3.40	-0.20
China	0.100	1.7	6.7	0.80

4.1.30 Human Capital

$dT/dt = \mu ET - \theta T$

$h=T/L$, $e = E/L$

$dh/dt = \mu ehL - \theta h - nh$

A non autonomous equation. The system cannot be expressed in intensity units!

p dk/dt + v dh/dt is different from dV/dt!

Value of changes in wealth is not enough as a criterion for sustainable development!

5 Session I: “Welfare Related Approaches to Measuring Sustainability”

5.1 Introduction by Bernd Fischer

“Handlungsorientierte Nachhaltigkeitskonzepte (ProNa)”: A new BMBF framework programme for education and research

5.1.1 ProNa

- solutions for sustainability problems (transdisciplinarity)
- normativity
- interdisciplinarity
- from environmental studies to sustainability science (environment; society; economy)

5.1.2 Activities:

- social action for sustainability
- sustainable production and consumption
- concepts for sustainable use of regions
- sustainable use of natural resources

5.1.3 Social Action for Sustainability

Structured along challenges for society:

- Globalisation (economic and technological drivers – social and ecological effects – cultural diversity and identity)
- Socio-demographic change (social integration – flexibilization of occupations – generational justice)
- Ecological reconstruction (sustainable consumptive patterns and infrastructures – future scenarios and risk provision)

5.2 Statement by Dr. Frank Jöst

Welfare related indicators for sustainable development

1. Prerequisites: operational definition of sustainable development

2. Economist’s approach: conceptual framework for indicators

3. Conclusions and recommendations for future work

5.2.1 Prerequisites: operational definition of sustainable development

Two approaches towards sustainability:

1. Ethical approach: sustainability as a comprehensive concept of intergenerational justice

2. Scientific-technical-economic concept: calculating limits for individual behaviour on the basis of natural science, information about techniques and costs

5.2.2 The Economist’s approach

5.2.2.1 Welfare theoretic approach

Two fundamental welfare theorems

- Maximize
  Intertemporal welfare function (consumption, environmental quality, distributive goals) s.t.
  - Development of production possibilities
  - Development of the stock of environmental goods and resources
  - Distributive goals

5.2.2.2 Advantages

1. The intertemporal price system signals the intertemporal scarcity of all goods, i.e, contains information on past, present and future production and consumption possibilities as well as the state of the environment

2. Prices have a clear-cut interpretation and allows one to solve the aggregation problem consistently Such a price system is a prerequisite for the calculation of all types of indicators, in particular for green national account or capital-saving rules

3. The prices contain information concerning the present and future scarcity of resources

5.2.2.3 Disadvantages

1. Time horizon, and discount rate are not determined by scientific reasoning. Prices are ambiguous indicators.

2. Perfect information concerning future events, or a probability distribution of possible future events. Problem: uncertainty and ignorance

3. Tractability: Existence, uniqueness and stability of the solution of intertemporal optimisation approaches

4. Problems with the welfare economic approach and variable and endogenous population

5.2.3 Recommendations and guidelines for future work

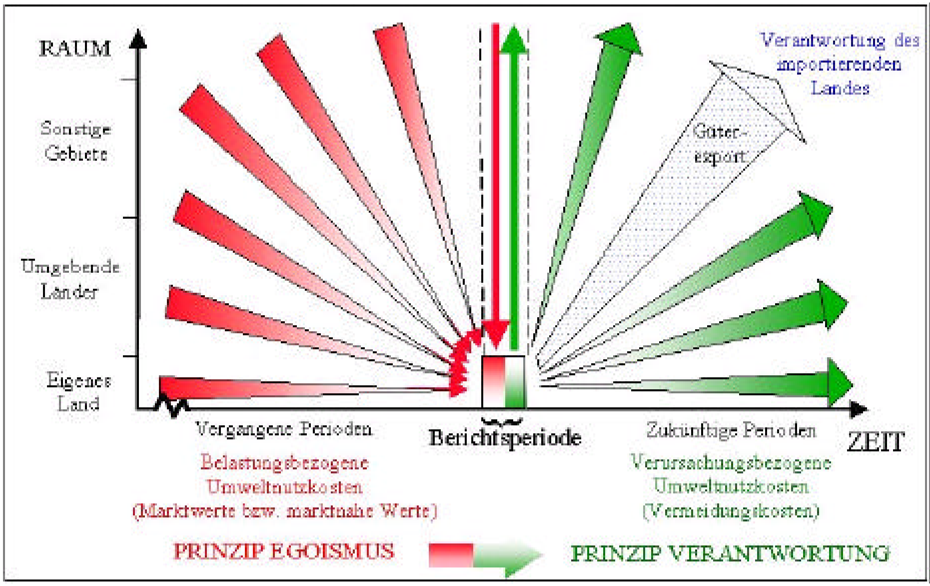
1. Clarify the limits of a scientific approach to sustainability. This also helps us to learn which aspects of a sustainable development could in principle be monitored by indicators

2. We should proceed in modelling the interactions between natural and socio-economic systems in order to derive prices for ecosystems. And we should extend this research by using this approach in order to derive prices for ecosystem services independent of human goals

3. Collect physical data on pollution flows and stocks of pollutants, because such data are a prerequisite for coupled ecological-economic models

5.3 Statement by Prof. Carsten Stahmer (in German)

Bei der Frage der Anpassung von Rechnungssystemen geht mir immer dieses Lied von der Loreley durch den Kopf: *„Ich weiß nicht, was soll es bedeuten, dass ich so traurig bin."* In den 70ern gab es großen Optimismus, dass das BIP durch bestimmte Größen zu einem Wohlfahrtsmaß erweitert werden könnte. Ich habe dann an dem „System for Integrated Environmental and Economic Accounting" (SEEA) in Vorbereitung der Konferenz in Rio 1992 mitgearbeitet. Aber schon damals hatte ich Zweifel, ob der Weg richtig ist. Wie K.-G. MÄLER vorhin sagte, ist die Frage wichtig, *wessen* Wohlfahrt eigentlich gemessen werden soll. Unsere diesbezüglichen Überlegungen möchte ich anhand von folgender Graphik verdeutlichen:

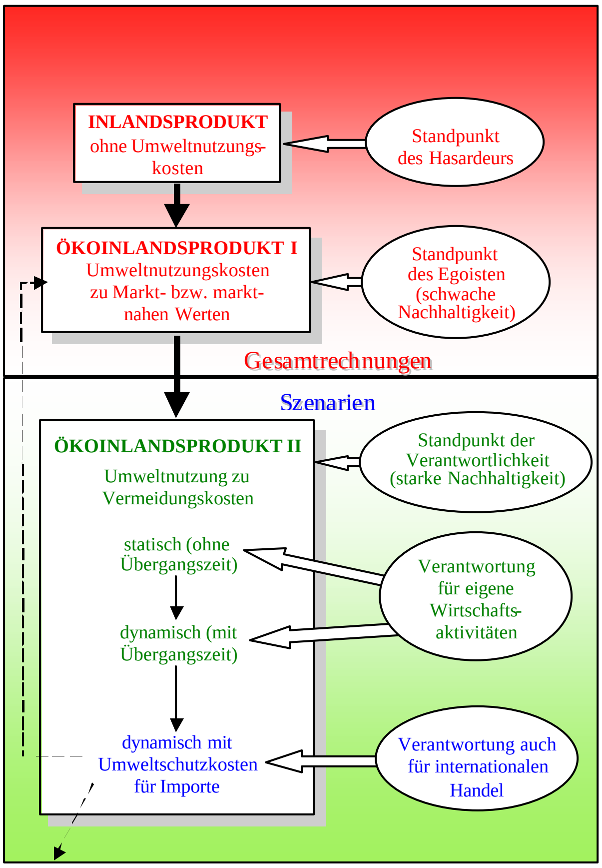


Source: Stahmer 2001

Wir haben damals zwei Bewertungskonzepte entwickelt: 1. die belastungsbezogenen Umweltkosten ("cost borne") der vergangenen Periode zu der Frage, wie die eigene Wohlfahrt betroffen ist. Man könnte hier auch von einem "Betroffenheitsmaß" sprechen. 2. die verursachungsbezogenen Umweltkosten ("cost caused") zu der Frage, was die zukünftigen Auswirkungen unseres Handelns sind. Dieses zweite Konzept ist letztlich handlungsbezogener, weil es fragt: "Was machen wir, und wie wirkt es sich aus? "

Nach diesem Ansatz gibt es keine spezifische Wohlfahrt mehr; eine solche Messung rückt in den Hintergrund. Außerdem sagen wir, dass es nicht reicht, nur Handlungen der Gegenwart zu berücksichtigen. Stattdessen müssen wir einen dynamischen Prozess analysieren und Pfade für zukünftige Entwicklungsmöglichkeiten definieren. Ursprünglich hatten wir gedacht, wir könnten im BIP z.B. für das Jahr 2002 statisch gewisse Größen korrigieren, aber ein solcher Ansatz wird so nicht mehr verfolgt. Stattdessen gibt es eine Tendenz zur Modellierung von Volkswirtschaften. Ein Beispiel ist der "Ecological Footprint". Dabei reicht es nicht aus, das unmittelbare Handeln zu analysieren, sondern es müssen auch die indirekten Wirkungen untersucht werden. Das heißt, es geht um den berühmten „ökologischen Rucksack" und um den Export von Problemen. Im statistischen Bundesamt wird dazu die Ansicht vertreten, dass

"Accounting" und "Modelling" eine Einheit darstellt. Die verschiedenen Abstufungen dieser Einheit sind der folgenden Graphik zu entnehmen:



Source: Stahmer 2001

6 Session II: “Indicators Derived from Satellite Accounts”

6.1 Statement by Stefan Giljum

Possibilities and limits of physical accounting for measuring sustainability - The example of material flow accounting and analysis (MFA)

6.1.1 About SERI:

- The Sustainable Europe Research Institute
- Pan-European think tank; main office in Vienna
- Themes: European Sustainability Policy, Ecological Economic Policy, Sustainable Societies, Production and Consumption, Globalisation and international trade,
- Research and Consulting:
  EU Commission, governments, NGOs, business and trade unions

6.1.2 Physical accounting: foundations

- Integrating existing environmental and natural resource related data with the national accounts
- Tool for integrated economic-environmental assessments
- Indicators (one-dimensional & interlinkage)
- Main areas of application:
  - Analyses of economy-environment relationships
  - Evaluation of policy measures and instruments
  - Prognoses and scenarios
  - Comparisons (sectoral and international level)

6.1.3 International Accounting systems

- NAMEA (National accounting matrix including environmental accounts) – EUROSTAT
  - Energy accounts and emission data

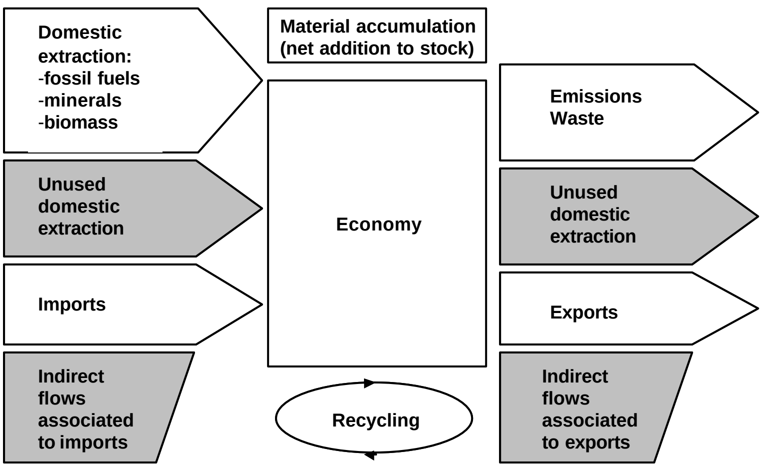
- SEEA (System of Integrated Environmental and Economic Accounts) – United Nations
- Full set of physical accounts:
  - Energy accounts
  - Land cover / land use accounts
  - Economy-wide MFAs (material inputs and outputs)
  - Physical input-output tables (PIOTs)

6.1.4 Material flow accounting and analysis (MFA): foundations

- Analysing the composition of the physical "metabolism" of societies ? determining the physical „scale" of an economy
- Monitoring its developments with appropriate indicators
- Basic assumption: all materials extracted or moved by humans exert pressure on the environment
- Many environmental problems are directly or indirectly related to the material metabolism of the economy ? can be monitored with material flow-based indicators (climate change; waste problems; soil degradation; air and water pollution)

6.1.5 MFA: standard method

EUROSTAT (2001): Methodological guide for economy-wide MFAs



6.1.6 MFA strengths

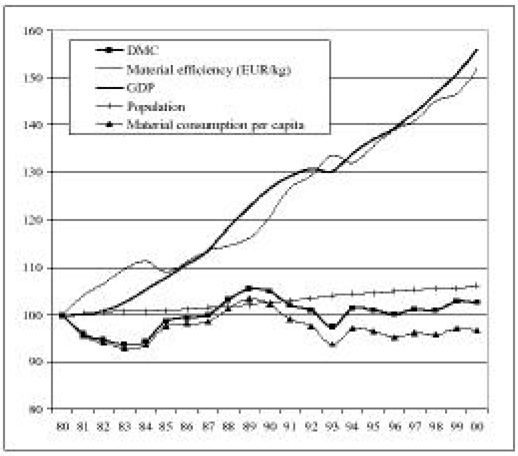
- Comprehensive approach (megatons versus nanograms) ? complete accounting of the biophysical dimension of economic activities
- Data organization compatible with System of National Accounts – integrated economic/ecological indicators
- Indicators on all levels of aggregation (micro, sectoral, macro / material groups / input, output, consumption, trade)
- Macro indicators: Total environmental pressure (as an environmental indicator equivalent to GDP, employment)

6.1.7 MFA: weaknesses

- No detailed information on environmental impacts
- No weighting of material flows - no consideration of qualitative aspects (scarcities, toxicities), all flows are accounted in one single unit (tons) – value-neutral?
- Problem of aggregation: big flows dominate aggregated indicators, no information on material substitution, less is not necessarily better
- Economy as a black box: no separation between material inputs for production vs. consumption – MFA-based consumption indicators misleading ? information from PIOTs needed

6.1.8 EU-15: DMC, 1980-2000

Direct material consumption (DMC) = domestic material extraction + imports – exports

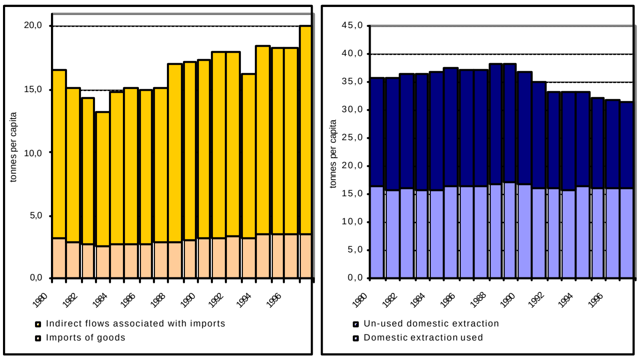


- Relative dematerialisation (de-coupling)
- in DMC: no consideration of hidden flows (ecological rucksacks)

Source: EUROSTAT (2002)

6.1.9 EU-15: TMR, 1980-1997

Total material requirement (TMR) = domestic material extraction (used and unused) + total imports



Source: Moll/Bringezu/Schütz (2003)

6.1.10 MOSUS: general facts

- Is Europe sustainable?
- Modelling opportunities and limits for restructuring Europe towards sustainability (MOSUS)
- MOSUS is funded by the 5th framework programme of the European Union (sub-programme environment and sustainable development)
- Co-ordinator: Dr. Günther Fischer (Land use department; IIASA)
- Core team: Prof. Bernd Meyer (GWS), Dr. Friedrich Hinterberger (SERI)
- Consortium: 12 members from 7 EU and accession countries
- Project duration: February 2003 – January 2006

6.1.11 MOSUS: the model

- GLODYM (Global Dynamic Model) provided by GWS
- Multi-country, multi-sectoral system of econometric input-output models and macro models (55 countries / world regions; up to 36 sectors; time series from 1980-2000)
- Linked by bi-lateral trade models of 25 product groups
- Extension by environmental input data in physical units:
  - material inputs,

  - land cover and land use,
  - (energy inputs – already included in energy models).
- comprehensive economic-environmental simulation tool

6.1.12 MOSUS: project goals

- Comprehensive quantification of current level of resource use in Europe: including indirect resource requirements associated with imported products - “ecological rucksacks” (materials, energy, land) on sectorally disaggregated level
- Formulating EU development scenarios and evaluate the environmental, economic and social impacts of key environmental policy measures implemented in Europe (including trade-offs)
- Presenting quantified policy recommendations responding to environmental changes and to reconcile key policy goals of the EU

6.1.13 Future research need

Status quo: rapidly growing data pool, but little (sustainability) policy-oriented analysis

- Alternatives to weight-based aggregation (link to evaluation & weighting methods / LCA; distance to target) – increase meaningfulness for environmental policy debates
- Sectoral disaggregation: PIOTs (statistical offices?) & IO modelling (physical or physical-monetary)
- Linking MFA and other physical accounting approaches (e.g. land use accounting)
- Scenarios and simulations (e.g. future waste / emission problems)
- International comparisons; effects of globalisation and international structural change
- Regional analyses (NEDS project)
- Linking micro and macro levels

6.1.14 Conclusions

- Physical satellite accounts: important role in Sustainability Economics
  - comprehensiveness

  – consistent and standardised data organisation

  – avoiding problems related to monetarisation

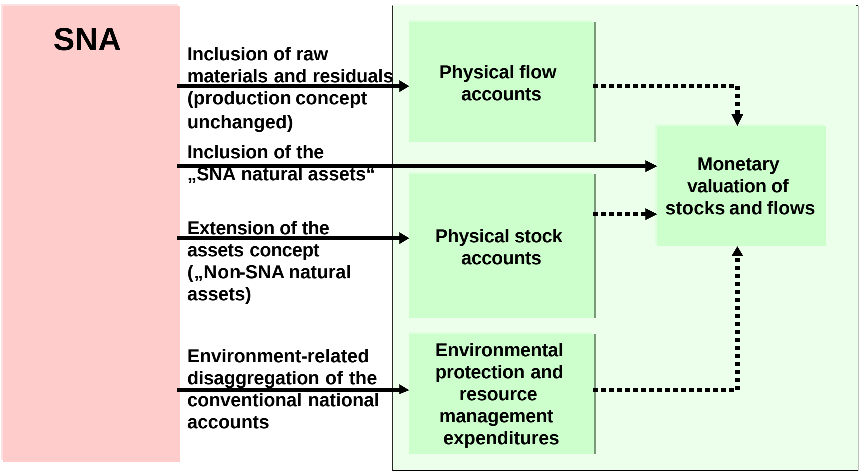
- System of both welfare-related and physical indicators to cover all dimensions of sustainability
- Physical accounts: not an end, but a means

  – Methodological development (qualitative aspects)

  – Integrated sustainability analyses (GoSD project)

6.2 Statement by Dr. Karl Schoer

6.2.1 Modules of the German Environmental Economic Accounts (GEEA)and its relationship to the System of National Accounts (SNA)

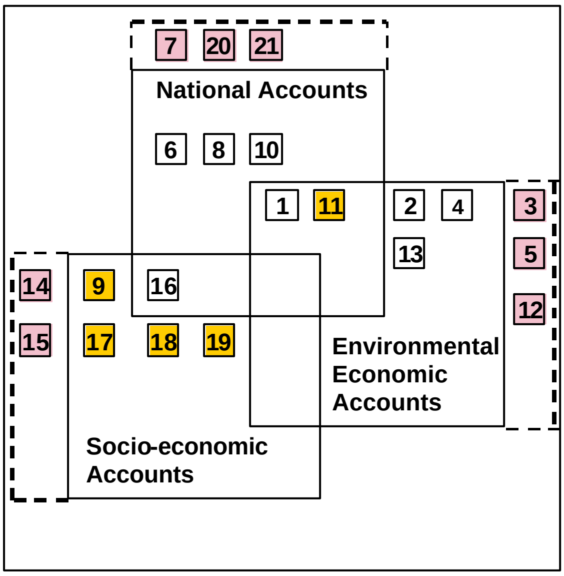


6.2.2 GEEA and the national strategy for sustainable development

- Sustainable development requires a holistic approach: Co-ordination of sector policies, simultaneous achievement of conflicting goals, interlinkages between indicators and subjects have to be observed.
- Indicator set for sustainable development: Indicators are a communication tool (problem description, performance control). The integrated analysis (diagnosis, forecasting, policy formulation) an underlying detailed and integrated database.

- Expanded accounting data set: The national accounts and its satellite systems (environmental economic and socio-economic accounts) are the ideal framework to meet the data requirements for an integrated analysis.
- Data supply for Germany: A considerable proportion of the indicators for sustainable development is already embedded into the accounting data set

6.2.3 Embedding of the German sustainability indicators into the accounting data set



1 Productivity of energy and raw materials
2 Emissions of greenhouse gases
3 The proportion of renewable energy sources in overall energy consumption
4 Increase in land use for housing and transport
5 Development of stocks of specified animal species
6 Balance of public sector financing
7 Private- and public-sector expenditure on research and development
8 Capital-outlay ratio
9 Educational outcomes for 25-year-olds and number of new students
10 Gross domestic product
11 Transport intensity and share of the railways in providing transport
12 Proportion of ecological agriculture and general statement on nitrogen surplus
13 Air pollution
14 Satisfaction with health
15 Number of burglaries
16 Labour force participation rate
17 Full time children care facilities
18 Relationship between male and female gross annual earnings
19 Number of foreign school-leavers who have not completed secondary school
20 Expenditure on development collaboration
21 EU imports from developing countries

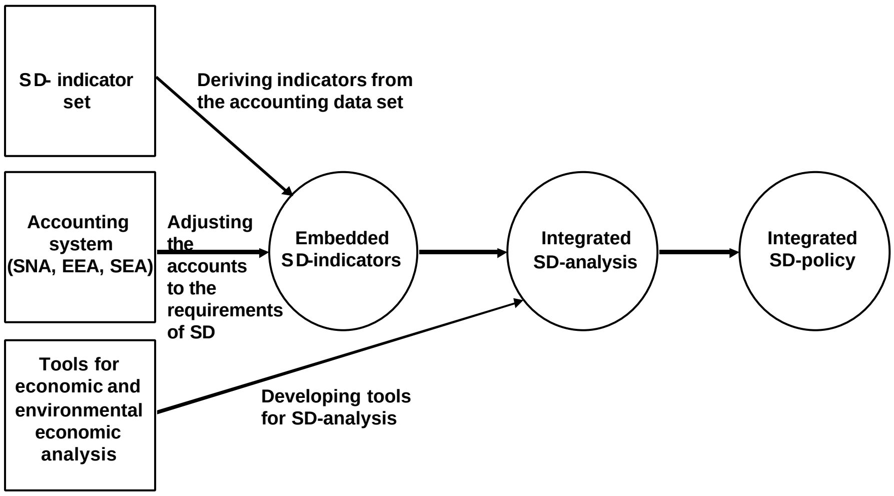
6.2.4 Available German EEA data in a NAMEA-type breakdown

	Unit
Primary material by aggregated categories of material	Tonnes
Abstraction of water from nature and water flows within the economy	m^3
Primary energy consumption (total and emission relevant)	Terajoule
Air emissions	Tonnes
Greenhouse gases by type	Tonnes
Air pollution by type	Tonnes
Waste water and other discharge of water into nature	m^3
Waste by waste categories	Tonnes
Land use for housing and transport by land use categories	km^2
Figures on the transport sector by mode of transport	
Transport related energy consumption, fuel consumption, air emissions	Terajoule Tonnes
Kilometres driven, person kilometres, tonnes kilometres	km
Transport related environmental taxes by type	Euro
Stock of vehicles by type	Number and Euro

1) Only figures until 1995, old classification

Part of the sustainable development indicator set

6.2.5 Strategy for an integrated sustainable development analysis and policy



6.2.6 Strategy for sustainability analysis

- Future revisions of the indicator system: indicators should preferably be derived from the accounting data set by aggregation
- Development of the accounting data set: high priority on expanding the system towards the requirements of sustainability analysis
- Development of tools for an integrated economic, social and environmental analysis

6.2.7 Issues of the meeting

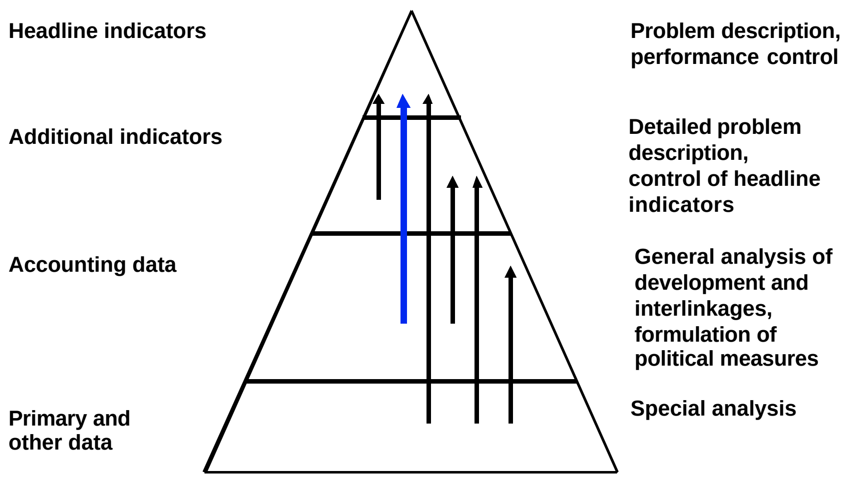
- Causal relationships: The system character of the accounts helps to establish causal relationships (driving forces, pressures, state, response). Limitations: effects may occur in another time period or region, high complexity of relationships
- Relationship between approaches: The physical flow and stocks accounts are the basis for monetary valuation required for welfare related approaches
- Suitability of different approaches for diagnosis, forecasting, policy formulation: GEEA can provide indicators (diagnosis). The main area of application for GEEA is modelling (diagnosis, forecasting, policy formulation
- Division of labour between statistical offices and research institutions: The German tradition leaves modelling to research institutions

- International linkages (cost caused and cost borne): In the accounting framework links can be established between imports and exports and the related environmental pressures by IOT-analysis
- Advantages and disadvantages of satellite accounts for decision makers: Satellite accounts provide high flexibility in responding to political demand. The complexity can be reduced by embedding the indicators into the accounting system. Indicators: Performance control, modelling: policy formulation)
- Success of indicators for measuring sustainable development: Indicators are necessary for reducing complexity for the public and for decision makers and for identifying political priorities. But a more systematic approach is desirable (close relationship to the accounting system).
- Implicit aggregation by weight in the material flow accounts: That approach is only appropriate for mass-materials. Analysis should be rather based on aggregated type of materials.

6.2.8 Conclusions for the research agenda

- Development of a systematic sustainability indicator set based on an expanded accounting system
- Development of modelling tools for an integrated analysis of sustainable development

6.2.9 Data requirement for a strategy on sustainable development



7 Session III: “Systemanalytische Ansätze”

7.1 Statement by Prof. Richard Tol

Integrated Assessment Models and Sustainability

7.1.1 Integrated Assessment

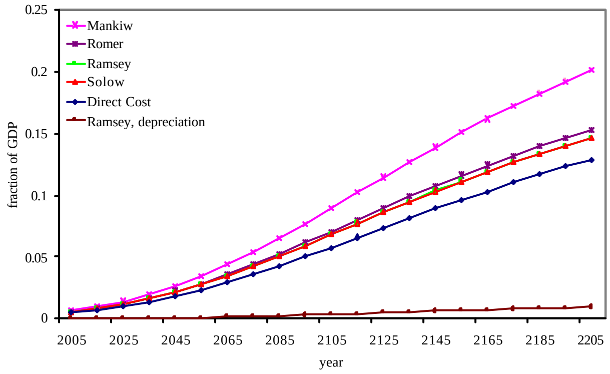
- Integrated environmental assessment is policy-relevant multidisciplinary research on complex environmental issues
- Integrated assessment models (IAMs) support integrated assessment; typically, integrated assessment models combine parts of various disciplines in order to inform stakeholders through scenario analyses, multicriteria analysis, cost-benefit analysis, and cost-effectiveness analysis

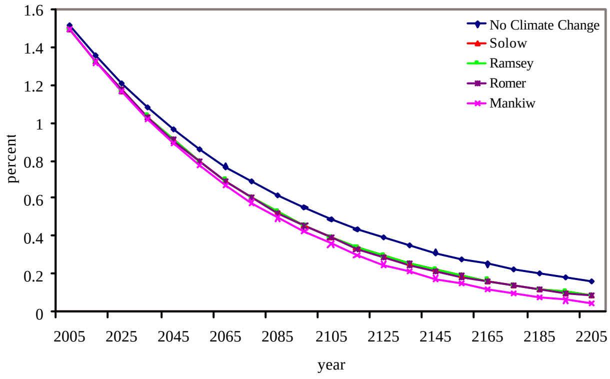
7.1.2 IAMs and Sustainability

- IAMs are used for *strategic* policy advice, that is, they are designed for the broad questions about what to do
- Sustainability, of course, is a long-term system property
- IAMs are therefore suitable for identifying unsustainable paths of development, and assessing potential countermeasures

7.1.3 Climate Change

- Climate change is the current domain of development for integrated assessment
- Strong sustainability and climate change is a bit boring; no matter what we do, the atmosphere will warm for a few more centuries, the sea will rise for a few more millennia – strong sustainability is always violated
- Weak sustainability is much more interesting, at least in this case


0.25
0.2
0.15
0.1
0.05
0
fraction of GDP
Mankiw
Romer
Ramsey
Solow
Direct Cost
Ramsey, depreciation
2005 2025 2045 2065 2085 2105 2125 2145 2165 2185 2205
year


1.6
1.4
1.2
1
0.8
0.6
0.4
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percent
No Climate Change
Solow
Ramsey
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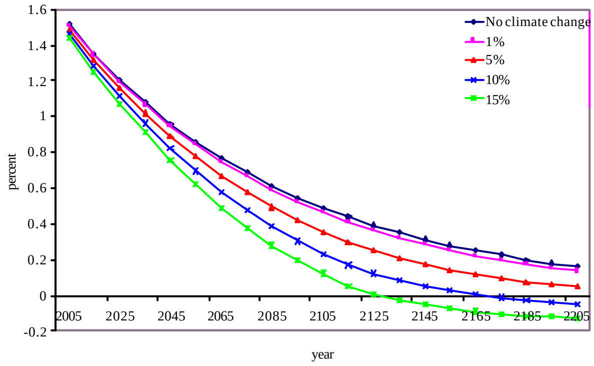
2005 2025 2045 2065 2085 2105 2125 2145 2165 2185 2205
year


1.6
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No climate change
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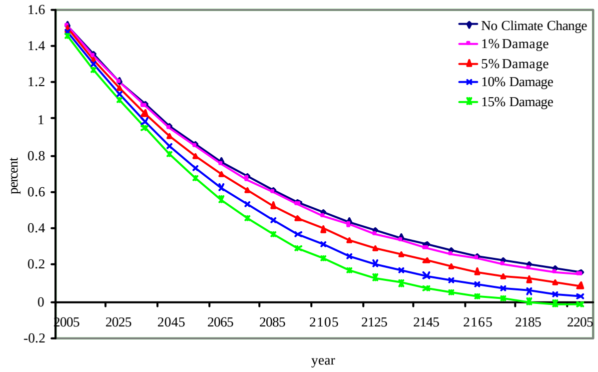
year


1.6
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percent
No Climate Change
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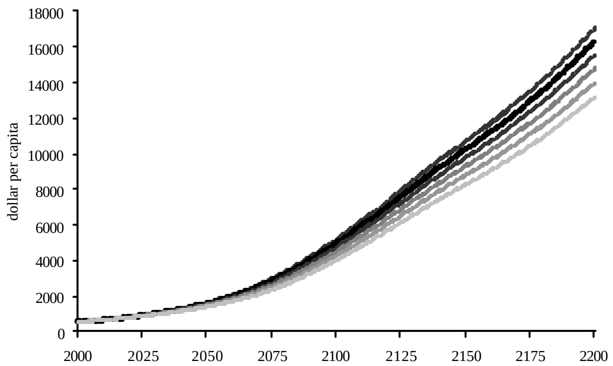
10% Damage
15% Damage
2005 2025 2045 2065 2085 2105 2125 2145 2165 2185 2205
year


18000
16000
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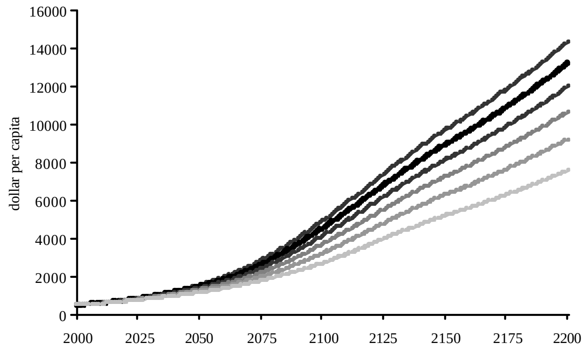
10000
8000
6000
4000
2000
0
dollar per capita
2000 2025 2050 2075 2100 2125 2150 2175 2200


16000
14000
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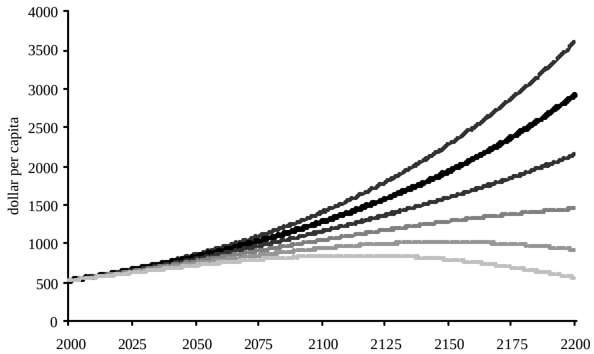
10000
8000
6000
4000
2000
0
dollar per capita
2000 2025 2050 2075 2100 2125 2150 2175 2200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3000
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1500
1000
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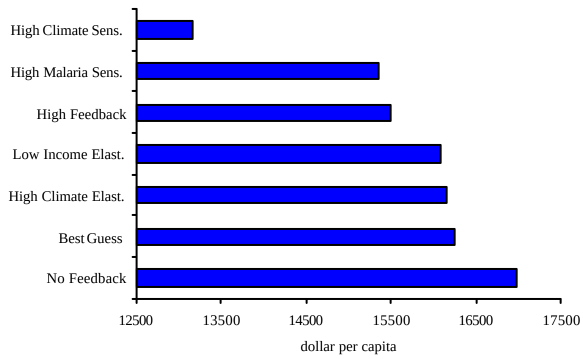
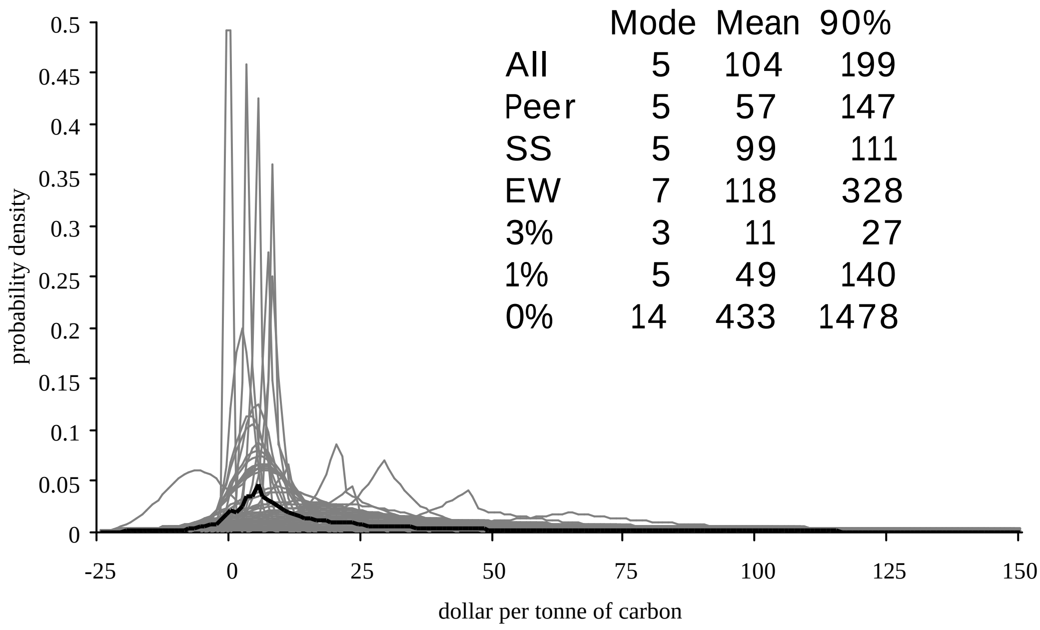
0
dollar per capita
2000 2025 2050 2075 2100 2125 2150 2175 2200


High Climate Sens.
High Malaria Sens.
High Feedback
Low Income Elast.
High Climate Elast.
Best Guess
No Feedback
12500 13500 14500 15500 16500 17500
dollar per capita



7.1.4 External Costs of Climate Change

Name	Description	Monetary value
Weak	Marginal cost	$8/tC
Intermediate	550 ppm max	$49/tC
Strong	450 ppm max, 0 emissions in 2200	$495/tC

7.1.5 Conclusions

- Integrated assessment models give a view of the long-term developments of the coupled social-natural system
- However, for social read economic; for natural read physical
- We are only starting to include the feedbacks of environmental change on development, and the effects of development on vulnerability; similarly, only the crudest of anthropogenic effects are included in the current models

7.2 Statement by Dr. Felix Rauschmeyer (in German)

Bewertung von Nachhaltigkeit: die multikriterielle Entscheidungshilfe

7.2.1 Drei Hauptschwierigkeiten:

- Berücksichtigung künftiger Generationen
- Hierarchische Abhängigkeiten
- Rolle des Wissenschaftlers

7.2.2 Berücksichtigung zukünftiger Generationen

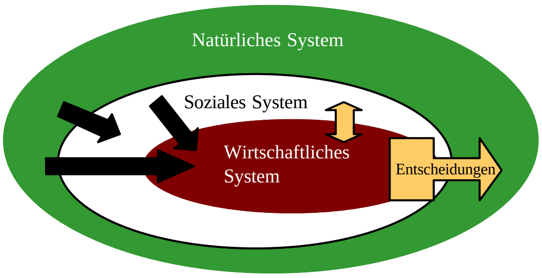
1. Möglichkeit: Gleichsetzung und Diskontierung

2. Möglichkeit: über kritisches Naturkapital

3. Möglichkeit: über Stellvertreter

- Jeweils Abhängigkeit vom Bewertungsverfahren: mathematisch und/oder diskursiv
- Unsicherheit über zukünftige Interessen

7.2.3 Hierarchische Abhängigkeiten



- Unsicherheit über Abhängigkeiten

7.2.4 Rolle des Wissenschaftlers im Entscheidungsprozess

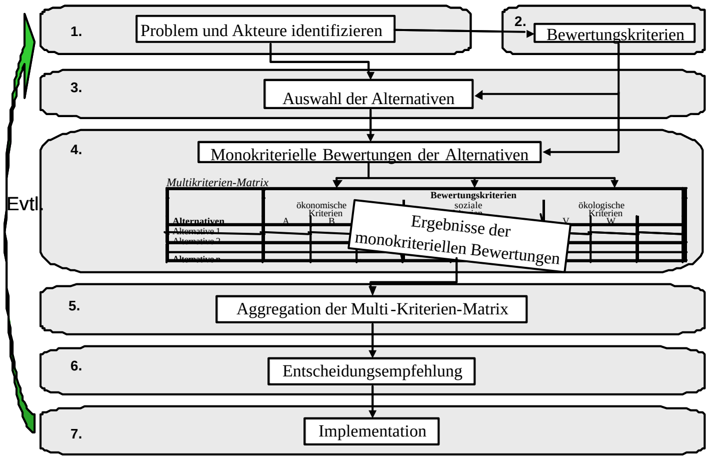
1. Wissenschaft der Nachhaltigkeit soll entscheidungsrelevant sein.

2. Entscheidungsrelevante Wissenschaft muss sich an Entscheidungsträgern orientieren.

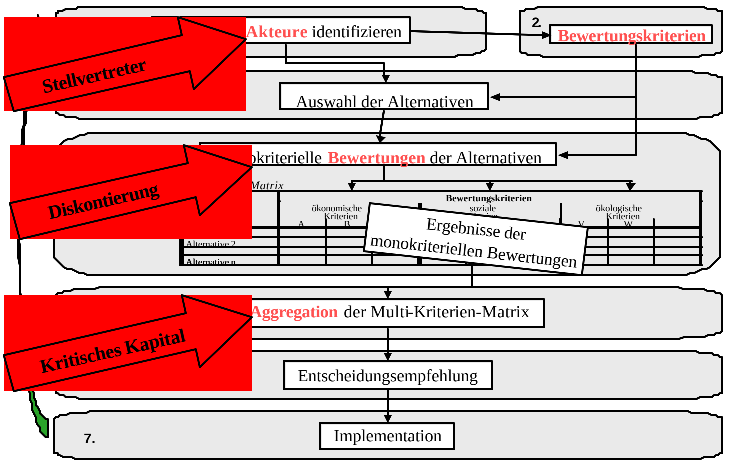
3. Wissenschaft der Nachhaltigkeit muss sich am normativen Konzept der Nachhaltigkeit orientieren.

- Unsicherheit über Werte

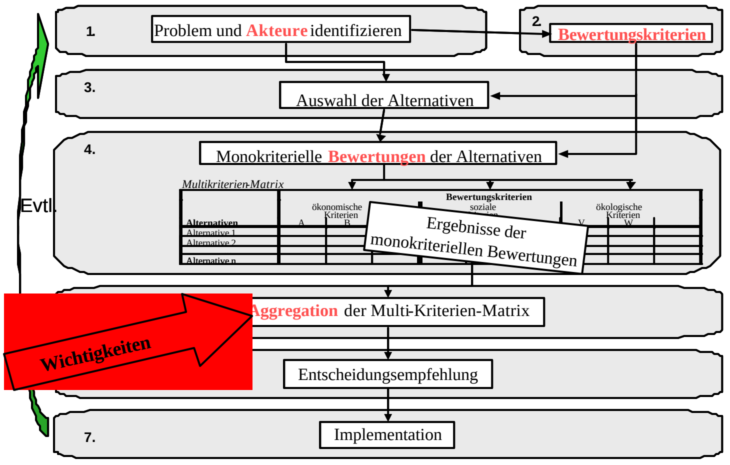
7.2.5 Multikriterielle Entscheidungshilfe



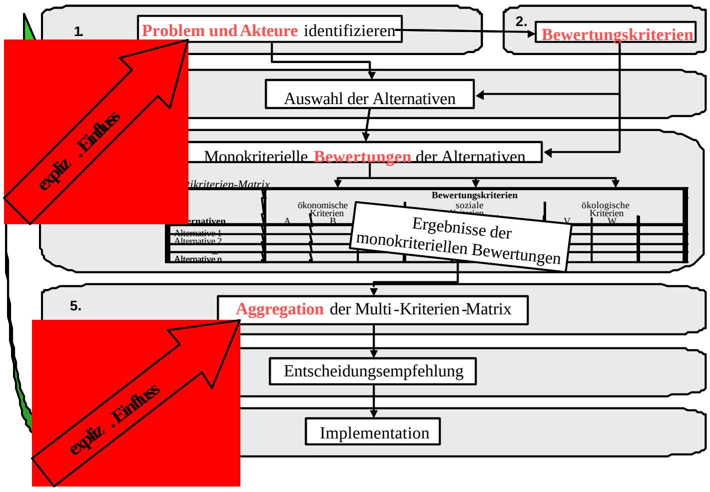
- Berücksichtigung künftiger Generationen ist über drei Möglichkeiten machbar: Diskontierung, Kritisches Kapital, Stellvertreter.



- Hierarchische Abhängigkeiten werden über Wichtigkeiten der Kriterien dargestellt



- Rolle des Wissenschaftlers in Entscheidungsprozess kann nur explizit gemacht werden.



7.2.6 Zusammenfassung

Der Hauptunterschied zwischen monokriteriellen Bewertungs-verfahren und der multikriteriellen Entscheidungshilfe ist weniger das mono/multikriterielle Herangehen, sondern die Leichtigkeit, mit der letztere in einen angemessenen sozialen Entscheidungskontext eingebunden werden kann.

Hier ist es leichter, die drei Hauptschwierigkeiten wissenschaftlicher Bewertung von Nachhaltigkeit offen zu legen und sie explizit im öffentlichen Diskurs zu thematisieren.

8 Session IV: “Messung sozialer und ökonomischer Nachhaltigkeit”

8.1 Statement by Prof. Carsten Stahmer (in German)

Diskurs für Nachhaltigkeitsstrategien

8.1.1 Die drei Dimensionen der Nachhaltigen Entwicklung

- Ökonomie: Geld (Stabilitätskriterien)
- Natürliche Umwelt: physikalische Größen (Tragfähigkeit)
- Gesellschaft: Zeit/Personen (Gerechtigkeit, Chancengleichheit)
  speziell: gleiche Teilhabe von Männern und Frauen an Familie und Beruf
  - Verteilung der Arbeit
  - Geburtenrate (demographische Entwicklung)
  - Geschlechtergerechtigkeit
  - Soziale Sicherungssysteme
- Meeting point der drei Dimensionen: angemessenes Wirtschafts-(Konsum-)Niveau

8.1.2 Soziale Dimension

- Alle Personen - sozioökonomische Gruppen, Haushaltstypen (Kinder, Erwachsene o. Senioren, Senioren)
- Alle Aktivitäten (Persönlicher Bereich, Eigenarbeit, Erwerbsarbeit)
- Zeitverwendung (geleistete Zeit, empfangene Zeit)
- Geldströme (Produktion, Konsum im weitesten Sinne)
- Physische Konsequenzen (Materialbilanzen)
- Sozio-ökonomische Input-Output-Tabellen
- Modellrechnungen: statisch-komparativ (Halbtagsgesellschaft)
- Sozio-ökonomische Gesamtrechnungen

- Sozio-ökonomische Modellrechnungen (disaggregierte ökonometrische Modelle)
- Machbarkeitsstudie

Der jetzige Kenntnisstand ist, dass wir in allen drei Nachhaltigkeitsdimensionen mit dem jeweiligen wissenschaftlichen Sachverstand forschen. Eine Mischung erschwert da teilweise den Diskurs eher, als dass sie zur Problemlösung beiträgt. Besser ist daher, wenn jede Gruppe für sich arbeitet und dann irgendwann der Diskurs beginnt. Ich habe das den *Meeting point* der Disziplinen genannt, an dem dann gemeinsame Lösungen gefunden werden müssen. Beim VÖW/VÖÖ-Treffen in Heidelberg war die Frage zentral, inwieweit das BIP als eigener Nachhaltigkeits-Indikator akzeptiert werden muss. Dabei kam heraus, dass die BIP-Höhe sich aus anderen Vorgaben ergeben soll, aber selber nicht am Anfang als Vorgabe dastehen kann. Denn wenn das BIP als selbstständiger Nachhaltigkeits-Indikator akzeptiert ist, wird es schwer, Kompromisslinien zwischen den Disziplinen zu finden. Die ökonomische Nachhaltigkeit sollte sich ganz stark an Stabilitätskritieren orientieren - also nicht am Niveau, sondern an der Struktur. Die Stabilitätskriterien haben dabei in vielem der Nachhaltigkeitsdiskussion vorgegriffen.

Was die soziale Dimension von Nachhaltigkeit betrifft, so ist das eine neue Forschungsrichtung. Bisher war die Diskussion eher ökologisch und ökonomisch dominiert. Aber die Nachhaltigkeits-Strategie der Bundesregierung ist da ein guter Anfang. Dabei rückt die Gerechtigkeit bzw. Chancengleichheit der verschieden Gruppen in der Gesellschaft dabei in den Vordergrund. Insbesondere die Geschlechtergerechtigkeit –die gleiche Teilhabe von Männern und Frauen an Familie und Beruf - strahlt dabei auf alle anderen Felder aus. Wenn ich also einen sozialen Indikator auswählen sollte, ware es dementsprechend der “Anteil der Männer an der Familienzeit”. Der liegt bisher bei 1-2 Prozent, während der Anteil der Frauen bei 98 Prozent liegt. Dieser soziale Indiaktor strahlt auf vieles aus. Mit ihm ware auch der demographische Wandel der Gesellschaft berücksichtigt.

Natürlich gibt es dazu es noch vieles auszuarbeiten. Bei der Messung müssten *alle* Personen und *alle* Aktivitäten einbezogen sein. Nur so hat man einen Zugang zur sozialen Dimension der Nachhaltigkeit. Denn wenn nur die Erwerbsarbeit einbezogen wird, dann deckt - wir haben das für alle Gruppen und alle Aktivitäten überschlagen - man im Schnitt nur zwei der 24 Stunden eines Tages ab. Insofern muss also ohne Eingrenzung das gesamte Aktivätsspektrum einbezogen sein, von den Kindern bis zu den Senioren. Hier sind insbesondere Substitutionsmöglichkeiten zwischen formeller und informeller Arbeit wichtig.

Die ökonomische Schiene alleine reicht für die Problemlösung nicht aus. Ich betrachte bei der sozialen Frage eher die Komplementärwährung "Zeit", die nicht nur ein Darstellungsmittel, sondern in vielen Diskussionen auch eine Währungseinheit ist. Wir brauchen also nicht nur Erwerbszeitkonten, sondern auch *soziale* Zeitkonten. So etwas könnte zentral sein für eine nachhaltige Gesellschaft. Möglicherweise brauchen wir andere Säulen für unsere sozialen Sicherungssysteme. Wir sehen ja, dass die Erwerbsarbeit prozentual weiter schrumpft, so dass man andere Methoden zu sozialen Sicherung braucht. Die traditionellen Instrumente alleine reichen da nicht aus.

Meine Empfehlung für die Forschung ware die Erstellung einer Machbarkeitsstudie zur sozioökonomischen Modellierung unter Nachhaltigkeits-Aspekten. Zur Modellierung sollte es einen größeren Verbund geben - auch unter Beteiligung des DIW. Nur wenn wir die Modellierungsphase erreichen, kann in dieser Hinsicht eine handlungsbezogene Politikberatung gewährleistet werden.

8.2 Statement by Dr. Klaus Rennings (in German)

8.2.1 Eine Chronologie der Nachhaltigkeitsindikatoren

- Phase 1 (seit 70er): Grünes Sozialprodukt
- Phase 2 (Anfang 90er): Physische Umweltindikatoren
  - Material Flow (u.a. MIPS – siehe Rennings/Wiggering 1997)
  - Critical Loads (SRU- siehe Rennings/Wiggering 1997)
  - Pressure-State-Response (OECD 1993)
- Phase 3 (seit Mitte 90er): 3-D-Indikatoren
  - Driving Force-State-Response (CSD – siehe United Nations, Economic and Social Council 1995)
  - HGF-Projekt (siehe Keimel 1998)
  - Akademie für Technikfolgenabschätzung (1997)

- Firmenratings (z.B. DJSI-Dow Jones Sustainability Index, SAM-Sustainabilily Asset Management)

8.2.2 Beiträge zur Messung von Nachhaltigkeit

- Promotion “Indikatoren für eine dauerhaft-umweltgerechte Entwicklung” (Bewertung monetärer und physischer Indikatoren) [SRU -siehe Rennings (1994)]
- Nachhaltigkeitsaspekte monetärer Indikatoren (intra- und intergenerative Gerechtigkeit) [ExternE – siehe Rennings/Hohmeyer 1997]
- Ökonomische Indikatoren für nachhaltiges Wirtschaften [HGF]
- Hauptbeitrag: [EU, BMBF - siehe Hemmelskamp/Rennings/Leone 2000] :
  - Empirische Forschung zu umweltfreundlichen Innovationen
  - Breitenbefragungen bei verarbeitendem Gewerbe und Dienstleistern
  - Mikrodaten zur ökonomischen und ökologischen Performance von Unternehmen

8.2.3 Probleme mit eindimensionalen Indikatoren

- Monetär (Ökosozialprodukt)
- Physisch (Ecological Footprints, Materialintensitäten)
- Zusammengesetzte Indices (Index of Sustainable Economic Welfare, ökologische Buchhaltung)
- **Als Meta-Indikatoren problematisch:**
  - Sehr stark mit Annahmen befrachtet
  - Intransparent
  - Undifferenziert
- Führen eher zu “Glaubensdiskussionen” als zu lösungsorientierten Ansätzen
- Verwendbarkeit von monetären und physischen Indikatoren für spezifische Zwecke, aber keine allumfassenden Indikatoren.

  - z.B. externe Kosten hilfreich als Indikatoren zur Messung des Nutzens von Umweltprojekten

  - Energieeffizienz hilfreich als Indikator für Öko-Effizienz in bestimmten Fällen

8.2.4 3-D-Projekte

- Tendenz zur Überkomplexität
- Fokussierung auf bestimmte
  - Konkrete Fragestellungen, Handlungsfelder
  - Schlüsselindikatoren (z.B. 21) zur Komplexitätsreduktion

8.2.5 3 Dimensionen von Nachhaltigkeit

- Umwelt, Ökonomie, Soziales
- Ausgangspunkt Umweltökonomie, Ecological Economics
- Umweltdimension ist Fokus der Diskussion um nachhaltige Entwicklung
- Synergien und Trade-offs zu sozialem und ökonomischen Bereich sind davon ausgehend zu lösen (Distribution, Allokation)
- Alle drei Dimensionen sollten durch Indikatoren abgebildet werden, ökonomische und soziale Aspekte vorrangig durch Synergien und Trade-offs (zur Vermeidung von Beliebigkeit)

8.2.6 Forschungsprogramm

- Mikrodaten zur
  - Umwelt-, Sozial und ökonomischen Performance:

    Firmen (nachhaltige Produktion)

    Haushalte (nachhaltiger Konsum)
- Engpässe:
  - Repräsentativität von Daten (Zufallsstichproben)

  - Zeitreihen (Paneldaten)
  - Konsistente Erhebung von Daten aus allen drei Bereichen, die sich sinnvoll analytisch verbinden lassen
- Spezifische Datenergebung je nach Forschungsprogramm, - project

8.2.7 Arbeitsteilung

- Arbeitsteilung Ämter vs. Institute
  - Ämter: VGR, UGR
  - Institute: Mikrodaten, Modeling
- Arbeitsteilung Ecological Economics vs Mainstream
  - Ecological Economics: Ausweitung methodischer Pluralismus, Interdisziplinarität, Kritische Reflexionen des Mainstreams
  - Mainstream: Tools, Modelle, zunehmende Etablierung von Nachhaltigkeitsthemen

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