A Sustainability Geoscope – Observing, Understanding and Managing the Sustainability Transition

Report on an international workshop sponsored by the German National Committee on Global Change Research and the Potsdam Institute for Climate Impact Research (PIK)

25 - 26 October 2001, Berlin, Hotel Intercontinental

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www.sustainability-geoscope.net

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1. Background

1.1. The Need for a Global Observation System

The 21st century will be characterized by global change at an unprecedented scale. Human activities and modern lifestyles in combination with strong population growth and technological advances are the main drivers of this change. The vulnerability of human societies to global change will increase dramatically over the next decades unless the global society will be able to achieve transitions to sustainability and establish an associated forward-looking earth system management. This challenge may be met only if adequate theories are available to create a more integrated worldview and to guide informed economic, social and environmental action. Sustainability science will have to be based upon next generation meta-theories, bridging the gaps that have evolved between natural sciences, economics and social sciences, and arts and humanities.

The development and validation of sustainability theories and the operation of associated computer models will require data streams of a content and quality that are currently not available. Today's growing data streams for parameters of the natural sciences, as from weather stations, buoys and satellites, will have to be matched by equally systematic, high quality observations of global socio-economic and cultural developments.

1.2. The Idea of a Sustainability Geoscope

The Sustainability Geoscope will provide a framework for theory development as well as an observation system for data collection on a global scale, comprising economic, social, environmental and institutional issues. The number of key variables to be acquired shall be limited. However, these key variables will be observed in the form of long time series on a large spatial sample. Data sources will be a combination of satellite remote sensing with on-the-ground observations.

Reducing the complexity of the earth system to a manageable set of key variables to be observed will pose a major challenge to the scientific community. Hence, the selection of relevant variables has to be based upon a corresponding theoretical background. But once data streams of a new quality are available they will in turn foster further advancement of sustainability theories. This interplay will allow creating new images and new understandings of the planet.

The idea of a Geoscope is not genuinely new. It will take advantage of important research efforts initiated under IGBP, WCRP and IHDP. In the socio-economic sphere a starting point may be, among others, a working list of sustainability indicators collected by national bodies and harmonised by the United Nations Commission for Sustainable Development. The Geoscope will be developed step by step and experience shows that it will probably require up to 20 years to deliver substantial results. But once operational, it may become a crucial decision-support tool in science, politics and management in order to meet the challenges of global change.

1.3. Objectives of the workshop

The workshop aimed at introducing the idea of a Geoscope to the international global change community and preparing the ground for interdisciplinary research efforts for sustainability transitions. A high-profile list of participants attended the workshop and started an open-minded, forward-looking discussion. The programme consisted of plenary sessions as well as small working groups, which pursued the following objectives:

- further development and clarification of the Geoscope idea

- stimulation of a theory-driven debate on society's future information needs
- identification of opportunities for international research cooperation and funding
- establishment of a global network and initiation of a Geoscope community
- definition of pilot projects to demonstrate the feasibility and use of a Geoscope
- development of a concept how to integrate a broad range of stakeholders >from science, politics, business and non-profit organisations.

2. Opening plenary session

Three co-authors of a seminal article on "Sustainability Science" in the Science magazine (Kates et al., 2001, www.sciencemag.org/cgi/content/full/292/5517/641) presented their thoughts on the Geoscope idea and its relationship with an emerging sustainability science.

2.1. An Invitation to the Sustainability Geoscope

(Prof. Carlo Jaeger, PIK)

Carlo Jaeger welcomed the workshop participants and introduced the overall topic.

The Sustainability Geoscope is an international initiative with a strong initial German component, to help structure future theory-based observations of a sustainability transition. It combines the observation of selected regions on a global scale with respect to policy measures relevant to sustainability by combining remote sensing methods with on-the-ground monitoring. One example of combining different methods of observation are the world famous maps of "The Earth at Night" (http://antwrp.gsfc.nasa.gov/apod/ap001127.html), where the density of human population have been approximated by detected city lights at night on satellite images. Resolution of modern satellite instruments facilitates new views and pictures of the earth surface (i.e. Ikonos with ~1m resolution allows identification of objects in cities). This provides a completely new toolset which has by far not been explored by the social sciences.

The present development path of the world is not sustainable. Envisaging a transition from the present to a sustainable future is our challenge. Natural science knowledge and social science speculation will not be sufficient. There are some global observations, e.g., remote sensing, but nothing comparable for the social and economic processes. Using satellite observations for social and economic sciences is another challenge. Satellite images are now capable to show off the tensions in the world.

A number of important research initiatives are represented at this workshop:

- Global Monitoring of Environment and Security (GMES)
- Land Use and Cover Change (LUCC)
- Environmental sustainability index (ESI)
  (CIESIN / World Economic Forum)
- Human-Environment Regional Observatory project (HERO)
- HELIO International
- IGBP Earth System Atlas

The following relevant organizations are not present, but the Geoscope is open for cooperation. This is a key component in the progress towards observing and understanding the Earth System:

- Global Terrestrial/Ocean/Climate Observing System (G3OS)

- Integrated Global Observation Strategy (IGOS)
- NASA Earth Science Enterprise
- NASA Digital Earth Project
- UN Earthwatch
- World Conservation Monitoring Centre (UNEP)

Some initiatives working on sustainability indicators which are important for the Geoscope:

- Working list of 57 indicators for Sustainable Development (UN CSD)
- Environmental sustainability index (ESI), CIESIN / World Economic Forum
- "Strawman Index" (CGSDI)
- Human Development Index (UNDP)
- Towards Environmental Pressure Indices (TEPI), Eurostat
- Policy Performance Indices (PPI), European Commission
- "Wellbeing of nations" index, IUCN / IDRC

Implementation of the Geoscope will not result from some bureaucratic initiative. Good ideas are scarcer than money on this planet. A step by step, networking activity, learning by doing approach is envisaged. The timeframe is of the order of 20 years. Some keywords for the development of a Geoscope:

- Step by step, Learning-by-doing
- Global network of existing activities
- Research framework programme "Geoscope" in Germany
- Network of research funding in other countries
- Time frame: 20 years

A central idea to establish and foster the Geoscope approach may be an international competition or contest for good ideas and initiatives into the envisaged direction. This will be similar to the list of mathematical problems that has been developed by the famous mathematician Stefan Banach (http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Banach.html) at the beginning of the 20th century.

A Geoscope competition could be organized, looking for good ideas from the research community. A conceptual framework for Geoscope studies may be sketched as follows: identify an intended action, look at its relevance for sustainability, analyse its potential consequences, look at what happens in reality after a few years, perform a comparative assessment, learn from the mistakes.

(Reference: Lucht, W., Jaeger, C.C., *The sustainability geoscope: a proposal for a global observation instrument for the anthropocene,* in: Contributions to Global Change Research: A Report by the German National Committee on Global Change Research, 138-144, 2001) (http://www.pik-potsdam.de/~wlucht/gs/information/download/pdf/gs_honnef_jan01.pdf)

2.2. Key Challenges on the way towards Earth System Management

(Prof. H.J. Schellnhuber, PIK)

Prof. Schellnhuber gave an introduction on the Key Challenges on the way towards Earth System Management. He showed his vision of the Earth System as the complex interaction between the "Physics" (Earth surface) and the "Metaphysics" (the consciousness of the global subject). From the physical space a "Global subject" or "Global identity" may emerge as a precondition for a sustainability science. The global subject in the other direction influences the physical space through management actions. The question is how our consciousness of global change will influence the direction of global change. We are not happy with "business as usual", but how can we drive the world to a sustainable situation?

A taxonomy of sustainability paradigms can be described, based on the various goals (positive or negative) that one can adopt: "Standardisation", "optimisation", "pessimisation", "equitisation", or "stabilization", to name some of them.

What is needed is to define "tolerable excursions" from the present Earth System status (e.g. Gulf Stream stability), and identify the critical thresholds that should not be trespassed in order to stay within a "safe domain" (tolerable window approach), e.g. Thermo-haline circulation (THC) in the North Atlantic.

Working Group 2 of IPCC has rated the reasons of concerns related to the various scenarios of future CO_2 emissions, and tried to quantitatively assess the impacts of a temperature increase of 1 to 6°C. Beyond 4-5°C the risk of large-scale discontinuities in the Earth System becomes very high. The cognitive basis for understanding the Earth System is still lacking as regards feedback effects, teleconnections, switch and choke points, thresholds, bottlenecks, etc.

As an outcome of the Open Science Conference in Amsterdam 2001 a list of 23 key questions has been prepared to cast an agenda for sustainability science – a programme to earth system science like the one proposed by David Hilbert for mathematics (Analytical, methodological, normative, strategic).

A "Hilbertian Programme" for Earth System Science

Analytic questions:

1) What are the vital organs of the ecosphere in view of operation and evolution?
2) What are the major dynamical patterns, teleconnections and feedback loops in the planetary machinery?
3) What are the critical elements (thresholds, bottlenecks, switches) in the Earth System?
4) What are the characteristic regimes and time-scales of natural planetary variability?
5) What are the anthropogenic disturbance regimes and teleperturbations that matter at the Earth-System level?
6) Which are the vital ecosphere organs and critical planetary elements that can actually be transformed by human action?
7) Which are the most vulnerable regions under global change?
8) How are abrupt and extreme events processed through nature-society interactions?

Methodological Questions:

9) What are the principles for constructing "macroscopes", i.e. representatives of the Earth System that aggregate away the details while retaining all systems-order items?

10) What levels of complexity and resolution have to be achieved in Earth System modelling?

11) Is it possible to describe the Earth System as a composition of weakly coupled organs and regions, and to reconstruct the planetary machinery from these parts?

12) Is there a consistent global strategy for generating, processing and integrating relevant Earth System data sets?

13) What are the best techniques for analysing and possibly predicting irregular events?

14) What are the most appropriate methodologies for integrating natural-science and social-science knowledge?

Normative Questions:

15) What are the general criteria and principles for distinguishing non-sustainable and sustainable futures?

16) What is the carrying capacity of the Earth as determined by humanitarian standards?

17) What are the accessible but intolerable domains in the co-evolution space of nature and humanity?

18) What kind of nature does modern society want?

19) What are the equity principles that should govern global environmental management?

Strategic Questions:

20) What its the optimal mix of adaptation and mitigation measures to respond to global change?

21) What is the best decomposition of the planetary surface into nature reserves and managed areas?

22) What are the options and caveats for technological fixes like geoengineering and genetical modification?

23) What is the structure of an effective and efficient system of global environment & development institutions?

One immediate task for this workshop and beyond should be to identify those questions with a high relevance to the Geoscope.

Prof. Schellnhuber mentions a German Research initiative called NESSIE (the Earth System InitiativE) with relevance to the Geoscope and discusses a possible "Second Copernican Revolution" (See reference for more details).

Looking at the Earth System can be done through *in situ* measurements (FACE experiments around the world (http://www.co2science.org/subject/f/faceag.htm)), satellite observations (Macroscoping, Bird's eye principle), and models (e.g. EMICs like CLIMBER (http://www.pik-potsdam.de/topik/t1nde/climber-3/) , or Syndromes (http://www.pik-potsdam.de/topik/t5rs/synapse/)). The Syndromes approach focuses around qualitative condensations of case studies panorama.

The Geoscope will zoom in on the *human factor*. An immediate issue for the Geoscope is *the water resource*. As an example one would like to elucidate the relationship between women education level and the average distance to a freshwater source. The source distance factor may be used as a function of Global Change.

(Reference: Schellnhuber, H.J., *Nature* 402, C19-C23, 1999 (http://www.pik-potsdam.de/nature_supp_esa.pdf))

2.3. Sustainability Science and Technology: Learning by Doing

(Prof. Robert W. Corell, Harvard University)

There is now a strong interaction between society and nature. The partnership in the new path we are trying to take is historically a new one. Co-production of knowledge in a new arena has to take place. The sustainable development business has been there for a long while, but this kind of wording now appears in the public press. A number of questions come up with respect to this thing called "Sustainability Science". It came from a number of works over the last twenty years, culminating in the late 90's. Today it is anchored with concerns for the human condition, but not part of the science agenda. We have slowly moved from the single disciplines' "island empires" (physics, chemistry, etc.) to interdisciplinarity, system research and connectivity to policy. Sustainability science is integrative across environment and development communities, natural and social sciences, multiple sectors of human activities, geographic and temporal scales, etc. It is a fundamental science stressing unity in the nature-society system, complexity and non-linear dynamics, cross-scale linkages, relationships and interactions. It is regional and place-based (Example of permafrost: there appears massive melting in Alaska, while almost no signal in Sweden). A number of core scientific questions are at stake: modelling nature-society interactions, understanding long-term trends, assessing limits, vulnerability and resilience, designing incentives for sustainability, integrating research monitoring, assessment and decision support. There is a large effort going on to redirect global change science. A group of independent scholars are developing an Initiative for Science and Technology for Sustainability, including a science agenda, the infrastructure, the science-policy connection (see http://sustsci.harvard.edu/). A series of Regional Workshops is planned in Africa, Asia, Europe, Latin America, North America and Pacific Islands, from fall 2001 until spring 2002. Barriers to progress should not be ignored: the tension between disciplinary and integrative science; the balance between national and international interests; the inadequacy of infrastructure and institutional arrangements in developing countries as well as in developed countries. The question of indicators for monitoring and reporting on sustainability is not yet well understood. Geographic Information Systems (GIS) are part of the new language that will help us talk to each other. Finally Prof. Corell describes as an example an approach in the Arctic case to a Geoscope-type analysis. He concludes on the idea that since the 1950's we have moved from the Geophysics Era into the Interdisciplinary Era into now the Sustainability Science Era.

2.4. Plenary Discussion

A short discussion takes place after the presentations. J. Hielkema talks about a paper he has written on what he calls "Dealism". Richard Klein asks a question related to how a Geoscope could measure thresholds and non-linearity. J.L. Fellous draws attention to the fact that the observing systems are not sustainable themselves at the moment. R.W. Corell gives some examples of thresholds, e.g., the sensitivity of the infectious potential of some diseases to temperature (none below 18.5°C, high above). C. Jaeger adds the level of income and its relationship with health. P. Kabat refers to the impact of the 11 September event, relatively a local event which had immediate global influence, while our efforts to highlight global change impacts have little effect. Other participants ask various questions, such as the role of religion as an impediment to sustainability; our real ability to make useful suggestions toward sustainability ("remedy worse than illness"); the level of sophistication we really need, particularly when it comes to talking with policy-makers; the cost-benefit analysis of the Geoscope; the issue of governance, etc. J. Schellnhuber distinguishes between information (instantaneously witness the World Trade Center explosion) and wisdom (understanding this event in depth). Sustainability science will not survive if it is not relevant and cannot derive practical application. R.W. Corell illustrates the digital divide between the North and the South. C. Jaeger is left with the question on religion. He recalls that the

Christian church has advocated against all forms of contraception, while Italy itself is far from population growth. The State of Kerala is very successful in terms of population control. Why? China shows the same success, but through dictatorial practices. A comparison of these three cases should be conducted. In some cases religion turns out to be a control factor against violence, in other situations it is the opposite. Finally he observes that politicians are not interested in risks and threats, but in opportunities.

3. Working group sessions (I)

After the opening plenary session participants split into four working groups on the following overall themes:

- Key Concepts
- Monitoring
- Policy and Management
- Implementation.

For each working group topic the organizers had asked one or two participants to give a brief presentation for opening the discussion. In addition, the working groups were given the following tasks for organizing themselves and structuring the discussions:

Charge to the Working Groups

- Each working group will select one moderator to lead the session and one rapporteur to report on the results to the plenary (max. 5 minutes).
- Discuss and finalize as far as possible answers to the following questions.
- Present the answers in one concise and short paragraph of text and/or a diagram or a maximum of 1 summary slide.
- Provide separately any additional material of interest that was generated.

Questions

1) What are **researchable questions** that might be addressed by a Sustainability Geoscope competition to be started soon?
   Examples for researchable questions:
   - Are all even numbers the sum of two primes?
   - Is there a reliable cure for cancer?
   - How can a sustainability transition work?

2) Which **existing initiatives** can be utilised to progress in the next several years with research into these questions?

3) Which **real-world actions** directed at sustainability could be studied in comparative regional studies?

3.1. Key Concepts

3.1.1. Bridging the gap between natural and social sciences

This working group was about *bridging the gap between natural and social science*. No real answer was given to the three questions charged to the working groups. Social science plays very little role so far in solving environmental problems.

3.1.2. Emergence of a global subject

(Wolfgang Lucht)

Beyond data, theory and analysis, questions of identity, intent, world views and beliefs likely play an important role in connecting sustainability science fully with the world of action in sustainable planning and management.

While global mindsets play an important role, regional analysis and action are likely the most important arena of "Global Subjects".

The phrase "Global Subject", intended to refer to an emergent global actor paralleling, for example, the historic rise of a sovereign state in a region, should be carefully studied as to its subtexts on power, potential domination, and adequacy as to other world views.

Researchable questions

- How can "soft" human data be consistently linked into models and analysis?
- How do new global collectivities respond, make things happen quickly, destabilize quickly etc.?
- How can sustainability science interact with civil society?
- What are the dangers and opportunities of global icons (images)?

3.2. Monitoring

3.2.1. Advances in (socio-economic) remote sensing

Researchable questions

- What are the spatial and temporal patterns of agriculture, particularly irrigated, and how do these contribute to global food security?
- Can regional results on social causes of unsustainable land use (e.g. deforestation) be generalised through patterns in earth observation (EO) imagery globally?
- Are there remotely-sensed patterns which can be linked to vulnerability?
- How EO mapping be used to help to define policy for freshwater resources?
- What methods do we need to develop to combine remote sensing and qualitative research approaches?
- Can EO data, particularly night-time lights, be used to disaggregate country-level socio-economic data?
- Can EO data be used to monitor both compliance with and responses to sustainable policies?
- Can EO data be used to determine where consumption is sustainable?
- What are the main factors contributing to dust in cities?

- How can spy satellite surveillance technology be applied to aid the monitoring of sustainable development?

Existing initiatives

- India as an example of practice for EO applied to sustainable development
- EU GMES
- East-West Center, Hawaii

Real world actions to be observed

- EO monitoring of agricultural transitions (e.g. Eastern Europe or China)
- EO monitoring of urban expansion
- Use of "Digital Earth / Open GIS consortium" technology for visualisation and analysis of distributed data sets.

3.2.2. Sustainable urban development and mega-cities

Cities in Eastern European transition countries

(Molly Varghese-Buchholz)

This working group was cancelled due to lack of interest among workshop participants. Nevertheless, Molly Varghese-Buchholz submitted her opening statements which she had prepared in advance.

The statements centre on the European efforts in the past years towards initiating the transition to sustainability. The Global Action Plan, Agenda 21, being a result of a long process of negotiations between the many stakeholder groups participating in the global discussion, I see this as the effort of the "anthropocene" to turn the rudder around.

Thus the statements also centre around the key actor in avoiding global environmental catastrophes or creating a sustainable world. The bottom-up approach has partly received due recognition in the Agenda 21 due to the bottom-level participation in the preparatory processes. The comprehensive policy drawn up by the EU is in accordance with this emphasis.

I would like to explain why I emphasised the bottom-up approach - which is part of the idea of strengthening the local level. Struggling to survive changes the perspective and impending global catastrophes can be immaterial to those who live from day to day - and these are half the world's population. One challenge is probably how to bring in this perspective as observation is essentially - at least to date - a top-down activity.

Transforming observation into a participatory instrument is probably achieved by strengthening the links between the scientific world and that of action research and e.g. Local Agenda activities. The emergence of new institutions or institutional structures world wide seem also to be an important requirement. This is certainly something which cannot be observed by satellite but could present a strong indicator.

- Those countries of Central and Eastern Europe (CEC) aspiring for membership to the European Union (named ‘candidate countries’) have also committed themselves to the adoption of the Acquis Communautaire”. Though there has been criticism that the compliance with current European environmental laws, for instance, would be exerting a heavy financial pressure and perhaps causing heavy social costs, the process of “Enlargement” as it is called, may also be seen as an opportunity to hasten the transition of these societies to sustainable development.

- For with the Treaty of Amsterdam a process of consultations and deliberations in the European Union on the adequate responses to the agreements of Rio in 1992 has culminated in 'sustainable development' formally being placed on the policy agenda of the Union. There has been a perceptive shift from concern for the environment to the need for an integrated approach, required to achieve the balance between economic, social and environmental concerns which only together ensures sustainability. Sustainable development has been anchored, as a recurring topic, on the Agenda of the leading institution, the Council of Ministers where it is agreed to continually review the activities and, as a result re-design the concepts behind the programmes initiated by the EU towards meeting this goal.
- The commitment to the process of Enlargement has resulted in an all-out effort to attend to the special requirements of the candidate countries, in promoting sustainable development: e.g. funding programmes in the various Directorates of the European Commission – ENV, TREN, REGIO, ITRE (Research) are explicitly formulated to support initiatives, innovation and networking in the said countries.
- A key issue on the European Agenda is assigned to role of the local level in assuring sustainable development – as rooted in the Agenda 21 itself. This is reflected in the emphasis in policy statements and resulting programmes on strengthening the local level of governance, on designing management tools which promote participation, support for networking and thus strengthening local action groups and NGO's. More recently, the White Paper on Governance encompasses the requirements on administrative structures if there are to live up to their role in assuring sustainability.
- There is a discrepancy between the urgency in the need for action and the inherent slowness of the process of effecting change in behaviour and attitudes. Change agents are acutely aware of this but no quick solutions seem to be in sight. The EU continues to place a great deal of emphasis on support for building up participatory structures. Discussions, analysis, exchanges of experience among LA 21 groups are in full swing and they receive support from the EU. The European Environmental Agency has initiated a monitoring activity based on a common set of indicators for local sustainability in urban settlements of Europe in which CEC cities are encouraged to participate.
- Beyond the policies which intend to encourage and strengthen participatory processes, disseminate 'good practice', promote energy savings, the use of rational technology and work towards achieving behavioural change, e.g. in traffic, there is also a commitment in Europe towards climate change, towards reducing and raising efficiency of production and consumption patterns (Integrated Product Policy, Eco-labelling, Urban Audit etc). Further, there is a clear commitment to "treating" the neighbour as oneself i.e. to the application of the same principles in relations with the so-called developing countries of the world. The last two policies have particular implications for the global community. The support which is being provided in enlarging Europe offers models for new relations between Europe and the "developing" community. Could this be where to proceed from creating a globally sustainable community?

3.3. Policy and Management

3.3.1. Knowledge management for the sustainability transition

As an opener P.H. Freeman presented the work of Development Ecology Information Service and its relevance to the Geoscope (see www.devecol.org).

Research questions

- How to build bridges between local and scientific knowledge?
- Inertia of the political system versus NGOs and corporations?

- What motivates politicians to change?

  Intermediate goals / mixing means and ends; Governance forms: democracies have no famines, but the distinctions are less clear if we look at malnutrition or water quality; autocratic vs. democratic

- What is the relationship between political institutions and earth system management?

  Do we want global management by a central authority backed by military power (the Bush model)? Territorial vs. sectoral institutions; regional (e.g. California) decision-makers vs. corporations; Shell has really changed its policies and operations in Nigeria; the importance of image

- Do corporations meet their public environmental commitments?

  World Business Council for Sustainable Development (WBCSD): selling the dream

- Ascertain whether big companies have the capacity to change faster than governments
- Identify world regions that are more vulnerable to global change

Real world action

- Gather empirical information to facilitate social science research for sustainability

3.3.2. Using indicators for vulnerability and sustainability

Marc Levy, Joseph Alcamo and Claudia Pahl-Wostl gave a brief introduction on current activities in the development of indicators, their respective strengths and shortcomings. The presenters agreed on the need of distinguishing the Geoscope from previous systems of indicators.

Some requirements on systems of indicators were formulated:

- Systems of indicators vary by their degree of aggregation, their specification and their influence in policy formulation.
- What is needed is the power of narrow targeted indicators but at the same time the breadth of the more aggregated indicators.
- Indicators should be in particular able to give a feedback for decision makers in terms of long term sustainability.

The discussion focused then on the following points:

- What are the needs (also by stakeholders) on indicators, what are the vision/objectives related to the choice of indicators? What kind of direction has to be taken? The panel agreed that there is no positive vision of sustainability available. However, it is possible to identify many developments which are clearly unsustainable. Therefore, some discussants proposed to focus on causes and problems.
- Another aspect, which was discussed in more detail, is the relation of a Geoscope to the existing systems of indicators. Why is Geoscope special? Possibly the linkages between data from natural sciences and socio-economic data. It remained an open question in how far data from satellites may be utilised and integrated in socio-economic data sets. Which of the existing data sets can be used in Geoscope? How can they be improved? A screening of existing systems of indicators has been proposed in order to identify leading indicators or to evaluate the data sets regarding their impact on policy decisions.

- The presenters could not agree on the question if the Geoscope should focus on few key indicators or – considering the lack of a positive vision on sustainability – to keep flexibility on the selection of indicators.

3.4. Implementation

3.4.1. Research alliances - linkages between international programmes

Brent Yarnal introduced the Human Environment Regional Observatory project (HERO, http://hero.geog.psu.edu/), involving four US universities and the USGS/EDC, and funded by NSF, NOAA and USGS. HERO is aimed at developing the infrastructure needed to monitor and understand environmental changes at regional and small local scales. This includes basic framework, facilities and equipment, and the strategy involves the development of data standards, building a Web-based network, field testing the concepts, and organising a network of researchers. Studies of vulnerability to environmental change (e.g. New Jersey shoreline to sea level rise) are underway. J. Marks asks how this would convert into operational procedures when the research interest vanishes.

J. Marks talks about the need for a global hierarchical observing strategy (GHOST), which is not only done from satellites. The present status (G3OS) addresses the Earth System, exception made of the human dimension. Those monitoring systems need to find a home outside the science budget. They are currently funded in a variety of different frameworks. The IGOS partnership is born from this concern, with the goal to improve co-ordination and coherence, avoid gaps, reduce unnecessary duplication, etc. The first IGOS themes are on Ocean and Carbon. What is missing is the human dimension. He indicates that in the Netherlands, efforts have been made to convince the government that monitoring activities should not be supported by the science budget, and that social sciences also needed monitoring. J.L. Fellous observes that human dimensions are there in IGOS themes like carbon, water or atmospheric chemistry. The real issue is that before a global observation strategy can be defined, one has to agree on the observing needs, and this is not yet the case in many respects.

P. Kabat presents an initiative on Climate and Space in the Netherlands. The problem of sea level rise and its impact on the Netherlands, the strategies and options (adaptation, mitigation) to face this risk, but also the associated opportunities, etc., are at the centre of this project. Networking of scientists is a key element to favour connectivity with the policy sector. The European Research Area idea offers a perfect framework for this kind of projects.

The discussion starts on the issue of the infrastructure needed for social sciences to play their role. J.C. Worms sees a role for his organisation in that respect. R. Dickinson wonders whether the educational infrastructure is there in order to form new people that can work across the disciplines. H. Hoff says that the problem of integration of social and economic sciences can be solved at local and regional scales, if not at global level. N. Akhtar thinks that the regional approach offers a good opportunity for scientists from developing countries, but they should not be left out of contributing to the global science agenda. S. Karlsson sees a difficulty for the social sciences to become integrated in the short term. P. Kabat objects that we don't have for this another twenty years, the time it took for the meteorologists to take into account the land surface. N. Jürgens says that the DIVERSITAS programme has many shared interests with the Geoscope.

An overall agreement is reached that the Geoscope should be conducted regionally, and that social scientists should become involved in the global partnership. J.L. Fellous expresses the view that adding IHDP to the IGOS Partnership is certainly useful, but will not solve the problem, as sitting in a Committee does not give you the power to mobilise a community without a strong infrastructure. This exists for meteorology, hardly for ocean and barely for

land. Concentrating at this stage on the infrastructure for social sciences would not make much sense.

Summary

The group concluded, based on existing initiatives, that a regional focus is most practical for Geoscope type endeavours. A minimum compatibility across regions and embeddedness in the global context is essential.

The South needs to be strongly included in both the very identification of the globally relevant questions and the implementation of data collection and research. The use of IT tools (Internet etc.) can facilitate cross-regional research links in the projects (see e.g. HEROINE).

The need was raised for thinking of the links between current endeavours and Geoscope – what can be fed into/handed over to Geoscope and when, as well as thinking of the link between Geoscope and more long-term core observational systems outside the research community. Furthermore, the links between science and policy, results and users have to be considered early.

There was a strong consensus for the immediate and long-term need for human dimensions/social science in current observation strategies. In Geoscope this is the core, but there are also more general needs for real HD-natural science integration in international programmes.

There were serious doubts raised whether this need can be filled at present – due to shortages of researchers and resources in the HD community. Measures recommended include educational efforts to "create" the integrated scientists in the younger generation and to encourage IHDP to join IGOS.

3.4.2. IGBP/IHDP Cross-cutting theme Water (1)

H. Hoff gives a rapid overview of the IGBP/IHDP cross-cutting theme "Water". Other themes are "Carbon" and "Food and Fibber". He insists that the partnership for this Water theme should be extended to policy-makers and to the private sector. P. Kabat introduces another international initiative (World Water Forum) in which he is involved, and suggests that Geoscope connects to it. N. Akhtar presents the situation in Pakistan with respect to freshwater, particularly as a result of anthropogenic impacts on river regulation (loss of ecological habitat and of biodiversity, change in fisheries), and as a consequence of climate change (drought, floods, reduction of water supply for human consumption, irrigation water shortage, food security problems, exodus, loss of nutrients supply to coastal shelf, etc.). L. Menzel describes his project called WADI (Management of Water related Disasters) on the crisis at the Horn of Africa as a result of droughts, which causes land erosion, lack of water, low harvest, with the added effects of insects, while civil wars create political instability, disseminate land mines, reduce agricultural activity, induce population exodus, refugees, etc. On top of that, climate change, geopolitical conditions (such as the consequences of 11 September), global economy, have additional impacts. Where should international help be directed?

Some questions raised in the discussion:

- Is water a public good, a human right, or a commodity?
- What price do people pay for different sorts of water (drinking, nature)?
- How much water of which quality is needed?
- Why do some water management practices work here and fail there?
- Has Geoscope to look at ethical questions?

- Is it sustainable to carry water to people living in dry regions, or should they be moved elsewhere?

J. Marks and J.L. Fellous express their perplexity with respect to this discussion. Notwithstanding the interest of these questions they had the impression that the Geoscope was rather a kind of observatory with no more than, say, thirty variables, that should absolutely be monitored. C. Jaeger notes that from this discussion one could derive a limited set, say a dozen, of standardised variables (e.g., flux of water of various quality, water price, quantity of water use for agriculture). He adds that long-term monitoring of the same physical variables is meaningful, which is not necessarily the case for social or economic parameters. J.L. Fellous says that as long as we are in research, we can afford to make whatever observations we want. If it comes to operational procedures you have to convince someone else to take over the burden, and this requires a clear definition of the variables that need be monitored. P. Kabat draws attention to the absence of universal variables in this field. The very concept of sustainability may have different meanings in the Netherlands and in Banizoumbou (a small village in Niger close to where the HAPEX-SAHEL campaign took place, with participation of NASA, CNRS, METEO-FRANCE, CNES and others). Traditional wisdom in Niger made life sustainable in this region, long before our heavy science came in.

As a conclusion C. Jaeger thinks that at this stage we mostly have to develop science and research useful for mankind.

Researchable questions

- A new creative look at the water vulnerability issue from various angles
  - Climate / biophysical
  - Social
- Water policy / management issues
  - Successes and failures
  - Underlying causes
  - Political levels: global – regional – national
- Water as a human right or as a commodity?
  - Short and long-term issues
  - Price aspects (drugs for water)
  - Movement of water at a price is likely to be unsustainable
  - Ethical questions
- Water quality – quantity changes
- Revival of common wisdom about water which has the potential of significant saving in water-related research

Existing initiatives

- There are enough, maybe more than enough, existing initiatives at global, regional and national level to which Geoscope could make a meaningful contribution:
  - IGBP/IHDP
  - IGOS
  - WWF – Global Water Dialogue
  - Major Dutch initiative (multi-partner white paper)
  - FAO/IWMI initiative on developing a programme for the systematic mapping and monitoring of irrigated agriculture on a global scale (WIAMMP)
- National level: Example of Pakistan

- Indus river regulation – damming
- Loss of ecological habitats
- Loss of biodiversity
- Food security problems – exodus of population
- Other social impacts
- Loss of nutrient supply to coastal shelf
- Reduction in fisheries

Real world actions

- What is the sustainability issue?
- Is there a sustainability option at all?
- Be aware of the element of surprise in scientific research
- Combine a limited set of key water-related variables with regional studies within Geoscope

4. First discussion of working group results

The working group rapporteurs presented a short overview of their results.

Key concepts. The first discussion was about *bridging the gap between natural and social science*. No real answer was given to the three questions charged to the working groups. Social science plays a very little role so far in solving environmental problems. The second session was on the *emergence of a global subject*. The role of world views and beliefs in connecting sustainability science with the world in action is important. Regional analysis and action are the most important arena of a global subject. The very concept of a global subject should be investigated in more depth. A first set of researchable questions has been identified.

Monitoring. Ten questions have been listed, including, e.g., spatial and temporal patterns of agriculture, particularly irrigated, and how do they contribute to food security? Are there remotely sensed patterns which can be linked to vulnerability? What methods do we need to develop to combine remote sensing and quantitative research approach? Can remote sensing be used to monitor both compliance with and response to, sustainability policies? Can EO data be used to determine where consumption is sustainable? Existing initiatives such as GMES, the Indian example, were cited. Real world applications, such as EO monitoring of agricultural transitions, of urban expansion, use of distributed data sets through GIS, are already operational. The second session on mega-cities was cancelled, due to lack of participants.

Policy and management. The first session was on *knowledge management for the sustainability transition*. Questions such as central global management under military authority versus decentralised regional management were discussed. Researchable questions look at vulnerabilities, identifying more vulnerable regions, "surprising surprises", identifying issues before they become "explosive", etc. The second session was on *using indicators for vulnerability and sustainability*. Researchable questions concern the requirements on systems of indicators, the needs of stakeholders related to indicators, the relationship between Geoscope and existing systems of indicators (e.g. satellite data), the evaluation of data with respect to their impact on policy decisions.

Implementation. The first session was on *research alliances and the linkages between international projects*. The discussion turned around the various interfaces (regional/global, north/south, research/observation, short/long term, science/policy, supply/social demand). The conclusions were on the regional focus, and the necessary inclusion of the south in the identification of globally relevant questions. Links between Geoscope and long-term observational systems should be thought of soon enough. Inclusion of social science into

international programmes is urgently needed. Educational efforts should be amplified for the formation of integrative scientists. The second session was on *Water*. A number of researchable questions were agreed upon: look at the water vulnerability issue from various angles; causes of water policies and management successes or (more frequently) failures; water as a human right or a commodity; price aspects of water (in some regions, trading water against drugs); reviving traditional wisdom about water in the world. Quite a lot of water-related activities are going on. A key question is whether there is really a sustainability issue? Or is it a dream?

Plenary Discussion

The discussion moderator W. Lucht introduced the idea of a Geoscope competition, offering rather symbolic prizes, like a Polish goose, a keg of Cretan olive oil, or a bottle of champagne, and, in some cases, possibly some thousand Euros. The challenge is on identifying regional activities that are affecting sustainability and are contributing to the construction of a Geoscope.

A. Alexiou gives his first thoughts. He reports on the interesting discussion in the implementation group on water, and has the view that he is not sure that the workshop is really converging on the charge it has been given, after the comments by J. Marks and J.L. Fellous that instead of putting forward endless lists of research questions, we should restrict to a small number of observation variables. M. Levy finds the Geoscope an interesting topic, but sees that at some point someone has to make a choice, which is not yet clear, whether it should look at the global Earth system, making intensive use of remote sensing or looking at human societies, as regional systems, and making little use of remote sensing and more use of more classical methods. J. Marks speaks in the same line as A. Alexiou did. J.L. Fellous says that Geoscope provides an impressive, timely, brilliant concept for something which is happening at various levels (e.g. the pragmatic French-style Space and Society, the European-style GMES, the space agencies-led IGOS, the German-style conceptual framework Geoscope). These are parallel initiatives but converging in many ways: networking, collaboration, transition from research to operational, etc. Other participants talk about various issues: *a Geoscope (among others)* vs. *the Geoscope (unique)*, regional/global focus, fragmentation of social sciences, short/long term perspective, the close relationship between studies on sustainability and vulnerability. C. Jaeger concludes that in terms of researchable questions, there are a lot of relevant ones on the table. As far as existing initiatives are concerned, there is both positive competition and collaboration. The less advanced issue is related to real world actions (example on the relationship between current conflicts in the Afghanistan region and options for oil pipelining from the region). Comparative studies should be made of such options. P. Kabat advocates in the same direction, starting from a small number of regional case studies and evolving to a small number to monitoring requirements.

5. Working group sessions (II)

5.1. Key concepts

5.1.1. Anthropogenic factors, institutions, syndromes

Summary

- Regimes
  - Economic growth
  - Redistribution / development
  - Environmental protection

- Reform
  - Integration vs. Opposition
  - WTO paradigm for environmental regimes?
  - Strengthening environmental regimes
    a) 5 clusters syndrome related
       (nature, climate, water pollution, hazardous substances, extractive resources)
    b) World Environmental Organisation (WEO)
       - Science assessment
       - Monitoring
       - Implementation reviews
       - Transparency and participation

5.1.2. Advances in economic theory and modelling

C. Kemfert introduced the economic model and database developed by the Global Trade Analysis Project (GTAP, http://www.gtap.agecon.purdue.edu/). GTAP has established a commonly used database and a global research community around the Applied General Equilibrium modelling approach. This initiative could serve as an example on how to establish a Geoscope research community and infrastructure. The GTAP experience also shows how important it is to maintain openness, flexibility and innovative power while creating a new research infrastructure.

Summary

The impact of humankind on the natural environment has never been greater. An important aspect is climatic change, because its impact is so pervasive, its effects are so long-term, and a solution in the form of substantial greenhouse gas emission reduction is still far away.

The Sustainability Geoscope opens a platform and a discussion forum for interdisciplinary research. From an economic perspective, an integrated approach and assessment of linkages between economics and the environment is the main challenge of the Sustainability Geoscope. Generally, more economics should be fed into natural science models and vice versa. Agriculture could serve as an important link.

Currently the Geoscope is not focused on the business world. Could it evolve into a decision-support tool, especially related to "corporate citizenship"? Should there be various Geoscopes, e.g. for science, politics, industry, society?

The Geoscope should be seen as a process to build bridges between economics and the natural sciences. In this respect, modelling efforts which integrate the economy and the biosphere could be very useful.

Research questions

1) Economic transition path towards more equity
   Because of an inequitable allocation and distribution of natural resources which determines largely the economic welfare, an investigation of economic impacts towards a more equitable allocation of resources and welfare seems to be necessary. "Development" as a means to achieve equity has to be redefined in a broader sense.
2) Investigation of economic impacts of sustainable life styles
   Life styles influence considerably the impacts on the environment. The consumption of energy seems to represent the key and dominant driving factor, as one example mobility significantly determines life styles. In the other direction, the environment also has an impact on possible

life styles. The analysis has to comprise both directions and should qualitative and normative aspects into account.

3) Economic impacts of innovation and induced technological change
In order to reach a sustainable development, concrete climate policy measures could be a first step to realise a drastic reduction of anthropogenic greenhouse gas emissions. A sustainable economic growth path could be reached by policy measures which endeavour a reduction of emissions. Policy measures ideally give an incentive to diminish emissions by less carbon intensive and more energy effective technologies. Induced technological change can be accomplished by research and development investments that foster energy efficient technologies. Besides the more general description of technical change and economic growth and their evolutionary theories of technological change, one important part should deal with endogenous technological change and the potential for technological innovation. Moreover, the perspective of engineers and related private companies as key actors in innovation should be integrated in a truly interdisciplinary analysis.

5.2. Monitoring

5.2.1. Observing the global diffusion of technologies and lifestyles

Klaus Jakob reviewed results of a study on diffusion of environmental policies in Europe since 1960. There is an interaction between environmental policy innovation and technological innovation.

Some important issues:

- Weak vs. strong institutions
- Markets and subsidies
- Capacity of institutions
- Conflicts with other policies
- Role of NGOs, e.g. the green movements, citizen pressure and involvement

Research questions

- What are preconditions for policy adoption and innovation?
  Idea: Study experience of North to discover relevance for the South
- What differences exist among world regions in environmental policy?
- How can we monitor impacts of environmental policies?
  Problems and challenges: time lag, specific regional circumstances

5.2.2. Regional sampling and comparative case studies

Human dimension bio-physically – Socio-economic metabolism and land use

(*Overhead slides by Marina Fischer-Kowalski*)

- Link to Geoscope vision
  - Next generation theories of sustainable economies and societies
  - Integrating the human dimension: bio-physical system perspective on economies/societies
  - Long time series observations / data
  - Link satellite remote sensing with on-the-ground statistical data
- Key bio-physical features of human economies

  - Dynamics of socio-economic energy metabolism, related to population and economic welfare
  - Dynamics of socio-economic materials metabolism: biomass, minerals, water, carbon
  - Land use patterns: human appropriation of NPP, built infrastructures

- Feasibility / acceptability / research links
  - Economy-wide material flow accounts available for EU-15, US, Japan and an increasing number of developing countries (Eurostat guidelines 2000)
  - New SCOPE-project: MFAStorM
  - IHDP: Two core projects (in IT and LUCC): TRANSITIONS (historic and contemporary change in material and energy flows) and LAND-USE CHANGE

- SCOPE: Material flow analysis for sustainable resource management – MFAStorM
  - Core question: Material flow analysis (MFA) on a regional and national level is a growing research field of increasing relevance to policy. MFA serves as a system-wide diagnostic procedure related to environmental problems, supports the planning of adequate management measures and provides for monitoring the efficacy of those measures
  - Team: Stefan Bringezu, 9 international partners

- IHDP: Transitions from agrarian to an industrial model of subsistence
  - How does systemic change in society-environment relations occur and what processes shape the relation between socio-economic activity and the natural environment?

  Case studies
  - Historical case studies (1800-2000): Europe (UK, Russia, France, Australia) and USA
  - Contemporary case studies: Amazonia (Brazil, Venezuela, Columbia, Bolivia) and Southeast Asia (Philippines, Laos, Vietnam, Thailand, Nicobar Islands)
  - Team: Marina Fischer-Kowalski, Team Social Ecology, 10 European, 6 Asian, 4 Amazonian partners

- IHDP: Land use change and socio-economic metabolism

  Case studies
  - Modelling the interrelations between biomass metabolism and land use in Austria 1949-2020
  - The impact of HANPP on biodiversity
  - Historical micro-studies of socio-economic metabolism, land use, HANPP, human impact on nitrogen flows, institutional and population dynamics and their relation to sustainable development
  - Long-term changes in socio-economic carbon metabolism and land use induced changes in carbon stocks in terrestrial ecosystems
  - Long-term changes in energy metabolism, land use and environmental impact in the UK, Russia, France, Austria, and the USA
  - Team: Helmut Haberl, Team Social Ecology, 10 international partners

- Information value: examples
  - Last two decades: stagnating energy and material consumption in core industrial countries, energy and material intensity declining. But: High and rising material intensity in developing countries (physical trade balances)
  - Medium term: relief on terrestrial ecosystems (HANPP and carbon storage) despite of increasing biomass metabolism

- Why striving for global rather than case study information?
  - Globalisation: interdependencies of socio-economic material and energy flows worldwide (trade, investments)

- Availability of satellite data and national statistics
- Need for consistent input-output modelling on various scales

LUCC case studies – two approaches

(Helmut Geist)

- New comparative case studies using standard protocols
- Synthesis review of existing case studies
- For more information on LUCC see http://www.geo.ucl.ac.be/LUCC/ .

Researchable questions

- What are fundamental processes uncovered by case studies?
- What do case studies tell us about carrying capacity?
- What do case studies tell us about possible trajectories?
- What are commonalities and differences among case studies?
- How does one translate cases into generalities?
- Does globalisation mean that regional case studies are invalid?

Existing initiatives

Many to choose from

- IHDP LUCC
- HERO, GCLP
- Institutional response to climate variation

Real world actions

- Recommendation: A new generation of case studies that compare stressed vs. unstressed, "sustainable" vs. "unsustainable", developing vs. developed, less-constrained vs. constrained (by infrastructure, economic, law/regulations, culture, biophysical environments). These case studies must include linkages between region and rest of the world.
- Map and choose, based on issues important to sustainability, e.g. water stress, transboundary issues, climatic sensitivity, green house gas emissions/mitigation

5.3. Stakeholder Dialogue

5.3.1. Managing climatic risks: Improving the knowledge base

5.3.2. Managing climatic risks: What are the opportunities?

Danish perceptions of surprises and extreme events in the greenhouse

(Jes Fenger)

Denmark is a small, fairly flat country to a large extent composed of islands and consequently with a relative long coast.

World map with vegetation zones

It is situated around 55° North, the same as e.g. Labrador, but the temperature is about 20°C higher in the winter and 10 in the summer. We therefore have temperate forests, where you might expect tundra. All know that this is due to a combination of the warm North Atlantic Current and predominantly westerly winds.

"Poeten og Lillemor"

Nevertheless, we would prefer it to be slightly warmer. What the increased greenhouse effect can offer us in the course of the next 100 years may correspond to what you have now in Heidelberg. My daughter lives there and it is quite attractive. If we could afford to look at Denmark in isolation, a moderate global heating will - in some respects – be beneficial in terms of increased agricultural potential, reduced energy demand and increased tourism from less fortunate regions. It is of course by no means an argument against reducing carbon dioxide emissions. But it is practical to know.

Greenhouse book II

We wrote so much in a national report a few years ago, and it was not favourably received.

Review from "Ingeniøren"

In fact we were publicly accused of being dull and uninspiring, de-dramatising the problems. Not far from betraying the noble course etc. This is where a possible change in the "Golf Stream" comes in handy. To my knowledge no simulations indicate more than a weakening or displacement within the next 100 years. The result is a lower warming in Denmark, but no direct cooling. What happens later is more uncertain.

Denmark in 1000 years

Another horror scenario is the rising sea. This is how Denmark may look 1000 years from now. As shown in a newspaper article after a recent COP meeting. Let me not expose anybody, but there is a tendency among some politicians and NGOs to cultivate catastrophe theories in order to justify expensive mitigation policies. Fair enough, because we cannot exclude such scenarios, and they could definitely be inconvenient, but they cannot be used in any *adaptation* policy. Because we do not know the world hundreds of years ahead. Therefore, the tactic is dangerous - for two reasons: It provokes some persons and interest groups to claim that the problems are generally exaggerated – or even non-existent.

Lomborg's book

A younger statistician Bjørn Lomborg who claims to know "The truth about the environment" is a very successful Danish example - in his own special way. More serious is the fact that the attention may be diverted from some well-established, more imminent and far more probable problems that we are facing. All over the world there will be *some* changes that we must adapt to, and we have a Danish proverb saying something like: "You can drown in a lake that is half a meter deep - on the average". What we need is therefore estimates of the probability and extent of extreme events within an undramatic scenario.

Ørestad

To give a single example: You can with marginal costs protect near-coast and low-lying infrastructure against a sea level rise of 50 cm. This is e.g. done in the planning of the new town district "Ørestad" at Amager near Copenhagen. It is much more expensive to safeguard against a flood that may only happen every 100 years.

Wadden Sea birds

Even if you can afford it, in some cases you may be reluctant to do so. A crucial problem in Danish coastal protection is the controversy between protection of agricultural land and the

development of a natural coastline with unique ecosystems. Here it is the current Danish attitude to choose the softest possible solution.

Computer at DMI

If may be nice with a few degrees higher temperatures in Denmark, but only if there is sufficient water. It is not enough to know the yearly precipitation to determine the resources. We must also know the time pattern and the intensity of the showers. All this requires regional models with high resolution and is a current challenge for our climate modellers. I have promised to conclude by saying that they can always use larger computers.

Sustainable building and dwelling in Schleswig-Holstein

Scenarios for a possible development until the year of 2020

(Klaus-Dietrich Sturm)

Introduction

The project ”Sustainable building and dwelling in Schleswig-Holstein“ follows the experts´ report ”Effects of the demographic, social and cultural changes in Schleswig-Holstein on the environment until 2010“ which has been elaborated by Öko-Institut (Institute for Applied Ecology) in 1996 on behalf of the ministry of the environment in Kiel. On the basis of the socio-structural trends for the domains of dwelling, mobility, recreation and nutrition the experts have estimated the environmental consumption to be expected and made proposals how environmental pollution could be avoided or reduced.

The domain of building and dwelling has proven especially important for environmental policies. The production and transportation of building material, the construction and the utilisation of buildings result in the consumption of raw materials and energy, the pollution of air and water, the generation of noise and waste, the sealing and the utilisation of ground. In addition, the building branch has suffered from a high rate of unemployment and social insecurity over the last few years.

In view of the outstanding significance of the field of action ”building and dwelling“ for a sustainable development, the ministry of environment, nature and forestry of Schleswig-Holstein asked Öko-Institut in 1999 to carry out the project ”Sustainable building and dwelling in Schleswig-Holstein“.

Combining new and well-proven elements

The commissions of enquiry of the 12th and 13th German Bundestag ”Protection of people and environment“ (1994 and 1998) already laid the foundation for a sustainability strategy in the field of building and dwelling. In 1998 Öko-Institut successfully carried out the project ”Material flow related components for a national concept of a sustainable development“ on behalf of the federal ministry of the environment. For the first time detailed and extensive analyses of material flows for the whole domain of building and dwelling have been carried out. This resulted in a reliable data basis on the federal level as well as an adequate method and a software tool (BASiS = demand-oriented analysis tool for material flows in scenarios) for the calculation of scenarios in the domain of building and dwelling.

Involving actors at an early stage - overcoming barriers

Right from the beginning the ministry of the environment attached great importance to the fact that the actors concerned (house building societies, building branch, investment bank, tenants' association, environmental associations, chamber of architects and engineers of Schleswig-Holstein, working group for contemporary building and the ministry of internal affairs as the highest authority for housing and urban development in Schleswig-Holstein) were involved into the project. This is an important condition for the cooperative elaboration

of a strategy of sustainability. Normally, the communication barriers between the individual sectors of politics, economy, administration and science lead to knowledge being produced and processed in a highly selective way within each sector.

In the first stage the actors got acquainted with the aims and the methods of the project. The direct contact with the various actors enabled the persons in charge to adapt national data to the specific situation in Schleswig-Holstein. This provided a base of data adjusted to the real situation (year of base 1998) that could be integrated into the model of material flow BASiS.

In order to be able to recognize long-term developments and future environmental problems as early as possible and to find solutions, scenarios had to be developed and the complete network of consequences has to be revealed for fundamental political decisions. During the second project phase the close cooperation with the actors resulted in two scenario assumptions for building and dwelling in Schleswig-Holstein until 2020.

The ”reference scenario“ assumes that the current trend will continue until 2020. Thus, efficiency will only be enhanced in accordance with the rates achieved so far. Therefore, sustainability of building and dwelling plays a limited role. By contrast, the ”sustainability scenario“ proposes a change of trend until 2020, i.e. considerable savings of energy and material will be reached in the domain of building and dwelling, renewable raw material will be used increasingly and less old buildings will be pulled down. These two scenario assumptions cover the following areas:

- creation of dwelling units
- reduction/consolidation of old dwelling units
- content of building material for new buildings (massive construction)
- proportion of one-casing/two-casing brickwork (new buildings)
- proportion of timber construction in new detached and semi-detached buildings
- proportion of cellars in new buildings
- proportion of low-energy constructions of new buildings
- proportion of zero-emission houses
- re-insulation of existing buildings
- proportion of biomass energy sources for heating
- proportion of solar energy used for hot-water heating systems
- recycling of concrete

The following two examples will explain the procedure:

In the case of timber construction, the reference scenario assumes a constant proportion according to the current level (10-15%). After some lively and controversial discussions the actors involved in the second project workshop, however, agreed on a doubled proportion of timber construction of 20-30% until 2020.

While the reference scenario proceeds from an increase of 5% until 2020 insofar as zero-emission houses are concerned, the sustainability scenario took an increase of 30% until 2020 as a basis.

During the third project phase the sustainability potentials revealed by the scenario technique were elucidated. Based on the results of the scenario calculations (which differ considerably) the workshop and the actors identified options for action and elaborated priorities for a future-oriented environmental policy. This was followed by a discussion about possible and necessary measures for a lasting way of building and dwelling in Schleswig-Holstein.

Results and conclusions

The reference scenario assumes that 22% more gross area will be required for building and dwelling until 2020 whereas the sustainability scenario assumes an amount of 16%.

According to both scenarios the need of concrete and brickwork material will clearly decrease due to the reduction of new building activities. As has been revealed by the reference scenario the annual amount of rubble from building sites will double from 2005 on, whereas the sustainability scenario assumes that the current amount will remain nearly constant.

The careful treatment of resources mentioned in the sustainability scenario (prevention of demolition, increased recycling of concrete) will lead to a saving of sand and gravel until 2020 which amounts to the total demand of more than two years in Schleswig-Holstein.

According to the reference scenario, the total emission of carbon dioxide produced by the domain of dwelling between 1998 and 2020 will decrease from 8.4 million tons to 5.8 million tons or, according to the sustainability scenario to 4.2 million tons.

Above all, the reduced emission of carbon dioxide can be explained by the improved thermal insulation standard of buildings (reference scenario: minus 1.8 million tons a year; sustainability scenario: minus 3.2 million tons a year). Thus, the thermal refurbishment of existing buildings involves the greatest possible saving potential of carbon dioxide.

The domain of building and dwelling is an important component for the project ”Future-oriented Schleswig-Holstein“. Here, the refurbishment of old buildings (in the cities) plays a special role. This equally holds for ecology (climate protection, soil protection, careful treatment of resources, avoidance of traffic) and with respect to economic and employment-related objectives.

Measures implemented so far/new focal points

The growing utilization of ground (also in case of the sustainability scenario) is a major challenge for politics. In order to reduce the utilisation of ground in the domain of dwelling and building, attractive alternatives to detached houses have to be developed. For this purpose, the government of Schleswig-Holstein is supporting ownership of homes in city centres.

For several years now, the building policy of Schleswig-Holstein has focused on the reduced consumption of resources. One example is the residence ”Klosterforst“ in Itzehoe. Within the framework of a conversion project, the concrete of barracks was recycled and processed on the spot for direct use.

From the legal point of view the amended building regulations of Schleswig-Holstein placed the timber construction onto the same level as the massive construction. This is an important component of an ecological and resource-saving way of building.

Refurbishment and modernisation will remain priority aims of the government of Schleswig-Holstein. This will allow the greatest possible reduction of carbon dioxide emissions. Government supports financially housing societies intending to modernise their flats to the largest possible extent.

The programme ”Thermal refurbishment of buildings“ has resulted in that workmen, planners and investors are acting with more environmental awareness. Moreover, the low-energy standard in the supported domain of new buildings has already lead to considerable savings of energy.

Due to the application of the carbon dioxide reduction programme of the Kreditanstalt für Wiederaufbau (credit bank for reconstruction), 12,000 flats were modernised between 1996 and 1999, not only for climate protection but also to the benefit of carpenters, joiners, roofers, painters and sanitary companies.

The project report „Sustainable building and dwelling in Schleswig-Holstein“ is available free of charge.

Climate Change – Managing the risk

(*Overhead slides by Davide Egilson*)

- Basis for Action
  - In light of new evidence and taking into account the remaining uncertainties, most of the observed warming over the last 50 years is likely to have been due to increase in greenhouse gas concentrations.
  - Furthermore, it is likely that the 20th century warming has contributed significantly to the observed sea rise through thermal expansion of sea water and widespread loss of land ice. Within present uncertainties, observations and models are both consistent with lack of significant acceleration of sea level rise during 20th century.
- Possible Hierarchy of Action
  - Globally: International law, general commitment (UNCLOS, Climate change, ozone and organo-halogens); Generally agreed principles (soft law, including guiding principles for donor countries and funding institutions); Global institutions (Regulations, guiding principles for emissions, monitoring, and selected action)
  - Regionally: Cooperation on monitoring and actions; Decisions and recommendations
  - Nationally: Laws, regulations and directives, economic incentives, education enforcement of national laws plus international and regional decisions and recommendations, monitoring and action
- Level of action
  - In general, decisions should be taken at the lowest decision-level possible where the gain of reducing pollution has strongest effects on the actors themselves
- Comparison of voluntary and legal global instruments
- The importance of coherent approaches
- A layout of an action plan
  - All actions must have independent monitoring mechanisms to assess the efficiency of the actions taken. The willingness to pursue actions is dependent on the credibility of the monitoring and assessment mechanism.
- Management options necessary to address environmental contaminants
  - Education
  - Technical solutions
  - Regulations
  - Economic measures
  - Monitoring
- On the use of available instruments
- Examples of preventive measures – role of different players
  - Public: education, better habits, pushing the government and the industry
  - Government: Laws, regulations and directives; education; international cooperation; economic measures
  - Industry: education, better habits, voluntary agreements, technical solutions (clean technology)

- Major options relating to policy instruments on climate change
  - Technology standards
  - Taxes on GHG emissions
  - Subsidies and other rewards on GHG abatement
  - Quantitative limits on each nation's emissions
  - Quantitative national limit, with a market in tradable GHG emission allowances
- What is the risk?
  - Speed of change: ice cores reveal history of quick warming and long periods of cooling down – how relates this to anthropogenic effects?
  - Local effects: where will change take place?
  - Global effects: stronger winds, higher sea level, will effects appear contemporarily or at different phase at different locations
- Anthropogenic climate change
  - Global warming
  - Sea level rise
  - Changing winds
  - Changing ocean currents
- What drives the Atlantic inflow to the Nordic Seas?
  - The Atlantic inflow mainly comes to replace the water carried out by the deep overflow which is driven by cooling and sinking of water up north
  - Anthropogenic climate change is expected to reduce cooling and sinking of water and hence the deep overflow
- The specific circumstances of the North Atlantic
  - The main risk factors relating to irreversible changes:
  - Manageable consequences: sea level rise to a certain extent, higher temperature on land, stronger winds
  - Unmanageable consequences: abrupt changes in ocean currents – hence: conditions of ecosystems, fisheries etc.
- The basic elements in sustainable resource management
  - To attain sustainable resource management, long-term objectives must be set on the basis of the precautionary approach, including the following common elements:
  - Adequate legal base, including enforcement and penalty mechanisms
  - Scientific understanding through research of the ecosystem and its variability
  - Integration of policies
  - Effective monitoring mechanisms
  - Involvement of stakeholders, indigenous and local people
  - Education and training
  - Economic incentives and global market conditions
- Summing up
  - Coherent and integrated action where all stakeholders are involved, is essential. The tools can be different, but the action is best performed in an integrated manner. In order to assess the success of any action, monitoring is needed.
  - Attitude of people matters often more than technology. Therefore education in the broadest sense of the word is needed.
  - It is essential to have some kind of independent monitoring mechanism in this approach so scientists, legislators, politicians can be ascertained that they are moving in the right direction

- Synopsis
  - Present day atmospheric burden of carbon dioxide and methane seems to be unprecedented during the past 420 years.
  - An anthropogenic climate change may already have had large effects on North Atlantic ecosystems.
  - Without restrictions on emissions, the effects are likely to increase.
  - Anthropogenic climate change is not regulated today.

Summary of the working group discussion

(*Wolfgang Cramer*)

- Gradual change may cause abrupt effects
  - Example of the North Atlantic circulation
  - Is the uncertainty still too high for the stakeholders?
- The Danish National Assessment
  - How to consider the positive impacts without being considered a climate sceptic?
  - Adaptation, e.g. in urban planning, happens today
- The UK Climate Change Impacts Programme
  - Scenario improvement and multiple sectoral studies
- Are stakeholders ready to act?
  - Yes, concern exists
  - No, the monitoring is still grossly inappropriate
  - Well, but the social and economic costs are still unknown (and probably underestimated)
- What about the Geoscope?
  - A conceptual base for understanding, observing and action?

5.4. Implementation

5.4.1. IGBP/IHDP Cross-cutting theme Water (II)

Water Global Availability Project (Water GAP)

(Joseph Alcamo)

J. Alcamo gives a presentation of the project Water GAP (Global Availability Project, http://www.usf.uni-kassel.de/usf/forschung/projekte/watergap.en.htm) aimed at evaluating the world water situation. For instance, water availability and withdrawal have been mapped and can be compared in various regions. Water stress maps are derived. Changes in withdrawal and availability between present and 2025 are also predicted, based on model analysis. Critical regions are defined according to different scenarios.

J.L. Fellous expresses some surprise at the north of France, recently severely flooded, being under water stress, according to the results shown, and asks about the spatial resolution of this kind of work. P. Kabat repeats the same question on the temporal resolution, and asks how the results would be modified if climate variability was introduced. H. Hoff continues on the issue of flooding.

Towards Sustainability: Transformation Processes in the Water Sector

(Claudia Pahl-Wostl)

Current regimes of resources management are often highly unsustainable judged by ecological, economic and social criteria. Many technological resource management regimes are inflexible and not built to adapt to changes in environmental conditions. This poses problems in a world characterized by fast change. The water sector is currently undergoing major processes of transformation. Today's situation is characterized by uncertainties e.g. in water demand, by increased environmental awareness, by pressure toward cost-efficient solutions, and by fast changing socio-economic boundary conditions. Due to climate change one expects a shift in the distribution pattern of extreme events. Hence, new strategies and institutional arrangements are required to cope with risk and change in general. When one considers processes of transformation and change, the human dimension is of particular importance. One needs to give more attention to human aspects rather than focusing on technological solutions. Resistance to change resides in institutions and rule systems. In this talk we will explore new approaches in agent based modelling and in linking analytical modelling and participatory approaches, the elicitation of mental models, as promising new developments to explore changes towards sustainability and the required transformations in technological regimes and institutional settings.

There is also an IHDP project on industrial transformation impacts on the water sector, concentrating on a limited number of cities in Europe, USA, China, etc., and which could be part of the Geoscope competition. The concept of "ecocities" is looked at through such studies.

M. Fischer-Kowalski draws attention to the importance of cooling water (for small industry as well as power plant purposes), which may be a strong limiting factor for regional development in many places, in competition with other water usage. In terms of real world actions, questions are raised with respect to dam construction, sustainability of dams (example in Pakistan of a dam swamped by sedimentation, so that a 35 m higher dam will be built over the present dam, resulting into submersion of 500 villages etc.), water management organisation and floods. However, there is already a lot of studies going on in these areas, and one would have to dig very deep to identify global variables that could be accessible to a Geoscope. P. Kabat thinks that there may be already too many on-going initiatives on water, and the Geoscope flag has to be very clear, if it is to add any value. He suggests a comparative study of a small number of specific cases concentrating on "hot spots" (How to select those? Sites where studies are going on now? Sites where we have past knowledge? Potential hot spots?). The output would be a better understanding of what are the real water issues. J.L. Fellous recalls the need to interact with the IGWCO Theme proposal, which is going to be submitted to the IGOS Partnership in early November. P. Kabat and H. Hoff insist that it is absolutely essential to provide a short note to the IGWCO promoters within two weeks, otherwise the chance for the social sciences to be part of the game will be lost. The session closes with these two conclusions: hot spots, link with IGOS.

Summary

- What are comparable measures of water stress across all regions that can be validated?
  - Water related diseases and mortality
  - Large scale seasonal variation

The working group agreed to write a position paper to include human dimensions in IGOS water theme

- Comparative case studies
  - Rural areas and mega-cities

- Current and potentially critical regions (hot spots)

The working group agreed to draft a list of case study areas

5.4.2. Geoscope pilot themes: lifestyles, food, biodiversity, etc.

S. Karlsson addressed the North-South knowledge divide. She stresses the role of field education. D. Krömker described her work using so-called "security diagrams" where top down statistics and bottom up data collection are mixed (http://www.usf.uni-kassel.de/secdiag/). Such projects' expectation from a Geoscope include data collection protocols, methodologies, in other words, playing the role of a clearinghouse. W. Lucht states that from his perspective water will be the first issue to demonstrate the value of a Geoscope, the second one being mega-cities, and the third one the relevance of remote sensing data for social sciences. P. Freeman (USA) asks the question: if I see sustainability, would I recognise it? A pilot theme could be to identify "success stories" of sustainability in the present world. M. Varghese-Buchholz explains what is going on with the concept of mega-cities in Europe. In connection with mega-cities and remote sensing data for social sciences, J.L. Fellous informs the group on the CNES policy of providing SPOT imagery at low cost to European scientists for GMES-related studies. Obviously Geoscope might be eligible for this.

6. Final plenary discussion: Long-term vision and short-term steps

C. Jaeger is the moderator for this last session, where brief reports from the working groups are being presented, some common views are being shared, and some next steps are being defined.

Key concepts. The discussions in the first session roamed around two presentations on *Anthropogenic factors and institutions*. Humans are the drivers, and should be placed at the centre. What are the key variables? Geoscope is not just another monitoring programme. New types of socio-economic data need be acquired. Different schools of thought are welcome. Attitudes and belief in the context of sustainability are among the parameters of interest. Linking Geoscope with existing institutions was discussed at length. In all cases initial steps have to be defined. The second session on *Advances in economic theory and modelling* had little participation. More economists should be brought into the debate. Given the diversity of information users a crucial question was raised: do we need several Geoscopes?

Monitoring. The first session was on *Observing the global diffusion of technologies and lifestyles*. It concentrated on the diffusion of environmental policies, and touched upon such issues as the preconditions for policy adoption, innovation, relevance to the South, differences between world regions in environmental policy, monitoring policy impact, extrapolating future technologies resulting from new environmental policies, etc. The second session discussed *Regional sampling and comparative case studies*. A presentation was made of an IHDP project on Transition from Agrarian to Industrial modes, which shows stagnation of energy and material intensity in developed countries, high and rising intensity in developing countries, where the former countries export their pollution. Some LUCC case studies were also presented. Some researchable questions remain, relating mostly to translating regional case studies into a global context. A new generation of case studies in contrasted situations (e.g. stressed vs. unstressed, developing vs. developed, etc.) is needed.

Policy and management. The first session was on *Managing climatic risks: Improving the knowledge base*, the second on *What are the opportunities*. Gradual change may cause abrupt effects (example of the North Atlantic circulation). Low probability/high risk scenarios are not considered enough, and something can be learnt from the engineering community. The uncertainty may however still be too high for the stakeholders. The Danish national assessment provides an interesting case where there are winners in climate change, and

shows that adaptation is already taking place (e.g. in urban planning in coastal areas).The UK Climate Change Impacts programme is aimed at scenario improvement and multiple sectoral studies. A question is: are the stakeholders ready to act? Yes, as concerns exist in the public; no, because monitoring is still grossly inappropriate. Geoscope may be the "Mother of monitoring programmes", because social and economic costs are still unknown and certainly underestimated. The final working group statement is that Geoscope should be a conceptual base for observing and action.

Implementation. The first session was the continuation of *the Cross-cutting theme Water*. Presentations showed that even if water stress studies should focus on regional aspects, a global perspective is necessary. Water management issues were also discussed, as well as other water stress causes (dams, etc.). A position paper will be prepared in view of the upcoming IGOS Partnership meeting. Comparative studies of hot spots (rural areas, mega-cities) will be undertaken. The second session investigated *Geoscope Pilot themes: lifestyles, food, biodiversity, etc.* An IHDP presentation on the knowledge divide was given, which inspired three research tasks: comparative studies; combining top-down and bottom-up approaches; recognition of sustainability. Geoscope should serve as a communication platform for methodologies, data, and the like.

Plenary discussion

C. Jaeger opens the discussion by inviting short reactions from some participants. B. Kasemir urges participants to pay more attention to observing concrete variables in future discussions. M. Fisher-Kowalski discusses the key questions that need further investigation and suggests that next steps should lead to concrete suggestions after this open exercise. J. Schwartzkopf found the meeting very stimulating and opening new research avenues. M. Varghese-Buchholz expresses her conviction that the mega-cities are a very relevant theme, and a concern on the northern dominance. H. Hoff is happy to see the support to this young initiative, and that water is selected as one of the initial pathfinder themes of Geoscope. J. Alcamo congratulates the organizers from PIK for their visionary idea, and encourages some thinking on who will be the users of the Geoscope information. Strengths of the Geoscope idea are the vision of a global monitoring system which integrates natural sciences and social sciences, and the objective to merge regional case studies with a global perspective.

C. Jaeger closed the meeting with thanks to all participants and organisers, a few thoughts on how complex the question posed by the Geoscope idea is, and possible next steps. Some of the next steps resulting from this workshop may be the following:

- More precise definition of "water" as a Geoscope path finding theme
- Establishment of a Geoscope as an "inter-acronym platform" between the large international programmes (IHDP, IGBP, WCRP, DIVERSITAS)
- Definition of a small set of global Geoscope variables
- Launch of a Geoscope competition for comparative regional case studies.

7. Programme

Thursday, 25 October 2001					
12:00	*Start*				
12:00 – 13:30	Business Buffet				
Room	LA-Café IV				
13:30 – 15:30	Welcome: An Invitation to the Sustainability Geoscope (*Prof. C. Jaeger*) **Key Challenges on the Way towards Earth System Management** (*Prof. H.-J. Schellnhuber*) **Sustainability Science and Technology: Learning by Doing** (*Dr. R.W. Corell*) ***Discussion (Moderator: H. Lotze-Campen)***				Plenary Session
Room	"Köpenick I/II"				
15:30 – 16:00	*Coffee Break*				
16:00 – 17:30	**Key Concepts** Bridging the gaps between natural and social science (*Rotmans, Renn*)	**Monitoring** Advances in (socio-economic) remote sensing (*Hielkema, Muller*)	**Policy and Management** Knowledge management for the sustainability transition (*Freeman, Jakob*)	**Implemen-tation** Research alliances – linkages between international projects (*Kabat, Marks, Yarnal*)	Working Groups
Room	*"Schinkel II"*	*"Schinkel III"*	*"Köpenick I/II"*	*"Zille"*	
17:30 – 18:00	*Coffee Break*				

Thursday, 25 October 2001					
18:00 – 19:30	**Key Concepts** Emergence of a global subject *(Lucht*)	**Monitoring** Sustainable urban development and mega-cities (*Varghese-Buchholz*)	**Policy and Management** Using indicators for vulnerability and sustainability (*Levy, Pahl-Wostl*)	**Implemen-tation** IGBP/IHDP Cross-cutting theme Water (I) (*Hoff, Kabat, Akhtar, Menzel*)	Working Groups
Room	*"Schinkel II"*	*"Schinkel III"*	*"Köpenick I/II"*	*"Zille"*	
20:00 – 23:00	Dinner in Skyline Restaurant “El Panorama”				

Friday, 26 October 2001					
08:00 – 08:30	Breakfast				
08:30 – 10:00	**First results of working groups** (*Moderator: W. Lucht*)				Plenary Session
Room	*"Köpenick I/II"*				
10:00 – 10:30	Coffee Break				
10:30 – 12:00	**Key Concepts**	**Monitoring**	**Stakeholder Dialogue**	**Implementation**	Working Groups
	Anthropogenic factors, institutions, syndromes (*Rosa, Winter*)	Observing the dynamics of future energy technologies (*n.n.*)	Managing climatic risks (I): Improving the knowledge base (*Jaeger, Rahmstorf, Stoll-Kleemann*)	IGBP/IHDP Cross-cutting theme Water (II) (*Hoff, Kabat, Akhtar, Menzel*)	
Room	*"Schinkel II"*	*"Schinkel III"*	*"Köpenick I/II"*	*"Zille"*	
12:00 – 13:30	*Business Buffet*				
Room	LA-Café V				

Friday, 26 October 2001					
13:30 – 15:00	**Key Concepts**	**Monitoring**	**Stakeholder Dialogue**	**Implementation**	Working Groups
	Advances in economic theory and modelling (*Kemfert*)	Regional sampling and comparative case-studies (*Geist, Fischer-Kowalski*)	Managing climatic risks (II): What are the opportunities? (*Rahmstorf, Stoll-Kleemann*)	Geoscope pilot themes: life styles, food, biodiversity, etc. (*Karlsson*)	
Room	*"Schinkel II"*	*"Schinkel III"*	*"Köpenick I/II"*	"Zille"	
15:00 – 15:30	Coffee Break				
15:30 – 17:00	**Long-term vision and short-term steps** (*Moderator: C. Jaeger*)				Plenary Session
Room	*"Köpenick I/II"*				
17:00	End				

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