Social Monitoring of Global Change: The Syndrome Approach. First Lessons from a New Transdisciplinary Research Project

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1 Aims of Social Monitoring of Global Change

The process of monitoring as adressed here attempts to observe and evaluate such patterns and processes between social systems and nature that are relevant for problematic anthropogenic Global Change and its implications for the future development of mankind within the natural environment. Monitoring is social in at least two respects: it aims at societies and different kinds of actors within them, and it is itself a social activity, performed by scientific and non-scientific actors. The first point is commonly held and needs no further reasoning. The second point seems quite less accepted. Nevertheless it deserves attention to understand that all observation and evaluation processes - if performed by individuals in everyday life or by scientific communities on a methodologically more sophisticated level - are heavily influenced by social factors and attitudes in different ways, including:

- the selection of issues or domains that need to be monitored,
- the selection of monitoring tools and methods,
- the criteria according to which monitored processes are to be evaluated,
- the practical and political process in which monitoring and usage of results is embedded

These points, probably common sense among social scientists, might raise the natural scientists' opposition. Often closely attached to the ideal - or rather ideology - of pure and objective science, natural scientists tend to ignore the social implications of their knowledge base and tool set. This is the more problematic the more the results of their research is used by social actors (e.g. governments, NGOs) to intervene in social and/or natural processes according to their respective interests, as it is common in monitoring.

"... monitoring has a policy orientation. While it is scientific, monitoring is not science." (Rodenburg 1995, S.79)

"Pure" science could be described as somehow "curiosity-driven", whereas scientific monitoring might be called "issue-driven" (Viederman 1995). The latter is interested in specific problems selected by social and/or political actors (and not by the scientific community alone), identifies the framework of analysis and the scales of measurement appropriate to the problems (and not by method and current state of the art alone), has to deal with and endure uncertainties (and not only be aiming at certain knowledge), is organized as an ongoing process (and not oriented to a conclusion), and is committed to reporting and communication of its findings (and not to scientific publication alone). This is valid especially in the case of monitoring human-nature interactions being part to a large degree of Global Change research.

Global Change (GC) is one of the great and still growing domains of natural science activities in the last years. Besides of understanding the functioning of the Earth System as a whole and of its subsystems, which is a major driving force behind this research type, monitoring of natural systems and their use and misuse by humans belongs to the core of its domain. Using advanced tools like Geographical Information Systems (GIS) or satellites for remote sensing, the natural sciences occupied with GC observe - supported by computer models - the state and the dynamics of the natural environment, especially those areas or components suffering severe human impact and subsequent damage. The broad range of activities underway can be illustrated by the interdisciplinary research done under the cover of the International Geosphere-Biosphere Program (IGBP) established in 1986 by the International Council of Scientific Unions. The questions addressed here are e.g. "How will global changes affect terrestrial ecosystems?" or "How will changes in land-use and climate alter coastal ecosystems?" Up to now a lot of useful research activities have been carried out and monitoring of natural ecosystems is an important part of it.

It will be argued here that GC research cannot be successful unless social sciences are integrated. True: The interactions between plants, soil and atmosphere are governed by natural rules and have to be described by natural sciences alone. But even from the purely ecological or natural science point of view measurement and monitoring of ecosystems is difficult and impeded with uncertainties, due to e.g. non-linearity of ecosystem response to stress, natural variability, inadequate knowledge about larger time and spatial scales and inadequate research on the linkeage of natural and managed ecosystems (Carpenter 1995). What is more important: the whole context of the natural processes under research is heavily determined by social structures, processes and actors. It is society as the ensemble of these elements that determines what kind of plants are used and how this is done (e.g. by low input subsistence farming or by high-tech and heavily subsidized agriculture), if and how land use underlies constraints by property rights (which might encourage overexploitation), what technologies are employed (e.g. slash-and-burn agriculture), how the output of natural processes is further dealt with physically (e.g. transportation, consumption, waste), and so forth. The emergence of research activities such as the International Human Dimensions of Global Change Program (IHDP) indicates the growing awareness of the scientific community - and of public funding agencies - for the necessity of integrating the social sciences potential for monitoring and analyzing GC.

Although thus the necessity of social science cooperation in GC seems quite obvious, it is commonly held even among social scientists engaged in environmental research that the social sciences are - in different degrees - not all too well prepared for such transdisciplinary efforts (e.g. Buttel & Taylor 1994). There are several reasons responsible for this situation: scientific tradition, research organization, funding structures, (sub)disciplinary specialization, mentality of scientists as "single fighters", and so on. One of the most important factor seems to be scientific tradition: it is not only crucial for the "corporate identity" of the social science "branch" in general, but is influencing the other factors mentioned in a degree not to be underestimated. One could name this traditional factor the "Durkheimian legacy" that prevents at least mainstream social sciences from getting more than superficially involved with the more or less pure facts of nature. According to the late 19th century statement of the famous and very influential sociologist Emile Durkheim a scientifically valid explanation of a fait social has to return to social facts alone. By no means could an explanation of social processes be accepted as a piece of social science if it would have to borrow from natural factors in the explanans. This seemed to him - and to many of his colleagues even from other schools of thought - as a relapse in naturalism that had been overcome within the course of scientific progress since the enlightment period. Anti-naturalism became something like the meta-paradigm of social sciences (Stehr 1995).

Previous authors like Montesquieu or Huntington had linked the development of society (e.g. legal instituitons) to natural conditions (e.g. climate) and maintained a connectedness between both that could and in fact would be weakend through technical and social progress, but which could never be dissolved by it. This sort of thought became more and more marginalized in sociology, economics and political science. The different approaches dominating these disciplines - such as functionalism, structuralism, phenomenology, action theory, sometimes even marxism - neglected the social influence of natural conditions and stated the independence of societies from nature. This strategy of de-naturalization or de-materialization of individuals and social systems mostly resulted from the intention to underline the inner-societal constraints to social progress (such as class structures, power relations or roles) and to stress the naturally unlimited potential for modernization and further development (Hannigan 1995; Wallerstein et al. 1996). The space of society was openend widely in order to learn about its intrinsic mechanisms and reproductive features. Social scientists from various disciplines collected data and generated theories about society and its development. These research activities can in fact be described as social monitoring in a wider sense; they should serve the purpose of self improvement and social progress. Insofar the theoretical mainstream trend of neglecting nature was part of the overall social process of modernization - and shared its ambiguities. It is an important part of what might be identified as the dominant social paradigm of modern, industrial socities (Harper 1996). One of the most momentous aspects of opening the social space was the neglect of ecological contexts of social processes. Neither the dependencies nor the consequences of social life were perceivable within the meta-paradigm of anti-naturalism. Social monitoring of society thus went along with blindness against its environmental embeddedness. This holds true even until recent times, when economists or sociologists engaged in monitoring different societies by social indicators (such as GNP, literacy rates or household consumption) widely ignore ecological factors (Reusswig 1994).

With rising levels of industrialization and urbanization this theoretical attitude - in fact the attitude of most social actors at times - seemed to be plausible or even the only adequate one. While former and contemporary rural societies were conceived as being substantially dependent of natural factors such as soil quality, climate, vegetation type or water availability, this seemed to be overcome in modern societies and their enormous technological capabilities. Too bad soils? Well, why not compensating natural shortcomings by industially produced fertilizers! Cold Climate? Construct glasshouses and put in some energy! Water shortages? Just tap groundwater by deep wells or build dams! Poor harvests? Start a Green Revolution or develop genetically transformed plants!

There has indeed been great progress in becoming independent from natural constraints by technological advancements. The practical performance of modern society seems to fully underline what the (neoclassical) economists proclaimed on a theoretical level as the substituitivity of nature by capital. Not all substitutional practices, of course, "went wrong" or lead to ecological damage. There are sustainable ways of substituting nature by man made capital. But this is no proof for the traditional "modernist" viewpoint - quite the reverse. Where human activities - be they technical or organizational - transformed and substituted natural factors in a sustainable manner, they always - intentionally or not - took into account basic features of the natural system and did not leave the possible trajectories of non-catastrophic co-evolution of man and nature. But very many forms of human interaction with nature in fact went wrong or at least show disturbing side effects from an ecological point of view. As these negative ecological consequences of modern societies have become obvious, theoretical reorientation within economics - in terms of neoclassical Environmental Economics as well as, even more pronounced, in Ecological Economics - has lead now to the insight, that nature can only, if at all, partially be subsituted by man made capital. In order to establish a sustainable development for society, or at least getting near it, we will have to regard the natural preconditions and consequences of society and to invest not only in human but also in natural capital (Jansson et al. 1994). Regarding the broad phenomology of GC, the timescales and the problem dimensions involved, there can be reasonable doubt about whether mankind will be able to re-direct its material and immaterial resources into the right direction to sustainable development. It has become obvious too, that former investment strategies - that is those who were based upon the theorem of unlimited substituitivity - have in fact contributed massively to the global environmental crisis we are facing today. Saudi Arabia might serve as an extreme, but not all in all too exotic example. If natural conditions like soil fertility, water availability and climatic factors impede upon agricultural production then the great desert of the Arabian peninsula is a good example for nature being extremely stingy with her gifts. Nevertheless the Saudi-Arabian government decided to cultivate wheat in the desert by intensive irrigation and fertilizer input; the country has become an exporter of wheat in the mid 80s. No problems - in terms of the old paradigm of substituting nature. This appears in a very different light if the new way of monitoring social systems - regarding society and nature as complementary - is followed. Then the environmental costs become visible - both in monetary and in non-monetary terms: the Saudi-Arabian government subsidizes farmers heavily to come down to world market prices and is propelling desalinisation by the returns of oil exports - a non-renewable resource. There are many other examples for negative environmental consequences - to put aside for a while the negative social ones - of the traditional strategy of "substituting" nature by capital or technology. The symptoms of GC that I will address in a later section present a lot of evidence.

The points in this section are simply: Global Change issues have necessarily to be monitored not only by natural but also by social sciences. And: for reasons of their tradition and because of overall modernization tendencies many social sciences are relatively bad prepared for the type of transdisciplinary research that has to be undertaken. This affects the contribution of these disciplines to monitor man-nature-interactions on a global scale.

2 Indicators and Systems

There is no common description of what GC really is. If one understands it very briefly as the changes of the earth system induced by human action, affecting negatively its structural patterns or its functional integrity, then it presents itself at a first glance as a confusing ensemble of critical trends within the interface between man and nature, refering to very different scales, problem types, sectors, and regions. Data collection and interpretation thus become extremely difficult. On a very aggregate level one can distinguish several features or areas of GC (Middleton 1994; Roberts 1994; Spangenberg 1991):

- Climate Change,
- Soil Degradation,
- Population Growth,
- Deforestation,
- Water Contamination and Water Scarcity,
- Loss of Biodiversity,
- Contamination of Oceans and Coastal Zones,
- Accumulation of Wastes,
- Urbanization,
- Uneven Development Patterns.

One could try to understand monitoring of GC as follows: select one or more of the areas mentioned according to some relevance criteria (e.g. soil degradation as a key problem regarding world food supply), define core indicators for processes involved (e.g. loss of topsoil per hectare), develop measurement systems and find data (e.g. expert assessments of regional soil degradation). In fact most of the monitoring activities now underway follow roughly this strategy. Social dimensions of GC are mostly treated the same way and integrated in an additive manner.

This additive type of integration can rely on indicator systems and monitoring programs in the social sciences that were initially developed in the period of the so called "Social Indicator Movement". During the 60s and 70s, when this "movement" was at its height, social scientists developed indicator systems for measuring and comparing the performance of societies in economic, social, political and other respects (e.g. crime, housing, satisfaction, use of time). The key point was to get a closer view of the quality of life within a society. Even environmental aspects had been monitored, but they were mostly regarded as side aspects, e.g. air pollution within housing areas. Main target group - besides the general public - were the politicians viewed as foremost responsible for improvements of society. Situated originally within the context of system confrontation with socialist countries these monitoring activities had thus a clear bias towards social reform and progress.

National and international social survey programs today, providing a continuos form of social monitoring, are the actual outcome of this movement. In the 80s the context of social indicators research shifted towards development processes. The question indicator systems should answer now was: what are the key elements of development processes so that their support on the part of politics (domestic or abroad) would help underdeveloped countries to reach the quality of life of more advanced nations. Aggregated indicators such as UNDP's Human Development Index (HDI), focussing on living standard measured in purchasing power, educational level and life expectancy in all of the world's countries since 1990, are recent results.

Furthermore there have been advances in integrating environmental aspects in traditional economic monitoring, leading for example to the Index of Sustainable Economic Welfare (ISEW) by Herman Daly and John Cobb (Hartmuth 1997). National and international accounting activities today - heavily influenced by the results of the Rio summit in 1992 - try to overcome the shortcomings of traditional accounting systems (mostly due to neoclassical economics paradigm), and to integrate social and environmental performance aspects of national societies (Henderson 1996).

Thus the way for integrated monitoring of man-nature-interactions should be possible in the above indicated way. But this turns out to be difficult if not impossible. The earth system in its natural aspects alone is too complex to fit in simple indicators; the existence of humans and social systems embedded within nature increase this discrepancy between reality and indicators. Because now we do not only have to deal with complexity, hierarchy, feed back loops, non-linearity and what is furthermore characteristic for natural systems, but also with social actors and systems that show (1) about all of these aspects of complex systems, and that can (2) more or less intentionally react upon natural systems and their own impacts on it. Humans do not only interact physically with natural systems, they have as intentional and self-conscious beings - at least in principle - knowledge of their actions in natural contexts and give meanings to them (e.g. Gardner & Stern 1996).

"In investigating social life we deal with activities that are meaningful to the people who engage in them. Unlike objects in nature, humans are self-aware beings, who confer sense and purpose on what they do. We cannot even describe social life accurately unless we first of all grasp the meanings which people apply to their behaviour." (Giddens 1993, S.21)

Societies as higher forms of organizing individuals can enhance or diminish this reflexive capacity (e.g. by (not) investing in science and education). That implies among other things: humans can learn from earlier experience, avoid failures and so on. And sometimes the new forms of interaction with nature resulting from social learning may lead to new malfunctionings (Fortune & Peters 1995).

There are several levels of complexity concerning humans and social systems in their specific interactions with nature. Social Monitoring - here understood as monitoring of societies - has to refer to all of them, depending on the type or scale of problem to be dealt with. These levels of social organization relevant to monitoring are descriped in Tab.1.

Level of social systems	**Example**	**Example for possible environmental relevance**
Individuals	You and me	Environmental sound behavior
Groups	Yuppies, elderly people, the environmentalists	Environmental performance of lifestyle groups, energy consumption of income classes
Organizations	Greenpeace, Procter&Gamble, trade unions, UNO	Ecosystem impacts of firms, successes of NGOs, environmental concern of trade union policies, state of implementation of antidesertification convention
Sectors	Agriculture, traffic	CO_2-emissions of cars, CH_4-emissions of animals
Institutions	Family, religion	Consumption level of private households, cultural attitudes towards nature
Societies	Germany, the Yanomani	National greenhouse gas emissions, agricultural practices of tribes
World	World market, ASEAN, all countries	Biodiversity impact of GATT, energy consumption of world trade, global CO2-emission

Tab.1: Levels of social organization relevant to monitoring

In order to charcterize the syndrome approach a little closer some basic methodological features shall be highlighted here:

- Different types of information and data are integrated, including quantitative and qualitative knowledge, expert knowledge, case and regional studies, conventional statistical data.
- Fuzzy logic as a tool to compute non-sharp, insecure information usually omitted by classical logical approaches.
- Geographical Information Systems (GIS) - a tool more and more used by the GC research community - are applied in order to spatialize data and systemic interactions in maps.
- Transsectorality is ecplicitely attained by the syndrome approach.
- Archetypes of human-nature are identified that reduce the complex manifold of interaction and data without oversimplification.
- Problem orientation is given because of the concentration on critical, non-sustainable developments in the Earth System.
- System dynamics is a crucial focus as trends and feedbacks (or possible remedies) are observed.

By giving briefly these features of the syndrome approach it must have gotten clear what is not intended by it: giving a total world model on the basis of bottom-up data collection and all encompassing process modelling. The models that tried to grasp GC with that strategy all failed - and probably had to do so because of overcomplexity. Founding monitoring activities on such a philosophy must almost necessarily lead to desorientation and informed blindness. We hold it to be self-evident that monitoring has to be oriented the other way around: top-down and selective - pattern-identifying and using a multiplicity of data offered worldwide. To give a closer impression of how monitoring according to syndromes could look like the next section will deal with the so called Sahel-syndrome.

4 The Sahel-Syndrome as an Example for Systemic Monitoring

As the key characteristic of the Sahel Syndrome we understand the overuse of agriculturally marginal land by a poor or impoverished rural population living in a context of action offering little or no alternative livelihood opportunities - thus leading to the further environmental degradation of their living sphere. This syndrome typically occurs in countries at a low level of socio-economic development and in regions vulnerable to human impacts due to relatively low agricultural production potential (QUESTIONS 1996). After having identified the areas in the world that are vulnerable to agricultural overuse (Cassel-Gintz et al. 1997) we concentrate on the syndrome mechanism as such. The vicious circle of poverty, environmental degradation and population growth lying at the core of this syndrome belongs to one of the most commonly held and scientifically investigated man-nature-interactions (e.g. Dasgupta 1995; Krings 1993; Lamprey 1983; UNRISD 1994). Fig.1 gives the central trends and their interactions. In-depth examination of the syndrome occurrence led us to the distinction of two basic sub-syndromes: the (semi-)arid and the (sub-)humid subtype. Although the main driving forces and effects are inheritent in both - thus leading to the identification of a common syndrome kernel -, different natural conditions (marginality due to aridity limitations in the first and marginality due to soil conditions in the second one) for agricultural production make it useful to regard both types separately. This distinction enhances the explanatory force of the model and ameliorates its regional fitting - including poverty-driven agricultural overuse practices in areas usually not associated with the term "Sahel" such as the Amazonian basin or the rainforest areas of some African countries.

Furthermore one can distinguish between such trends - beyond those belonging to the kernel of the syndrome - which are necessary for the occurrence of either subtype from those that are only possible, e.g. that can be observed in specific cases without being essential for the mechanism. This second distinction focusing on modal grades allows for further flexibility regarding different geographical expressions.

The important thing from an social science point of view - and having still in mind what has been said above to the Durkheimian legacy - is the fact that social and natural factors are combined, focussing their enhancements and mitigations. Social action can - under certain conditions - lead to environmental degradation, which in turn "downgrades" the framework of action for people and strenghtens their pressure on natural resources. Causal relations like the one at the core of the Sahel syndrome were theoretically denied by anti-naturalism in social sciences - although we find meanwhile broad empirical evidence for them (e.g. Hellstern 1993).

We not only identified the mechanisms of the syndrome, but also tried to measure its intensity and to identify regions in the world where it actually occurs. For that purpose we concentrated on key interactions. To detect this mechanism, Monitoring the impacts of humans and social systems on the environment as well as the consequences of natural processes and their anthropogenic transformation for social systems needs identification of relevant elements on every level - simply because the interrelations between society and nature play on every level. Furthermore the distinction between different levels of the social system is important with regard to the political dimensions and implications of monitoring (see below). Self-observation of society makes sense only if changes in problematic developments are intended. But social change is a complex process too (Vago 1996) - and it is level-sensitive. Some measures and instruments (e.g. ecological tax reform) work best at the nation state or international level, others (e.g. enhancement of environmental sound behavior) needs individual backing and engagement. Very often combined strategies with different targets and instruments for different levels of the social system apply best. In any respect it is fatal to mix levels and - for example - to impede burdens on the private households that should more effectively (and more equitably) be shouldered by governments and firms.

Identifying the right level is not only a question of the hierarchy of system elements one wants to observe. The development of indicators for monitoring is highly dependent on our knowledge about the main features of the observed system and its functioning. Otherwise we could never be sure to turn our attention to peripheral aspects. We need - at least on a basic level - information about the structure of the system and its development in order to define survey goals, methods and indicators. Without systemic knowledge monitoring of man-nature-interactions is like holding precision instruments into a misty landscape and putting questions aside like "What exactly are we measuring?" In case of social monitoring of GC the "object" of reference is the worldwide interaction of humans and social systems with nature and natural systems - an enlargement of topics that increases both the necessities of and the difficulties for GC research and monitoring activities. Here at the latest a systemic approach is indispensible.

Most of the monitoring systems developed so far have not attained the level of systemic integration of natural and social aspects. Nevertheless there are initial stages. The widely known Pressure-State-Response (PSR) concept of OECD tries to systemize both traditional and new indicators according to a basic notion of the position of social systems in nature: there are driving forces of social origin that "push" people (or organizations etc.) to use or overuse natural sources and sinks in a specific manner. The character and degree of this impact causes changes in the natural environment that can be observed by looking at different state indicators at different times. The response indicators focus on activities on the part of society that might stop or at least weaken the negative impacts of driving forces on natural systems. This last aspect is fully according to the above mentioned insight that humans and even whole societies have, at least in principle, reflexive capacities to monitor themselves - and to act according to the perceived discrepancies between actual environmental performance and self defined ecological targets. The UN Commission for Sustainable Development (CSD) is at the moment on their way to elaborate a system of indicators according to the PSR-concept and to implement it in national agenda setting for monitoring activities (UNCSD 1996). If we take the protection of the quality and supply of freshwater resources (put forward by chapter 18 of Agenda 21) as an example, then the annual withdrawal of ground and surface water counts as pressure or driving force indicator, the concentration of faecal coliform in freshwater indicates the state of the freshwater resource, and the waste-water treatment coverage as the response indicator.

Nevertheless even this quite advanced - and last but not least: politically relevant - approach has to deal with certain shortcomings. To concentrate on the most important one: aggregated indicators do not reflect the actual relationships between the different components involved. Withdrawal of surface water for example occurs for several reasons and purposes (e.g. for agriculture, industry or housing) and in different regions and socio-economic contexts (e.g. in affluent countries with "modern" infrastructure or in very poor countries for survival purposes). Due to hydrological and climatological differences (e.g. river runoff, evapotranspiration rates) the same social pressure may have very different impacts on the water system of a region. Finally there are many possible responses of societies to human induced pressure on surface water resources - reaching from waste-water treatment through water recycling techniques to water saving strategies. The interlinkeages between society and water vary widely according to natural and social differences. They should consequently be monitored and assessed in different ways. This does not endanger comparability of data - quite in the opposite. Aggregated indicators neglecting typical socio-ecological distinctions suggest comparability where in reality it does not exist. Systemic indicators, making transparent the different mechanisms and situations of human-nature-interactions, are the basis for realistic monitoring. "Realistic" means: focussing the impact of different social systems on different natural systems, concentrating both on typical driving forces and the whole earth system.

Briefly: the development of indicator systems for GC monitoring has to go hand in hand with the improvement of our systemic knowledge of the earth system. Otherwise the purposes of social monitoring mentioned at the beginning (definition of crucial domains, selection of methods and interactions between society and nature. To give an example one could focus on soil degradation as a global (mega)trend that can be observed and measured in many regions. But the regional differences are not only due to sorts and speed of degradation processes on different soil types, but also to social contexts such as farming type, embeddedness of agriculture, technical equipment etc. Although there might be very small differences between degradation aspects (such as fertility loss or reduction of topsoils by water erosion) on US- and on West-African agricultural lands, the social context of both processes is completely different: there are other driving forces (subsidized high tech agriculture in a world market context versus poverty driven, low-input subsistence farming on a local level), other feedbacks and other curation potentials. Each of the 16 syndromes under research by the project is not only a functional pattern on a global scale, it is as well a dynamic unit (timescales) with a (changing) geographical extension (spatial scales). Using syndromes as monitoring tools would thus answer at least four important questions:

- What is happening between social and natural systems? (functional aspect of monitoring)
- Who is acting why? (social aspect of monitoring)
- How quickly is it happening? (time aspect of monitoring)
- -Where does it happen (now)? (spatial aspect of monitoring)

As the baseline of analysis the 16 syndromes are grouped into three major categories:

- Problematic man-environment interactions due to unadapted use of nature as a resource (Utilisation Syndromes).
- Environmental problems due to human-focused development processes (Development Syndromes).
- Degradation of the environment as a result of human waste disposal (Sink Syndromes).

Syndromes constitute autonomous entities in the dynamics of the strongly coupled Earth System which in their dynamical behaviour have the potential to damage the viability of the system. It is therefore quite important to identify those areas which are

- prone to a certain syndrome or
- already affected by it.

Furthermore those factors and events have to be characterized which might serve as a trigger and therefore have to be avoided. These requirements led to the concepts of

- Disposition, constituted by structural conditions subject to changes of rather long time scales;
- Intensity, as the synonym for the actual presence of a syndrome; and
- Exposition; aiming at short term events initialising the syndrome mechanism.

Since one of the project goals is to formulate basic outlines of a sustainable management strategy it is necessary to add the concept of expressivity. This notion is used to describe slightly different types of syndromes which, for example, can be due to different natural or socio-economic conditions and which therefore require different remedy or prevention measures. As an explicit example the two distinctions of the Sahel Syndrome (see below) can be considered.

a) Utilisation Syndromes
Sahel Syndrome: *Oversultication of marginal land*
Overexploitation Syndrome: *Overexploitation of natural ecosystems*
Rural Exodus Syndrome: *Environmental degradation through abandonment of traditional agricultural practices*
Dust Bowl Syndrome: *Non-sustainable agro-industrial use of soils and bodies of water*
Katanga Syndrome: *Environmental degradation through depletion of non-renewable resources*
Mass Tourism Syndrome: *Development and destruction of nature for recreational ends*
Scorched Earth Syndrome: *Environmental destruction through war and military action*
b) Development Syndromes
Aral Sea Syndrome: *Environmental damage of natural landscapes as a result of large-scale projects*
Green Revolution Syndrome: *Environmental degradation through the introduction of inappropriate farming methods*
Asian Tigers Syndrome: *Disregardfor environmental standards in the course of rapid economic growth*
Favela Syndrome: *Environmental degradation through uncontrolled urban growth*
Urban Sprawl Syndrome: *Destruction of landscapes through planned expansion of urban infrastructures*
Disaster Syndrome: *Singular anthropogenic environmental disasters with long-term impacts*
c) Sink Syndromes
Smokestack Syndrome: *Environmental degradation through large-scale diffusion of long-lived substandes*
Waste Dumping Syndrome: *Environmental degradation through controlled and uncontrolled disposal of waste*
Contaminated Land Syndrome: *Local contamination of environmental assets at industrial locations*

Tab.2: Syndromes of Global Change

criteria, assessment of political relevance) will hardly be addressed. In the next section I will present briefly a research project that tries to take into account these points.

3 Systemic Monitoring of Global Environmental Change: The Syndrome-Approach

The goal of the project[1] is the description and restricted projection of the complex of problematic anthropogenic Global Change, with the aim of identifying and evaluating global management options. It is transdisciplinary from the outset, not in an additional sense as is often practiced: different disciplines work within a vague common framework mostly according to their own problem definition and methodology, putting the results together on a relatively late stage of research. In the project presented here the broad range of disciplines involved define the GC problems commonly and intertwine their research activities on the whole way. The development of a common problem definition and methodology is therefore crucial.

The philosophy of the project starts from the assumption, that GC phenomena cannot conceptually be resolved into isolated changes of hydro-, atmo- or anthroposphere. Monitoring that is based upon sectoral state indicators alone fails the systemic interactions of processes in all spheres, especially the social driving forces, their direct or indirect effects across sectoral borders and the feedback loops that "re-import" anthropogenic changes of the natural system back into societies. Systemic global monitoring as it is intended here aims exactly at these interlinkeages within the Earth System. So the definition of crucial changes of leading parameters within the different components of this system constitute only the starting point of syndrome analysis. We call these changes in earth system conditions symptoms or trends of GC - quite analoguous to medicine, where the doctor as an expert starts his diagnosis by identifying the central symptoms of the patient. Examples from the earth system would be trends like the loss of biodiversity, population growth, groundwater depletion, growing greenhouse gas emissions, increasing social discrepancies or the globalization of western lifestyles and markets. Basing upon an expert evaluation the project operates by now with about 100 globally relevant trends which define in their totality what is commonly understood by "Global Change". These trends do not necessarily have to be sharply quantified. Very often - not only in social systems - changes in the state of parameters have an essential qualitative core (e.g. individualization of societies), although there might be some quantitative indicators for it (e.g. size of per capita living room areas). These trends can be observed on the different levels of the social system mentioned in an earlier section. Some of them only play on individual levels (e.g. growing environmental consciousness), others at medium (e.g. growing national environmental protection measures) or macro levels (e.g. growing global relevance of NGOs). From a social science standpoint these macro-trends can be understood as objectivated, aggregated consequences of social action within a - itself transformable - structural context. Both - structure and action - are considered in their dialectics, as many sociologists today demand from scientific analysis (cp. Giddens 1993, who propels their duality).

But the provision of a qualitatively sensitive vocabulary for GC analysis would be far too little for systemic monitoring. What is missing there are the interlinkeages between the trends, their network of interrelations. One could decide to draw an all encompassing picture of GC by giving all the interactions relevant on a global scale. This linking of (almost) everything with (almost) everything would not be very informative, indeed it would be very close to white noise and leave our analytical interests as unsatisfied as before. The crucial point that defines the syndrome approach is to resolve this global network of interrelations into a limited set of patterns that occur typically when societies use nature as source and sink. We call these typical functional patterns of man-nature-interactions syndromes - again borrowing from medicine, where the combined occurrence of symptoms makes up a characteristical diagnostical unit.

Up to now we operate with 16 different syndromes of GC. This concentration reduces the mass of aggregated information within the trends by identifying only specific, syndrome-relevant aspects of trends and trend-interactions. This quite similar to what experts do when they characterize a specific problem type in a region. In fact syndromes can be regarded as mental expert maps of globally occuring critical

1 The project "Syndromdynamik" is funded by the German Federal Ministery for Education, Science and Technology (BMBF). Participants are scientists from different institutes and disciplines (e.g. physics, biology, chemistry, ecological modelling, economics, sociology). It is strongly connected with the coreproject "QUESTIONS" (An Expert System on Global Change: Qualitative Aspects of Syndromes and Transitions to Sustainability) of the Potsdam-Institute for Climate Impact Research (PIK). The conceptual framework of the syndrome-approach was originally provided by the Scientific Council of the Federal Government for Global Environmental Change (WBGU 1993, 1996), with which the project is cooperating as well.

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- Geographical Information Systems (GIS) - a tool more and more used by the GC research community - are applied in order to spatialize data and systemic interactions in maps.
- Transsectorality is ecplicitely attained by the syndrome approach.
- Archetypes of human-nature are identified that reduce the complex manifold of interaction and data without oversimplification.
- Problem orientation is given because of the concentration on critical, non-sustainable developments in the Earth System.
- System dynamics is a crucial focus as trends and feedbacks (or possible remedies) are observed.

By giving briefly these features of the syndrome approach it must have gotten clear what is not intended by it: giving a total world model on the basis of bottom-up data collection and all encompassing process modelling. The models that tried to grasp GC with that strategy all failed - and probably had to do so because of overcomplexity. Founding monitoring activities on such a philosophy must almost necessarily lead to desorientation and informed blindness. We hold it to be self-evident that monitoring has to be oriented the other way around: top-down and selective - pattern-identifying and using a multiplicity of data offered worldwide. To give a closer impression of how monitoring according to syndromes could look like the next section will deal with the so called Sahel-syndrome.

4 The Sahel-Syndrome as an Example for Systemic Monitoring

As the key characteristic of the Sahel Syndrome we understand the overuse of agriculturally marginal land by a poor or impoverished rural population living in a context of action offering little or no alternative livelihood opportunities - thus leading to the further environmental degradation of their living sphere. This syndrome typically occurs in countries at a low level of socio-economic development and in regions vulnerable to human impacts due to relatively low agricultural production potential (QUESTIONS 1996). After having identified the areas in the world that are vulnerable to agricultural overuse (Cassel-Gintz et al. 1997) we concentrate on the syndrome mechanism as such. The vicious circle of poverty, environmental degradation and population growth lying at the core of this syndrome belongs to one of the most commonly held and scientifically investigated man-nature-interactions (e.g. Dasgupta 1995; Krings 1993; Lamprey 1983; UNRISD 1994). Fig.1 gives the central trends and their interactions. In-depth examination of the syndrome occurrence led us to the distinction of two basic sub-syndromes: the (semi-)arid and the (sub-)humid subtype. Although the main driving forces and effects are inheritent in both - thus leading to the identification of a common syndrome kernel -, different natural conditions (marginality due to aridity limitations in the first and marginality due to soil conditions in the second one) for agricultural production make it useful to regard both types separately. This distinction enhances the explanatory force of the model and ameliorates its regional fitting - including poverty-driven agricultural overuse practices in areas usually not associated with the term "Sahel" such as the Amazonian basin or the rainforest areas of some African countries.

Furthermore one can distinguish between such trends - beyond those belonging to the kernel of the syndrome - which are necessary for the occurrence of either subtype from those that are only possible, e.g. that can be observed in specific cases without being essential for the mechanism. This second distinction focusing on modal grades allows for further flexibility regarding different geographical expressions.

The important thing from an social science point of view - and having still in mind what has been said above to the Durkheimian legacy - is the fact that social and natural factors are combined, focussing their enhancements and mitigations. Social action can - under certain conditions - lead to environmental degradation, which in turn "downgrades" the framework of action for people and strenghtens their pressure on natural resources. Causal relations like the one at the core of the Sahel syndrome were theoretically denied by anti-naturalism in social sciences - although we find meanwhile broad empirical evidence for them (e.g. Hellstern 1993).

We not only identified the mechanisms of the syndrome, but also tried to measure its intensity and to identify regions in the world where it actually occurs. For that purpose we concentrated on key interactions. To detect this mechanism,

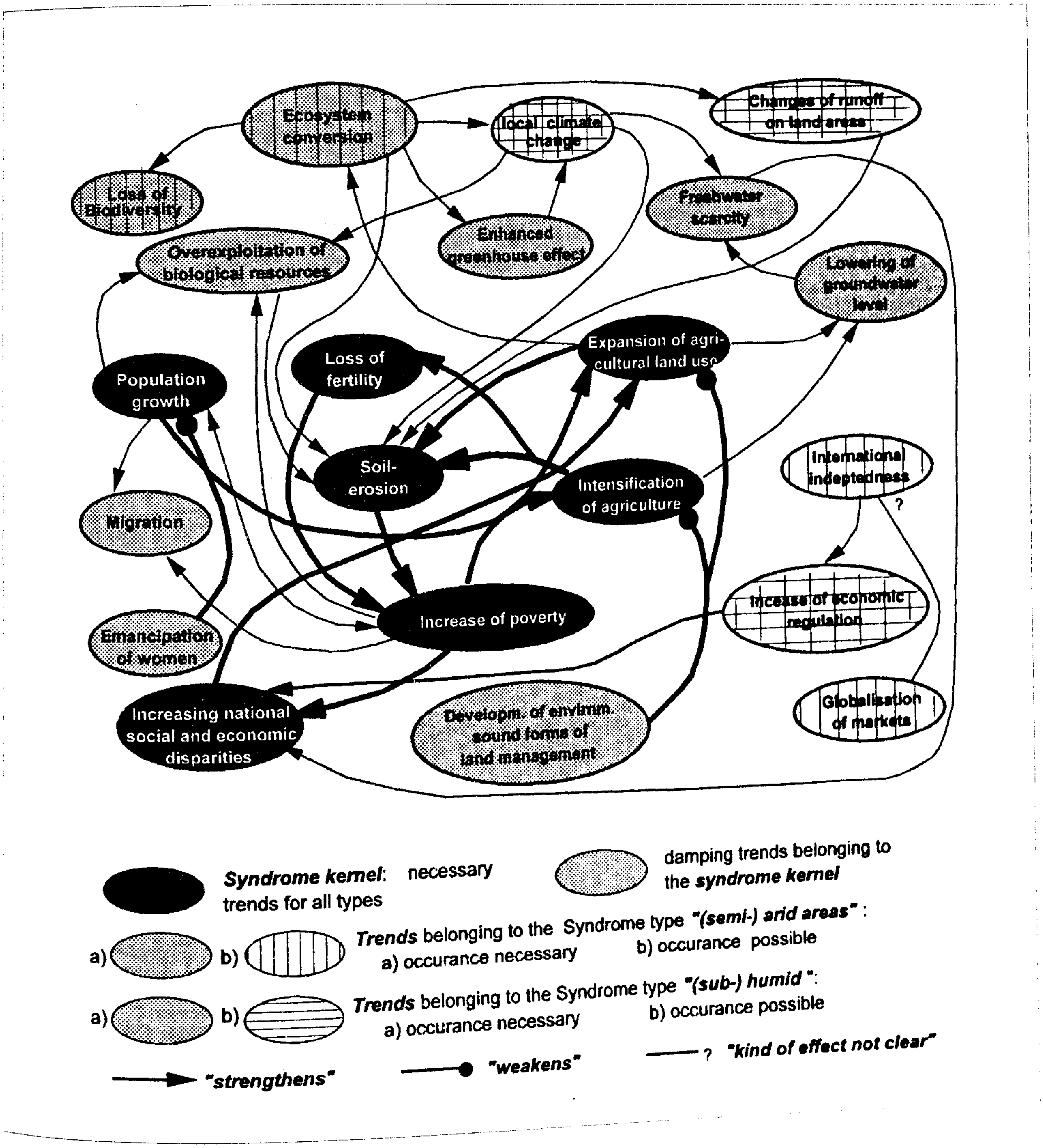

Fig.1: The Sahel syndrome specific network of interrelations

we assumed that for a given region at a given time t there is a measure A(t) for poverty near the subsistence level, a measure N(t) which denotes the extent and intensity of agriculture and a measure B(t) for the state of soil degradation (for a more detailed version including description of method and database cf. Lüdeke & Petschel-Held 1997). Thus we came to a systemic indicator for the syndrome, allowing for geographically explicit and system-knowledge-based global monitoring of one pattern of GC (see Fig.2).

Political action in order to avoid further development of the Sahel syndrome - thus contributing to further GC - can be specified along the most affected regions and address the most important trends and mechanisms responsible for syndromatic tendencies. Appropriate measures would have to cut the vicious circles and to enhance "help trends" that mitigate impoverishment and degradation processes. Because of the geographically explicit monitoring scope these political measures could be modified according to regional scientific expertise and democratic participation. And all this in a situation, where facts are often uncertain, values in dispute, stakes high, and decisions nevertheless urgent.

With regard to the above mentioned syndrome approach this means that even very appropriate monitoring systems according to complexities of the Earth System have to undergo a process of social debate and evaluation. Controversies about priorities, goals, costs and so on can never be avoided by the excellence of scientific outputs. The only thing they can do is to contribute to a sort of "upgrading" (not: substituting) public awareness and political decision making. This unavoidable - and under democratic circumstances even positive - task will be reached best when the political implications and assumptions of monitoring processes are made transparent. Science remains one player in the game, not the arbiter.

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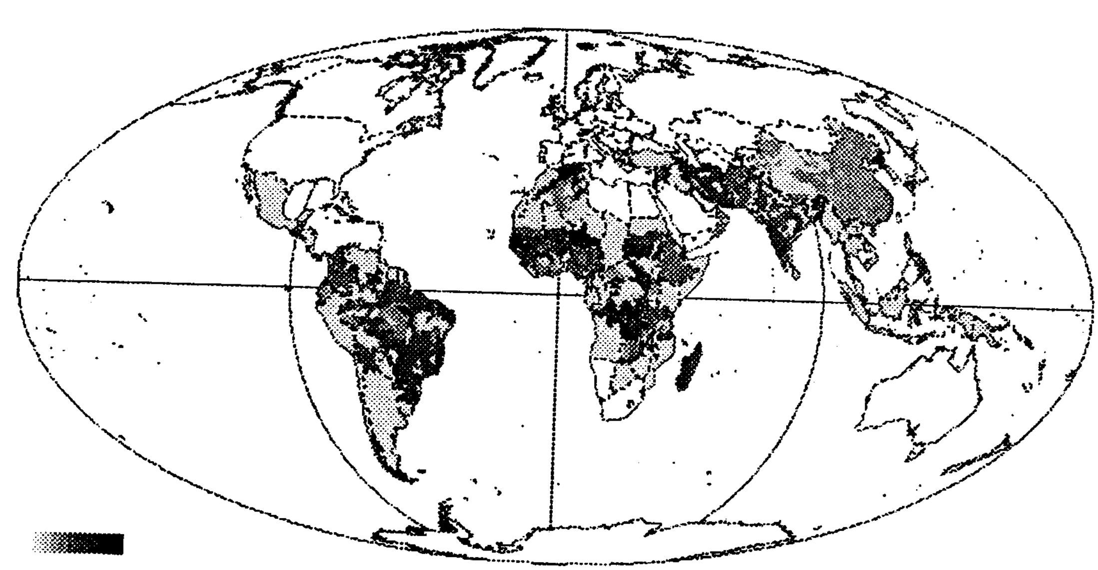

Fig.2: Presence of the Sahel syndrome (1985-1992); intensity increases with darkness

or national peculiarities. Reaching sustainability (as a concept of economic, social and environmental improvements in their interconnectedness) can be specified as avoiding catastrophic domains of the Earth System. The syndrome approach seems to be a very appropriate tool for the thus necessary monitoring activities.

5 Concluding Remarks: Monitoring as a Social Process

Monitoring as a social activity not only because social processes and actors are observed, but also beacuse they are involved. This holds true not only for the selection of criteria and methods, but also and in fact more obviously for the formulation of targets or desirable states of man-nature-interactions to be monitored. What might be called the "sustainability discourse" - that is the public and scientific debate about central characters and single issues of sustainable development - offers the reference framework for these targets (cp. Brand 1996). If we don't know where we want to go we cannot decide whether or not observed environmental changes are problematic or not. Monitoring needs targets too. In the last instance agenda setting for environmental quality goals is a political process. The question is not: "What sort of environment should exist at a specific place on the earth?" but rather: "What sort do we want to have there?" In other words: it has something to do with power, values, preferences, cost-benefit-analyses, weighing-up of alternatives according to divergent possibilities, interests and perceptions, publicity and so forth. If one distinguishes between polity (the institutional framework), policies (the programs and agendas) and politics (the processual dimension), then agenda setting is as much a question of politics as of polity and of policy, as which it is seen most of the time (Dobson & Lucardie 1993; Held 1991).

The formulation of targets is a process very much depending upon the resources and relations of social actors - be they politicans, environmentalists, businessmen, multiplicators etc. Science plays an important role in that process - regard alone the complexity and non-visibility of target states at stake - , but it is not the main actor. True: many actors engaged in the politics of sustainability rely on scientific results. But they do so in order to raise their legitimacy in a society heavily depending on science in many (other) domains. And that means: it is the political function of science involved here, not the originally scientific one that has to be taken into account. This holds true not only for agenda setting as such but even for the formulation of scientific research topics regarded as important for GC (Hannigan 1995; Liberatore 1994; Wynne 1994). However far reaching one estimates the political influence on science - there seems to be little doubt that the process of agenda setting in the sustainability framework is political and not scientific alone. And if monitoring global environmental change implies agenda setting, then monitoring is a social process in the specific sense of politics. The crucial point in implementing monitoring as politics is to find the right balance between