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EMISSIONS AND PURPOSIVE INTERVENTIONS INTO LIFE PROCESSES

Indicators for the Austrian Environmental Accounting System

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"EMISSIONS" AND "PURPOSEFUL INTERVENTIONS INTO LIFE PROCESSES" - INDICATORS FOR THE AUSTRIAN ENVIRONMENTAL ACCOUNTING SYSTEM[1]

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ABSTRACT

The Austrian government has decided upon developing an environmental information system which can be linked to the System of National Accounting (SNA). In this framework we are to propose causer-related physical (not monetary) environmental indicators. "Causer-related" means that we do not investigate the effects of human actions on nature, but we seek to answer the question "which economic actor does what to deteriorate or change the environment?". The proposed system contains three parts, economic-ecological system indicators - ESIs - (for example energy intensity), emissions - EMIs - and purposeful interventions into life processes - PILs. Whereas EMIs are more or less inevitable side-consequences of the production process, PILs do not refer to the unintentional emergence of annoying by-products. The desctruction of ecosystems and the deterioration of life chances of other species are strongly influenced by such purposeful interventions and not just by emissions. Moreover, there are strong indications that, as the "mechanical" paradigm of nature is vanishing and the "cybernetic" paradigm is arising, EMIs will loose and PILs might gain importance. Obviously, genetic engineering as new approach in biotechnology is a typical example for this new paradigm. The importance of these new technologies is rapidly growing, and they are strongly promoted - last but not least because it is hoped that they will be the urgently needed "clean technologies". On the other hand, as OECD stresses, "new biotechnology is distinguished from all other major technologies of the 20th century by the fact that its impacts on the quality of life are arriving earlier and may go deeper than its economic impacts." In view of such concerns we consider indicators for genetic engineering to be an important part of an environmental information system. We propose two subsets of indicators for genetic engineering. One is called indicators of risk and should refer to the "hypothetical risk" of genetic manipulations. The other subset is called indicators for the intenstity of intervention and should monitor the qualitativ new kind of genetic variation of GEOs that are deliberately released. It is the intention of this article to open the floor for the discussion of genetic engineering as relevant part of environmental information systems.

1. INTRODUCTION – THE PROJECT "CAUSER-RELATED ENVIRONMENTAL INFORMATIONS"

Commissioned by the Ministry for Environment, we are to devise a consistent set of causer-related indicators to be connected to the Austrian System of National Accounting (SNA). This requires that the *share of every sector of the SNA* (for example: electricity production) to one indicator (for example: SO_2–emissions) can be evaluated. The resulting information system should on the one hand be communicable to economists, on the other hand relate to the problems considered by environmental scientists. The indicators are supposed to be a *part of the physical section* of the planned Austrian satellite-system.[2] Up to now, the availability of causer-related environmental data in Austria is very limited due to restrictive data-protection legislation and moreover due to the typical Austrian secrecy-mindedness of private companies and official authorities.[3]

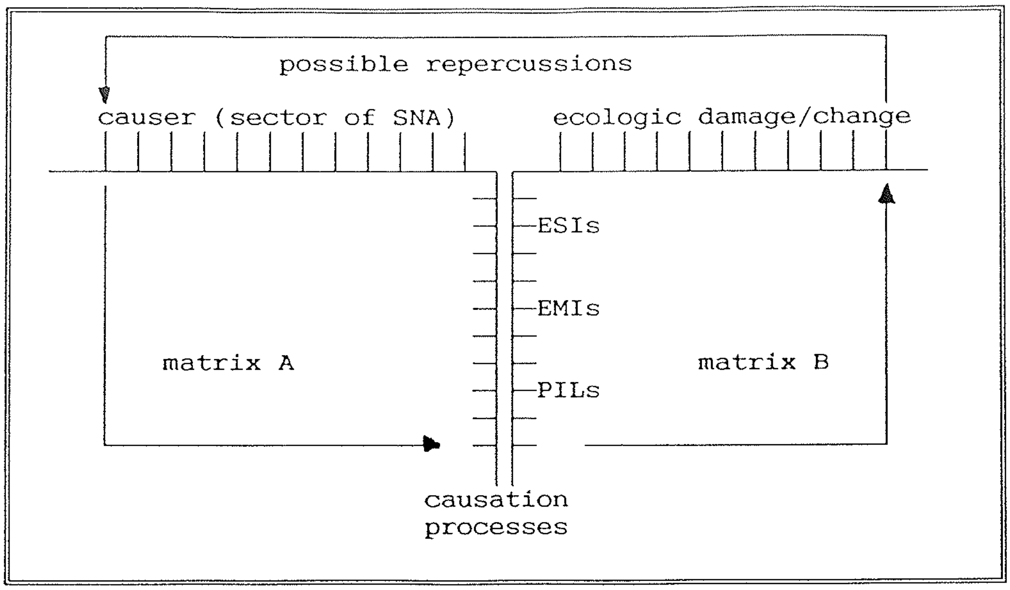
Figure 1 explains the *methodological demands* of our information system to environmental indicators. "Causer-related" means that we do *not* investigate the ecological degradations or changes induced by economic activities, but seek to develop indicators, which mirror a relevant *"causation process"* leading to ecologic degradation or ecologic change. "Causer" simply is the sector of the SNA, which is responsible for a causation process, for example an emission. We also do not reflect the possible repercussions of changed ecological circumstances to the economic system. The main aim of the current international efforts in developing a "green GNP" is to *raise the awareness* of the social system of its activities at the expense of the environment.[4]

The proposed system of environmental indicators consists of three parts:

1/ *Economic-ecological system indicators* (ESIs),[5] for example: energy intensity, transport intensity, risk intensity and other physical attributes of the production/consumption process relevant for the environment. ESIs seek to measure the "ecological efficiency" with which human needs are satisfied.

2/ Reporting *emissions* (EMIs) in a narrow sense is the most established field of causer-related environmental data. We classify emissions by their aggregate state (gaseous, liquid, solid or energetic) at the moment of leaving the economic system. This seems to be the best solution to the statistical problem of double-counting.[6]

3/ *Purposeful interventions into life processes* (PILs) are no unintentional side-effects of produc-



matrix A: causer x causation processes
matrix B: causation processes x ecologic damage/change

Figure 1: Schematic presentation of the project "causer–related environmental indicators"

tion, but are just made in favor of a particular social use.[7] These indicators are intended to mirror the causation processes for issues such as biotope–destruction, violence towards animals and genetic engineering.

The indicators which are supposed to build up the described information system have to meet three restrictions. First, they should be based on data available, or at least on data which could be made available within the next years. Secondly, the set of indicators suggested should be able to find acceptance both with economists and with ecological scientists resp. environmentally interested experts. Thirdly, the environmental indicators have to be technically compatible to the design of the SNA.

2. SIMILARITIES AND DIFFERENCES BETWEEN EMISSIONS AND PURPOSEFUL INTERVENTIONS INTO LIFE PROCESSES

The most conventional approach in causer–related environmental reporting is to focus on emissions which can be defined as transportation of obtrusive physical entities over the (functional) border between the economic system and nature. What is essential about the notion of "emissions" is that emissions are *not purposefully produced* but more or less inevitable side–consequences of the production process. Nobody works a steam power plant to produce SO_2 or CO_2 – its purpose is simply to generate electricity. But there also exists another type of mechanism of influencing ecological processes which we have called "purposeful interventions into life processes" (PILs). This mechanism does not refer to the *unintentional* emergence of annoying by–products. If you build a dam, you want the energy of the river to drive turbines instead of eroding the riverbank and inundating the floodplains. Although a water power plant normally does not produce emissions, it strongly affects the ecology of rivers, floodplains and wetlands.[8]

We currently consider three groups of PILs:[9]

1/ *Interventions into biotopes:* Indicators which try to evaluate direct human influences leading to degradation or changes of natural ecosystems. Our current considerations contain models for human influences on net primary production, human influences into the water household and the purposeful release of synthetic substances like anorganic plant nutrients and pesticides.

2/ *Violence towards animals:* Indicators that subsume the well–known matters of prevention of cruelty towards animals. This group contains two indicators, one for the circumstances of keeping animals (long–term aspect) and one for short–term aspects: Killing animals and animal experiments.

3/ *Interventions into Evolution:* Indicators for direct (genetic engineering) and indirect (breeding techniques) influences on the gene pool.

As Moscovici[10] and Oechsle[11] stated, emissions are a typical problem caused by the current mode of production which according to them is characterized by a *"mechanical" paradigm of nature*. The necessity to reduce emissions is broadly accepted, and in the long run the importance of this mechanism of destroying nature will diminish. On the other hand a new "cybernetic" paradigm is arising, which is characterized by *qualitatively new* and enhanced possibilities of human control over nature. This new paradigm can be seen in many examples. Robert Korab[12] points out that application of analytical–chemical methods in ecology yielded new possibilities of directing and utilizing natural processes in order to meet human demands. New biological technologies are developing rapidly and are strongly promoted – last not least because it is hoped that they will be the urgently needed clean technologies.[13] These tendencies can be described as

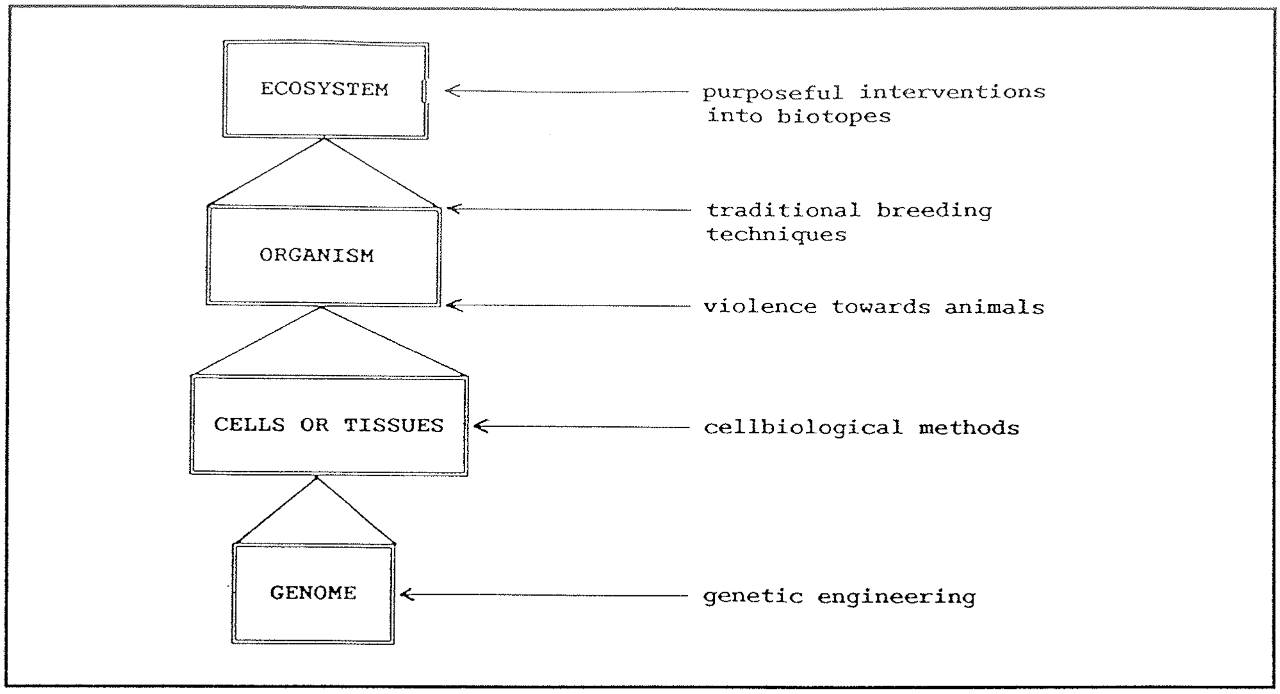


Figure 2: Systematics of PILs refering to the level of intervention

a strategy of replacing EMIs with PILs, for example using biological instead of chemical techniques. Therefore it is our opinion that a causer–related environmental information system, linked to an influential system of social reporting such as SNA, has to contain EMIs as well as PILs – otherwise it would not be *open to meet future demands.*

3. GENETIC ENGINEERING AS PURPOSEFUL INTERVENTION INTO LIFE PROCESSES[14]

Among the three groups of PILs "Interventions into Evolution" is the most unconventional. Here we are just in the stage of conceptual clarifications for the development of indicators for genetic engineering or new biotechnology respectively. In fact biotechnology is considered to be a "broad enabling technology"[15] of fast growing economic importance. However as OECD stresses "new biotechnology is distinguished from all other major technologies of the 20th century by the fact that its impacts on the quality of life (...) are arriving earlier and may go deeper than its economic impacts." Regardless whether environmental consequences are difficult to analyse and measure, it is clear that some of them already have begun.[16] In view of such concerns we consider indicators for genetic engineering to be an important part of an environmental information system.

For the development of *universally applicable* indicators for genetic manipulations one has to ask for *basic features* of this technique. In the case of genetic engineering the "causation process" consists of *two steps*. The first is the *artificial combination of genes* which have evolved along different evolutionary paths within a single organism. This can be achieved by the *transfer of one or more genes* into a host–organism or by the *fusion of cells or protoplasts* of two species which cannot be crossed in a traditional manner.[17] Subsequently the resulting "genetically engineered organism" (GEO) is propagated, in most cases by *cloning–techniques*. The second step is the release of a population of GEOs into the environment. There are (at least) three different ways of release of GEOs into the environment: the *deliberate release*, the *accidental release* from closed systems, and the *infection of persons* with genetically engineered microorganisms. With reference to the methodological concept of the project, the economic sector which is responsible for the release of GEOs is regarded as the causer of a genetic manipulation.

Genetic engineering represents a *new quality of intervention* into natural systems. This can be seen by comparing the tools of recombinant DNA–technoloy with traditional breeding–techniques. The latter also are capable of modifying genotypes, but neither can they alter the genome directly, i.e. alter DNA sequences well–aimed, nor bypass the border of reproductive isolation. Thus genetic manipulation has some important consequences in terms of biological significance, which should serve as *guideline* for the development of indicators.

First, direkt manipulation of the genome is an intervention into *the most central biological system* which could be characterized as the *"control system of living organisms"*, as well as the *"backbone of evolution"*. This fact has given rise to a risk–focussed discussion on potential biohazards of GEOs. However, the aim of our contribution as well of our projekt is *not* a summary of this debate. We only want to refer to an aspect, which suggests to postulate a kind of *"hypothetical risk"*, inherently associated with genetic manipulations. Genetic engineering represents the last step of the "progressive atomization of the natural phenomena"[18] in the field of biology. Genes are isolated from a donor organism and put into the regulative context of the host genome. Due to the immense number of genes controlling metabolism and directing the development of organisms – which in addition are mainly unknown – the consequences of genetic manipulations at the level of the organism seem very difficult to assess. Subsequently, the GEO which may have entirely new attributes, is released into an ecosystem. Each of these two steps represents a *combination of two complex systems* which are not (and maybe cannot be) *entirely characterized*. Thus the potential impact of GEOs on the environment cannot be completly predicted.[19]

Secondly, genetic engineering can bypass the *border of reproductive isolation*. Thus, alterations in the genome are not longer restricted to different combinations of allels which already exist in the gene pool of a species. In contrast to this, genetic manipulation spreads the posibilities of producing genetic variants in a qualitative manner. Evolution, which is based on constructing new systems on the basis of already existing systems, is replaced by the *arbitrary combination of genes*, regardless of their *evolutionary context*. Nature is considered as a "arsenal of pieces wich are unconnected among one another and which can be combined arbitrarily."[20]

4. PATHS TOWARDS POSSIBLE INDICATORS

One methodological demand of our project is, not to consider damages of the environment, but to restrict to *"causation–processes"*. In the case of genetic manipulation this point of view would neglect specific characteristics of genetic engineering. Thus it is necessary to consider two subsets of possible indicators.

One subset – *indicators of risk* – should refer to the *"hypothetical risk"* of a genetic manipulation which sometimes is designated as "low probability high risk". It should consider the possibility that selection favours a GEO in the environment, which could result in its massive propagation and a disturbance of the affected ecosystem. Besides it should consider the possibility of *accidental releases* from closed systems, as well as infections of persons with genetically engineered microorganisms. This subset of indicators should describe the undesired side–effects of the application of genetic engineering and should be included in the "risk intensity" indicators as part of the ESIs.

The other subset – *indicators for the intensity of intervention* – should monitor the *qualitatively new mode of genetic variation* in the genomes of GEOs that are deliberately released. Analogous to frequencies of mutation which measure accidentally occurring mutations, those indicators could mirror genetic variations. This subset represents indicators for "purposeful intervention into life–processes".

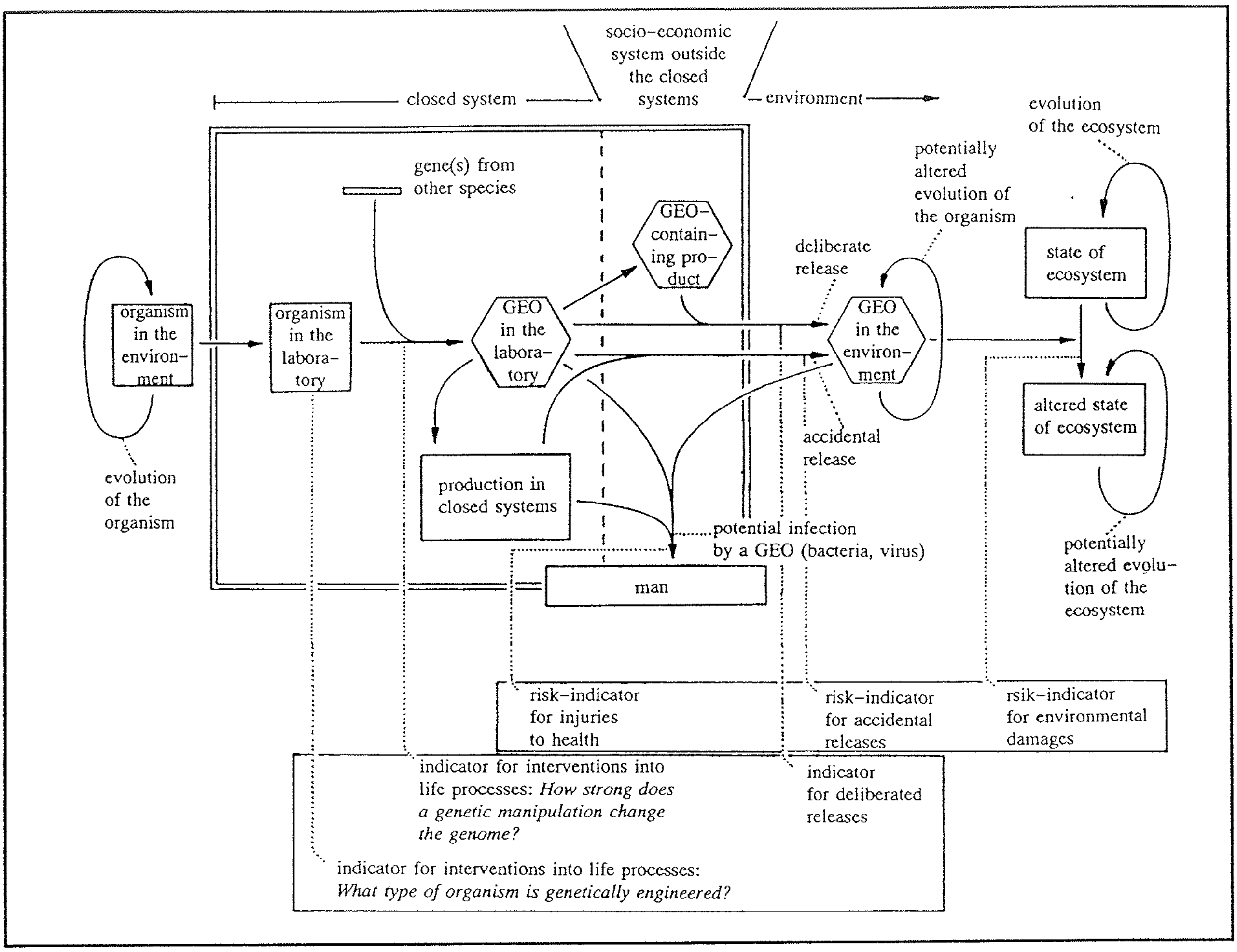


Figure 2: Starting Points for Indicator Development

Figure 3 gives an overview of the process of genetic manipulation, the different ways of release into the environment, and the possible effects on the environment. Moreover, it demonstrates possible starting points for indicators.

For genetic manipulation, the host organism is *isolated* from its environment and introduced into a *closed system* (genetic lab). There he is *transformed* with one or more genes (the fusion of cells or protoplasts as mentioned above is not considered here). Consequently he may be *released* in different ways (see Figure 3).

The potential *effects* of GEOs in the environment can be devided into *short–* and *long–term* aspects. On the one hand a GEO–population could cause short–term fluctuations in ecosystemic processes, resulting in an altered state of the ecosystem. On the other hand the new gene in a GEO could mean a "genomic shock"[21] that triggers a series of evolutive alterations. Such alterations could also change the evolutive development of the whole ecosystem.

We suggest the following conceptions for the development of indicators.

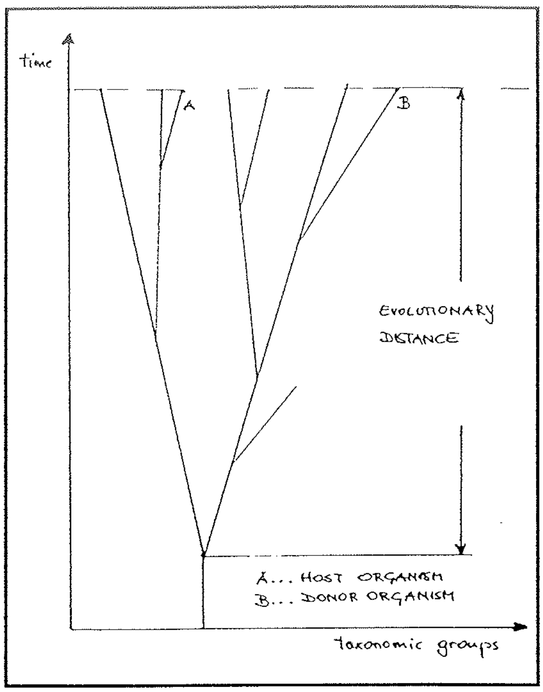


Figure 4: Possible conceptualisation of the "intensity of intervention": The evolutionary distance

Indicators for the intensity of intervention:

- The primary point of reference for the definition of such an indicator is the *transfer of genes between species*. We need a model to value and estimate the strenght of a genetic manipulation at the genomic level.
- Even if the process of gene-transfer is basically equal for all species, the resulting GEOs clearly are not. Thus we also have to consider the specific *characteristics of the host organisms*.
- Finally we have to bear in mind that not a single GEO but a population of GEOs is released. Thus an appropriate quantity for the amount of deliberately released GEOs is needed.

One possible concept for the evaluation of the "intensity of intervention", which we herewith want to put forward for further discussion, could be the "evolutionary distance" between donor and host organism.

Risk indicators:

- First there should be an indicator for the risk of *accidental release*.
- Secondly a risk of *infections* by certain genetically engineered organisms should be taken into account.
- Finally an indicator is necessary which refers to (relativly) short-therm *environmental damages* possibly resulting from a (small) fraction of releases.

It is the intention of this article to open the floor for the discussion of genetic engineering as relevant part of environmental information systems.

FINAL REMARKS

Some of the presented ideas still are in the stage of theoretical conceptualisation. Nevertheless they have been included here, because in order to improve the proposed information system it is essential to get as much feedback as possible. So we invite you, to send us your critics and, by doing so, to help us improving our work.

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