Chapter 1
Humans are a Part of the Biosphere

Act only on that maxim through which you can at the same time will that it should become universal law.
Immanuel Kant's Categorical Imperative

Quidquid agis, prudenter agas et respice finem[1]
(Whatever you do, act wisely and consider the end)

The blemished biosphere

Humans in the industrialized world have accomplished a feat over the course of the last two centuries that is without precedent in human history. With their determination and their machines they have succeeded in achieving an unprecedented level of material wealth. Due to these efforts the people of the industrialized nations live amidst a profusion of technical possibilities, products and services, which has--without a doubt--reduced the level of uncertainty, of risk, decisively. For hundreds of millions of people this wealth obviates the daily struggle for the provision of food, material needs and energy. If this is not "progress" in the best sense of the word, if this is not an achievement of human civilization, what then could be imagined progress, what, an achievement?

In this book we will concern ourselves with ecological themes, with the negative consequences of progress to date. To disavow progress would be to ignore the presuppositions of ones own work. The fact that we can ponder the effects of our achievements, that we can discuss them and understand ecological relationships, that we can research and write books are all direct consequences of these achievements. Perhaps it is therefore especially difficult for humanity to understand, or to merely imagine, that we are approaching limits--to understand that disastrous mistakes have been made.

The price for civilization's progress is and has always been to change the environment in which we live. These changes have acquired a new quality--for three reasons.

First of all: in order to favorably alter the environment, humans used to rely on the use of their own physical strength, the strength of their domesticated animals and on wind and water power, until the age of modern machinery--until James Watt's invention. The utility he could derive from nature, the productivity of his daily work, was limited. Since the invention of the machine this "labor productivity" has risen by a factor of thirty, forty or even fifty--in special cases up to fifty-thousand. In Germany's lignite open cast mines, one machine that is operated by five people is able to extract up to 240,000 metric tons of coal per day[2]. Machines have increased the human capacity for initiating material flows so dramatically that the unintended consequences have taken on a new set of characteristics.

Secondly: since 1800, humans have increased their numbers more than five-fold. Not only has the technical ability of humans to move material flows increased, but the number of people who use these technologies and who derive material wealth from them has grown.

Thirdly: for today's mass-produced goods, we rarely use the materials which we take from natural material fluxes in their preexisting state, as our ancestors did. The products which we produce, use and eventually throw away consist of materials which have been chemically and physically altered in numerous ways. The chemicalization of the material flows has led to a situation in which natural processes--which ordinarily break down and convert materials--are only able to affect the material flows emitted from the technosphere over exceedingly long periods of time.

The material flows which we set in motion severely disrupt natural development processes of ecosystems. The biosphere is forced to react in the following two ways:

First: The naturally occurring ratios of different materials are no longer unaffected, even on a global scale. CO_2 in one atmosphere is an example. Over the last 150 years humans have succeeded in changing its concentration in the atmosphere by about twenty percent, from about 280 ppm to more than 350 ppm (parts per million). It should not surprise

us if the biogeochemical cycles of the earth do not change to accomodate this anthropogenic strain. In primitive systems such reactions can be approximated. The more complex the system becomes--and the earth's atmosphere is an unusually complex system--the more difficult such an approximation becomes. Furthermore, the long-term and indirect effects cannot be accurately predicted at all.

Second: Materials are introduced into the environment which do not naturally occur there. A spectacular example of this are the CFCs; spectacular because it illustrates the degree to which one can be ignorant of the long-term consequences of such a chemical. The group of chemicals to which the CFCs belong is chemically very unreactive, which, from the perspective of humans and of nature, means that a chemical or biological reaction with a CFC is highly unlikely. In other words, they hardly affect biological processes at all--they are especially non-toxic. For decades this was agreed upon and because of certain other technologically desirable characteristics they were used in an increasing number of applications: in refrigerators, as foaming agents for expanded plastics, in aerosol cans and for cleaning printed circuit boards in the electronics industry. But suddenly measurements indicated a growing "ozone hole" in the stratosphere. We realized that in an entirely different chemical environment than was to be found on earth, the CFCs were no longer unreactive. In any case they were reactive enough to disrupt the unstable chemical equilibrium of ozone in the stratosphere--globally. No one had anticipated this with enough precision to have drawn the necessary conclusions. Sherry Rowland alone, while researching otherwise unrelated systems, recognized that such effects were possible with CFCs[3]. Up to that point, whether for shortsighted economic reasons or simply out of ignorance, no one had considered these effects to have been a necessary *evil*.

The possible future of humanity

Humans cannot afford to be indifferent to the ways in which the environment reacts to anthropogenic material flows. The human species is a part of biological evolution of life on this planet. This development was made possible by ecological systems that were and continue to be both complex and dynamic. This planet's biosphere--the sum of all life on it as well as the sum of all physical prerequisites such as moisture, climate, and others--has created the conditions under which an organism such as the human species could emerge. These conditions provided the conditions in which the human species could survive and develop what we refer to as civilization. If we alter these conditions--this support system--they will change from the way they were when human life became possible. It is not a question of 'if,' but rather of 'how much,' of 'what,' 'where' and--above all--of 'how fast.' Ecological changes must not necessarily and in every case be negative. They are almost always negative, though, when we force changes too quickly. This is precisely what characterizes our economic activity: time is supposedly money. As long as saving time translates into an economic profit, though, no economic system will prevail that can claim to be sustainable under "conditions of marginal ecological stability," to use a phrase of Udo Ernst Simonis.

If we dislodge the ecological systems from the state in which they made human life both possible and tolerable, whether consciously or unconsciously, we must expect that over the long term the conditions will become less favorable for our continued survival. The biological survival of the human species could become endangered. We do not mean here

that human biology would change in such a way that survival cannot be guaranteed. The changes in global ecology do not threaten our survival through effects on human metabolism, but rather through negative effects on our surroundings, such as the water supply, climate conditions, or the prevalent UV radiation.

Humans live within ecological surroundings and depend on them. In this sense we are creatures like all others. But this particular creature is intelligent enough to destroy the system which enabled its emergence. The biosphere of the planet is in a very fundamental way indifferent to this fact. It will most assuredly continue to exist--in some altered form. Ecological development is never dependent on one of the many life forms it has brought forth. If humans wish to have the biosphere continue to put up with them, they must see to it that the ecological conditions under which they became a viable species prevail. And if we expect ten billion people to remain within the carrying capacity of the earth, then we must be especially concerned about returning the ecological conditions to a more stable state.

Humans are stronger than the geosphere

What about the stability of the biosphere? The basic scientific premise is that the rapidly increasing anthropogenic material translocations are changing the evolutionary balance. These translocations are already greater than those from within the geosphere,[4] and in some cases exceed them by a factor of 200. For millions of years, geological processes determined how and when the faces of the earth would change; now humans have taken on that role. In pre-industrial nature--the result of millions of years of evolution--the material flows between environmental reservoirs were more or less a balanced state of affairs. Supplies of important biological materials such as air, water, soil and sediments remained fairly constant, if one looked beyond the inter-seasonal variations. Both industrial and economic forces have now disturbed these material flows, and the reservoirs are rapidly changing their composition, when compared to the speed of geological processes (Fig. 8). At some future date, other, new equilibria may establish themselves. But these new conditions will not be advantageous to humans because they are divergences from the conditions under which humans first emerged. Forest dieback, the ozone hole and changes in our climate are premonitory examples of this development.

Humans are in the process of calling into question the livability of the only earth they have.

The livability crisis will manifest itself in different regions of the earth in different ways. In some cases the determinant factor will be the climate--in others, the availability of drinking water, the changes in vegetation, or soil fertility. Each technical attempt at "improving" the situation, insofar as it is effective and affordable, will require the mobilization of new material and energy flows, which would serve to exacerbate the situation even further. Social conflicts, wars, urban flight, and mass-migration are sure to follow. In the end there will only be losers.

Humans against both geosphere and biosphere

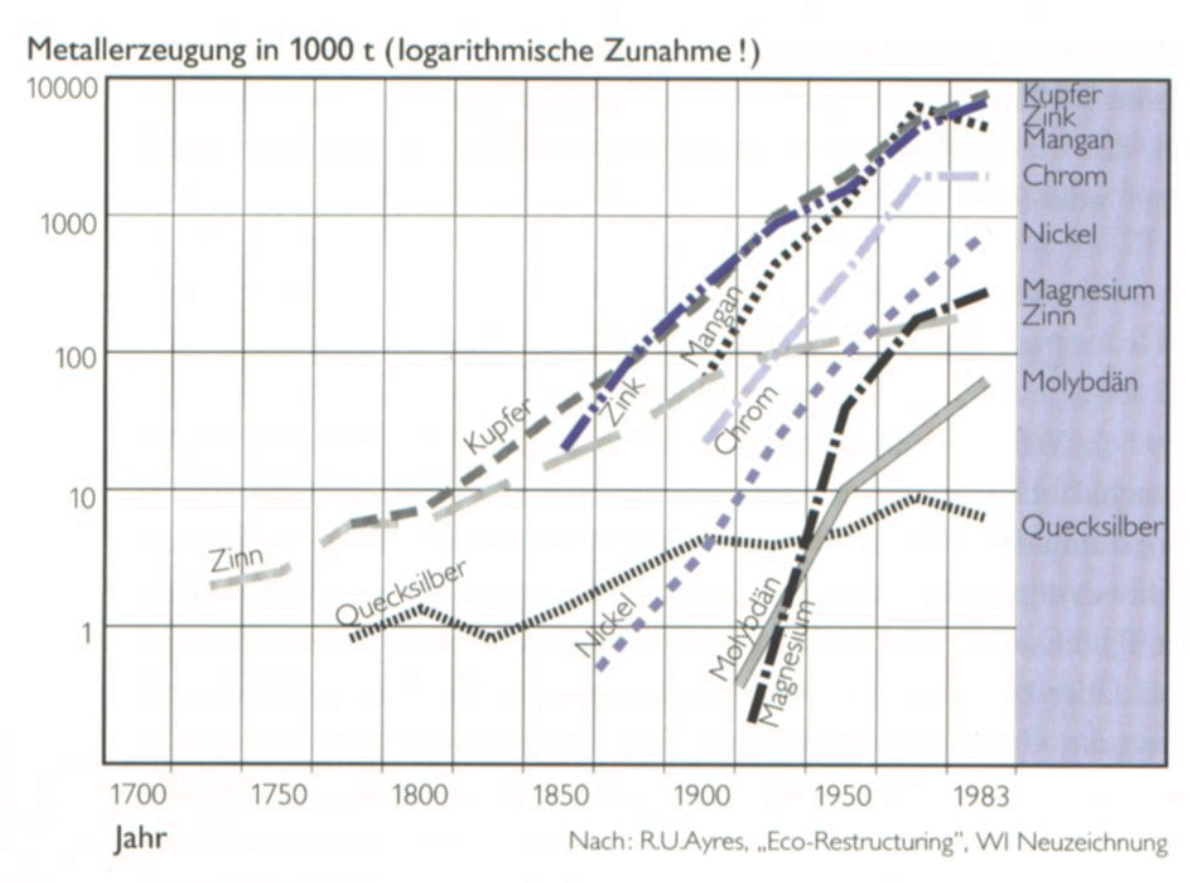

Fig 8: Seit Beginn der industriellen Revolution nehamen die menschenverursachten Stoffströme rapide zu, in vielen Fällen sehr viel schneller als die Zahl der menschen. Hier wird die Zunahme des Verbrauchs von Metallen dargestellt.

Commonly the human use of energy is used as a measure of the effect of human behavior on nature[5].

In a later chapter of the book we will articulate reasons why we feel this to be an inadequate measuring stick. The indirect consequences of energy "use" through technology are really only marginal from an ecological perspective. Energy "use" does become a relevant factor via the material flows associated with it. In this category we include the large quantities of water, oil, coal, natural gas, CO_2, SO_2, and NO_X, as well as the enormous amounts of overburden which are involved in mining coal, and the frequently underestimated magnitude of groundwater that must be pumped away (Fig. 9).

In addition to these material flows, which are directly associated with energy transformation, we include all of the others we move about: plowed soil, building materials, excavation materials, sand, minerals, water (used for hydroelectric power, irrigation, industry and drinking water), as well as industrial, agricultural and forest products (including those moved about in international trade) and all emissions, effluents and "solid waste."

When we talk about material flows in this book, we do not only mean those flows which humans manipulate or chemically alter for their economic value (see Table 1).

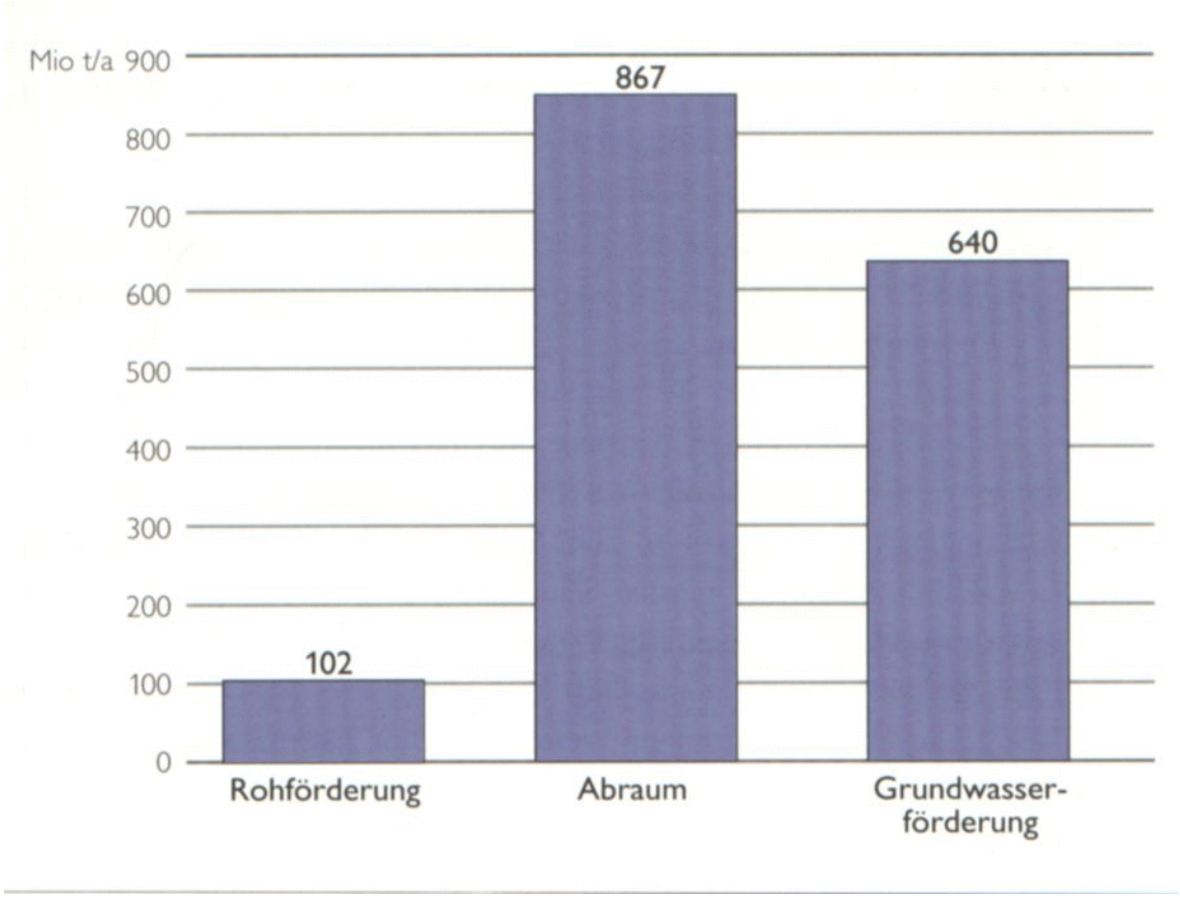

Fig 9: Bei der Gewinnung von Braunkohle im Obertagebau wird sehr viel mehr Abraum und Wasser bewegt als Kohle selbst.

Each movement of material, each dislocation of matter from one place to another is a material flow, with concomitant effects on ecological coherence.

These can be positive or negative effects. Material flows set in motion by nature can also be negative in the sense that functioning ecological *Lebensräume* (habitats or living spaces) are destroyed. A landslide in a mountainous area is an unequivocally negative ecological event for the landscape buried beneath it. Ecological conditions are subject to perpetual change because of the material flows which they set in motion. In the end new ecological relationships emerge. Nature is neither "gentle" nor "unchanging." Sometimes it is destructive and it is always in flux. Thus humans are not doing anything unheard of by mobilizing material flows.

But humans have not abided by the rules according to which nature plays the game. Natural ecological changes are, with a few exceptions, either slow, or they happen on a very small scale, or both. An ecological upheaval may destroy in one location, but another such upheaval may provide fertile soil for new life somewhere else. Throughout evolutionary history, ecological fluctuations have changed enormous, thriving landscapes into deserts. But nature has seen fit to change deserts into blossoming gardens in which new life emerged without the helping hand of a gardener. Overall, ecological changes have always been diverse and have brought forth diversity. Never have they favored one organism over time at the

expense of all others.

With humans it is different. They change their *Lebensraum* only for their own benefit--for short term benefits-- on a large scale and with tremendous speed. The areas in which the laws of evolution, unaffected by human intervention, are still valid are increasingly being crowded out. And naturally no new ecological diversity is brought forth through these efforts. Humans would not be capable of such a feat, even were they so predisposed, as the complexity of ecological systems far exceeds our ability to manipulate them in such a way.

Humans create new sets of prevailing ecological conditions on this planet, and we do not even know if one day there will still be room for us in the new regime. What we do know is that it is becoming increasingly unlikely.

Table 1 *taxonomy of anthropogenic material flows*

I primary materials*

1. earth** (including overburden, excavation materials and altered soils
2. geologic raw and building materials** (including energy carriers, sand, gravel, minerals and ores)
3. water**
4. air**
5. biotic raw materials (from organic and other agriculture)

II intermediate and final goods

1. industrial secondary and intermediate goods
2. industrial final goods***
3. infrastructures (i.e. transportation systems, buildings and facilities)
4. packaging materials

III waste products

1. solid and liquid waste
2. airborne emissions
3. contaminations

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* *Some of the "primary materials" lack any economic value in and of themselves. Some of the "primary materials" only partially enter into industrial products (i.e. ores, water and air).*

** *Materials which are either not or only partially entered into closed loops/circulation.*

*** *Final goods which are intentionally dissipative, in other words, they are emitted into the environment in such a diluted form that they cannot be retrieved (i.e. pesticides, exterior paints)*

The barrel is full

The biosphere is no longer able to swallow the material flows which humans set in motion--as if sinks existed into which it could all just disappear without any long-term consequences. The material flows must necessarily remain within the biosphere, where they force reactions with natural systems, and where they alter the biosphere itself. For millions of years these changes were either very small or they happened so gradually that they went unnoticed. A third possibility was that because they remained local, humans were able to move out of harm's way. In the meantime, however, it appears as if the productivity of our industrial systems has reached, if not overshot, certain limits. This cannot be determined from any single occurrence, but rather from the sum total of the warning signals, and the fact that these signals are increasing in frequency.

The big warning signals are *Waldsterben* (forest dieback), soil erosion, potable water shortages, the greenhouse effect, the ozone hole, respiratory diseases, species extinctions and pollution of the world's oceans. These warning signals are sounded because toxins are discovered in areas as remote as the frozen wastes of the arctic, and the deep wells in Provence. These signals are transmitted to us by scientists and environmentalists, by doctors, fishermen and foresters, by a few politicians, and by the growing surge of environmental refugees[6, 7]. For several years now, an entire economic sector, the insurance companies, has joined the ranks of those issuing warnings[8]. Especially the large reinsurance companies, those who insure other insurance companies against devastating losses, are finding evidence for these trends in their balance sheets.

The *Münchner Rückversicherungs-Gesellschaft*, one of Germany's most famous reinsurance companies, recently announced that the insurance industry will have to start changing the way it calculates[9]. Anticipated future trends will have to be taken into consideration as well, rather than merely extrapolating the events of the past, as has been the standard procedure. Premiums will have to rise and the deductible levels below which the policy-holder would have to pay will rise as well. The natural disasters which occurred in1992 were given as the reason for this announcement. The insurance managers argued that both the number and severity of the storms had markedly increased. In 1992 alone, 100 billion German marks worth of damage had occurred globally, of which only 40 billion had been insured. In total the insurance companies had enumerated 509 natural disasters, far more than in the preceding years. It was "surprising, that for the last six years, almost every year a record level of damage occurred."

The symptoms are there for those who wish to see them. But in many cases the symptoms are but the tip of the iceberg. Just one example to illustrate this: if the water in a well is found to have a concentration of nitrate that is unsafe for humans, this means that the nitrate has seeped through many soil strata into the groundwater, originally coming from fields that were too heavily fertilized (agricultural runoff). Some soils hold retain nitrate very well, though. So if it has made it into the groundwater, either the buffering capacity of the soils is already exceeded, or--and this is more likely--the soil structure found between the field and the groundwater does not bind nitrates very well. In both cases the nitrate concentrations in the well water are a sign that the soils in the catchment area of the well already contain high levels of nitrate. Unfortunately, these nitrate deposits can be mobilized,

if, for example, the climate changes and precipitation levels increase. The groundwater can then be contaminated within very short time spans.

As frightening as some of these symptoms are, they may often indicate much more dangerous conditions that are merely latent. Many changes that occur on a small scale, or over the entire biosphere, have the dangerous characteristic of only manifesting themselves after a delay. Once the symptoms have been recognized, it may already be too late to put on the brakes. A recent international agreement provides for a drastic reduction in the use of CFCs. Yet even if all the CFC-producing and consuming nations were to abide by these provisions immediately, these chemicals will persist in attacking the ozone layer of the stratosphere for several decades. This is because it takes them decades to reach the stratosphere, where they can begin to do damage. The CFC concentrations which are doing the damage to the ozone layer--as we are able to measure it--reflect those quantities produced and released decades ago. We do not know today how much more of the ozone layer will be destroyed, and how this will affect life on earth. We have stepped on the brakes. We can do no more at this time. We can only hope that the vehicle will be able to stop in time.

Another example: decades of air pollution appeared to have left the Great Lakes of North America untouched. No effects of acid rain on the water quality were observable.

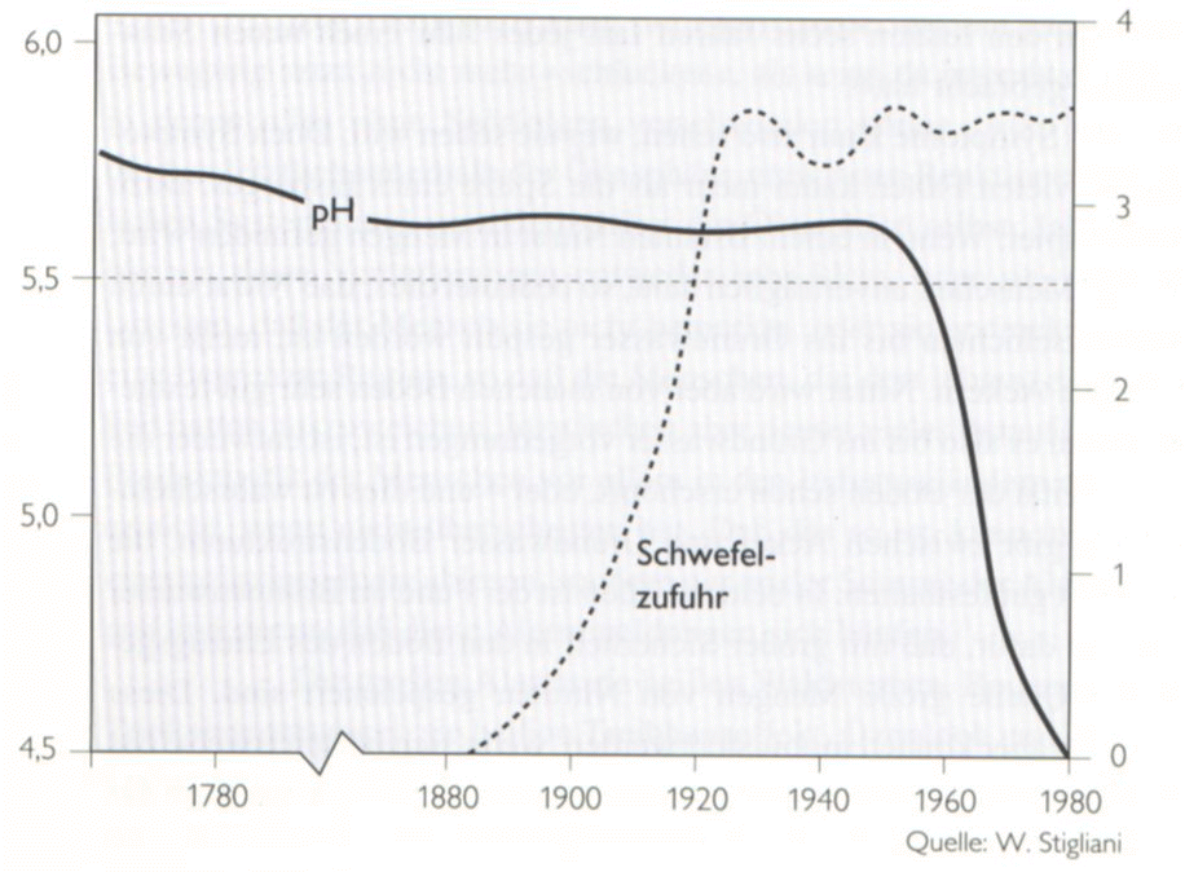

Fig 10: Gut fünfzig Jahre lang pufferte Wasser des großen Elchsees (USA) den Schwefel ab, der aus der Luft herunterregnete. Dann sackte der pH-Wert nahezu schlagartig ab - der See versauerte, als die Schwefelzufuhr sich bereits stabilisiert hatte. Niemand weiß, wieviel solcher Zeitbomben noch ticken.

Then suddenly the buffering capacity of the huge lakes was exhausted. Within a very short time, the water acidified--the effects were undeniable. In this case nature's ability to stabilize and buffer jointly suppressed all known symptoms up until the point at which a change in course was no longer viable[10] (Fig. 10).

Systems analysts refer to this capacity of ecological systems as "overshoot"[11]. External damaging influences manifest themselves with such a delay that the buffering capacity is exceeded. Even if the source of disruption is then immediately removed, the system may already be damaged so severely that it begins to erode. It no longer has the strength to renew itself and "turns over," reaching a different equilibrium. What the characteristics of this new equilibrium will be, and whether or not there will be room for human life is very difficult to predict. Were the ozone layer to disappear completely, life might be forced back into the oceans from which it emerged millions of years ago. All terrestrial life forms would be damaged so severely, either directly or through the destruction of their nutritional base, that few animal and plant species would be likely to survive.

Even if the ecological catastrophe is not characterized by such overt destructiveness, a species as demanding as humans might have a difficult time. If humans cannot find a more ecologically benign economics, which would include their behavior as consumers, then it would seem foreordained that our economic life in the next century or two would be determined by defensive actions against ecological catastrophes, which we are initiating right now. This would literally lead to a fight for survival that only the rich would be able to carry on, those who are sitting on the necessary raw materials and who can access the necessary experience and technical aptitude. We should be wary of too readily assuming that the OECD countries will necessarily belong to the privileged side.

Some indicators seem to show that we exceed the limits of the biosphere long before the catastrophe becomes one of global ecological proportions. Well in advance of that we will experience economic and social crises, both of which are inextricably linked. Meadows, Meadows and Randers[12], in the follow-up to their report to the Club of Rome, Beyond the Limits, drew up a list of indices that signal when overshoot has occurred within the economic sphere. Those indices which are the most important in our context are the following:

> *Capital, resources, and labor must be diverted from final goods production to exploitation of more scarce, more distant, deeper, or more dilute resources.*

In fact almost everywhere in the world coal and many other minerals are mined with increasing effort and declining yields from ever-lower quality deposits. The depth of bituminous coal mines in Germany is now a matter of kilometers. In the copper mine in Butte, Montana, the copper content of the ore has dropped from thirty percent to one-half of one percent. Where it took three tons of rock to obtain one ton of copper it now takes two hundred tons, without considering the increased requirements of energy and the increased amount of water that must be pumped off. So far this increased expenditure in industrial nations has not been a deterrent to the continued production of final goods. We still have access to high quality deposits of all the important raw materials, that can be extracted inexpensively--but often at the expense of the local populations.

Capital, resources, and labor must be diverted from final goods production to activities that compensate for what used to be free services from nature (for example, sewage treatment, air purification, flood control, pest control, restoration of soils, pollination, or the preservation of species).

Flue gas desulfurization in power plants and catalytic converters are two examples of the fact that we are well on our way to diverting extensive technical and financial resources to preserving the air we breathe in a form we do not consider downright toxic. The U.S. economist William Cline has calculated that a global climate change would likely cost the U.S. economy close to sixty billion dollars per year in decreased harvest yields, higher consumption of electricity, more difficulty maintaining water supplies, as well as in disaster relief[13]. Ernst Ulrich von Weizsäcker[14] estimates that we are losing about 3,000 metric tons of fertile topsoil every second. Lester Brown, of the Worldwatch Institute, calculated the loss of topsoil in the United States for the year 1977 at six tons of soil for every ton of grain produced[15]. In the Deccan region of India the erosion rate of topsoil lies between 40 and 100 metric tons per hectare per year, in the basin of China's Yellow River it is 100t/ha/a, and in Guatemala between 200 and 3600t/ha/a[16]. Soil conservation is still not a priority. In the places where it has been tried, the process of building up the soil has been a costly and tedious project. Yet here again, the effects are measurable in the industrialized nations, but are not felt in terms of reduced production of final goods.

Capital, resources, and labor are used to protect, defend, or gain access to resources that are increasingly concentrated in just a few remaining places.

The world has seen its first war over cheap oil--the Kuwait war of 1991. The plans to explore the potential for oil-drilling in the ecologically sensitive Arctic National Wildlife Refuge in Alaska is an unmistakable signal as well. The experiences with the exploitation of Russian oil and natural gas reserves have also been ecologically catastrophic.

So much for the signs of "overshoot." We have every reason not to wait until catastrophic ecological reactions become undeniable. The biosphere's reactions to anthropogenic material flows must not necessarily lead to collapse. The attempt to counter the prevalent trend is always worthwhile, and the sooner the better. In our case this means humans must drastically reduce their energy and material flows. We, especially those of us in the industrialized countries, must make do with significantly reduced material flows. We must dematerialize our goods and services.

Chopping away at the tree of economic prosperity

Contemporary Western industrial products and services destabilize the biosphere because they are produced, used and eventually discarded with excessively wasteful amounts of materials--over their entire product life. Every industrial product and every service carries a "rucksack" of materials around with it, which have accrued at one phase or another of the product's life. Each ton of lignite coal from the coal-producing areas along the Rhine carries with it a "rucksack" of eight tons of overburden. Each kilogram of platinum carries with it 300,000 kg of dislodged material with it--just from within the mine! It would generally not

involve any great technical difficulties to achieve the same goal--the same "service"--with considerably less material expense. One can, for instance, make even diamonds with fairly compact machines today, instead of having to mine them.

If large material flows must be moved to produce a product, or to offer a service, then this product or service has a high "material intensity." In an analogous way, if it takes a relatively large quantity of resources to produce very little, the "resource productivity" is low. In western industrial nations the standard production process has a higher material intensity and a concomitantly lower resource productivity than would be technically possible. The same holds true for the formerly planned economies. Resources have been and continue to be used wastefully. It is not the availability of resources that is limiting economic growth. This view, associated with the publication in the early seventies of the sensational report to the Club of Rome The Limits to Growth, has retreated into the background, or rather into the future. The sum of ecological feedback due to the effects of anthropogenic material flows will threaten humans, nature and even economic growth long before we run out of resources. Hubert Markl has characterized this predicament as having three components:

1. *The problem of solid waste accumulation*
2. *The problem of external environmental costs which one could term thoughtlessness, although a lack of foresight might be more apt*
3. *The problem of counter-evolution, or better nature's resistance*[17]

As long as business as usual, such as we have witnessed over the last two hundred years, does not give way to new approaches, we will force the biosphere to react with ever greater force, to the point at which our lives will become increasingly shaped by defensive strategies to ward off ecological disasters of our own making.

Numerous attempts to quantify in monetary terms the costs of environmental disruption indicate that we already devote a considerable portion of our GNP not to improving the quality of life or to increasing our wealth, but to repairing the damages incurred because of our production and consumption levels. These "defensive" expenditures are estimated to be twelve percent of GNP for Germany[18]. As provisional as numbers from such research must necessarily be, they do make a fundamental point: if we destabilize the biological basis of our existence, then we will have to take on the responsibility for some of the services formerly provided by nature for free. And it will be up to us to foot the bill and to deal with the unanticipated setbacks. If we fail to eventually get the message, then it is very likely that we will one day no longer be able to foot that bill.

Ernst Ulrich von Weizsäcker has put it this way: "We are entering the century of the environment, whether we want to or not. In this century everyone who considers himself a realist will be forced to justify his behavior in light of the contribution it made toward the preservation of the environment"[19]. The sobering quality lies in the words "whether we want to or not." Either we make the next century a century of the environment, or the environment will force us to do so. Weizsäcker does not mean for us to take the "century of the environment" as a promise either. "What is meant is the cruel reality which is already manifesting itself and which will be culturally determinant if humans continue looting the planet for a decade or two to come."

The "richer" nation states, those who in the past have accumulated wealth at the

expense of the biosphere, will occupy the more advantageous initial position in the fight against increasingly malevolent ecological conditions, and will be better able to actively or passively protect their citizens. They have access to more and better technology and knowledge. In these countries, infrastructures are in place with which to effectively dampen, repair or conceal the environmental disruption. They will have the opportunity to build dams, literally, as well as figuratively. They will build physical dams along the coasts against rising, or at least more stormy, seas, and figurative dams against the millions who will take any chance they get to flee to places where even poverty is preferable to the conditions they had to face at home.

We must draw the inevitable conclusion: goods and services must be dematerialized dramatically, from cradle to grave, and the industrial nations must take the first step. How dramatic the dematerialization must be we will try to estimate in the chapters ahead. We will also show how much a technology which deals with resources in a different way can achieve. The necessary change, however, is not merely a technical one, but a structural one as well. It must encompass large areas of economic life as well as cultural values.

Structural change and the immune system of human societies

After this brief outline of the conceptual starting point of the book and its goals, one note to the impatient, who find themselves wanting to give up in light of the slowness with which environmental policy progresses in a world that is so unquestionably heading for dramatic changes (if it is not already in the midst of them).

It is true that warnings of environmental disruption caused by human activity are nothing new, and it is true that these warnings have generally not had much effect in the political sphere. It is also true that science today finds itself in an entirely different situation than a century ago; its relationship to politics is closer, and its knowledge is deeper. But this justifies neither impatience nor resignation. Let us look back. How long has it been since the first large scale, or even global, changes in the biosphere became visible--visible to everyone? We have known of damage to forests for a long time, but this has generally been a phenomenon limited to industrial regions. It has been scarcely thirty years since we observed dying forests far away from industrial centers, and dying lakes in Scandinavia and the U.S., in areas that would otherwise be considered pristine. The ozone hole was discovered less than ten years ago.

This means we now know beyond a doubt that some effects of human activity do not, or no longer, dissipate and become harmless. We know that we must act, but we have not known it for very long when compared to the time frames within which societies are able to rethink.

We obviously are also dealing with ignorance, with power struggles and powerful, shortsighted economic interests. We also obviously do not know how much leeway the biosphere will grant us to experiment and drag our feet. If we want to bring about the transition to a more ecologically benign economics within the market system and in a democratic fashion, then we have no choice but to anticipate the inertia of societal learning processes and to use the democratic means at our disposal to effect change.

If we hope to avert an "ecological revolution" or even an "eco-dictatorship" we will have to begin the ecological structural change very soon.

Every society has a defense mechanism that impedes change which might overtax the whole or the individual. We could refer to this as an immune system[20]. This immune system is as necessary for society as the biological one is for the health of the individual organism. If internal or external circumstances force a society to change too many things at once, bad things can happen. One can complain about stubbornness and conservatism or even about ecological stupidity, but one should keep in mind that the necessary transformations require a broad consensus. This societal agreement will be the more difficult to achieve, the greater the internal conflicts are within a society as well as on a global level. Politics based on consensus has never beena place for simple solutions; the eco-politics of the future will be even less sympathetic to such attempts.

One must take this immune reaction of society into consideration if one intends to initiate such a fundamental structural change as would be expedient to ensure the long-term stability of the biosphere. The goal must be to set in motion developments that permit society to discover what had been foreign, and to embrace it as something positive. This would then not be a revolution, but a kind of self-help, allowing new ideas to grow. The prerequisite for achieving this goal is to initiate developments at the right point. To stay with the medical analogy, we need to apply the right stimulus at the right "acupuncture points," but we must be sure that the points are carefully selected.

We shall return to what constitute expedient "acupuncture points" in the upcoming chapters. The "acupuncture point" *par excellence* is without a doubt the *price* of using the environment. Globally, few issues are as much a matter of course as for people to make their decisions about investment and purchasing according to the prevailing market prices. If prices "speak the ecological truth" as Ernst Ulrich von Weizsäcker has put it[21], much of what would be ecologically necessary would take care of itself.

A second "acupuncture point" is the availability of *information* about the ecological relevance of one's actions. This information is indirectly contained in the prices, insofar as they reflect the ecological costs involved. If the goods and services which are ecologically "costly" have a high monetary price, stickers and certificates with purchasing suggestions are no longer as necessary. As long as the prices do not meet these criteria it will remain important to make use of symbols such as the "Blue Angel," denoting any ecologically relevant information, to augment the incomplete price.

A powerful means available within our form of politics is to show that alternatives are available and achievable. Another goal of this book will be to point out some of these alternatives.

[1.1] *The latin translation of a phrase found in a book of the Apocrypha, Jesus Sirach, 7:40.*

[2.2] Information from The Rheinbraun AG in Cologne.

[3.3] Molina, Rowland, Stratospheric sink.

[4.4] Lester R. Brown, State of the World 1992. New York: W.W. Norton, 1992.

[5.5] We speak of energy "use", but should not forget that energy is never used up; rather it is transformed. The heat of steam is converted to the turning motion of the turbine, which in turn is turned into electricity. This then is converted to the motion of the streetcar's wheels and into the friction generated by those wheels and the brakes. In the final analysis all energy transformation processes yield waste-heat, equal in content to the energy with which we began, but in a form no longer usable. Even so, this heat warms the earth's atmosphere ever so slightly.

[6.6] Al Gore, Earth in the Balance: Ecology and the Human Spirit. Boston: Houghton & Mifflin, 1992.

[7.7] Weizsäcker, Earth Politics.

[8.8] Schweizer Rück, Umweltschutz--Lebensschutz. (brochure) Zürich, 1989.

[9.9] Frankfurter Rundschau, 23 April 1993.

[1.10] William Stigliani, Changes in valued "capacities" of soils and sediments as indicators of nonlinear and time-delayed environmental effects, in: International Institute for Applied Systems Analysis (IIASA), November 1988.

[1.11] Donella Meadows, Dennis Meadows, and Jørgen Randers, Beyond the Limits: Confronting Global Collapse, Envisioning a Sustainable Future, Vermont: Chelsea Green, 1992.

[1.12] Ibid.

[1.13] Lester R. Brown, "A New Era Unfolds." in: State of the World 1993. New York: W.W. Norton, 1993.

[1.14] Ernst Ulrich von Weizsäcker, lecture manuscript.

[1.15] Lester R. Brown, State of the World 1989 and 1990.

[1.16] David Pimentel, World Soil Erosion and Conservation. ed. in Cambridge Studies in Applied Ecology and Resource Management.

[1.17] *Hubert Markl, Die ökologische Herausforderung der Wissenschaft. Festrede zur 172. Ordentlichen Mitgliederversammlung der Senckenbergischen Naturforschenden Gesellschaft, Frankfurt, November 14, 1989, in: Natur und Museum, 120 (4), Frankfurt a.M., January 4, 1989.*

[1.18] Christian Leippert, Die heimlichen Kosten des Fortschritts. Frankfurt a.M., 1989.

[1.19] Weizsäcker, Earth Politics.

[2.20] Klaus Woltron, Der Wald, die Bäume und dazwischen--Die Suche nach dem verlorenen Ganzen. Wien 1992.

[2.21] Weizsäcker, Earth Politics.