Chapter 2
Environmental Policy Today

The Minister of the Environment today is still too much of an end-of-the-pipe minister, someone for ex-post environmental repairs. Others are making sectoral policy, and the Minister of the Environment adds a little filter of environmental recognition at the back. This is and remains a second-best scenario; it would be better to include the issue of environmental compatibility in the initial policies.

German Minister of the Environment, Klaus Töpfer, in an interview with the "Frankfurter Rundschau," June 1, 1993.

Classical environmental policy: water

Frankly most ecological problems have not really been taken seriously by the majority of people--or by politicians. The reason for this is a narrowed focus. Where changed environmental conditions directly affect human well-being, they are taken very seriously and expeditious relief is made a political priority. The subtle and usually very slow changes in our biological life support systems brought about inadvertently by human activity are often the much more dangerous and insidious ones. The narrowed focus may obstruct our view of the real problem. By trying to ameliorate the perceived problem we may be unwittingly causing greater harm to the systems whose support functions we have yet to appreciate. Furthermore, we might very well commit the fallacy of viewing ourselves as apart from the biosphere rather than a part of it. But humans live within, and because of, the biosphere. As long as we allow the dying forests to remain the concern of environmentalists and foresters, we have not yet understood what is happening to our life support systems. To put it differently, our concern does not really appear to be for the well-being of humanity, but for the well-being of one generation--our own. Throughout history this has never been a contradiction, but because of the speed with which we are transforming our biosphere, it has become one.

Our relationship to water illustrates our short-winded reactions to fundamental problems. This example also illustrates an area of concern in which some issues, though far from enough of them, have taken a turn for the better.

One of the first effects of industrialization on what we now call "the environment" which caught most people's attention was the pollution of rivers and streams. The contribution made by fouled water to diseases such as cholera and dysentery are as old as the cities themselves; but this isn't our concern, because for centuries people did not understand these connections. What we are talking about are the effects everyone can see and smell. Water that is dyed with bright colors, that is choked with large amounts of foam and out of which dying fish are washed up on the banks.

The earliest disputes over the preservation of streams and rivers in the last century are chronicled in Wilhelm Raabe's novel <u>Pfister's Mühle</u>[1]. This first of disputes was not instigated by environmentalists who appreciated the ecosystemic integrity of the water, but by fishermen who saw their livelihood threatened. Initially the fishermen lost. Apparently their contribution to the general welfare was thought to be less important than that of the polluting industry. From an ecological perspective, many other such defeats must have been suffered since that time, as our pride over aquatic life returning to rivers as large as the Rhine and the Thames can attest.

Once freshwater fishing ceased in Western Europe, the inhibitions vanished. Karl Otto Henseling characterizes quite vividly the development of jurisdiction and of the laws governing trade and industry in the second half of the nineteenth century, in his book on the history of the chemical industry[2]. The verdict of the *Reichsgericht* (German Supreme Court until 1945) of December 22, 1897, from which Henseling quotes the following sentence, constituted a milestone in this development. "The water flowing in a public as well as in a privately held river constitutes the sluice provided by nature, not only for runoff, but for the frequently contaminated water necessitated by economic enterprise and which must be carried off, as well."

Not until after World War II was anything done about this state of affairs, and even then it was not for any ecological reasons. Foam was blown out of the streams onto the streets and disrupted traffic. Property values dropped if they were in the vicinity of flowing water, and swimming in open water was forbidden almost everywhere. Today Germany, at least the western parts, can hold its own in an international comparison. It possesses one of the densest networks of water treatment facilities using the very best technologies. According to the newest OECD statistic[3], in Germany 86% of the population (West 91%, East 62%) are connected to a public sewage system. In Great Britain it is 87%, in France, 68%, in the U.S.A., 74% and in Japan it is 39%. The OECD average is at 62%.

And yet we are still forced to prohibit swimming in an attempt to protect ourselves from most of the rivers. Even so it has still not become a public issue that cities and even many rural communities draw their water from deep wells or pipe it in with the help of aqueducts from reservoirs that often lie up to several hundred kilometers away. The reason for this situation is frequently that their own ground water is either insufficient, or too contaminated with nitrates and other pollutants. The health of Lake Constance has been threatened once already, but was saved. The motivation behind preserving it was partly due to tourism, and partly to the fact that central Europe's largest lake was in the process of being designated the future drinking water supply for several millions of people.

While the waterways are becoming "cleaner" in Germany and in other European nations, the efforts to preserve the abutting oceans, which would very definitely be in the interest of the fishing industries, have not shared in the success.

Environmental and health policies?

We still don't pay adequate attention to ecological connections. We do not care to maintain their integrity for their own sake. We act when our interests are at stake.

We have always asked: what the are effects of individual substances, and we have rarely gone beyond the toxicologist's highly specific viewfinder. Dioxins are not a problem for ecosystems, they are a problem for human health. Formaldehyde, asbestos, pentachlorophenol (PCP), lead and cadmium share a similar role.

We find ourselves asking about toxicity, about carcinogeneity and about other negative consequences to humans, to a few select plants, animals, microorganisms and communities. Environmental policy has dealt primarily with the question of whether the anthropogenic substances found in nature are harmful to humans. Surprisingly, the question is never turned around. We never ask if the things that benefit us might not harm the environment. No systematic attempt to determine the toxicity of medicines with respect to the environment is presently undertaken anywhere in the world. How fish might react to ingesting valium is still not high on anyone's list. (Klaus Töpfer, the German Minister for the Environment, has proposed that such a criterionbe applied to the testing of medicines.)

A distinction between health and eco-politics is not commonly made. In the interest of better protecting the environment , such a distinction would be very advisable. What is called environmental policy today is often a combination of the two. If the Ministry of Environment were to focus its efforts on truly environmental problems, it would have a very positive effect, in light of the limited resources at its disposal.

In this book we wish to distinguish between the terms health policy, environmental policy and eco-policy. Central to our health policy is the health of the individual person.

Eco-policy, on the other hand, is concerned with the condition and stability of the biosphere. In the final analysis we do, admittedly, come back to human welfare, to their survival on this planet, to their long-term well-being, their opportunities for self-realization and their economic interests. To reach this goal, eco-politics must look beyond the individual, beyond the present generation, beyond borders and concern itself with the long-term stability of the carrier systems, which make human life possible. This is an entirely different approach than the environmental policy which targets pollutants. Pollutants and their toxicological and eco-toxicological effects are but one of several categories with which eco-politics must be concerned. Classical environmental politics concerns itself with cleaning up a lake which has been contaminated through human activity; eco-politics has as its goal the preservation of our ecological inheritance, and must therefore deal in an ecologically beneficent manner with material flows, energy and the available surface areas of the earth.

Environmental policy deals most frequently with the ends of a human activity, eco-policy deals with the beginnings.

Environmental policy can fall back on administrative law, injunctions, prohibitions, laws, conditions and other such instruments. The goal of eco-policy is to effect a profound structural change in the economy.

Returning to the example of water: pollutants in fresh water are simultaneously a health threat to humans and of concern to the environment. Protecting waterways thus remains an important goal of both health and environmental policy. The ecological problem, though, does not have to do with the small amounts of toxins suspended in the water, but with the millions of tons of soil which erosion has washed away, or even with the vast quantities of water itself which we divert into canals or use for irrigation. Water is diverted, rerouted, drained and pumped to obtain other economic goods and services such as hydroelectric power, coal, sand, highway systems, entire cities and many other things. Whether or not the biosphere will react to such interventions is rarely taken into consideration.

We do not mean to imply that humans should not use or divert naturally occuring material flows. It is just that to date, humans have done so on such a grand scale and without properly understanding the consequences--without researching the consequences. Too rarely is an ecological perspective invoked, permitting the question of whether this intervention was necessary, or whether it could have been carried out with less of an impact. Instead the narrowly economic perspective is chosen.

In Germany it is generally believed that inland navigation is especially ecologically benign. New numbers from Hartmut Stiller[4] of the Wuppertal Institute indicate that the picture is not that clear. If one includes the tons of building materials that must be moved about for the construction of canals, and if one divides these quantities by the number of tons of freight and the distance over which they are transported along these waterways, inland navigation fairs only marginally better than road or electric rail transport. The difference is on the order of ten to fifteen percent, and the amount of environment required for each ton-kilometer lies above 300 grams! As a comparison, a small diesel truck burns between sixty and eighty grams of fuel per ton-kilometer of freight. The high numbers for barges on inland waterways result from the construction requirements of the canals. In building the locks and lining the canals, enormous quantities of earth as well as cement and steel are required. Using an existing waterway is not very expensive, although in some cases the dredging procedures are considerable, and the locks are subject to significant stress, whether in rivers or canals.

Over the last decades humanity has experienced the local and global repercussions of the biosphere to anthropogenic material flows, which had previously been considered harmless (collapsing subsurface mines, the Aswan High Dam in Egypt, CFCs and CO_2). It seems that humans would do well to anticipate a biospheric reaction in the short or long-term, every time they move large material flows. Whether this will actually occur, and how, where and when can only be predicted in those cases where we have access to specific knowledge of the effects and interdependent chains of effects of these substances within the biosphere. This rather coincidental and necessarily incomplete knowledge is not a very confidence-inspiring foundation for policy-making, especially when the goal is to initiate reliable structural change with respect to the economy. What we need is an indicator or measure which can be referenced by both policymakers and economists in the cases where specific knowledge is either incomplete or nonexistent.

Pollutant of the week

"Classical" environmental policy is in a dilemma of a different kind as well: it strives to achieve something which it cannot.

Humans have so far dealt with the environment's reactions in a manner already caricaturized as "pollutant of the week." This caricature implies that we are always ready to act when the environment surprises us, or if an accident occurs which makes the headlines.

Following industrial accidents involving chemicals, the public is given the impression that no one has control of the situation. It begins with a statement by the company president that everything is more or less under control and that there is no danger. No one believes him, least of all the press. At this point the public receives a very extensive series of impressions which are exceedingly difficult to sort out. Suspicions, insufficient knowledge of the actual dangers involved in this "unprecedented" event, attempts at winning political brownie points, visual recordings of much laborious cleanup work as well as human suffering and anxiety are fused into a series of impressions that ebb and flow along with the news media's attention. An interest in the actual effects and in what we may have learned has never been the characteristic attitude of the mass media anyway. Who knows what is going on in Bhopal or Basel today? All of these accidents do in fact lead to new understandings and often to new investments and improvements in management to better avoid such events in the future.

The problem is that the next accident will most certainly occur at another location within the same or another factory, and will involve other chemicals. Then, as viewed from outside, everything seems to go out of control. For the continuation see above. . .

This book will not further illustrate the problem of the "pollutant of the week." Many publications exist on this topic[5]. It is also not our intention to add to the debate over which products are good for our society, and which constitute unacceptable luxuries or are the result of misleading advertisements. What concerns us are the excessive demands which *all* products make upon nature.

The phenomenon of the "pollutant of the week," with its recurring dismay over the "unprecedented" effects, serves to illustrate quite well the fact that our knowledge of chemicals and the increase in such knowledge over time is neither an adequate nor a very stable foundation upon which to build an ecological economics. If one considers that roughly 100,000 materials are synthesized and sold on the market today (with 20-30,000 accounting for the greatest quantity); if one considers that emissions and discharges constitute another 100-200,000 and if one realizes that nature produces millions of different materials, one must recognize the fallaciousness of imagining that we could ever explain complex environmental problems--let alone predict them--with the help of incremental and specific examinations of individual substances.

This statement obviously excludes substances which, by their very nature, are unequivocally lethal, such as concentrated hydrochloric acid, strychnine or dioxin. In responsible societies, such substances will hardly be permitted to acquire ecological significance for health reasons alone.

The inability to understand or predict these interrelationships is not only due to the sheer number of chemicals, materials and compounds humans release, but also to the complexity of those biological systems receiving them. The variety of possible reactions and the range of their possible intensities, the generally delayed reaction time of the biosphere as well as the frequent physical separation between cause and effect all bear on the issue of our limited understanding. (Who would have thought that hairspray would contribute to the destruction of the ozone layer thirty kilometers above our heads?)

We cannot condone the planning of profound international structural change of the economy on the basis of a small number of more or less randomly selected material flows recognized to be ecologically "harmful." Each year we would then be faced with having to add several new "pollutants" after necessarily exhaustive international deliberation--and our planning would have to be revised accordingly.

If such an incremental approach were to inform political decision making, the result could easily be the creation of other problems of comparable magnitude elsewhere. We will give two examples of this later on in the chapter. Furthermore, the perspective of a single discipline cannot possibly be expected to predict global ecological consequences of our actions with any political precision. From the perspective of scientific theory it seems reasonable to conclude that humans will never be able to surround all imaginable effects, all synergies and antagonisms of materials and compounds in the environment, let alone predict the working out of these relationships in time and space with enough time to effect meaningful political interference. Even if it were possible, which scientist would be willing to carry the political and economic responsibility of such predictions?

Many global environmental effects manifest themselves very gradually, over decades. Beyond a certain point it doesn't matter much if something about the technology changes. Once the reactions in the biosphere have been initiated, they can sometimes continue for decades. They cannot be stopped, and can potentially even develop in an irrevocable manner with a dynamic all their own and independent of our attempts to interfere.

It is scientifically fundamentally impossible to examine, simulate or quantify, let alone monetarize all possible chemical, physical, and biological effects on ecological systems, even for a single substance that we have introduced into the environment.

Environmental policy which suffers from these limitations is unable to do more than clean up where damage has already been done, and take precautions to prevent known problems from recurring in the future. While this is far more than is currently done in most countries, it is insufficient as a guide for structuring economic processes in such a way that they will continue within ecological boundaries over time.

Principles for environmental protection

The following three principles were formulated in the German Parliament in 1973:

1. *The precautionary principle*: environmental policy shall prevent damage, not just remove the effects.
2. *The principle of cooperation*: various sectors of society, such as the economy, the government and unions shall participate in environmental policy decisions.
3. *The polluter pays principle*: the party responsible for the damage must pay the cost.

After twenty years of experience with these principles, their effect with respect to material flows can be summarized as follows:

1. Avoiding materials that have been identified as environmentally dangerous cannot provide a basis for a precautionary policy. We have already mentioned the reasons. Nevertheless the precautionary examination of new materials prior to their introduction into the market, and continued monitoring such as required by the *Chemikaliengesetz*, is sensible because in this way, many particularly noxious effects can be avoided.

2. The principle of cooperation is sensible and has been effective wherever governmental agencies inquired and listened to the parties involved, prior to making a decision. This holds true for legal procedures as well as for voluntary agreements. The principle of cooperation has been effective more often than the public seems to believe. Nevertheless, improvements would be welcome. This also holds true for the impartial willingness to engage in dialogue on the part of industry, consumer advocacy groups and unions. The Germans' willingness to enter into discussion of these matters has not kept pace with their economic strength. Especially television, sadly enough, falls short of providing any examples worth imitating.

Eco-politics, as we propose in this book, requires a profound, and above all, international, societal change. Such change will not come about without the full participation of all social groups and individuals. People need to have access to reliable and simple information about the environmental significance of processes, goods and services so they can be participants in the formation of political objectives and are able to make sense of their role as consumers in the marketplace. Consequently we require a generally accepted method for measuring the environmental stress intensity of political and economic alternatives if we hope to succeed.

3. As sensible as the polluter pays principle is, it has remained internationally ineffective. As long as cause and effect of ecological disruption occur within the borders of a nation this principle is a practical approach, even though the implementation is far from straightforward, even under these circumstances. But in the international arena the hurdles

have been too high. This derives partially from the fact that international trade flows are so interwoven and that the question of responsibility and ownership are sometimes far from clear. It also has to do with the fact that the countries of the industrialized North have built up their wealth with resources from around the world for two hundred years. The countries of the South perceive this as two hundred years worth of accumulated environmental sins on the part of the North, and demand reparations in the international arena.

Once we have come to an international agreement on the principles according to which the environmental significance of processes, goods and services shall be measured, we will be in a position to quantify environmental damage and identify their causes. Such a procedure could even relate the respective amounts of environmental damage associated with functionally equivalent outcomes. This would be highly relevant to future GATT negotiations[6]. In this book we will be introducing such a procedure.

Alongside these three principles, we could imagine adding the following principles to the list, constituting an outline of a future eco-policy. We suggest the following areas:

1. The plausibility principle should become the basis for our economic decision making. I.e., whenever possible, the decision making process should favor alternatives (when such exist) which minimize the environmental stress potential.
2. Wasteful use of matter, energy, and space (unnecessarily lavish from a technical perspective) inevitably leads to undesired ecological effects, often across national borders.
3. Societal contracts on the national and international level are a prerequisite for a sustainable economy, as the market is incapable of internalising the ecological costs of mistakes[7].
4. Economically, technologically, and societally amenable adaptations to the conditions imposed by the ecological guard rails require decades; they presuppose long-term political reliability and stability.
5. The decision making power of national governments includes the care of the biosphere and not merely the right to unlimited use of its resources.
6. Existing facilities and products should not be replaced with ecologically preferable solutions until such a replacement would be ecologically beneficial overall.
7. The principle of convergence between South and North, East and West for the use of natural resources.

Reasons for the dilemma of environmental policy

It is important to understand fully the reasons for the dilemma of classical environmental policy if one is about to propose new concepts in their place. Six reasons are enumerated here. We will be returning to them periodically throughout the book.

1. The failure to recognize systemic mistakes in our economics. These mistakes are not inherent to the market system, but rather derive from the way in which we currently practice economics. This economic system is oriented toward deriving the greatest possible profit from the available capital and labor. It maximizes the capital and labor productivity.

By contrast the raw materials do not count for much at all when it comes to determining the final price of the goods and services. One need only look at the prices of raw materials on the international markets in a daily paper to realize this. Resource productivity is therefore not maximized. Optimization at the level of the firm leads to economically and ecologically nonsensical results today. It is profitable to sell apples from New Zealand in Central Europe, and Dutch tomatoes (consisting mostly of water) in Vienna. It is also profitable, as Stefanie Böge from the Wuppertal Institute has shown in considerable detail, to accumulate unimagined transportation distances for a glass of yogurt. (see the chapter "The travels of one glass of yogurt.")

2. The assumption that the sum of incremental political reactions to environmental problems and subsequent "measures for their amelioration" will add up to a long-term environmental policy. We have discussed this already in some detail.

3. The confusingly large number of complex, often overly specific, and internationally incompatible assumptions and data from both real and imagined experts which are brought to bear on the causes and strategies for the elimination of specific environmental problems.

4. The absence of a rugged ecological indicator with which to approximate the extent of environmental stress associated with the provision of *all* economic goods and services, and with which to make directionally stable improvements possible.

5. The absence of internationally recognized methods for Life Cycle Analyses (LCAs).

6. The deeply rooted uncertainty over the extent of the necessary structural change of both economy and society necessary to effect the long-term restabilization of the biosphere.

Humans have realized that the biosphere is no longer in balance, and a number of things are happening in the course of attempts to right past wrongs. Successful restorations are no longer the exception: the salmon returning to the Thames river, perhaps even to the Rhine in the near future, the de-linking of economic growth and energy consumption in countries of the North, the increase in total area of the nature reserves in Germany, and much more. Unfortunately we can just as easily find examples of situations that have worsened. Presently the most alarming are the signs of human-induced global climate change as well as decreasing concentrations of ozone in the stratosphere. The regional problems that are expected to command our attention next will in all likelihood be water-related.

Apparently humanity has not managed to curb the dynamics of environmental change despite all of the individual successes. We do not yet know what and how much must be done in order to curb this trend. Politically, little can be done until we have at least a rough estimate of the necessary extent. The answer will determine whether small alterations and reforms will be sufficient or if we must initiate fundamental structural changes. Without such an assessment, our eco-policies are doomed to fail. We have tried to estimate the degree to which humanity, specifically that segment residing in the industrialized North, has overdrawn its ecological account. We will introduce these estimates later in the book, along with a defense of why we believe the international community cannot circumvent the issue of fundamentally restructuring their economic systems.

We offer the following summary of the reasons why classical environmental policy faces such a dilemma:

The conceptual issue which is fundamentally missing from environmental policy that concerns itself with pollutants is the necessary focus on appropriate structural changes with which to restabilize and preserve the biosphere as the only foundation for both biotic life and human economic behavior.

In closing this section, we offer some thoughts on how an environmental policy which concerns itself with pollutants might look were it better able to fulfill its own claims. One of these claims is found in the precautionary principle: recognize and prevent environmental consequences of human activities before either humans or the environment have had to suffer from harm. This standard could be met at least in part with instruments that detect environmental damage at very early stages. Such instruments must be able to detect unanticipated environmental changes as well. The astronomers using radiotelescopes in their search for extraterrestrial lifeforms would be hard pressed if they only used frequencies or signals which we find useful on earth.

Nowhere in the world do we have an environmental observation system set up to detect a wide range of diverse and unanticipated changes in the biosphere, that is also capable of sending reliable early warning signals.

The emphasis here is on the word "unanticipated." Were such a network of observation points designed using the same technical sophistication which we employ in contemporary technical and scientific innovation, and in the creation of new goods and services, then we might very well have the ability to detect many of the "external effects" of our present economic endeavors. It is true that not even the most sophisticated observation system is able to detect processes which have not yet begun, so that even this system would have its limitations, but it would doubtlessly give environmental policy an additional opportunity to detect, and attempt to correct, disturbances much earlier.

An early warning system, designed to detect unanticipated biospheric reactions, must measure aggregative parameters, i.e. not single causes; and where possible, it should measure generalized, aggregated information about the observed effects. In principle, such an arrangement would not be so different from a large assortment of thermometers. The significance would simply lie in knowing with considerable certainty that something was amiss. In a limited way we already have such indices. The pH value, indicating the acidity of a body of water, is such an aggregative parameter in that it conveys something of the condition and change in the ecological makeup of the water, without carrying any explicit assumptions about the chemicals responsible for the change. The biotic oxygen demand, or BOD, is a measure of the nutrient content of a body of water.

Much remains to be done in the realm of biology, though. Our goal should be to design reliable, automated systems with the ability to indicate even the slightest changes in the rates of key biological processes. We would, in effect, be dealing with "environmental quality probes" made up of a combination of cultured organisms, cells or organelles and a recording device. Additionally, measuring arrangements could be developed further--and automated--that would respond to slight changes in the behavior of fish, water fleas, ants or any other species, while differentiating between the normal range of behavior and erratic, or statistically deviating behavior[8].

An interlude: the science - politics - news media triad

We indicated our skepticism about the potential for science to eventually provide all the politically relevant information about the complex and interrelated causes and effects of human activity within the biosphere. So as not to be misunderstood, we realize that science asks questions about the complex interrelationships in the biosphere and attempts to answer them. Svante Arrhenius, for example, asked the question about a rising level of atmospheric CO_2 100 years ago[9]. The motivation to ask such questions and any associated reservations are initially not politically driven. Scientists formulate such questions in a way that is not readily accessible to most. To the lay person, their use of complicated and exceedingly "precise" language or jargon obscures what they are doing. At the inquiring stage their questions should not--in fact cannot--be taken as serious political advice. This is not inconsequential in an age when politicians must increasingly rely on the expertise of scientists. This inability of scientists and politicians to communicate may have rather unpleasant consequences for all involved, including the watchful public.

We know the lament: Before the end of the nineteenth century, concerns about an impending greenhouse-effect due to the widespread use of coal were heard. By the turn of the century, numerous scientific papers existed on the topic of forest dieback as well as other environmental calamities. But no one heeded them. Why should the situation be so different today?

To many people who follow the reports of environmental catastrophes and global changes it remains a mystery why so little political action is taken to stabilize the biosphere, and why the action which is taken is so slow. In fact much of the evidence seems to indicate that humans have less and less time left to make up their mind to do something. Besides the fact that impatience was never a good guide, we should not to overlook one thing: the conclusion that humans are either unable or unwilling to structure their economic behavior in line with ecological requirements because they did not heed any of the warnings so far, is unwarranted. Individual scientific discoveries are by no means a societal force, and are generally not conceived as such by the scientists themselves. Scientific discoveries are initially always limited, isolated discoveries. An honest scientist will interpret even an alarming discovery first and foremost as an invitation for peer review, and not as an invitation to political crisis meetings. Not until many scientific discoveries can be assembled into a larger picture, along with more or less severe, observable damage where scientists predicted it would occur, does science find itself an actor in the political realm. In the environmental arena, Sherry Rowland's warning of the consequences of using CFCs provides a spectacular example[10].

Science has only achieved this status in a few areas. Science observes patterns of recurring local and global damages and increasingly finds itself able to decipher cause and effect complexes. In several cases, science has been able to link human acitivites with global effects with such reliability, that the remaining doubts should be considered relevant only within the scientific research communities involved.

But there are limits to certainty. Results that permit no doubts do not further the goals of science. Science would quickly become an ideology if this were permitted. If researchers were unwilling to refute the claims of their colleagues, especially in such politically charged fields as environmental and climate research, we would be in dire straits.

Unfortunately, these doubts, which are really the motivating force of science, are paralyzing political decision making. As the role which science plays in political decision making becomes ever more important in our increasingly complex world, the conflict between the internal demands of science and politics is exacerbated. Two dangers involved in this dilemma are becoming increasingly apparent; they serve neither the interests of science, politics nor the environment:

First of all, science must always remain open to doubts--exactly what politicians use as an excuse for inaction.

And secondly, we must concede that sometimes individual scientists look for the confirmation they are denied by their peers, in the public and political spheres.

When these problems occur jointly, and when scientists and politicians work hand in glove with the news media, the result is too often nothing but smoke, mirrors and derailed environmental policy. This phenomenon of scientists entering the political arena is all too frequent, and is generally considered either accursed or mildly amusing. Although the problem is a serious one, its characteristics are very much those of a caricature:

1. The story begins with either a press "leak" or with an industrial catastrophe.
2. The responsible minister is dismayed and inquires of scientists from within and outside of industry "whether this could happen *to us*."
3. Science offers past discoveries and early warnings of the phenomenon, but counters this with the need for further research, as the available scientific results are not easily and unequivocally transferable to the present problem.
4. The press accuses the responsible parties of having ignored or even obfuscated the early scientific discoveries.
5. The minister defends himself with reference to the scientists' professed need for further research. He allocates funds to their research.
6. Science eagerly accepts the funds and scientists increase their research activity. If the initial event is succeeded by other similar events, legal action is demanded, to close factories or to intervene in some other way. Otherwise little else happens politically until the next "leak," at which point, see no. 1 above.

To get beyond this impasse, science cannot hide in its ivory tower, i.e. persist in its claim that discoveries will be interpreted according to scientific criteria exclusively, and that all futher use of the data is up to someone else. Rather the opposite is necessary. In light of the caricature above, it is becoming ever more important for scientists to contribute their own political interpretation of the results, or at least to seek a dialogue with politicians.

This exchange should not consist of the scientist attempting to convey the full complexity of his or her discovery in the hope of seeing it adopted as law--unmodified. The simple and simplified stands a much better chance of gaining a political hearing. An important task for future science will be to contribute to this simplification, to a "scientific" simplification which could include the search for aggregative, summarizing indicators that reduce complex problems to simple, measurable quantities. This is the only way that we can hope to preserve the essential elements of the scientific discovery, without running the risk of introducing any of a number of possible errors.

To many scientists this will sound like an unwarranted encouragement to participate in trivializing the results of their professional work. But this would be a misunderstanding. What is meant is a process of translation from the scientific discovery into the political praxis, from the complexity of the discussion among peers into a straightforward simplicity required for making knowledge the basis of the everyday acitivities of non-scientists. The concern of this book; to introduce an ecological measure dressed in everyday clothes, is an example of what is meant here.

Energy--the environment's number one enemy?

We cannot afford the luxury of examining one chemical after another for decades with the hope of legislating their eventual reduction. Instead we need reliable standards for ecologically beneficent economic behavior. The search for such standards is not new. In science and politics, energy has now been debated for a considerable time as a possible candidate for such a standard. Let us examine this assumption in greater detail before we deal with the specifics of environmental assessment procedures common today.

To summarize in advance:

The environmental detriment of energy use does not follow from the environmental dangers of energy. The energy flows set in motion by human activity are only of marginal ecological significance. The problem stems from the material flows associated with the provision and use of the energy.

The human use of energy is only a small fraction of the sun's energy. The global energy balance is not affected in any significant way by the considerable energy demands of modern industrial and consumer societies. The amount of solar energy that is intercepted by the earth's land areas is 3,000 times the amount of energy humans used in all of 1990 (Fig 11).

Energy consumption--an indicator of environmental stress?

About a dozen gallons of diesel fuel and some primitive road-building equipment are sufficient to rid one hectare of forest, even tropical rainforest, of all its trees. This equals about 1,000 tons of timber, or perhaps twice that amount, in addition to the destruction such activity brings to the innumerable plant and animal species. It would take decades or even centuries for the trees to grow back, assuming that is possible at all. The resulting erosion can add up to a loss of between 10,000 - 50,000 tons of soil and the complete and utter destruction of any soil fertility. We can have all this for the same amount of fuel we put into the tank of our car on a family vacation without even realizing it. It seems unlikely that energy use would be a good measure of environmental stress in light of the above.

As everyone who lives in Provence knows, it only takes a box of matches and some lighter fluid to burn down entire slopes of the **Maurengebirge**. Lighting forest fires seems to be a popular sport in some Mediterranean countries, sometimes in order to gain access to otherwise protected land in order to develop it. The required energy is almost negligible. Plowing farmland with large tractors and other implements that reach far down into the

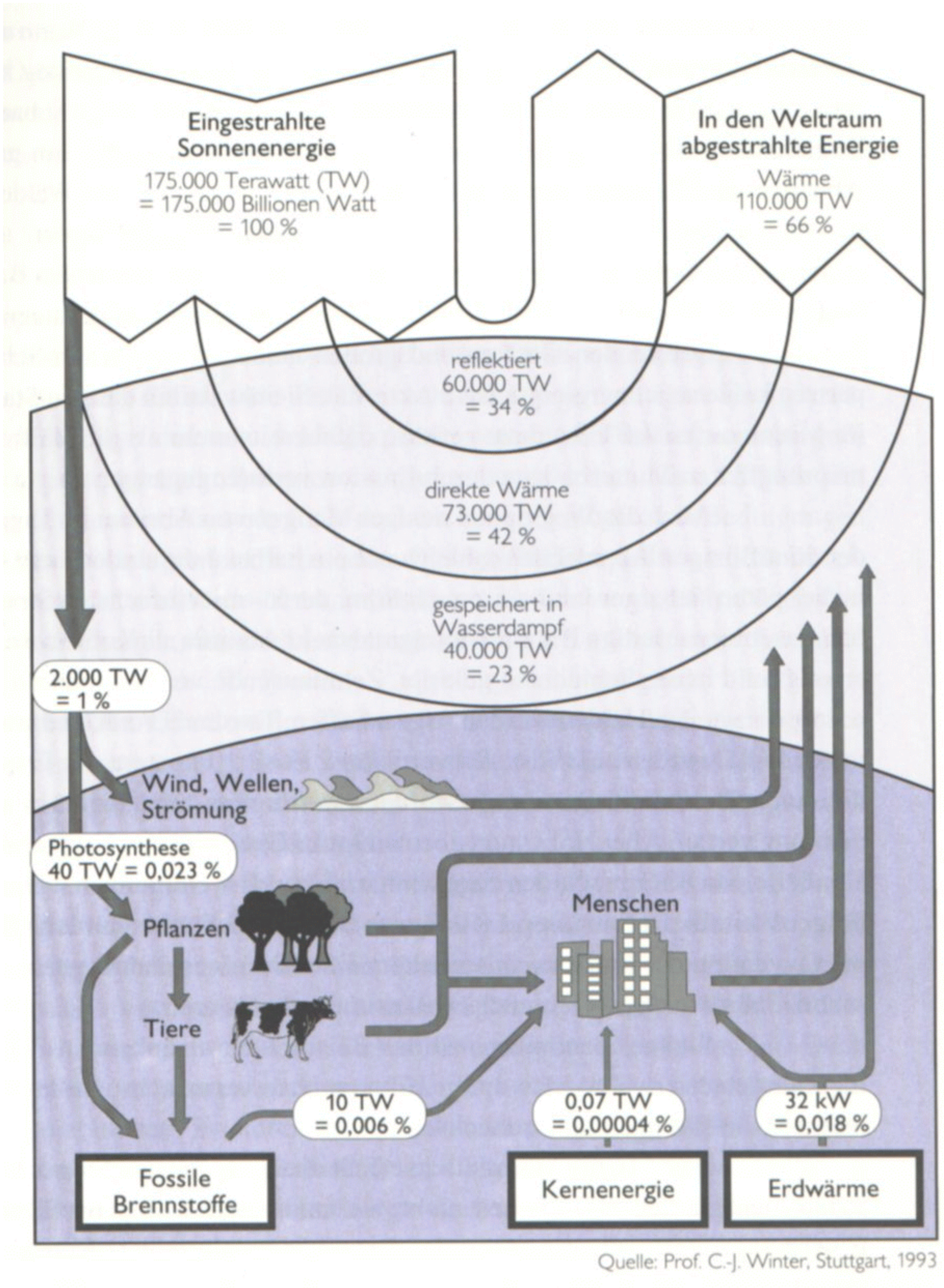

Fig 11: Nur ein Bruchteil der Energie, die die Sonne auf die Erde strahlt, erreicht die Erdoberfläche. Doch selbst dies ist ein Vielfaches der Energie, die der Mensch freisetzt. Die Energieströme auf der Erde werden noch lange von der Sonne bestimmt werden, nicht vom Menschen.

ground does not require much energy. This practice has nevertheless caused so much erosion in some states in the Midwest, that only half of the original topsoil is still in place.

Simple roadbuilding equipment was used to carry off enormous quantities of overburden in the open pit coal mines in the Appalachians until the mid-1970s. As much as twenty times the amount of coal extracted was dumped into the valleys as overburden. Thousands of square kilometers of forest were destroyed in this manner. Roughly ten percent of the retrievable energy from the lignite coal was thus wasted. The problem was that wood is not of much use in a power plant. Hundreds of streams were filled in, resulting in massive flooding. More than 10,000 kilometers of streams and rivers so acidified through the oxidation of the sulfur compounds in the overburden, that the water was no longer usable.

Earlier in the book we discussed the subsidence of parts of the Ruhr area of Germany because of subsurface mining activities. Even here the energy balance was positive, at least initially.

An energy balance alone does not surround the ecological consequences of many human activities. It is even possible to draw erroneous conclusions from such an energy balance as the extreme examples show. Energy use is only a part of the ecological truth of human activity. Sometimes an important one, sometimes not. In practice, the question will often arise as to what extent it is possible to reach the goal of estimating the environmental stress intensity more quickly by drawing on simplifying assumptions. We believe that only very careful analyses of the material and energy inputs at all stages of the life of representative products and services will convey that information. We must not neglect anything until we have studied representative examples and determined the magnitude of that which we are tempted to neglect.

Renewable Energy sources

If environmental policy focusses too exclusively on any one particular problem, it runs the risk of creating new ones. A very striking example of this would be the notion that our present energy demand, (and, as some would argue, also our future demand) could be met with solar energy and hydroelectric power. Such a plan is absolutely unrealistic and incompatible with a concern for the ecological integrity of our activities. Vast areas would have to be covered with solar panels and global distribution networks would have to be built to transport an energy form, which, to date, has only generated a yield of ten to fifteen percent on any large-scale project attempted so far. Although the efficiency of such power plants is rising, we would still be forced to dam up every river and flood every valley in order to even begin to meet the demands of a society which has adjusted itself quite comfortably to the abundance of coal, oil, natural gas and nuclear energy.

Few doubts can reasonably be raised about the need for expanding our present use of renewable energy sources. Over the long haul, the non-renewable energy sources will be exhausted, as their name implies. Over the short haul, they too contribute massively to the destabilization of the biosphere through their rucksacks of material flows. Nevertheless, no advocate of renewable energy would support the above scenario. He would be suspected of contributing substantially to the ecological catastrophe which he was professedly trying to avoid. In order for a solar energy scenario to be realistic, we must provide those energy-intensive services using far less energy, which means that they will have to get by with significantly reduced material flows. Only if energy can be provided with a decisively reduced material intensity per energy unit (kilowatt-hour for instance), only when significantly less energy is needed for each unit of service, will we be on our way toward a sustainable economy. Energy policies that follow ecological principles must therefore begin with policies which change the structure of supply and consumption; solutions which focus on a single problem may therefore be justifiably suspected of merely postponing the ecological problem.

The case of CO_2

The most recent discussion concerning possible climate changes highlights an important isolated problem, probably the largest environmental problem ever to be publicly debated. From an ecological perspective it is but a partial problem, however, and we must be wary of forgetting the other problems when so much energy is suddenly devoted to the debate over CO_2 reduction. Within just a few years, CO_2 emissions became a new qualitative measure of all technologies and services. Even the battle lines between nuclear power opponents and advocates ceased to be clearly drawn.

Carbon dioxide is emitted into the atmosphere from quite a variety of anthropogenic sources, and only one of them, albeit the most important, is the burning of fossil fuels: coal, oil and natural gas. If we only include this source, the flow of carbon dioxide with which we stress the earth's atmosphere and affect the earth's climate, we are capturing only one of the many material flows which occur in the context of providing and using energy. We must therefore treat carbon dioxide as merely one aspect of the energy problematique. We must be particularly careful when attempting to curb the emission of CO_2 or even in trying to remove it from the atmosphere that we do not again mobilize terrific material and energy flows, if our efforts are not to be counterproductive.

The president of the Japanese Science Council, Professor Jero Kondo, has suggested that we solve the CO_2 problem by collecting the "surplus" carbon dioxide in the atmosphere using solar energy, before turning it into industrial chemicals. He recommends the same strategy for the CO_2 in smoke stacks. He also shows pictures of what such equipment would look like, and which chemical products could be obtained in that way[11]. This just might be the starkest example of an "end of the pipe" technology. Professor Kaya of Tokyo University, one of the highest-ranking advisors to the Japanese government, refers to the next century as the century of "decarbonization"!

As an aside, the assumption that the contribution made by CO_2 to climate change is the only possible ecological effect of the massive anthropogenic CO_2 emissions does not hold water. CO_2 is, after all, one of the most important compounds involved in plant growth. We simply do not yet have much data on the direct biological effects of increased CO_2 concentrations in the earth's atmosphere.

The discussion about climate change and CO_2 is therefore anything but superfluous. As long as it does not shift the balance in the environmental debate and political practice too much, it may serve the future of eco-politics in a very important way: if scientists from around the world concern themselves with a problem of such magnitude as global climate change and allow themselves to be scientifically fascinated by it; if conferences are held and in some--admittedly rare--cases political consequences are drawn, then we are experiencing what amounts to a first-rate example of the potential political and scientific action--the willingness to debate and to seek consensus, of which humans are capable. It is important to carry on debates about partial problems of eco-politics, if only to develop the instruments necessary for carrying on such politics at the international level. Yet it could lead to false conclusions, were we to forget that we are dealing with but a part of the problem..

Balances: how much environment does one product life cost?

It is a generally accepted fact that money is in short supply and that costs must therefore be carefully calculated. The rich and the poor do not differ much on this point. They have a more or less well defined understanding of the budget within which they can operate, and they know that in the private sector they cannot get around the limitation of only spending their money once. Terms such as incidental, or follow-up costs, belong to the everyday language of economics, because money is accepted, quite naturally, as a limited means.

Our dealings with the raw materials of this earth follow very different paths. As long as the often highly destructive efforts required for the provision of the goods and services we consume are not reflected in the price we are asked to pay, they will have no noticeable effect on our purchasing decisions. The fact that the bells and whistles with which we adorn our automobiles--from the spoiler to the low profile tires and magnesium wheels, the tuned mufflers and tinted glass--often come from halfway around the globe and were produced with enormous quantities of raw and auxiliary materials, not to mention energy, does not usually figure into our assessment. Neither does the fact that packaging materials, which instantly become waste once they cross the store counter, required high-quality raw materials for their production. Flying somewhere on vacation produces more carbon dioxide than can be granted an individual as their entire yearly CO_2 budget--if we keep in mind the protection of the earth's climate. If we go by today's prices, resources are apparently still inexhaustible and cheaply obtainable. The ecological consequences of their use change nothing in the final price--at least not yet.

The experience of the last few years has shown that in order to gauge the environmental tolerance of goods we must take into consideration all facilities, raw materials, products, packaging and transportation requirements that can be classed as inputs, and the estimation must cover all stages of the product cycle. In other words, the areas of raw material extraction, production, use, recycling and finally, disposal. The situation is analogous for the estimation of the environmental stress intensity of processes and services. The primary reason for these very high standards is that we have no way of knowing or estimating *a priori* which inputs or which phases of a product's life are associated with the greatest strains on the environment. A nuclear power plant, for example, requires the mobilization of enormous quantities of material before it is ever taken on line, whereas a coal-fired power plant necessitates the greatest throughput of material during its operation. Going by our present eco-toxicological knowledge, aluminum is a harmless material, but in its production, vast areas are laid to waste and tremendous quantities of energy are required. The material flows associated with the production of a catalytic converter are on the same level of magnitude as the weight of the finished car. This short enumeration indicates the need for large quantities of data. Furthermore it demands that a large number of very different criteria be taken into consideration if we are going to estimate the relative environmental stress of goods and services.

For several years now, individual products and even product lines have been subjected to "Life Cycle Analyses" or to one of several other related procedures. The more one restricts one's inquiry in time and space, the easier such a procedure becomes. The use of energy and water in a washing machine is relatively easy to compute for the useful life of the machine. Thus the comparison of an "environmentally friendly" washing machine with a conventional one is fairly simple. Whether or not such a comparison is warranted cannot be determined right away. The more in-depth such an analysis goes, the more difficult it becomes. It also becomes increasingly important to decide what one is looking for, what one is valuing. Is the criterionthe use of energy needed to operate the machine, in other words, the energy coming out of the wall socket? What about the energy required to explore and extract the raw materials, the production, packaging and transportation of the good? Or does the amount of waste and pollution perhaps furnish the decision making criterion? What is then to be considered a pollutant and what is not? Or are we instead more concerned with the amount of surface or land necessary to produce a product? How are we to decide how to compare differing types of land with each other?

In the ideal case, such an analysis would take all direct and indirect environmental effects of a product or service into account. But the first attempt to approach this ideal state will bring to light another problem: how is one to decide among differing damage potentials? How is, for instance, the ability to alter the genetic makeup to be compared with an observed toxicity to fish? The potential for changing the climate is difficult to assess alongside favorable characteristics of decomposition. We have no way to make such comparisons objectively, that is, no way to decide such matters independent of the interests or perspectives of the analysts or the reigning political authorities. As already noted, we presently find the CO_2 emissions associated with a product to be far and away the most important characteristic. Five years ago it was a very different picture. At this juncture we note a subjective force creeping into the analysis. This makes it contestable.

These, in brief, are the reasons why we presently do not have a useful method for comparing the environmental stress intensities of differing products, processes and services. Without such a method it remains doubtful whether we can expect to create a sustainable economy. If ecological criteria are to enter the realm of economic decisions--and they must for the economy to become sustainable--the degree to which one decision puts stress on the environment relative to another must be given much greater importance. In order to do this, the political and economic actors need reliable and transparent information about the environmental stress intensity of economically and ecologically relevant products, processes and services, calculated from the cradle to the grave, from the first cut of the spade or bite of the power shovel in extracting the resource, to the landfill or incinerator at the end of the service life. Any inaccuracy or incompleteness in this package of information can lead to mistakes that in the long-run may prevent us from meeting our ecological mark.

It is obviously true that we produce and use products which require so much more material and energy during one particular phase of their life that the other phases do not make the list; only that particular phase affects the ecological integrity in an important way. While a washing machine requires considerable material and energy for its production, the washing machine is--to put it bluntly--a machine designed to move large material flows *during* its service life. Each wash cycle requires electricity and so much water that after only a few uses, the water used would more than outweigh the machine itself. Could we therefore expect a fairly accurate picture to come from an analysis of only the service life of the washing machine? While this can be presumed, any further speculation would not be helpful. This presumption would turn out to be false if we discovered in the production of this machine, any small amount of material used that had itself necessitated the displacement of large amounts of material for its procurement, or great quantities of energy--in other words, that carried around with it a large ecological rucksack.

We must therefore always know with the greatest possible precision the material ingredients of such devices or machines. Speculations of the sort mentioned above are therefore not useful as a basis for production decisions or legislative endeavors which have ecological structural changes as their goal. Legislative attempts at revamping the tax structure can only hope to influence such a structural change with any directional stability if a reliable picture of the energy and material flows is available, and the opportunity exists to add up all the little rivulets that would otherwise go unnoticed, and which in the end add up to ecologically relevant flows.

A further reason why we cannot avoid adding up the material flows from the the cradle to the grave stems from the incredible interlinkages between the product flows on the world market. Were a small country with high import-quotas to decide to tax the use of raw materials, this measure might well have no effect whatsoever, as the greater part of the goods and services used in the country, requiring high levels of raw materials for their production were imported and thus not included. Not until it is known how and where the material flows occur, can a country make ecologically effective political decisions (and would, in the above case, have to push for international agreements).

Material flow analyses "from the cradle to the grave" or better "from the cradle to the cradle," as Walter Stahel would say, are also necessary. Thus the goal of Life Cycle Analyses and similar procedures are worthwhile, even if--as we will try to show--they are still not easily achieved. A carefully carried out Life Cycle Analysis requires two to three person-years of work today. It cannot be done under any circumstances in less than one person-year. The labor costs for one such analysis would quickly add up to five- or six- digit figures, and if one considers that millions of products are currently sold on the market and would have to be analyzed to provide a complete picture, then the endeavor already looks problematic from a financial perspective.

Internationally harmonizing the assessment of the environmental dangers of materials is a frustrating business. In twenty years the OECD managed to bring about agreement in fewer than ten cases.

Whichever way one looks at it, without a scientifically defensible yardstick permitting rough estimates that can be manipulated simply, cheaply and easily; that considers criteria that are relevant to all processes, goods and services without exception; that permits the comparison of data without complications and contradictions and that nevertheless reliably points in the right direction--without these criteria, the neccessary overview of national and global material flows will not come about. We will be introducing such a measure in the next chapter, illustrating the characteristics it should have and what it might look like. Not until we have the help of such a measure can we compile Life Cycle Analyses as screening procedures. Only in this arrangement can they be assembled in an acceptable amount of time, with an acceptable amount of effort, and on the necessary scale, i.e. for all ecologically relevant processes, products and services. Where it then becomes necessary to inquire in greater detail--because for example the initial analysis did not show one alternative to be unequivocally preferable--then other procedures should be used, also and especially with respect to the question of the possible eco-toxicological effects of the materials involved. Stefan Bringezu of the Wuppertal Institute has worked out this argument in considerable detail[12].

A plethora of methodological approaches exist with which to describe the ecological risks associated with goods and processes, and a large number of names and terms are used in this context. This diversity materialized with a certain inevitability, as innumerable attempts were made to come to terms with the effects of human activity on the biosphere at various levels. So it is quite sensible to examine the environmental relevance of a chemical with different methods than the environmental significance of a firm, and to treat differently again the metabolism of a city, region or nation with their respective environments. As diverse as the methods may be, it must still always be the goal to find decision making criteria for the protection of the biosphere. The question thus becomes what, if anything, these many approaches have in common, and if there is perhaps a kind of "principle cause" of all these environmental effects. We can answer this question affirmatively. Wherever human activity changes the biosphere, material flows are involved, including those that are displaced to make energy available. We will return to the question of how these approaches can inform our measure of environmental harm at a later point.

As some terms will reappear throughout this book, and because this book is based on the experiences gained from past attempts at recognizing environmental effects, we will deal briefly, though not exhaustively, here with some of the important and currently used instruments for the description, registration and quantification of environmental stresses. More detailed treatments are to be found in the appendix.

Life Cycle Analyses

The German *Umweltbundesamt*, or Ministry of the Environment, has defined the term "Life Cycle Analysis" as follows:

> *The Life Cycle Analysis involves the most comprehensive comparison possible of the environmental effects of two or more different products, product goups, systems, procedures or behavioral patterns. It is to aid in the process of uncovering weak points, in the improvement of environmental characteristics of products, in decision making with respect to both procurement and purchasing, the promotion of environmentally friendly products and procedures, the comparison of alternative behaviors and the explication of behavioral recommendations. Depending on the underlying question this comparison may be complemented by other aspects, such as an assessment of the relative efficiency of funds spent for the purpose of environmental protection.*

Product Line Analyses

The term "product line" was introduced by the Öko-Institut Freiburg[13] in Germany. It is an attempt to expand the LCA concept, which has a strong natural science-ecological emphasis, by introducing social aspects and the concept of utility. In this sense, then, the Product Line Analysis is to be located somewhere between the "Life Cycle Analysis" and the "technology assessment."

Life Cycle Analysis of spatial or geographic entities

One particular type of LCA is concerned with the effects of human activity on spatially delimited ecosystems such as the mudflats of the North Sea, or areas in the Alps, or other ecologically sensitive regions, but also of the *Ruhrgebiet*, Germany's agglomeration of industrial cities, or other urban areas. Berlin and its surrounding areas, as well as the city of Düsseldorf, have already had such analyses performed. The investigation of a product or service is not at the heart of this type of LCA. Instead an inquiry into the stresses and the theoretical carrying capacity of a region is undertaken. The goal is usually to obtain information about the long-term development of a region, with respect to industrial siting, for instance, or tourism. To restore or rehabilitate a region requires such an analysis. When managing structural change, this type of analysis can provide insight into the areas where "undisturbed" developments might still be possible, as well as how the stress is distributed. The *Umweltbundesamt* has published a series of papers on these topics.

Using the *Ruhrgebiet*, Helmut Schütz and Stefan Bringezu from the Wuppertal Institute have delineated how a more spatially oriented LCA might look (see the chapter on "SIPS"). These developments are of considerable significance to any future environmental statistics of Germany, or to those of any other country or geographical area.

Environmental Profiles

The results of an LCA can be highly complex. In order for these results to be useful in practice, for bestowing an *Umweltzeichen* (environmental label) for instance, they can be simplified with an assessment framework. The result is a so called environmental profile. In its simplest form it is a table, indicating which of the criteria used in the assessment matrix were met by the various products, processes and services compared, and which they failed to meet. The environmental profile simplifies considerably. It stands at the end of a series of assessment procedures, and cannot be sensibly used for further analyses or assessments without reference to the LCA and the assessment framework.

Technology Assessment

Technology Assessment belongs to the oldest procedures for assessing technology. Its reach goes well beyond the registration of effects on the environment. The term "Technology Assessment" (TA) comes from the U.S. Congress' Committee for Science, Technology and Development, which concerned itself with the "unanticipated consequences" of technology in

1966. The Committee defined TA as a type of early warning system that is intended to help detect societal, health and environmental side effects of new technologies. In order for long-term and cumulative effects not to be overlooked, it was determined that complex interacting mechanisms between social conditions, technical and scientific developments and their effects should be examined. In addition to the focus on risk analysis, a catalog of decision making aids and alternative suggestions for policymakers was agreed upon as well. As a result of the work of the Committee, the Office of Technology Assessment (OTA) was founded in 1972, which has done highly acclaimed work for over two decades now.

For many years the Germans debated the merits of having their own institution for technology assessment. A special commission of enquiry concerns itself with this topic. Since 1990, the Office of Technology Assessment of the German *Bundestag* has taken over the coordination of these matters. Because of the broad interpretation of the concept, the cooperation between different societal groups is always necessary. To consider it a purely scientific affair would be too limited a perspective.

Technology assessment has now been a rallying point of the labor unions and is understood in this context as a procedure for the assessment of social consequences of technologies in the realm of production. The area of concern is in fact with present technologies, deemed problematic for one reason or another, as well as with technical developments which are expected to generate relevant effects in the future.

Environmental labelling

Experts at a 1991 conference organized by the United Nations Environmental Program or (UNEP) decided what an environmental label was: "Programs dealing with environmental labelling are making the positive statement that a product or service that is to be used for a particular purpose is less harmful to the environment than similar products or services."[14]

In Germany the "Blaue Engel" or "Blue Angel" has been issued for 15 years now. Canada, Japan, the Scandinavian countries, Austria, the Netherlands, France, Singapore, and India have their own such labels. In 1992 the European Union decided to introduce its own label.

The Blue Angel has become a trademark and a frequently used decision making aid in Germany. In May of 1993, 3,500 individual products from 873 producers carried the label. Fourteen percent of the products and fifteen percent of the producers were from outside the country. The label is given out for seventy-one different product categories, including household chemicals, home, garden, and office equipment, building materials, water saving devices, particularly quiet devices, paper and cardboard products as well as reusable packaging. In the field of transportation they are issued for public transportation, retreaded tires and car washes.

According to a private law contract with the "German Institute for Quality Control and Labelling" (RAL), the Blue Angel may be issued. It is issued by the pluralist "environmental labelling jury" on the basis of criteria set up by the German Ministry for the Environment.

Environmental compatibility tests

Since 1990, public projects must be tested for several environmental effects. This has since been written into the law concerning environmental compatibility testing. The effects which are tested are those on humans, animals, plants, soil, air, climate, landscape as well as on cultural and intrinsic value. These tests are a first attempt to systematically register and compare material flows that result from constructing facilities and businesses. The goal is to compare the different alternatives and either to throw out all variations, or to select the one which will cause the least harm to the environment. The procedure of an environmental compatibility test is roughly equivalent to a Life Cycle Inventory within an LCA, with a subsequent balance assessment.

Environmental Audits

An environmental audit has been defined by the European Union[15] as a "management instrument with which to obtain a regular, systematic, documented and objective assessment of the achievements of the organization, management and processes for the protection of the environment. It shall further serve the following goals:

1. simplifying the role of management in promoting behavior which would have an effect upon the environment;
2. assessing the corroboration with management policy on environmental matters."

Materials reports

Materials reports attempt to describe the effects of a chemical upon the environment. The toxicity to humans and the environment are described according to a differentiated conceptual framework. For several years an internationally agreed upon pattern has been used, originally developed by the OECD and later adopted by the World Health Organization (WHO).

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4.4 Hartmut Stiller, Material Consumption in transport infrastructure. *Fresenius Environmental Bulletin*, 2(8), August 1993.

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1.11 Jero Kondo, Contribution at the Europerspective-Conference, Wiesbaden, June 1993.

1.12 Stefan Bringezu, Resource Intensity Analysis -- a Screening Step for LCA, *Fresenius Environmental Bulletin*, 2(8), August 1993.

1.13 Projektgruppe Ökologische Wirtschaft (Öko-Institut and others), Produktlinienanalyse--Bedürfnisse, Produkte und ihre Folgen. Cologne, 1987.

1.14 Harald Neitzel, The development of the Blue Angel scheme in Germany. Lecture manuscript, Berlin, August 1993.

1.15 EWG Prescription No. 1836/93 of the council, June 29, 1993 on the voluntary participation of businesses in a community system for environmental management and environmental business audits, published in Amtsblatt der Europäischen Gemeinschaft No. L 168/1 of July 10, 1993.

The travels of one glass of yogurt

One little glass of strawberry yogurt is an inexpensive item. It costs a few cents. One would think the producer wouldn't have all too much room for extravagant production methods. And besides, how could a little strawberry yogurt harm the environment? Milk from the nearby dairy, some fruit, a lid--albeit an aluminum one--but otherwise just a few odds and ends--one would think.

Stefanie Böge from the Wuppertal Institute has examined the few odds and ends. With the help of the *Südmilch AG* in Stuttgart she researched just one environmental aspect of Swabian strawberry yogurt--its transportation. She suddenly found herself on a trip across Germany and beyond.

The dairy farmers are actually from the surrounding area of Stuttgart. Even the sugar is from produced locally. But the bacteria needed for turning milk into yogurt are shipped in from Niebüll in Germany's northernmost state. The glass itself is produced in Bavaria with raw materials from North-Rhine-Westphalia, and even the aluminum lid travels from the lower Rhine area via Bavaria to Baden-Württemberg. The strawberries grow in Polish fields and are processed in Aachen, on Germany's border with France, before being shipped to Stuttgart, where they are added to the yogurt. In the packaging for shipping the glasses she discovered various and sundry ingredients from cardboard to glue and plastic wrapping from Bad Rappenau, Aalen, Cologne, Lüneburg, Varel, and Ludwigsburg, as well as from suppliers in Austria and France.

Once returned home, Stefanie Böge added up the distance: 7,857 kilometers of roads had been used, and all with trucks. When divided into one glass of yogurt weighing 150g, this means that each glass was driven 9.2 meters before it could be bought off the refrigerated shelf in Southern Germany. These nine meters are probably on the short side, as the trucks sometimes returned empty, and the trips for buying and returning the glass are not included in the calculation.

One can spend a long time arguing about whether nine meters are a great distance or not. What is certain is that several of those meters would not have had to be travelled if the transportation had been optimized according to ecological criteria. Strawberry farmers exist in the immediate vicinity of Stuttgart, and the same goes for fruit processing and packaging materials.

Even so, no processing plant demands that ingredients be shipped thousands of kilometers out of malice or complacency. Economically, such "chains of transportation means," as the traffic scientist calls them, make sense. With numerous taxes, fees and other measures we subsidize traffic. Therefore we should not be surprised when carefully calculating entrepreneurs contribute their share to it. Predictions indicated a doubling of truck traffic even before the European borders ceased to have any significance for intra-European trade.

What should one do? Stefanie Böge made some suggestions. A consumer can already contribute meaningfully by selecting locally produced products from nearby stores. Politically, the prevailing conditions must be arranged in such a way that businesses have an incentive to both avoid unnecessary transportation as well as to optimize the unavoidable tranportation, and, where it is possible and sensible, to switch to other modes of transportation such as the train or ship. If yogurt were, for example, sold in standardized reusable packaging, many of the supply and return shipments could be avoided. By raising the cost of transportation, buying ingredients locally would automatically become economical.

Her appeal to business can be understood as a general conclusion: "The more decentralized an economy organizes the structure of its production and the faster the packaging and transportation industries can harmonize their efforts (with respect to both transportation packaging as well as the packaging of individual products), the sooner we can reach the goal of reorganizing our freight transportation in more environmentally friendly ways."

Brandrodung im Amazonas.-Urwald: Ein paar Liter Benzin und einige Grillanzünder genügen für einen ökologischen Kahlschlag von katastrophalem Ausmaß.

Ein Loch im Planeten Erde: 400 Meter tief ist dieser künstliche Krater bei Mirny in Rußland. Hier werden Diamanten gefördert - und viel Erde.

In eine Mondlandschaft verwandeln die Baumaschinen deises Gelände am Euphrat in Südost-Anatolien. Hier entsteht der Atatürk-Staudamm.

Braunkohletagebau bei Most-Brüx/Tschechien: Tonnenweise wird Erde abgetragen, um eine Tonne Kohle zu gewinnen

Tausende graben sich bei Ariquemes in Brasielien auf der Suche nach Zinn durch die dünne Humusschicht des Urwalds

Ein einziger griff dieser Maschinen und ein Urwaldriese ist abtransportiert. Energieaufwand: ein bißchen Dieselsprit.

Abfallstrom als Leichentuch: Rotschlamm aus der Aluminiumproduktion wird bei Stade in eine offene Deponie gespült.

Ölsee in der russischen Taiga. Aus einer undichten Pipeline flossen 160 Millionen Liter täglich. Ein Unfall unter vielen.

Archeloos-Staudamm in Griechenland: Narben werden ins Antlitz der Erde gegraben, um Wasser dort verfügbar zu machen, wo die Natur es nicht (mehr) liefert.

Lavastrom von menschenhand. Das Nickelkombinat Norilsk entledigt sich seiner Schlacke in offenen Gruben. Fläche ist kein Kostenfaktor in Sibirien.