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Advancing Sustainable Resource Management

Using Ecological Footprint Analysis for Problem Formulation, Policy Development, and Communication

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February 27, 2001

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This study argues that:

A. Sustainability is a specific term with a specific meaning: it requires avoiding ecological overshoot.
B. Overshoot can be measured. And there is evidence that humanity is in overshoot. In fact, most industrialized countries run massive ecological deficits.
C. To move out of overshoot, governments need first and foremost to develop ecological accounts to track overshoot and to run social marketing campaigns that gather popular support for reducing human pressure on the biosphere.

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1. The Problem: Human Demand Is Eroding the Planet's Natural Assets[1]

While much discussion of global resources over the last few decades has focused on the depletion of non-renewable resources such as minerals, ores and petroleum, it is increasingly evident that renewable resources, and the ecological services they provide, are at even greater risk.[2] Examples include collapsing fisheries, carbon-induced climate change, stratospheric ozone depletion, species extinction, deforestation, and the loss of groundwater in much of the world. The depletion of these assets is serious since people are a part of nature, and depend on its steady supply of the basic requirements for life:[3] food, water, energy, fiber, waste sinks, and other life-support services. The depletion is particularly serious since the human demand for these resources is still growing, thereby accelerating the liquidation of natural assets.

Out of this concern, the sustainability proposition emerges. Sustainability is a simple idea. It is based on the recognition that worsening ecological conditions threaten people's well-being. When humanity's ecological demands in terms of resource consumption and waste generation exceed what nature can supply, we move into what is termed "ecological overshoot." Just as constant erosion of business capital weakens an enterprise, such overshoot erodes the planet's "natural capital," and reduces humanity's ultimate means. [4] Thus, sustainability is a commitment to creating satisfying lives for all within the means of nature.

While defining sustainability is fairly straightforward, trying to make the world sustainable is frustrating and confusing at times, which makes the task look monumental. Moreover, it can be seen as ominous, since recognizing ecological limits challenges how we organize our lives—even though the purpose of sustainability is to secure our well-being.

At the core of this quest for sustainability is the need to be able to live with ecological limits. These limits are not like a rigid wall that brings a speeding car to a halt. Rather, ecological limits can be transgressed easily. More timber can be harvested than regrows, more fish can be caught than are spawned, more CO_2 can be emitted than nature can reabsorb, and topsoil can be eroded while crops grow. Initially, most of these transgressions go unnoticed.

There is a perception, often voiced in the business press, that because there are no apparent shortages of raw materials, the concept of limits has been overstated. This confusion is caused by the seeming elasticity of ecological limits, and new technologies that enable rapid resource extraction and easier access to remote locations. A simple analogy would again be a car: If a car is low on gas, accelerating to ninety miles per hour does not disprove the gas gauge. Similarly, pumping water out of an aquifer more quickly does not change its ultimate capacity or recharge rate.

The importance of avoiding overshoot is still ignored not only in general conversations but also in many public policy discussions of sustainability. In fact, our ability to transgress ecological limits without perceptible consequences may create influential misconceptions in the sustainability debate. For example, in a recent interview on reaching a world population of 6 billion, Nafis Sadik, then Executive Director of the UN Population Fund, stated that "many environmentalists think [that the carrying capacity of the earth] is four billion, maximum. But now we have six billion people." [5]

Once humanity exceeds the biological limits or carrying capacity of the planet, further expansion impoverishes us, since such "development" is not achieved by using the regenerative "interest" of nature, but by liquidating natural capital. This is why systematic resource accounting—documenting the cumulative effect of humanity's consumption of natural capital and generation of waste—is core to achieving sustainability. As long as our governments and business leaders do not know how much nature we use or how resource use compares to the existing stocks, overshoot may go undetected—increasing the ecological debt of society.

The depletion of ecological assets systematically undermines the well-being of people. Livelihoods disappear; irreconcilable conflicts emerge; families are hurt; land becomes barren; resources are used more efficiently before they eventually run out. The good news is that continued overshoot is not inevitable: it is possible to have satisfying lives for all within the means of nature.

2. The Goal: Satisfying Human Needs

Satisfying lives for all is not only possible, but a necessary ingredient for sustainability. It is a necessary ingredient for all sectors alike: government, civic society, and businesses. Here are three reasons why satisfying human needs is now everyone's responsibility.

- First of all, the enormous social and economic inequities that exist within countries, and even more blatantly worldwide, are not only inhumane, but also threaten everybody's security. How can one expect constructive cooperation in an increasingly interdependent and fragile world, if an ever larger part of humanity is denied the possibility of having healthy and secure lives? As ecological scarcity increases and competition for ecological capacity becomes even fiercer, keeping many disenfranchised would most likely fuel destructive social conflicts and degrade our social fabric.

- Second, once humanity is in ecological overshoot, development based on expansion becomes a negative-sum game. If the planet is "full" of people who are depleting its natural capital, making more stuff cannot make people better off. Such development not only appropriates nature's future income, but also destroys nature's capacity to provide present and future services. As a consequence, addressing equity through economic expansion becomes a physically impossible strategy that only accentuates the conflict over resources. A true sustainability package must devise more courageous strategies to promote equity, rather than just promising more production.

- Third, people want fulfilling lives. A sustainable society cannot be built on martyrdom and suffering. To make sustainability a reality, we must find ways for people to thrive in all senses without needlessly overtaxing the ecosystems that support us.

We need development that enhances people's possibility of having healthy and secure lives, and that is fair to people alive today and in the future, while at the same time maintaining the

integrity of our ecological assets. That's what we mean by "satisfying lives for all within the means of nature."

Most science-based definitions resonate with this shorthand for sustainability. They center on the interplay of the ecological and the human sustainability imperatives. For example, in *Caring for the Earth,* the World Conservation Union (IUCN), together with the United Nations Environment Programme (UNEP) and the World Wide Fund for Nature (WWF), defined sustainable development as "improving the quality of human life while living within the carrying capacity of supporting ecosystems."[6] In their brochure, "Action for Global Sustainability," the Union of Concerned Scientists argues that "humanity must learn to live within the limits of natural systems while ensuring an adequate living standard for all people." The "four system conditions" of sustainability developed by the Natural Step, under the leadership of Karl-Henrik Robèrt, probably provide the most comprehensive framework for sustainability. They also build on the two sustainability imperatives: one system condition explains the human imperative while the remaining three detail what living within the means of nature involves. [7] In essence, sustainability requires that we not turn our resources into waste any faster than nature can reconstitute waste into resources.

All of these approaches agree that the current conflict between these two imperatives—staying within the capacity of our ultimate means (natural capital) and reaching our ultimate ends (satisfying lives for everybody)—is at the core of humanity's current self-destructive path. It is this contradiction that defines the dynamic of unsustainable behavior.

Framing sustainability with these two core requirements makes the concept more tangible and effective. Some may object that this approach leaves out an often-mentioned "third element," the economy. But it doesn't. The economy is the domain where all the action happens. While economic performance is not a goal in itself, it is a means by which to achieve the goal: meeting the human imperative without violating the ecological imperative.

3. Present Obstacles to Sustainable Resource Management

While simple to spell out, sustainability is hard to implement. Some initiatives have successfully reduced human pressure on distinct ecosystems, but on the whole, humanity has not lived up to the challenge to reduce, or even stabilize human pressure. Reasons abound. The most prominent one may be that the challenge seems too daunting. It is daunting for the "golden billion" that is blessed with unprecedented personal wealth and material abundance, since the current situation provides them with comfortable lives, while their privileges might be called in question if the world adopts a sustainable path. It is also daunting for the other 5 billion members of humanity, since they lack resources for mobilizing development that does not liquidate natural and social assets. Many are caught in daily survival struggles that make it nearly impossible to allocate resources for redirecting our common course.

Too few of the institutions serving the golden billion have taken an active stand to give sustainability teeth and to make progress toward measuring sustainability. On the contrary, they have a propensity to keep the debate fuzzy, which conveniently diffuses the pressure to address

the challenge, thereby maintaining the status quo. This allows them to find consolation for their concerns about the future in vague discussion, while not risking accountability for their actions or having to abandon the system that maintains their privileges.

Vagueness is also advanced by a few misconceptions of core concepts. For example, ecological limits are considered to be visible and obvious. But they are not visible. The most influential decision-makers in this world, including most professionals, live urban industrial lives where scarcity is not present in their daily routines. On the contrary, urban shoppers are enjoying an explosion of diverse and refined products, taking for granted the basic supply of energy and clean water.

Nor are the limits obvious. As explained above, due to the possibility of overshoot, resource use can increase even after ecological limits have been transgressed. Since nature has some reserves, humanity can, for a while, take more than nature can regenerate. This overshoot eats up nature's reserves and weakens its capacity to regenerate. Without balancing our ecological books, we do not know whether human draw on nature's "accounts" exceeds nature's "interest payments."

Also, society cannot perceive ecological limits through a monetary lens. For wealthy people, resource prices have decreased over the years, as pointed out by a long tradition of economic studies.[8] However, prices only signal availability of a resource on the market, not its availability in the biosphere.[9]

Finally, many have claimed that it is impossible to assess with certainty the remaining stocks of resources. This is true for most non-renewable resources that are hidden in the Earth's crust. However, the argument does not apply to the even more critical renewable resources, since they are above ground and therefore visible and measurable.

For all these reasons, sustainable resource management is only possible if sustainability is defined in a way that is accountable and consistent with ecological realities. This paper argues in the following sections that the sustainability approach outlined above can serve as such a consistent and ultimately accountable framing of the challenge of sustainable resource management.

4. Keeping Track of Humanity's Use of Nature with the Ecological Footprint

As simple and generic as it sounds, "living within the means of nature," the ecological bottom-line condition for sustainability, turns out to be a specific, measurable criterion. It is measured by determining how much nature, or more specifically biological capacity, is available and comparing this supply with human demand.[10] Only if human demand does not exceed nature's supply can we claim to meet the criterion.

The "ecological footprint" methodology provides a natural capital account that can determine at each scale, from the global down to the household, how much of nature's services are appropriated for supporting these entities.

The supply side of the equation is the most straightforward part of the resource assessment. The amount of nature or bioproductive capacity that humanity has available worldwide is given by the size of the planet's areas that are biologically productive.[11] To determine the per capita supply of ecological capacity, the biologically productive land and sea that exists in a given year is divided by that year's population. For the year 2000, this resulted in an average of 2.1 hectares per person, while in 1996 this was still at 2.2 hectares (see Table 1).[12] Of these 2.1 hectares per person, 1.6 are land-based natural and managed ecosystems such as forests, pastures, and arable land and 0.5 hectares are ecologically productive ocean areas, most of which are located on continental shelves.

It is questionable whether people should use all of the 2.1 hectares per capita since the human species is not alone on this planet. People share this planet with over 10 million other species—most of which are excluded from the spaces occupied so intensively for human purposes; for example through industrial agriculture and urbanization.

There is a great range of opinion about how much bioproductive area should be kept relatively untouched for other species, even merely for the utilitarian reason of maintaining species that are necessary for basic life-support services. Some conservation biologists suggest setting aside at least one quarter for biopreservation, and in some areas up to 75 percent. The highest conservation targets in policy documents are far smaller. The authors of the Brundtland Report *Our Common Future*[13] invited the world community to protect 12 percent of all the biologically productive space, which is politically courageous, but still may be ecologically insufficient.[14] Using this conservative number, the bioproductive space available per person today shrinks from 2.1 to 1.8 hectares.

This supply can now be compared to human demand for biological capacity, which is calculated by adding up the various areas from all over the world that are occupied to produce the resources they consume and to absorb the waste they generate. This total represents a population's ecological footprint, which is proportional to the level of consumption, and population size, and inversely proportional to the efficiency of the prevailing technology. Non-renewable resources are reflected in the accounts only to the extent that their use damages the biosphere for instance trough mining, processing and consumption. We currently account only for the embodied energy associated with the use of non-renewable resources.

The footprint approach we have developed over the last few years builds on publicly available statistics from United Nations agencies and aims at providing robust underestimates of human impact in order to avoid exaggerating the severity of the present ecological condition. We do this by leaving out aspects that are not conclusively documented. Examples include the use of freshwater with very locally specific impacts, or the emission of a variety of pollutants. Also, if an area performs various functions, it is only counted once in a footprint assessment. Finally, if there is uncertainty about the yields of a given bioproductive space, we use an optimistic figure to provide a conservative estimate of human impact. To make footprints internationally comparable, we express them in standard hectares. One standard hectares is one hectare of bioproductive space with world average capacity to produce biomass.

Similar to static GDP accounts that document economic performance, ecological footprint accounts describe ecological outcomes by documenting human dependence on ecological flows. It does this by using static accounts that add up resource flows as captured by national statistics, and therefore does not depend on extrapolation or an understanding of causal relations. Like in the case of GDP accounts, footprints also provide a myriad of other indicators or subcomponents that can be extracted from the overall accounts. In other words, footprints offer not just a single result, but a comprehensive accounting system that allows for a variety of analyses. [15]

Our latest and most complete estimates, based on 1996 data,[16] show that the average American required approximately 12.3 hectares to provide for his or her consumption. This ecological footprint is over 5 times more than is available per person worldwide. In comparison, the average Canadian lived on a footprint about one-third smaller (7.7 hectares), and the average German on one that was half the size (6.3 hectares). Table 1 lists the results for the E-9 countries,[17] the world's 9 environmental and economic key countries. A table with the world's largest 150 countries is provided in the appendix.

Data for 1996	*Eco-Footprint* *per person* [ha/cap]	*Biocapacity* *per person* [ha/cap]	*Eco-Footprint* *per country* [km^2]	*Biocapacity* *per country* [km^2]
Brazil	2.6	11.6	4,108,000	18,615,000
China	1.8	0.9	22,722,000	10,844,000
Germany	6.3	2.5	5,112,000	1,998,000
India	1.1	0.7	9,991,000	6,979,000
Indonesia	1.5	3.2	2,959,000	6,399,000
Japan	5.9	0.9	7,415,000	1,076,000
Russia	5.4	4.1	7,834,000	5,948,000
South Africa	4.0	1.4	1,536,000	523,000
US	12.3	5.6	33,006,000	14,899,000
WORLD	**2.8**	**2.2**	**163,809,000**	**125,404,000**

Table 1: This alphabetic list of the E-9 nations, shows the ecological footprint and the biological capacity per person and for each country as a whole. A list of 150 countries is provided in the appendix (source: *Living Planet Report 2000*).

Again, the ecological footprint figures are conservative estimates of human impact, not only because of optimistic yield figures and leaving out impacts due to insufficient data, but also because these accounts do not include substances and activities that are systematically at odds with sustainability and should be phased out. Examples are the use of bioaccumulative and ecotoxic substances such as plutonium, mercury, CFCs, DDT, and PCBs. In other words, footprint results point out how much ecological capacity is necessary to maintain the potentially sustainable activities of humanity.

In spite of these underestimates, the accounts show that global overshoot is occurring. Even though the average footprint of all 6 billion people on Earth is 2.8 hectares per person,

significantly smaller than that of most industrialized nations, it still exceeds the bioproductive capacity that exists per person worldwide by over 30 percent. If we set aside 12 percent of the globe's biological capacity for other species and ban all consumptive human uses in these areas, then overshoot amounts to over 50 percent. In other words, it would take 1.5 years to regenerate what humanity consumed during 1996.

The global North-South divide becomes powerfully evident from looking at footprint results. While the one billion people living in OECD countries[18] have an average footprint of 7.2 hectares per person, the other 5 billion people live on only 1.8. OECD countries' footprints exceed their biocapacities by an average of 3.8 hectares per person.[19] That's what we call an "ecological deficit". All the non-OECD countries put together run much less of an ecological deficit, since their collective footprint barely exceeds their bioproductive capacity.

5. Limitations of Ecological Footprint Analysis

Footprint accounts as established for our analysis of nations do not provide the full picture for managing resources sustainably. Particularly, as their aim is not to exaggerate human impact, many significant impacts or resource uses are understated or neglected. Most prominently, the accounts undercount the waste side of the human economy, as well as its dependence on freshwater. Footprint analyses also say nothing about quality of life. They merely reflect the draw on nature from a given lifestyle.

There are many aspects of footprint accounts that could be improved to make them more robust, versatile or sensitive. [20] But we would contest van Kooten and Bulte's claim that these imperfections make footprint accounts "useless for policy analysis".[21] In fact, these authors and others[22] seem caught in a few misconceptions about carrying capacity and footprint analyses. For example, they claim that: [23]

- Carrying capacity accounts are questionable since "the evidence from exercises involving crops and food, and from fuelwood availability, suggests that quite a few African countries have gone well beyond carrying capacity. But this means that they must be steadily dying or starving (independently of any crisis droughts etc), or that the numbers are wrong, or that they have found other strategies for coping with physical scarcity".[24] However, our point is that either the country can still afford to import ecological capacity (as in the case of Egypt), or the country overshoots its carrying capacity, which is possible for some time. But the effect of overshoot is natural capital stock depletion – and indeed that's what we are witnessing in many parts of the world, and for the atmosphere as a whole.

- "Carrying capacity indicators imply zero substitutability between assets."[25] On the contrary, footprint accounts document how much capacity can be used without depleting the natural capital stock. In this way they are measures for strong sustainability. Since footprint accounts aggregate a number of ecological services, they imply plenty of substitutability among various natural capital services. The bottom-line conclusion of

footprint assessment is merely that the overall or aggregate use of natural services must not exceed nature's regeneration rate if overshoot is to be avoided.

- "Carrying capacity is irrelevant since resource yields can be increased in the case of renewable resources, and depletion profiles can be extended by technology in the case of non-renewable resources."[24] Indeed, carrying capacity can be altered: both eroded as in the case of desertification, and enhanced as in the case of careful management schemes. That's why ecological footprints are always compared to the biocapacity of a given year. In fact, as footprint accounts point out, technological efficiency is one possible strategy to reduce humanity's draw on nature (as long as the efficiency gains are not outpaced by an increase in consumption).

- "Carrying capacity calculations have limited relevance when trade is possible since the scarce resource can be imported in exchange for another asset in which the exporting nation has a comparative advantage." [24] Footprint accounts do not argue against trade or for "autarchy". They point out that not all countries can be net-importers of ecological capacity if global overshoot is to be avoided. Footprint accounts make ecological trade imbalance visible and show to what extent nations depend on net imports of ecological services. Further, Pearce's interpretation that shifting to imports from high-yield areas will reduce a country's overall footprint is incorrect. From a global perspective, this is a zero-sum game at best. And in fact, in our accounts, a shift to imports from higher-yield areas does not reduce the importer's footprint. Also, it is not our point to claim that "certain economies that are highly urbanized (Netherlands, Singapore, Hong Kong) can never be sustainable since they can never meet their ecological demands from their own land." [24] Rather, we point out the ecological impossibility of all countries following the Dutch example – or, as pointed out above, that of OECD as a whole.

- "Carrying capacity is a **survivability** concept not a **sustainability** concept. Survivability is about maximizing the time available on Earth for human species, independently of the quality of that existence."[24] We agree. Living within carrying capacity is a minimum requirement for sustainability. In other words, living within global carrying capacity is necessary but not sufficient for sustainability. Currently, humanity does not even meet Pearce's survivability criterion. This points to the need to reduce overall human demand and the need for robust carrying capacity accounts to track progress.

- Calculating the fossil fuel footprints in terms of area needed to absorb the corresponding CO_2 is inadequate according to some critics.[24, 26] We argue that this approach is the prevailing way of dealing (or rather not dealing) with atmospheric CO_2 accumulation. This space represents the degree by which the planet would need to be larger in order to cope with anthropogenic CO_2 output. Finding other ways to combat atmospheric CO_2 accumulation would open dramatic possibilities for reducing humanity's footprint. Another method of calculating the fossil fuel footprint is to assess the biological area necessary to produce a substitute. This would lead to even larger footprints.

- "There are substantial uncertainties about how to calculate the land areas required to offset waste flows."[24] This is correct. If we included them – and for some local examples this is possible – footprints would become even larger.

- Footprint accounts make no distinction between land uses that are sustainable and those that are not.[26] Again, this is correct. In order not to produce exaggerated results with present footprint accounts, we assume the most optimistic case: that current land-use practices are sustainable.

In summary, in spite of possibilities for improvement, current footprint accounts are reasonably robust underestimates of the extent to which nations' (or the world's) ecological demands are exceeding nature's regeneration rate.

6. Interpreting Ecological Footprint Results

Ecological footprints and ecological deficits provide us with a number of critical insights. The case for the globe as a whole is simple: most fundamentally, the minimum requirement for global sustainability is that humanity's footprint must be smaller than the biosphere's biological capacity. In contrast, the implications for nations are less straightforward. For example, is Sweden, with a large footprint per person but even larger biological capacity per person, ecologically sustainable? What about Egypt, which has a per capita footprint smaller than the global average biological capacity, yet larger than its domestic biological capacity? Clearly, if everyone in the world led the same lifestyle as the average Swede, the Earth would not be able to sustain its human population for very long. Nor would humanity be sustainable if all countries ran an ecological deficit like Egypt – or like all OECD countries combined.

While footprint analyses do not answer the question of whether a given country should live within the world's average biological capacity, or within its national biological capacity, they offer a quantitative measure of the ecological challenges and conflicts humanity needs to resolve if it wants to achieve global sustainability.

Apart from scrutinizing the ecological performance of countries from a number of angles,[27] ecological footprints also provide a context for analyzing, exposing, and counteracting overshoot. They make a case against running ecological deficits, an issue even more serious than accumulating economic deficits. With an ecological deficit, there is no collateral securing the debt, no intention to pay back future generations, and, without solid ecological footprint accounts, no mechanism to document how much we owe. We are writing checks without balancing the (ecological) books. More specifically, these analyses help to:

- Manage common assets more effectively rather than valuing them at zero because their contributions to society are not systematically assessed;
- Serve as a warning device for economic and military long-term security; to recognize emerging scarcities and overall global trends;
- Recognize (decreasing) options by analyzing the compound effect of a number of ecological pressures such as climate change, fisheries collapse, agriculture, forestry conflicts, and urban sprawl;

- Identify local and global possibilities for climate change mitigation and the competition between domestic sinks, joint implementation and domestic CO_2 reduction; and
- Test policy options for future viability and possible unintended consequences.

But there is another benefit to establishing footprint accounts. A nation profits from analyzing its ecological deficit, because reducing it can increase a country's competitiveness. That's what we concluded in *Winners and Losers in Global Competition*, a study sponsored by a Swiss bank and released earlier this year. For this study, we analyzed to what extent national competitiveness as defined by the World Economic Forum correlates with the ecological sustainability and ecological performance of nations.

For the World Economic Forum, competitiveness is evaluated using an extensive survey asking business leaders from all over the world about the educational level of workers, quality of infrastructure, political stability, reliability of financial institutions, government support, and production costs within their countries. The competitiveness indicator is calculated by assigning weights to the various issues and aggregating the results. We then plotted this competitiveness against ecological deficit as measured with our footprint accounts.

One key finding was that countries without an ecological deficit were more likely to be competitive. In fact, almost all countries without ecological deficits were competitive, and those that were not have suffered from violent internal conflicts, such as Peru, Colombia and Brazil.

Obviously, there are countries that are competitive while still living with an ecological deficit. Examples are Switzerland, Holland, Singapore, and Japan. These are all countries that were lucky to enjoy an early head start and accumulate financial assets in a time when expansion was easy. With this financial advantage, they are still able to access resources. But among the countries we studied who gained their competitiveness more recently, none had an ecological deficit.

However, in the future, for those countries with ecological deficits that are still competitive, it may be increasingly difficult to maintain or gain competitiveness as the global ecological deficit increases and resources become scarcer. These countries will be wise to reduce their ecological deficit in order to decrease their risk exposure and secure future well-being. Also, countries without ecological deficits will be enticed to become more protective about, and give more care to, their strategic ecological reserves as they become ever more valuable assets. Luckily, both of these strategies strengthen global sustainability.

Those non-competitive countries living beyond their ecological capacity will have great difficulty keeping afloat. Their ecological deficits already play out as a liability today. In these countries, sustainability requires a structural change in the economy that will be difficult to achieve with their poor competitive position and their lack of financial assets to pay for such a transition. These countries are faced with the daunting challenge of eliminating their lagging competitiveness, resulting from weak infrastructure and a scarcity of financial resources and training, while at the same time dealing with the liability of an ecological deficit.

This is particularly significant in global terms, since the world economy's ecological deficit is increasing. As this ecological debt builds, ecological productivity is reduced. Because this depletion of natural capital will make it more difficult for countries to cover their ecological debt, it is in the self-interest of nations with an ecological deficit to reduce it. In an ecologically indebted world it will also become more difficult for every country to cover its ecological deficit by foreign purchasing. In the short-term, this predicament can be circumnavigated with strong currencies, improved access to less exploited resources and cheaper extraction methods. In the long-term, however, ecological scarcity will be a major brake on the economy. And not only for resources: waste sinks, currently used almost free of charge, will become a cost factor because of international agreements such as Kyoto (on carbon dioxide), Montreal (on stratospheric ozone-depleting gases), and Basel (on the export of industrial waste). It will therefore be critical for all to reduce ecological deficits with an eye toward creating economic stability and ensuring nations'quality of life.

For those countries with abundant ecological endowments such as Finland or Sweden, it is easier to remain competitive. They have greater room to maneuver. For them too, it makes strategic sense to restrict their resource consumption and waste production, since as ecological creditors, they are in a position to enhance their current and future competitive advantage. Using up their ecological reserves or even reducing them would jeopardize their future economic advantage, thus making them more vulnerable to economic downturns. It is therefore in the interest of each nation--both creditors and debtors--to reduce their nation's ecological footprints.

This insight could serve as an incentive for all countries to reduce their national footprints and more effectively manage and protect their ecological resources, as these increasingly become an a strategically significant part of national wealth. If countries act in their long-term self-interest, the result will be global sustainability.

7. Policies Necessary to Reduce Human Pressure

While recognizing the need to reduce human pressure seems obvious and straightforward, addressing this challenge so that people feel better off is nothing short of a thorny affair. National governments have a large array of options for affecting the way resources are managed. These possible actions can be classified into three groups:

a) Keeping an eye on national assets

Governments check on their national assets in two ways. First, they compile statistics on a number of national assets and activities such as economic performance, social health, international trade, or resource consumption. The choice of which statistics are provided or collected influences what is considered important or what gets attention. Second, governments engage in compliance: making sure that individuals and organizations follow laws and regulations.

b) Managing national assets

Governments directly manage a number of national assets. These include research facilities, educational institutions, public health and social security organizations, national defense, public land and parks, and infrastructure for transportation and communication. Each of these assets needs to be managed for, and can help shape, society's sustainability.

c) Guiding markets

Governments are most visible in the way they manage markets. This is done not only through monetary policies, but even more so by setting standards and regulations, some of them in the context of international negotiations, and by developing incentive systems (subsidies and taxes) for directing markets and generating revenues. In addition, through procurement, governments can develop or strengthen emerging markets that are considered beneficial to the national economy.

No single policy initiative will redirect a nation's use of resources toward sustainable possibilities. Rather, society must pursue the whole spectrum of opportunities in order to be successful.

A myriad of policy options could reduce a nation's ecological deficit. Here are a few examples:

a) Keeping an eye on national assets

- Establish transparent and publicly available sustainability indicators and accounts that track core requirements of sustainability. This includes developing natural capital (or "biological capacity") accounts in each country, and setting specific targets for natural capital use.
- Strengthen enforcement of regulations that affect sustainability, such as pollution control, land-use zoning, or restricted forestry practices.

b) Managing national assets

- Adapt infrastructure for sustainability. For example, avoid expansion of built-up areas, particularly for car use; and transform energy infrastructure to favor energy savings over production, and efficient, small scale energy sources over large power plants.
- Support research for sustainability. For example, support research toward steady-state economics, efficient urban systems, and low-impact and resource-saving production systems.
- Strengthen education's contribution to sustainability. For example, encourage educational initiatives that teach how to reduce human pressures on ecosystems.
- Reorient public health and social security to enhance sustainability. For example, develop humane, equitable, and widely acceptable policies to reduce human population; encourage a change of eating habits away from resource-intensive foods such as meat and dairy products, or processed foods that are transported long distances.
- Protect natural assets. For example, establish a network of ecologically representative protected areas covering significant areas of each ecosystem type; designate marine protected

areas to safeguard marine ecosystems and give depleted fish populations a chance to recover; eliminate destructive fishing practices, such as cyanide and blast fishing on coral reefs.
- Link national defense to mitigating ecological and social crises

c) Guiding markets

- Develop regulations and standards that encourage sustainability. For example, ensure that forests outside protected areas are well managed according to standards set by the Forest Stewardship Council; raise farming standards to encourage sustainable farming systems that do not systematically degrade biological capacity; protect soil from erosion and degradation caused by intensive agriculture, overgrazing, or salinization; discourage the use of agricultural chemicals by taking into account the local assimilative capacity of agro-ecosystems; stop the use of hazardous pesticides and increase the use of biological control and pest-resistant varieties.
- Put in place incentive and tax systems that encourage equitable reductions in resource consumption and that phase out perverse subsidies that promote resource use, pollution, and population growth. For example, cut subsidies that contribute to overfishing and promote market incentives for sustainable fishing, such as the Marine Stewardship Council; eliminate export subsidies; encourage policies to incorporate environmental costs in the price of goods and services; shift energy subsidies from fossil fuels to energy sources which reduce or eliminate pollution, especially renewable sources such as solar and wind; increase energy prices to cover the full environmental costs of energy use, and eventually remove government subsidies on energy.
- Support international negotiations that promote sustainability. For example, ratify and strengthen international agreements that discourage countries from externalizing their ecological costs, for example the Kyoto protocol or the Basel convention; assist lower-income countries to invest in sustainable energy technologies.
- Redirect government procurement toward sustainable alternatives to set good examples and stimulate new markets. For example, promote the recycling and reuse of wood and paper products by only consuming those types of forest products.

8. Building Public Support for Action

There is an abundance of policy options for reducing ecological deficits. But there is less indication that the public is calling for their implementation – at least not yet. Only once it is viscerally clear to people that ecological deficits threaten their well being will the support build. This is not a call for public information campaigns. There is sufficient information available to people explaining the ecologically delicate situation humanity finds itself in today.

Rather, the question is how to help the public recognize that these ecological trends are relevant to their lives and that current patterns of economic expansion are undermining their own possibilities by liquidating the ecological (and social) assets that fuel the human economy. Once this recognition translates into broad concerns, the perceived heat will focus society's attention on the cost of ecological decline and every sector will start to bring forward its solutions. That's

where we already have a head start: libraries are stacked with possible solutions and promising policy options. But only people's craving for them will give them traction.

Another barrier to generating social support for such propositions is the perception that sustainability is a daunting task. Some even see it as an impossible venture. All this produces is a pervasive and paralyzing sense of futility. However, the question is not so much whether sustainability is possible, but rather at what cost humanity will get there. Waiting too long will make solutions more costly, the transition possibly painful, and the resources more scarce, since overshoot will erode valuable ecological capacity.

Governments can help society address sustainability. This does not mean imposing particular values. It means catalyzing a discussion of how to deal with the difficult decisions that nations, regions, and businesses face in a world with a declining resource base and increasing human demands. Activities for catalyzing this discussion include:

a) *Clarifying in specific and accountable terms what sustainability means*. Being explicit and clear about the goal, offering well-defined measures to track progress towards the goal, and identifying responsibilities for action sharpens the debate. It is the specificity that generates the actions and reactions necessary for a public debate.
b) *Showing that addressing sustainability is desirable*. Without examples of what a sustainable society could look like and what benefits it brings to our lives, people will remain reluctant to abandon their current patterns of living that are familiar and comfortable. Still, while some claim that "we can't afford sustainability," it is increasingly clear that society can even less afford unsustainability. In fact, in a world with growing overshoot, the costs of inaction may be rising steeply.

This means that effective policies for sustainable resource management may depend more heavily on social marketing than has been recognized before. This may require policy analysts to broaden their conception of policy development. But social marketing is not new to government policies. Particularly the public health field, for example with AIDS prevention and anti-smoking campaigns, have long traditions in using a broad array of intervention options. Essentially, this broader policy approach involves working on three levels simultaneously (see Figure 1).

Level 1 refers to changing the physical outcomes of human activities. This could means being as creative as possible in making resource decisions within the existing economic constraints. Examples include resource-saving initiatives of companies, some of which have used decision frameworks such as the one developed by the Natural Step.[28] Or experimenting with possibilities that are not yet economically feasible, but may be in the future once the technology is established and proper incentives are put in place. Examples include the development of new technologies that are not yet ripe for the market such as fuel cells, hyper cars, or new advancements in renewable energy.[29]

Exploring and implementing such policies are essential, not only to push the envelope of technology to reshape markets and catalyze breakthroughs, but to capture people's imaginations. It is with such specific examples that remote dreams crystallize into attainable possibilities.

Level 2 focuses on redirecting market forces to realign individual interests with social ones. Various policies concepts describe a variety of "sticks and carrots" that can be used – particularly interesting is the discussion of an ecological tax reform.[30]

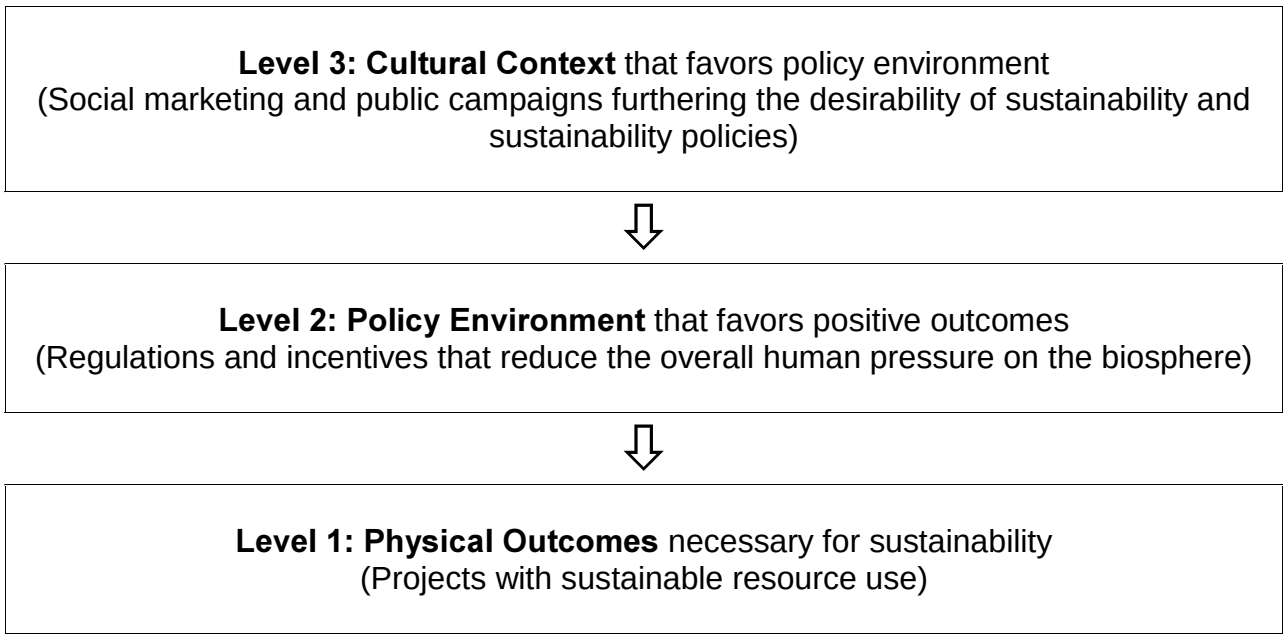

Figure 1: Three levels for policy intervention. While the conventional policy interventions focus on Level 2, combining them with Level 1 and 3 interventions will produce more promising results.

Level 3 may be the most neglected intervention point, but possibly the most promising one. Its focus is to redirect the culture in a way that makes it crave for sustainability, and support the restructuring of incentive systems in favor of sustainability. To capture people's imagination, examples at level 1 need to exist to make the new options realistic. At the same time, campaigns can help reshape the public's perception of the costs and benefits of competing development scenarios. [31] One of the most powerful ways to focus society's attention is to stimulate conversations around sustainability. It is the conversations that determine in each decision-making process which aspects will be considered significant. Particularly with topics that are controversial, like sustainability, the conversation culture needs extra support to overcome the social temptation of avoidance. There, public campaigns that are attractive, factually correct, and non-judgmental can become invaluable since they help 'legitimize' carriers of sustainability discussions.

9. Conclusion

To achieve sustainable resource management, it is essential to abandon fuzzy sustainability concepts and become specific about the core requirements of sustainability. These requirements can be spelled out in explicit terms, the most paramount being to avoid ecological overshoot.

From the perspective of resource management, overshoot may be the most central sustainability concern. The good news is that it can be measured – the bad news is that it is no longer a possibility, but a fact, even for the globe as a whole. As pointed out, OECD countries generate not only a disproportionate share of human pressure on the biosphere, but also represent the segment of humanity that exceeds its own ecological capacity by the greatest proportions.

While these trends can still be ignored today, as the biosphere accumulates an ecological debt, impending costs point clearly to the undesirability of overshoot.

Nations can protect themselves from the fallout of overshoot first and foremost by developing ecological accounts that are able to track overshoot. Also, they need to run effective social marketing campaigns that gather popular support for reducing human pressure. Without this groundwork, it is unlikely that policy reforms for sustainable resource management will be successful.

Attachment: *Living Planet Report 2000's footprint list of 150 countries. (or download entire spreadsheet from www.rprogress.org/ef/LPR2000)*

References:

[1] Sections 1 and 2 build on Paul Hawken and Mathis Wackernagel, 2000, "Satisfying Lives for All Within the Means of Nature: How a Honed GRI Could Advance True Sustainability," GRI/CERES, Boston. http://globalreporting.org/PilotFeedback/CommissionedFeedback/CommissionedFeedback.htm

[2] World Resources Institute (WRI), United Nations Development Programme (UNDP), UNEP, World Bank, 2000, *World Resources 2000-2001, People and Ecosystems: The Fraying Web of Life,* Oxford University Press, New York. United Nations Environment Programme (UNEP), Stockholm Environment Institute, 1999, *Global Environment Outlook 2000,* Oxford University Press, New York.

[3] Jeffrey Krautkraemer, 1998, "Nonrenewable Resource Scarcity," *Journal of Economic Literature* Vol 36 pp 2065-2107.

[4] This approach is consistent with the notion of "strong sustainability." Strong sustainability refers to the criterion of not depleting natural capital. Weak sustainability, in contrast, implies no depletion of total capital, i.e., natural as well as human-made capital. This means that natural capital could be diminished as long as it is compensated by a commensurate increase of human-made capital. Apart from the lack of adequate methods to compare the value of human-made and natural capital, such weak sustainability would assume that there is substitutability between human-made and natural capital. While there is some substitutability among different aspects of natural capital (e.g., fuelwood versus bio-fuel from corn), and even some marginal substitutability between natural capital and human-made capital (e.g., fuel-wood versus wind-mills), there is no absolute substitutability, since human and non-human life depend on the functioning of the biosphere. In the past, weak sustainability may have been a sufficient criterion for beneficial development. But this is no longer the case in a time of global overshoot. Since humanity is using the biosphere's capacity more rapidly than it can regenerate, further trade-offs of building human-made capital at the

expense of natural capital undermine the well-being of future generations. Nevertheless, strong sustainability does not condemn humanity into stagnation. On the contrary: stagnation is more likely with weak sustainability policies since they could continue to liquidate natural capital. In contrast, societies adopting strong sustainability could continue to flourish. For example, human-made technology can become more effective in providing services to people without increasing its draw on natural capital, or costs of expanding human infrastructure can be saved by stabilizing or even reducing human population.

[5] Jim Motavalli, 1999, "Conversations with Dr. Nafis Sadik: The UN's Prescription for Family Planning," *E: The Environmental Magazine.* July/August 1999, Vol. 10, No.4, p10–13.

[6] Page 10 in World Conservation Union (IUCN), the United Nations Environment Programme (UNEP), and the World Wide Fund for Nature (WWF), 1991, *Caring for the Earth,* World Conservation Union (IUCN), Gland Switzerland.

[7] For more information on The Natural Step, see <http://www.naturalstep.org>.

[8] Harold Barnett and Chandler Morse, 1963, *Scarcity and Growth*, Johns Hopkins Press, Baltimore. Julian L. Simon, 1996, *The Ultimate Resource 2*, Princeton University Press, Princeton NJ. Jeffrey Krautkraemer, 1998, "Nonrenewable Resource Scarcity," *Journal of Economic Literature* Vol 36 pp 2065-2107.

[9] William E. Rees and M. Wackernagel, 1999, "Monetary Analysis: Turning a Blind Eye on Sustainability". *Ecological Economics* Vol. 29 No. 1 p 47-52.

[10] The well promoted Environmental Sustainability Index of the Global Leaders for Tomorrow Environment Task Force of the World Economic Forum overlooks this basic requirement (http://www.yale.edu/envirocenter/research/esi.html). For instance, ESI virtually ignores environmental impacts beyond national borders, making sustainable development elusive. According to this Index, the United States ranks among the top countries in the world while producing 20 tonnes of carbon dioxide per person per year, five times the world average, and ten times the amount that the biosphere can currently assimilate on a per person basis. By confusing standard of living with environmental sustainability, ESI produces flattering scores for wealthy countries, even though it would take 3.5 planet Earths if all world citizens used resources at the rate of OECD countries.

[11] We define the biologically productive space on the planet as the area that produces, as a whole, over 95 percent of the biosphere's biomass production.

[12] One hectare corresponds to 10,000 m^2 or 2.47 acres. One hectare is roughly the size of a soccer field.

[13] World Commission on Environment and Development (WCED), 1987, *Our Common Future* (aka: The Brundtland Report), Oxford University Press, Oxford.

[14] Today, about 3 percent of biologically productive space is set aside as protected reserves, worldwide. However, conservation biologists believe that, independent of interspecies fairness, it may require far more merely for the utilitarian goal of biodiversity preservation. Wildlife ecologist and scientific director of the Wildlands Project, Reed Noss, along with Allen Cooperrider, conclude that most regions will need protection of some 25 to 75 percent of their total land area in core reserves and inner buffer zones. These projections all assume that this acreage is distributed optimally with regard to representation of biodiversity and viability of species, and is well-connected within the region and to other reserve networks in neighboring regions (Reed F. Noss and Allen Y. Cooperrider, 1994, *Saving Nature's Legacy—Protecting and Restoring Biodiversity*, Island Press, Washington, DC).

[15] For more details, consult the national footprint accounting spreadsheets, which can be downloaded from the Redefining Progress website at http://www.rprogress.org/ef/LPR2000/

[16] World-Wide Fund for Nature International (WWF), UNEP World Conservation Monitoring Centre, Redefining Progress, Center for Sustainability Studies, 2000, *Living Planet Report 2000*, WWF, Gland, Switzerland. The first study of national footprints was: Mathis Wackernagel, Larry Onisto, Alejandro Callejas Linares, Ina Susana López Falfán, Jesus Méndez García, Ana Isabel Suárez Guerrero, Ma. Guadalupe Suárez Guerrero, 1997, *Ecological Footprints of Nations: How Much Nature Do They Use? How Much Nature Do They Have?* Commissioned by the Earth Council for the Rio+5 Forum. International Council for Local Environmental Initiatives, Toronto. The methods are also described in Mathis Wackernagel, Larry Onisto, Patricia Bello, Alejandro Callejas Linares, Ina

Susana López Falfán, Jesus Méndez García, Ana Isabel Suárez Guerrero, and Ma. Guadalupe Suárez Guerrero, 1999, "National Natural Capital Accounting with the Ecological Footprint Concept," *Ecological Economics,* Vol 29 No 3.

[17] For a further discussion of the significance of the E-9 countries, see Christopher Flavin, 20001, "Rich Planet, Poor Planet," in Lester Brown *et al*., 2001 *State of the World 2001*, The WorldWatch Institute, W.W. Norton, New York.

[18] The member countries of the Organization for Economic Co-operation and Development include: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, the United States, and the United Kingdom.

[19] World-Wide Fund for Nature International (WWF), UNEP World Conservation Monitoring Centre, Redefining Progress, Centre for Sustainability Studies, 2000, *Living Planet Report 2000*, WWF, Gland, Switzerland.

[20] Mathis Wackernagel and J. David Yount, 2000. "Footprints for Sustainability: The Next Steps." *Environment, Development and Sustainability.* Vol. 1 No.2: 21–42.

[21] G. Cornelis van Kooten and Ervin H. Bulte, 2000, *The Economics of Nature: Managing Biological Assets*, Blackwell Publishers, Oxford. For quote, see p.264.

[22] David Pearce, 2000, Public Policy and Natural Resources Management, Draft paper for DGXI, European Commission. Jeroen van den Bergh and Harmen Verbruggen, 1999, "Spatial Sustainability, Trade and Indicators: An Evaluation of the Ecological Footprint," *Ecological Economics,* Vol 29 No 1, p. 61–72. (April 1999). VROM-council, *Global Sustainability and the Ecological Footprint*, Advice 016E, The Council for Housing, Spatial Planning and the Environment, The Hague, September 1999.

[23] In view of the limited space, the following list and responses are merely a succinct summary of the arguments. See also Mathis Wackernagel and Judith Silverstein, 2000. "Big Things First: Focusing on the Scale Imperative with the Ecological Footprint", contribution to Robert Costanza's "Forum: The dynamics of the ecological footprint concept" in *Ecological Economics.* Vol. 32, No 3, March 2000. pp 391-394.

[24] Pearce, 2000, see endnote 22.

[25] van Kooten and Bulte, 2000, p.265, see endnote 21.

[26] Pearce, 2000, and van den Bergh and Verbruggen, 1999. See endnote 22.

[27] Ecological footprint accounts provide a variety of tools and indicators for countries, such as the production footprint, impacts of different sectors, dependencies on particular resources, etc. that can provide a richer picture of the ecological performance of a country. Wackernagel and Yount (2000, endnote 20) give an overview of possible uses of the tool.

[28] Karl Henrik Robèrt, "Tools and concepts for sustainable development."The Journal for Cleaner Production. Vol 8 No 3 2000, p 243-254. Brian Natrass and Mary Altomare, 1999. *The Natural Step for Business: Wealth, Ecology and the Evolutionary Cooperation*, New Society Publishers, Gabriola Island.

[29] Visions of what sustainable cities could look like are explored in R. Rogers' *Cities for a Small Planet* (1998, Westview, Boulder, CO). Examples of the new industrial revolution that could produce far more sustainable possibilities are explored in *Biomimicry* (J. Benyus, 1997, Morrow, New York) and *Natural Capitalism* (P. Hawken, A. Lovins, and L. H. Lovins, 1999, Little, Brown and Co., Boston).

[30] David Pearce, E. Barbier and A. Makandya, 1989. *Blueprint for a Green Economy*, Earthscan London. David Pearce and E. Barbier, 2000. *Blueprint for a Sustainable Economy*, Earthscan London. Jeff Hamond, et al. 1997. *Tax Waste, Not Work*, Redefining Progress, Oakland.

[31] See Allen L. Hammond, 1998, *Which World? Scenarios for the 21st, Century*, Island Press, Washington D.C. Doug McKenzie-Mohr and William Smith 1999. *Fostering Sustainable Behavior : An Introduction to Community-Based Social Marketing,* New Society Publishers, Gabriola Island. Malcolm Gladwell, 2000,*The Tipping Point,* Little, Brown and Co., Boston.