

## VISIONS BEYOND THE FAR HORIZON<sup>1</sup>

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### Visión más allá del horizonte lejano

«All human interactions are opportunities either to learn or to teach»  
M.Scott Peck (Lloyd, 2000)

### INTRODUCTION

You and I are very fortunate for, we have been provided with opportunities «to see beyond the obvious». At any given place a soil has a sequence of horizons, and there we sense the importance of history as we dig deeper into the genesis and evolution of a soil landscape. As we look out across a landscape there are boundaries of the surrounding area; they obviously are visual horizons. Through training and experience, each of us has learned how to see beyond the obvious, how to anticipate what lies beyond those horizons; and to recognize the deep-seated values associated with the temporal and spatial horizons of our world.

It is a humbling experience to comprehend the frailties of our own species and our seeming unwillingness to think and to act as rational beings. Consider this phrase - 'nonmaterial needs of human development' (Meadows et al., 2004). Is this jargon from a new trend in sociology? No, this phrase is about a critical aspect of being human. It simply means that we don't need big fancy houses and cars, we need admiration and respect. A steady flow of new fashionable clothes isn't needed, but we do need to feel that others consider us attractive. We need excitement and variety and beauty. We need something interesting to occupy our minds and emotions. Trying to fill these kinds of needs for a quality life with material things is a set-up for failure. Too many material goods are false solutions to never-satisfied longings. Such actions create an unquenchable appetite - more, more, more - more growth for the sake of growth (Gardner, 2004). Beyond this short sightedness is a much larger need - the far horizon of Hope - hope to provide a sustainable habitat for the continual development of humankind in harmony with the available environmental resources.

I'd like to tell you several stories and link their lessons together as a way to explore some potential horizons that are presently beyond the obvious.

«The aim of education is knowledge, not of facts, but of values»  
William R. Inge (Lloyd, 2000)

## THE MICROBE EXPERIMENT

Remember in introductory microbiology when you prepared a nutrient agar, put it in a petri dish, inoculated it with a microbial solution, and then measured the production of CO<sub>2</sub> as a surrogate for population growth? At first not much production, then some, and suddenly a rapid rise indicating that the microbes liked their environment and were rapidly reproducing. Eventually the rate of increase leveled off, and the sudden decrease of CO<sub>2</sub> production was about as exponential as had been the prior increase. The population quickly fell to levels lower than the initial concentration.

What happened? The biological exponential growth phenomena happened - the famous S-curve response to a non-renewable resource followed soon after by the collapse and a new quasi-equilibrium as adjustment of demand and supply occurred. Someone once remarked that growth for the sake of growth is the ideology of the cancer cell. This little experiment illustrated what may well be a universal reaction - be it biological, physical, chemical, industrial, economic, or social. There are limits - there are boundaries - and it is worthwhile to know something about such horizons and thresholds.

## EASTER ISLAND

One of the most remote places on this planet is Rapa Nui - Easter Island (Hyerdahl, 1958). Sometime before 800 AD a few people reached this semi-arid, cool, isolated paradise forested with the huge Chilean wine palm and several other species, a few birds, but no large animals. The forest was cleared for gardens, the trees provided canoes to go to sea, and dolphins became the main animal food. The population grew. Tribal chiefs convinced of their lineage to God, wanted statues to honor themselves (Diamond, 2004). Huge statues were hand-carved out of the volcanic lava formations, trees were used as rollers to haul the statues

many kilometers and by clever engineering the 10-15 meter high statues were raised. Prosperity was good, the volcanic soil fertility was replenished by organic debris, fishing was great, and as the population increased so did the chiefs' desires for more statues. But around 1600 shortages began to occur - fresh water, food, and fuel were in short supply - yet each was necessary to carry out the demands of the chiefs.

Prof. Jared Diamond (2004) dramatized the situation by wondering what the Easter Islander who cut down the last Chilean wine palm tree might have said.

'What about our jobs? Do you care more for trees than for people?' or 'Have some respect for private property rights. Get the big government of 'the chiefs' off our backs!' or 'You predict environmental disaster, but your environmental models are untested. We need more research.' Or perhaps, 'Never fear, technology will solve our problems somehow. We shall find substitutes for wood.'

There was revolt, the 'long-ear' chiefs were overthrown, and new military leaders (the short-ears) took over. With no canoes there were no dolphins to eat and the people turned to the next largest animal available; humans. The people were starving, sick, and at war. Eventually 70-90% died. Aha, a fundamental process of the universe at work. Once the trees were cut down and people had no more canoes, they could not escape. There was nowhere to go when they got into trouble. Easter Island was so remote there was nobody to come help them. The 'ecological footprint of Easter Island humanity' was too much for the resources that were available. The social and economic systems did not function in a way that encouraged and implemented sustainability - thus collapse occurred.

## HUMANITY'S FOOTPRINT

«Human beings and the natural world are on a collision course»

World Scientists' Warning to Humanity (1992).

Can you imagine trying to figure out the carrying capacity of our world? If the Easter Islanders couldn't do it for their world, how will we do it for ours? Well, a few years ago Prof. Mathis Wackernagel (2002) in collaboration with 10 other international economists devised an interesting measure of the carrying capacity of the earth. They wanted to account for humanity's current demands on the planet's resources and the wastes produced in terms of biologically productive areas necessary to maintain the flows needed for such an assessment. The usable biomass productivity of different kinds of areas were expressed as standardized, 'global hectares'. The details are provided in their paper and include the following six human activities that require mutually exclusive productive land:

1. Growing crops for food, animal feed, fiber, oil and rubber requires the most productive land of all. There are 1.5 billion ha (1.3 cultivated, 0.2 unharvested) with an equivalent productive factor of 2.1 gha/ha.

2. Grazing animals for meat, hides, wool, and milk requires pasture land. There are 3.5 b ha with an equivalence factor of 0.5. The metabolic needs for 5 major classes of livestock are estimated and the needs met from feed and crop residues are subtracted.

3. Harvesting timber for wood, fiber, and fuel requires natural forest and plantations. There are 3.8 b ha with an equivalence factor of 1.3. Production estimates are made for a number of kinds of forests

4. Marine and freshwater fishing requires productive fishing grounds. Coastal waters provide 95% of marine catch (2.0 b ha and inland waters add 0.3 b ha) with an overall equivalent productive factor of 0.4.

5. Accommodating infrastructure for

housing, transportation, industrial production, and hydroelectric power requires built-up lands. This is the least well documented but estimated to be 0.3 b ha with an equivalent productive factor of 2.2.

6. Burning fossil fuels requires land to sequester enough emissions to avoid an increase to atmospheric CO<sub>2</sub>. Oceans handle about 35%, thus forests must sequester about 65%. Sequestering by forests is a weighted average for 26 forests biomes. The equivalence factor is 1.3.

To aggregate the impact components, they adjust the land and sea areas according to their bioproductivities and multiply each land use category by an equivalence factor. These factors scale each area in proportion to its maximum potential yield and the global average each year is assigned a value of 1. In 1997 the global average human demand was 2.3 global hectares of productive land equivalent per person. The highest was for the US with 9.7, the UK used 5.4 and Germany used 4.7 global hectares per person. The average existing global biocapacity in 1997 was 1.9 global hectares per person (Wackernagel et al., 2002).

There has to be equilibrium (balance) between the resources used and the wastes produced, otherwise if they are not balanced the global system is not operating in a sustainable manner. Their current estimates indicate that our global community started to overshoot the planet's available resources sometime in 1980.

Our collective economies, societies, and resource uses have all been experiencing exponential growth since the Industrial Revolution, pushing them ever closer to critical thresholds. At the present time we are using 20% more resources than are globally available on a sustainable basis.

The UNDP Millennium Ecological Assessment (2005) released earlier this year reports that 60% of the ecosystems that they evaluated are experiencing degradation or are used unsustainably. It is obvious that humanity's ecological footprint,

regardless of how we measure it, is too large. Aha, a fundamental process of the universe - showing up again.

## ECONOMICS OF SUSTAINABILITY

«To know when you have enough is to be rich.»

Luo Tsu (Lloyd, 2000).

Often when our bank accounts get low, we consider getting a loan to cover our current expenses. We borrow from the future to pay for the present. Credit cards have made the borrowing process easier and faster. Pay back is less certain.

The concept of a global society incorporates the effects of both the size of population and the size and composition of its consumption (World Watch Institute, 2005). Our ecological footprint grows when population grows because it increases with consumption. If everybody on earth enjoyed the same ecological standards as North Americans, we would require three earths to satisfy the aggregate material demand using prevailing technology. The borrowing has been easy, the pay back is less certain.

In 1987 the so-called Brundtland Report, *Our Common Future*, stated that a sustainable society is one that «meets the needs of the present without compromising the ability of future generations to meet their own needs» (Meadows et al., 2004, p. 254). Almost two decades later it still conjures up ideals of stewardship, conservation, respect, empathy, and a vision of humanity in a sustainable environment.

To be materially and energetically sustainable, economic throughputs would have to meet three conditions:

1. the rates of use of renewable resources (such as freshwater supplies, timber, and soil productivity) do not exceed their rates of regeneration

2. the rates of use of nonrenewable resources (such as oil and metals) do not exceed the rate at which sustainable

renewable substitutes are developed, and

3. the rates of pollution emission (waste disposal) do not exceed the assimilative capacity of the environment.

For a society to be sustainable, the combination of population and capital and technology would have to be configured so that the material living standard is adequate and secure for everyone and fairly distributed (Meadows et al., 2004). Hear again these words, «... without compromising the ability of future generations .....» Such a society, with a sustainable ecological footprint, would be vastly different from the one in which most people now live.

## WHY A SOCIETY MAKES MISTAKES

Before the Agricultural Revolution, land was more or less public, or at least territorial as far as tribes and nomadic groups were concerned. Once rooted in place, private property and public domain became meaningful realities.

Do you remember the story that Prof. Garret Hardin (1968) called «The tragedy of the commons» when describing the problem of population? Picture a pasture that is open to all and that each herdsman will try to keep as many cattle as possible on the commons. As rational beings each herdsman seeks to maximize his own gain. On the plus side is the fact that he receives the proceeds of selling an additional animal. On the negative side are the effects of overgrazing and pollution, however, they are shared by all the herdsmen. Each herdsman concludes that the only sensible course is to add another animal to his herd, then another, and another. Every rational herdsman reaches the same conclusion.

Therein lies the tragedy! Each man is locked into a system that compels him to increase his herd without limit - in a world that is, itself, limited. The tragedy of the commons reappears with pollution and the disposal of wastes into «the commons».

A failure of group decision making is that

no one says «Stop it!» Prof. Diamond (2004) suggests a hierarchy of 4 decision points that affect actions, reactions, and implementation.

1. Does a group anticipate a problem? Often there is no prior relevant experience of such problems.

2. Does a group fail to recognize a problem when it has arrived? Some problems develop so slowly they are nearly imperceptible. (like the leaching of soil nutrients, the loss of one more tree, the addition of one more kg of contaminant).

3. Even when a problem is recognized does a group try to solve

the problem? All too often not, because of what's called rational

behavior on the part of the group. This is the story of 'the tragedy of

the commons'. It is especially frequent when a decision making elite is

able to insulate itself from the consequences of its actions. It is hard for

people to stop doing something that is intimately tied to their strongest

held values. And finally -

4. Does a group give up because some problems are just too difficult to solve with the available technology?

Prof. Diamond concludes that our biggest risk is not of an asteroid collision about which we can do nothing - which would wipe us out like the dinosaurs. Instead, all of our major problems today are problems caused by us, primarily the consequences of population. There are many bright spots where smaller segments of society, including many individuals, are working diligently to solve problems created by unsustainable activities and practices. Even with these bright spots, as a global community of nations and of individuals we appear to be somewhere between level 2 and 3 - failure to recognize a problem and not trying to solve it.

## ECOSYSTEM DEGRADATION

The degradation of ecosystem services could grow significantly worse during the first half of this century, according to the MEA report (UNDP, 2005), and is a barrier to achieving the Millennium Development Goals. Ecosystem degradation can rarely be reversed without actions that address the negative effects or enhance the positive effects of one or more of the five indirect drivers of change: population change, change in economic activity, sociopolitical factors, cultural factors, and technological change.

The challenge of reversing the degradation of ecosystems involves significant changes in policies, institutions, and practices that are not currently under way. An effective set of responses to ensure sustainable management of ecosystems (UNDP, 2005) must overcome barriers related to: « inappropriate institutional and governance arrangements; market failures and the misalignment of economic incentives; social and behavioral factors including the lack of power of some groups dependent on ecosystem services or are harmed by their degradation;

underinvestment in the development and diffusion of technologies to increase use efficiency; and insufficient knowledge about ecosystem services and management to enhance them while conserving them.»

### **MOVING TOWARD NEW HORIZONS**

So maybe the problem really is the system we live with and are an intimate part of. If so, what lies ahead? Dr. Meadows and her colleagues (2004) suggest a simple set of guidelines about restructuring any system. These common sense ideas, as paraphrased below, can be worked out in hundreds of ways and at all levels of society.

1. Extend the planning horizon. Choose options more for their long-term costs and benefits. Develop incentives and provide tools and procedures to report, respect and be responsible for issues that unfold over decades.

2. Improve the signals. Learn more about and monitor the real welfare of the human population and the real impacts of human activity on the world ecosystems. Include environmental and social costs in economic prices.

3. Speed up response time. Look for signals that indicate when the environment or society is being stressed. Decide in advance what to do if problems appear, have in place arrangements necessary to act effectively. Educate in systems thinking.

4. Minimize the use of nonrenewable resources. Fossil fuels, fossil groundwater and minerals should be used only with the greatest possible efficiency.

5. Prevent the degradation of renewable resources. Protect soil productivity, surface water, rechargeable groundwater and all living things. Use only within regeneration rates.

6. Use all resources with maximum efficiency. The more human welfare that can be obtained within a given ecological footprint, the better the quality of life can be while remaining below the limits.

7. Slow and eventually stop exponential

growth of population and physical capital. Very essential - involves institutional and philosophical change and social innovation. This guideline asks, simply, for a larger and more truly satisfying vision of the purpose of human existence than mere physical expansion and accumulation. New horizons lie beyond the obvious.

Why do we have this strong urge, this commitment to growth? Because we have been locked in a system of «the commons» for a long, long time. Most people in the world today desperately need hope. Hope is to cherish a desire; to nurture a want. Growth may be a false hope, but it is better than no hope at all. Growth, however, is not solving the fundamental problems of humanity. These problems are poverty, unemployment, and unmet needs. Remember admiration and respect, dignity and integrity, excitement and beauty? We seem to be growing the wrong things if we want to restructure our global system.

All of us are in this overshoot together. There are enough resources to go around, if we manage well. If we don't manage well, no one, no matter how wealthy, will escape the consequences. If we cut down the symbolic last tree there is no escape - there is no place to go - and there is no one is out there to help us.

### **THE ROAD TRAVELLED**

Our hunter-gatherer ancestors increased their population to levels such that in places there was scarcity of abundant plants and game animals. Some intensified their migrations, others stayed in place domesticating animals and cultivating plants. For the first time it made sense to own land. Many anthropologists think that agriculture was not a better way of life, but a necessary one to accommodate increasing populations.

Larger populations created new scarcities, especially of land and energy. The Industrial Revolution began in England with

the substitution of abundant coal for vanishing trees. Labor concentrated around mines and mills, eventually elevating technology and commerce above religion and ethics in human society. Machines, not land became the central means of production. Feudalism gave way to capitalism. People were taught to constantly think in terms of money - finding a profit in the market. As wants multiplied and markets became more scattered, the bond between humans and the rest of nature was reduced to the barest instrumentalism. Instrumentalism is the doctrine that «use» determines the value of everything; it is the economics of pragmatism.

The incredible productivity and burgeoning population that the Industrial Revolution generated has now created its own scarcity. Not only of game animals, not only of land, not only of fuels and metals, but of the total carrying capacity of the global environment. Yes, the carrying capacity of our planet is an endangered commodity. The Sustainability Revolution will arise from the visions, insights, experiments, and actions of billions of people scattered all over our world (Meadows et al., 2004).

In complex systems, information is the key to transformation. Not more, but relevant, compelling, powerful, timely and accurate information. As each of us is painfully aware, systems strongly resist changes in their information flows, especially in their rules and goals. Someone once said that if you want to understand something, just try to change it.

Everywhere there are folks who care about the earth, about other people, and about the welfare of their children and grandchildren. They recognize the human misery and the environmental degradation around them, and they question whether policies that promote more growth along the same old lines can make things better (Meadows et al., 2004). But there is hope. Values provide meaning, and it is meaning that drives action, so we need to get our

basic values right. A study by the United Nations University concluded that the major shared moral values in the world, regardless of culture, gender, age or other class are; honesty, compassion, fairness, responsibility, and respect (Glenn and Gordon, 1999).

## TOOLS OF HOPE

«Can we move nations and people in the direction of sustainability? ...

If we actually do it, the undertaking will be absolutely unique in humanity's stay on earth»

W.D. Ruckelshaus  
(Meadows et al., 2004, p.265)

There are hundreds of governments or quasi-governments, and several thousand languages that bond us into groups, yet our world is still structured more like «a commons» - alone and in potential danger of collapse - than a sustainable integrated planet hurtling through space. As a human species we have developed a fantastic plethora of unimaginable commodities and institutions. This legacy of exceptional growth, however, has not been sufficient for a peaceful, exciting, continual development of humanity in a world where future generations are as important, or even more so, than ours.

A Revolution of Sustainability will need to use data gathering, systems thinking, rational analysis, computer modeling and the clearest words possible. These are some of the usual scientific tools that can encourage peaceful restructuring of our current world system. But more powerful, meaningful and essential are the interpersonal tools; visioning, net working, truth-telling, learning and loving (Meadows et al., 2004).

And this, my friends, brings my stories back to soils and the lessons they hold for us. Horizons are markers of change, of development, of transitions. A clear vision of what lies beyond the obvious is the far

horizon - the horizon of Hope - at the beginning of a sustainable global habitat with harmony among humans and the ecosystems of their sustainability. Be a champion for that vision, never lose sight of the brilliance and comfort it kindles for all of humanity.

Networking with others, our spouses, friends, colleagues, institutions and individuals everywhere - with knowledge to share about sustainability is truly powerful. In a network all are equal - some may facilitate but they do not control. Ideas, techniques, experiences are everywhere and we can tap into each other's strengths and knowledge and overcome weaknesses and misunderstandings. Look at how far the Internet has brought us in a capacity to network globally as well as locally. Never underestimate the changes that individuals can and do make. Be active and network.

We often know an untruth when we hear one. Many are deliberate and are understood by both speakers and listeners. Such untruths are meant to manipulate, lull, or entice us, or to postpone action, justify a self-serving action, to gain or preserve power, or even to deny an uncomfortable reality. We are told that one of the most important tenets of systems theory is that information should not be distorted, delayed, or withheld. Lies corrupt and distort information systems.

Be aware of verbal traps and popular untruths. You can deny the idea that having more things makes one a better person. You can question the notion that more for the rich will help the poor. And please remember that a warning about the future is not a prediction of doom, it is a recommendation to follow a different path.

We need the truth to be able to make informed actions. There are many things to do to bring about a sustainable world. New farming methods have to be developed, new businesses have to be started and old ones redesigned to reduce their footprint. Land has to be restored, parks protected, energy system transformed, and international

agreements reached. All people will find their own best role on this journey.

Learning means the willingness to go slowly, to try things out, and to collect information about the effects of actions including the crucial information that an action is not working. Whatever you do, do it humbly. No one can be free to learn, not even the world's leaders, without patience and forgiveness.

«Finding the right balance between the apparent opposites of urgency and patience, accountability and forgiveness is a task that requires compassion, humility, clearheadedness, honesty, and - that hardest of words, that seemingly scarcest of all resources -

love» (Meadows et al., 2004, p.281).

The deepest difference between optimists and pessimists is their position in the debate about whether human beings are able to operate collectively on a basis of love. Donella Meadows, a compelling futurist, believed that individualism and shortsightedness were the greatest problems of our current social system and the deepest cause of unsustainability. A far better alternative, she said, is love and compassion institutionalized in collective solutions. The sustainability revolution will have to be a collective transformation that permits the best of human nature to be expressed and nurtured. For many of us, sustainability is the social acceptance of stewardship.

Aurelio Peccei, an industrial leader and founder of the Club of Rome to look at the future, observed a quarter of century ago, that the humanity of our times must ...

«...be capable of restoring within us .... love, friendship, understanding, solidarity, a spirit of sacrifice, conviviality, and it must make us understand that the more closely these qualities link us to other forms of life and to our

brothers and sisters everywhere in the world, the more we shall gain»

(Meadows et al., 2004, p.282).

Humanity cannot triumph in this

adventure if people do not learn to view themselves and others as part of one integrated global society. Seek out and trust in the best human instincts in yourself and in every one. The most promising mental model of our world suggests that the limits are real and close and in some cases below our current levels of throughput. It also suggests that there is just enough time, energy, material, money, environmental resilience, and human virtue to bring about a planned reduction of the ecological footprint of humankind - a revolution to a much better world for the vast majority. There is no way of knowing for sure, other than to try it.

#### **A CONCLUDING COMMENT**

«The world is too dangerous for anything but truth, and too small for anything but love»

Rev. William S. Coffin (Lloyd, 2000).

As part of our search for knowledge we have been involved with the pedosphere. We have been exposed to horizons and dreamed of what lies beyond; we have seen life grow and then disappear, and we realize that soils are systems comprised of many subsystems. We have seen use and abuse of soil resilience. We comprehend more fully the uncertainty of history and the vagaries of the present in the stories recorded in soils. We have learned that a soil at one place is a member of the vast community of soils at other places - a kind of global society. Soil reinforces our philosophy and belief in the values of humanity and enables us to finally recognize a key message about a sustainable world.

It is simply this -»Sustainable Only If Loved«. Yes, indeed, «So Obvious Is Love». We thank you SOIL. I leave you with a personal thought.

#### **GO TOWARD THE LIGHT**

**It is dark now, not only does the moon not shine**

**The cleverness of world leaders still covet 'what's thine'**

**Exponential growth has captivated a world-wide soul**

**Unbridled consumption fosters poverty and takes its toll**

**Technology and runaway economies say 'that's mine'**

**We exist on a planet with the utmost of extremes**

**Starvation and malnutrition haunt like midnight screams**

**Excesses of materialism abound for over-developed ones**

**Unrealistic cities and roads, luxuries covering naked bones**

**Dehumanized entities have lost touch with nature's dreams**

**It is dark now in the hearts of a myriad of bewildered beings**

**«Near» sightedness is when visions see only such things**

**Immediacy will never offer us intergenerational equity**

**Nor safe promotion and protection of environmental quality**

**Moving fast over global limits toward the disaster it brings**

**We exist on a planet where the candle of Hope is aglow**

**Although the flames of Faith, Truth and Love no longer show**

**Hope remains bright in the hearts and souls of humankind**

**You and I and those around us are parts of a collective mind**

**With Hope we can relight the other three that they may grow**

**With the power of vision to see far beyond the obvious**

**The horizon of this new found wisdom is truly glorious**

**A world once again within its limits to sustain us all  
Sufficiency for humans and for all things  
«big and small»  
Have Faith in the Truth of Love to make the dark obnoxious**

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## **BIBLIOGRAPHY**

- DIAMOND, J.M. 2004. Lessons from environmental collapses of past societies. Fourth Annual John H. Chafee Memorial Lecture on Science and the Environment. National Council for Science and the Environment, Washington DC.
- GARDNER, G., ASSADOURIAN, E., SARIN, R. 2004. The state of consumption today. In WorldWatch Institute, State of the World 2004. W.W. Norton & Co., New York. p 3-21.
- GLENN, J.C., GORDON, T.J. 1999. State of the future. American Committee, United Nations University millennium Project. July 1999.
- HARDIN, G.1968. The tragedy of the commons. *Science* 162(5859): 1243-1249.
- HYERDAHL, T. 1958. *Aku-Aku: The Secret of Easter Island*. Rand McNally & Co., New York. 384 p.
- LLOYD, B .2000. The wisdom of the world; messages for the new millennium. *The Futurist* (May-June 2000): 42-46. Also accessible online [www.wfs.org/Q-intro.htm](http://www.wfs.org/Q-intro.htm)
- MEADOWS, D.H., RANDERS, J., MEADOWS, D. L. 2004. *Limits to Growth; a 30-year Update*. Chelsea Green Publishing Co., White River Junction, VT. 338 p.
- UNITED NATIONS DEVELOPMENT PROGRAM (UNDP). 2005. Millennium Environmental Assessment. Summary and details accessed online [www.greenfacts.org/ecosystems/millennium-assessment-3/99-main-findings.htm](http://www.greenfacts.org/ecosystems/millennium-assessment-3/99-main-findings.htm) on March 31, 2005.
- WACKERNAGEL, M., SCHULZ, N.B., DEUMLING, D., LINARES, A.C., JENKINS, M., KAPOV, V., MONFREDA, D., LOH, J., MYERS, N., NORGAARD, R., RANDERS, J. 2002. Tracking the ecological overshoot of the human economy. *Proc. Natl. Acad. Sci. USA* 99(14): 9266-9271. Accessed online [www.pnas.org/cgi/content/full/99/14/9266](http://www.pnas.org/cgi/content/full/99/14/9266) on May 2, 2005.
- WORLD SCIENTISTS. 1992. *World Scientists' Warning to Humanity*. Available at [www.ucsusa.org/ucs/about/page.cfm?pageID=1009](http://www.ucsusa.org/ucs/about/page.cfm?pageID=1009).
- WORLD WATCH INSTITUTE. *Vital Signs 2005; The Trends That are Shaping Our Future*. W.W. Norton & Co., New York. 2005. 139 p.
- 1 Key note invited speaker from the Xth National Congress of Soil Science.