The greatest challenge for zoos.

Effectively raising awareness of the urgent necessity to achieve global sustainability

Leobert E.M. de Boer

The earth is the only living planet in our solar system, and maybe even in the entire milky way or universe. Ever since its origin, almost four billion years ago, life has influenced the physical circumstances in the thin outer layers of our planet. Life drastically changed the composition of the atmosphere, greatly influenced the chemical conditions in the hydrosphere, and played an important role in the weathering of rock surfaces. So important became the role of life, that it started to play a crucial regulatory role in global climate, and in keeping captive the atmosphere and hydrosphere, which - in the absence of life - might long ago have disappeared during the normal evolution of a planet like ours. Several times, life on earth came on the verge of total extinction, as a result of attacks from the outside (collisions with large asteroids) or from the earth's interior (massive volcanic eruptions). Each time, however, life managed to re-conquer the oceans and continents thanks to its great diversity and evolutionary properties. And each time life was able to reestablish its regulatory influence at global scale. Through all of the four billion years, life managed to stabilize the conditions in the outer layers of our planet and to keep them within the narrow limits between which life itself could flourish.

As one of the myriads of life forms that resulted from the continuous evolution of life on earth, some 15 millions years ago the first great apes appeared, and these soon evolved into chimpanzee- and bonobo-like creatures. Four million years ago one of these lineages took on the habit of walking erect. "Lucy" and her kin were born, and although they were not much different from their ape-ontemporaries, their erect body position turned out to be the opening to a whole series of subsequent changes in body and brain in the evolutionary lineage that would eventually lead to what we use to call "modern man".

"Modern man", with big brain, perfect communication by speech, incredible muscle coordination especially for the use of his hands, and with unequaled ability to transfer and build up knowledge over the generations, first appeared in Africa, less than 200.000 years ago.

Some 100.000 years ago (hardly more than an instant on the scale of the four billion year history of life on earth) modern man started to disperse over the globe. In remarkably short periods of time he populated all of the continents, and, more recently reached even the most remote oceanic islands.

Already in his early days in Africa modern man had learned to become increasingly independent of the natural circumstances in his original ecosystem. Lacking the physical built and equipment of a carnivore, for instance, he developed weapons and group hunting techniques, as well as the use of fire to cook meat, thanks to which he widened his choice of food, and thus was able to live in a wider range of ecosystems, and to survive a variety of circumstances better than any other species.

This trend to become more and more independent of the natural limitations of the environment dominated all the rest of human history and development. When reaching the Bering Strait man clothed in Eskimo-thick furs, and survived on seal and fish.

Only a thousand years later he turned up in the Amazon basin, dropped off all of his clothes to live in the humid-hot rainforest, to hunt birds and monkeys, and to collect fruits and tubers. No other animal species could ever have adapted to such extreme environments so rapidly.

A major next step on the road to become as independent as possible was the development of agriculture, some 10.000 years ago. This enabled humanity - amongst other things - to live in much higher population densities than naturally would have been possible. No wonder that soon afterwards the first cities came into existence. (Here we see excavations at the 8.000 year old Jericho site).

Going through human history in big steps, we then arrive at the industrial revolution, less than 200 years ago. With the large scale use of fossil fuels, this marked the beginning of an era of ever accelerating development towards further independence of nature.

Thanks to high-tech medical care, today we have become largely independent of natural disease, and live up to twice our natural life span.

In the chilly city of Helsinki we recreate in a tropical swimming paradise . . . . and last year the first ice skating rink on the equator was opened in Nairobi. We drive around the world in hundreds of millions of cars, ...
and fly to the most distant holiday destinations; twice a-year if we can, and if possible to tropical bounty islands, the Himalayas or even the Antarctic. Our shops are bursting with products, and every year we consume more than the previous year.

A single human city now inhabits ten times as many people than there ever lived great apes at any given time, gorillas, chimps, bonobos and orang utans in Africa and South East Asia combined. And our numbers continue to grow.

If we look at the growth of the global human population we see that we were one billion in 1850, a number which tripled in the subsequent 100 years, and once again doubled towards the year 2000. Although population growth is slowing down now, demographers predict that stabilization can hardly be expected before 2050 when there will be 9 billion people word-wide. The picture becomes much more dramatic, however, if we combine population numbers with the ecological footprint per person, that is the impact the average global citizen has on the environment. If we put this figure at a hypothetical one for 1850, it would be three in 1950 and some six in 2000, while it will be ten or more in

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*** Chairman, European Association of Zoos and Aquaria (EAZA)**

2050 when at least part of the people in the second and third world countries will have caught up a bit with North, Europeans and Japanese. The total human footprint globally will then have risen to a staggering 90 or more times that of 200 years ago, back in 1850. One of the clearest examples of the great impact humanity has on global natural systems is the increase of atmospheric CO2 through the burning of fossil fuels.

The famous "hockey stick" graph shows that especially during the past 50 years we managed to raise atmospheric CO2 concentration by 30%, and if we continue to burn fossil fuels with the current speed, we will have doubled this concentration by 2050.

It cannot be denied now any more that - as a consequence of our doings - climate is changing world-wide. Temperatures are rising, polar ice and glaciers are melting rapidly, tropical storms are increasing in strength and the distribution of rainfall on the continents is changing. Predictions of further change over the next few decades are alarming.

This graph shows how enormous the influence of life on earth on the atmospheric CO2 concentration has been throughout its long history. The current atmosphere contains only 600 Gigatonnes of Carbon (in the form of CO2), while all living plants, micro-organisms and animals contain five times as much. Another ten times as much is buried in the lithosphere as organic fossil fuels, while life was responsible for the storage of as much as 15 million Gigatonnes of Carbon in limestones mainly consisting of the skeletons of microorganisms that once lived in the oceans. Life really is a major factor in the Carbon cycle on earth. Without life, the planet would have looked completely different, and especially the atmosphere would not nearly be what it is now. At the same time the graph shows how easily man can disturb the situation. Doubling or tripling of atmospheric CO2 will require the burning of only a fraction of all available fossil fuels, or the destruction of only part of the earth's biomass.

But the influence of humanity on global natural systems is much greater than that on atmospheric CO2 alone. Look at this little table, listing the total biomass (in terms of Carbon content) of man and other animals. It shows that currently the human world population constitutes eight times as much biomass as all other living land animals together. We have really become the one and only species dominating the land. Even more astonishing it is to see that we, for our luxury living, keep as much as 20 times the biomass of all wild land animals in the form of cattle.

Since 1950 the world meat production for human consumption has grown five fold, whereas the human population "only" doubled in the same period. This tendency probably will continue for some considerable time, as the second and third world are slowly catching up with the rich countries, amongst others by increasing their meat consumption.

The same is true for the consumption of fruit and vegetables in a country like China for instance. Population numbers do not only grow steadily, but the consumption per person is growing even faster.

With six billion people world-wide, we currently use 40% of all available arable land for food production for only a single species, us. With the same average level of food consumption per person, in 2050, when there will inevitably be nine billion humans, we will need 60% of all arable land. Most probably, however, the consumption of meat will keep rising, especially in third world countries; and because meat production requires six times as much land compared to vegetable food, in 2050 we will probably need as much as 80% of all arable land, leaving only a mere 20% of most of the continental ecosystems for all the rest of the millions of biological species. But if we are unlucky, and stabilization of the world population is not reached in 2050, it will be only a matter of years thereafter that nothing is left any more for our fellow inhabitants on the land.

For the past couple of decades, thanks to improved breeds and agricultural techniques, the yields of crops per hectare kept growing, lending hope that the required increase of total agricultural area to feed a growing human population might be relatively limited.

Statistics, however, show that - for instance for grain - the growth of yields per hectare is leveling off, as if we are reaching, or did reach already the maximum possible.

One of the techniques used to raise yields per hectare, the irrigation of agricultural lands using water from rivers and lakes, as well as ground water, obviously is reaching its limits.

Frequent and large scale dust storms in for instance China are the result . . . and large extents of land on other continents are changing into deserts.

For some time the abundance of fish in the oceans seemed a solution to the human desire for luxury food. . . . and oceanic fish catch increased as much as five fold over the past 50 years, leading to an incredible over-exploitation of oceanic ecosystems.

Returning to the graph showing human and animal biomass, it is obvious that not even this over-exploitation will help us out in the long run. Already now, there is as much human biomass as there are fish in the oceans. We could easily eat all of them within a year or two!

But there is still more than CO2, climate change, human population growth and food production problems. The incredibly rapid increase of the production of consumer goods, for instance, of which automobiles are only one of the many examples. Large scale mining, to deliver the raw materials for many of our consumption goods, destroys vast natural areas, and heavily pollutes even vaster ones.

Tropical rain forests, and other forest ecosystems are rapidly being cut down to produce other raw materials, . . . often leading to erosion and the creation of waste land or even deserts where once biodiversity-rich, and bio-massive ecosystems flourished.

Altogether humanity has been, still is, and will continue to dramatically influence and change the thin, outer layers of

our living planet, the conditions in which were so exquisitely regulated by life during all of its four billion years history. With modern technology man has reached the maximum independence ever of his natural environment. At least, that is what many want us to believe.

A growing number of leading scientists, however, warns that continuation of this human attitude may lead to disaster, not only for the living world, but particularly for humanity itself. The main reason for this great pessimism is, that - in addition to his direct interference in the chemical composition of atmosphere, hydrosphere and outer lithosphere - man is depriving the biosphere of two of its strongest weapons in the war against excessive change. Firstly, man is greatly reducing the biosphere's biomass, for instance by replacing toweringly high forest ecosystems, full of a variety of organisms, by vast extends of flinder thin crop monocultures. The power of the biosphere to help regulate climatological conditions has always depended on its sheer mass in the oceans as well on the lands. Reducing biomass by reducing nearly all of the natural ecosystems in size and quality, disables the current and near-future biosphere to level out the ongoing, human imposed climate change. **Life has won the war on climate change many times in the past, but this time things may be different.**

Secondly, human activities deprive the biosphere of its natural biodiversity. Currently, this still may be going on with modest speed, but soon the loss of biodiversity may accelerate considerably, when many of the tiny ecosystems fragments remaining may turn out to be too small to be vital. This loss of biodiversity will deprive life on earth of its ageold property to maintain ecological stability, as well as of its great power to adapt to even extreme changes in the global environment through evolution. Whereas the reduction of global biomass is a great danger in the short run, as it leads to a loss of life's regulatory abilities, the loss of evolutionary potential, above all, is a risk in the long run.

Consequently, at the maximum height ever on humanity's long road towards independence of the natural environment, mankind soon is going to have to face the truth: looked at it at a global scale, and through the time frame of the history of life, we have always been, we are, and we will continue to be dependent on the global environment for our continued existence. We are speaking of "globalization" now, and of the "global village". But these words focus on humans, their doings, economics and society only. It is high time to start thinking globally in terms of mankind as part of the global community of all living things

Man, whether clothed in black suite in New York, or living near to naked in the mountain forests of Papua New Guinea, belongs to a contemporary biological species, one of the many millions of other biological species living on this planet today. The number of us now is in the billions. We outnumber almost every other species, at least our fellow vertebrates. But time has come for us to understand that -in spite of our superiority in numbers, intelligence and influence - the trillions and after trillions of individuals of other contemporary species, ranging from microbes, to plants, worms, insects and elephants, all, world-wide, work together to regulate and stabilize the conditions in the outer layers of Planet Earth in such a way that not only they, but also we can live and thrive.

The same leading scientists that I have mentioned, and many others are more and more vigorously arguing that the "moment of truth" is much nearer than many of us, the greatest pessimists included, would ever have wanted to believe. The year 2050 now often is mentioned to indicate the time frame magnitude within which global bioregulatory systems may start to break down as a result of human activities, with totally unpredictable consequences. However, that these may be disastrous to the survival of humanity, or at least to the prolonged existence of human culture as we know it today, seems obvious anyway.

This timeframe also marks the length of time still left to us to bring about the necessary changes, to revert current human developments, and to convince the "global village" of the believe that the future of humanity lies in re-establishing harmony between us (as global citizens) and our (global) responsibilities. This means nothing more or less than that humanity must succeed to reach "global sustainability" within the next few decades. Reaching global sustainability, in its turn, means nothing more or less than that humanity should cease to use more than Planet Earth with all contemporary organisms can sustainably - in the long run - deliver to us. Continuously taking (much) more than that may lead to the disturbance, and possible break-down of the extensive, but delicate network of equilibria between the living and the non-living components of Earth.

A couple of decades to reach this ultimate goal by 2050, is ridiculously short, given the slowlyness with which changes in society and politics usually take place. Having noticed the very limited progress made since the Rio Conference in 1992, when the necessity of global sustainability was first brought to the attention of a broad political and societal audience, the United Nations recently launched the "Decade of Education on Sustainable Development". This decade - 2005/2014 - should see major initiatives of governmental and non-governmental organizations to create the widest possible awareness world-wide of the unavoidability of achieving global sustainability.

The zoos of the world can and should play a prominent role in this awareness raising decade. Zoos are pre-eminently suited to convey messages about the urgent need to achieve sustainable development globally. Firstly, because zoos reach sheer masses of visitors. Their doorsteps are much lower than for instance those of natural history musea, and their network is much denser, at least in large parts of the world. 90% of Europe's population, for instance, lives in reach of a zoo, and 25% or more pays a zoo visit annually. Secondly, zoo visitors almost by definition have an interest in animals, wildlife and nature, otherwise they would not even consider visiting a zoo. This basic interest is the best starting point for raising awareness of the necessity to respect nature. Thirdly, most if not all zoos exhibit animals, plants and biotopes from all around the world, enabling them to draw the visitors' attention to the interconnectedness of all sections of life on earth; an interconnectedness that plays a crucial role in understanding why we must look at sustainability at global levels (however important local sustainable behavior remains to be). Fourthly, visitors in zoos stay usually for several hours, which means that we can capture their attention much longer than for instance

television news items, or news paper articles can do. Fifthly, and maybe most importantly, a zoo visit has much to do with emotion; emotion connected with the beauty of animals and their behaviors and the beauty of living things in general. There is no better starting point than this emotion about beauty when we want to tell our visitors that it requires global sustainability for our children and future generations to enjoy life on earth as much as we do now.

You might argue that the zoos are already very active in conservation education, including the spreading of the message of the need of sustainable development. This is true, zoos are amongst the most active propagators of conservation. But I believe, in the light of all I have said before, that we should become even much more active and efficient, and maybe we should reconsider our approach of the whole global sustainability issue.

A first change in our approach we may need to consider is to focus much more on the prolonged existence of humanity when explaining the need for global sustainability. So far, zoos have mainly focused on endangered species, habitats and ecosystems in their conservation education. Some quotes: "We should not allow our closest relatives, the great apes, to become extinct", "we should not sacrifice wonderful wilderness to build cities or roads", or "We should not disturb rainforests that needed millions of years to evolve".

All such messages appeal to man's responsibility towards nature. In spite of various good examples of the success of such messages, by and large we have to admit that the overall status of nature conservation currently is worse than ever. Ask yourself: how much nature was lost the past ten years, and how much could be saved? And you will have to conclude that the trend is worse than ever. Let us therefore start to tell the ultimate truth: nature conservation, as part of global sustainability is crucial to the survival of human culture. Nature does not need us. It will doubtlessly survive, in what ever form, after we have vanished. But we need nature! If that is the truth, let us tell it! We also should seriously consider to put much more emphasis on the very limited amount of time there is left. Global sustainability must be achieved within a matter of decades. Consequently, it is not a problem to be solved by future generations. If todays' generation does not lay sound fundaments for the solution, our children may be faced with irreversible effects before they are in their middle ages. This is another truth that needs to be told!

Then, I believe zoos must put much more emphasis on the great, global interconnections between biosphere, atmosphere, hydrosphere and the surface of the lithosphere; on the great questions of how important a role life plays in regulating the circumstances world-wide, in such a way that life, including humanity can thrive. To explain this to a wide audience in an attractive and understandable way, will be very difficult and will require great skill and creativity. But I am convinced, that if any type of institution can successfully do this, it is the zoos.

Great skill and creativity will also be required to convey the urgent message of global sustainability in such a way that we are not depressing our visitors and chasing them away from our zoos. That would be counter productive. Once again, however, I believe that especially the zoo community will be able to touch their visitors' minds and emotions in such a way that potentially negative messages are turned into positive and hopeful ones.

One might argue that really effectively taking up the large global sustainability issues, in the end can only be done by the world's political and economic leaders, and that it is far beyond the zoo community's power to even try to influence these. On second thought, however, politicians and other leaders - from the local up to the international scene - will not start moving issues higher up their agendas before they discover major concern about such issues among broad sections of their electorates. As long as there is no major concern about climate change, unsustainable practices and the resulting risks for humanity's future, politicians will keep giving priority to other concerns, such as the call for economic growth and increased luxury. If zoos really want, and really would use their potential of raising awareness, they can play a substantial role in spreading concern about sustainability among large sectors of our societies. And through this, they will be able to contribute considerably to moving the issue higher on the leadership's agendas. Our potential influence is much greater than we currently may dare to believe.

Looking back at the recent history of the global zoo and aquarium community, from the mid 1980s on we saw an increasing focus on this community's role in ex situ conservation. SSPs, EEPs, ASMPs, other regional breeding programmes, TAGs and collection planning and were the main topics on the agenda's of conferences of regional zoo associations and of WAZA. From the mid 1990s onwards, we saw an ever increasing involvement with *in situ* conservation, resulting in the prominent place this issue currently occupies in conferences, in our zoos and in our minds. I sincerely believe that the global zoo and aquarium community should be prepared to accept yet another new challenge now, and that is to start working to support the United Nations Decade of Education on Sustainable Development (DESD).

If the zoos of the world would do this with the same amount of energy and enthusiasm as they showed in their ex situ and in situ conservation activities, they will certainly prove to be one of the best partners for the UN in helping achieve the objects of DESD.

With my plea to enter a new phase of zoo activity I am not intending to say that we should stop our previous activities. On the contrary, our *ex situ* work is more important then ever, and will even become more crucial in the future. We must continue to extend it, just like our support to *in situ* conservation. Simultaneously, zoos should continue and extend all their ongoing conservation education activities. What I would want to see develop, is that we add a new dimension as kind of an umbrella over all our previous, continued and to be extended activities: the overarching dimension of global sustainability, without which our other activities would not make real sense.
Obviously, the educators of zoological park and aquaria will have to play a crucial role in this great task, and beyond any doubt IZE is the global body to show its membership the

way we will have to go. However, for zoos and aquaria to explore and exploit their full potential of raising massive awareness of the urgent necessity to achieve global sustainability, it requires more than using the expertise of their educators to the best advantage. To achieve this great task it will also require the creativity, expertise and above all the strong support of all staff, directors, managers, researchers, PR and marketing officers, keepers and all other included. I therefore call not only upon IZE and its membership, but upon the entire global zoo and aquarium community to accept this most difficult challenge. Only if all of us work intensively together there is a chance that we may accomplish it. And speaking of the necessity to achieve global sustainability as soon as possible, we have no choice but to grasp this chance, however small it may be!

Notes

Most of the information in this paper is based on generally accepted views in modern biology, geology and geochemistry, and can be found in a variety of textbooks on these subjects. The inclusion of detailed references therefore was not believed necessary. The sources of specific quantitative data in the tables and graphs however, are given in the notes below. (Editors note: : tables and graphs are not included in this printed version. See note on ordering hi-res illustrations and the complete pdf of this paper).

Note 1: Human population and ecological footprint. This table merely wants to show a rough indication of the order of magnitude of the increase of human influence on Planet Earth during the timeframe 1850 - 2050. Global human population sizes for 1850, 1950 and 2000 are rounded off to one billion. The estimate for 2050 is the average of what demographers currently believe (some optimists believe stabilization in 2050 may be achieved somewhat below 9 billion; others, however, fear that human population may increase to 10 billion or over). The relative footprints per person compared to 1850 are the author's personal, and indicative estimates.

Note 2: Global atmospheric concentrations of Carbon Dioxide, 1760 - 2003. This is the so called "hockey stick" graph, which can be found in virtually all literature on climate change. This particular version was taken from Brown (2004).

Note 3: Amounts of atmospheric and organic Carbon. The figures are rough estimates based on data from Smil (2002).

Note 4: Biomass of animals, cattle, fish etc. These data come from Smil (2002). Note that "animals" means "mammals" (thus, "land animals" does not include worms, insects etc.) Also note that "biomass" is expressed in terms of Carbon content. The average human body weight of 45 kg, for instance, comprises less than 8 kg of Carbon (C).

Note 5: World meat production Taken from Brown (2004) (source: FAO).

Note 6: Fruit and vegetable harvested in China, 1961 - 2003 Taken from Brown (2004) (source: USDA).

Note 7: Area for human food production (world wide). The fact that 40% of all arable land (land that has sufficient quality to be used for agriculture) is currently used to produce food for the 6 billion human world inhabitants is mentioned in many relevant publications. The 60%, estimated for 2050 is simply an extrapolation to 9 billion inhabitants. The 80% for 2050 in case the current trend of increased food an meat consumption continues, is the author's rough estimate.

Note 8: Grain production in China, 1960 - 2004. Taken from Brown (2004) (source: USDA).

Note 9: World grain yield per hectare 1950 - 2000 and projection to 2010. Taken from Brown (2004) (source: USDA).

Note 10: World irrigated area Taken from Brown (2004) (source: FAO)

Note 11: Oceanic fish catch 1950 - 2003. Taken from Brown (2004) (source: FAO).

Note 12: Biomass, cattle, fish etc. See note on Table 3.

Note 13: World automobile fleet 1950 - 2003. Taken from Brown (2002) (source: World watch).

References and Recommended readings (accessible to a wide audience)

Brown, L.R. (2004), Outgrowing the Earth. W.W. Norton & Company, New York (272 pp.).
Diamond, J (2006), Collapse; How Societies choose to fail or survive. Viking Adult, New York (592 pp.).
Flannery, T. (2005), The Weather Makers. Atlantic Monthly Press, New York (384 pp.).
Leaky, R. & R. Levin (1995), The Sixth Extinction. Anchor, New York (288 pp.).
Lovelock, J. (2006), The Revenge of Gaia. Basic Books, New York (176 pp.).
Smil, V. (2002), The Earth's Biosphere. Massachusetts Institute of Technology (346 pp.).
Wilson, E.O. (2002), The Future of Life. Knopf, New York (256 pp.).

The illustrations, graphs and tables associated with some of the points presented are images taken from a variety of sources. In the electronic version they are compressed to reduce the number of bites. Thus it was not possible to include them due to quality or space. For those interested they are available on request to Dr. de Boer in their original size. Some of them, however, may not be used freely because of possible copy rights. Also the PDF file with illustrations in the left margin is available to anyone who wants it via email attachment. Just write to pravin@zooreach.org asking for Dr. Bert de Boer's keynote address at IZE conference. Eds.