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AN ECOSYSTEMIC PERSPECTIVE OF ENVIRONMENTAL AND HEALTH SUSTAINABILITY[1]

Carlos Machado de Freitas
Research fellow of the Center for Studies into the Health of the Worker and Human Ecology / National School of Public Health. Oswaldo Cruz Foundation.

ABSTRACT

As we move from the XXth to the XXIst century alternative approaches are emerging, like ecosystemic ones, which are trying to integrate socio-economic aspects with biophysical aspects for understanding and looking for solutions for the environmental problems that, while they originate at the local level, have a regional and global impact. These approaches have been trying to integrate long and medium term perspectives when it comes to looking at the environmental degradation processes and the social inequities that are inherent to the economic development model, have become both intensive and extensive throughout the XXth century and now threaten our environmental and health sustainability, signifying impacts upon humans, other species and life support systems. These transformations demand not only systemic perspectives to understand these problems, but also present us with the challenge of formulating focal and/or global strategies to face up to the threats presented by the economic development model of industrial societies.

Key words: Ecosystemic approaches / environmental sustainability / health sustainability / sustainable development

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INTRODUCTION

The scale, magnitude and uncertainties that permeate the current environmental crisis show how human activities have been producing drastic environmental changes at both the local and global levels, resulting in many serious health problems. Because of their complex nature these problems require the search for alternative approaches that integrate socio-economic and bio-physical aspects when it comes to understanding and searching for solutions for them (FREITAS et al., 2006).

As we move from the XXth to the XXIst century the need for developing these alterative approaches has intensified, a process that is described in the World Resources Institute (WRI, 2000) report for the years 2000-2001. This report points out the need for adopting an ecosystemic approach that makes it scientifically possible to recognize the "systems" within ecosystems in a holistic and not sectorial way, that is oriented towards decision-making and whose presuppositions are that we have the capacity to contribute to: (1) a coming together of diverse pieces of information that make it possible to show the interfaces between the goods and services of the various ecosystems that must be balance with the environmental, political, social and economic goals; (2) formulation of broad public policies and more effective institutions for implementing them; (3) participation of the general public in the management of ecosystems, particularly local communities.

In 2001, the United Nations launched its *Millennium Ecosystem Assessment* (MEA, 2005), a four year program conceived to respond to the need to provide political decision makers with scientific information about the relationship between changes in the ecosystems and human well-being. Its results were published in March, 2005 and point to a situation of rapid and extensive transformation in ecosystems, resulting in the degradation of approximately 60% of their services (water, air, climate, etc.), with an increase in the chances of non-linear, abrupt and irreversible changes that will have important consequences for humans (emerging diseases, sudden alterations in water quality, a collapse in food supply and changes in regional and global climates, etc.) and will disproportionately affect the poorest people, thereby contributing to growing inequity and constituting a factor in the origin of poverty and social conflict.

Starting from an ecosystemic perspective the objective of this article is to bring elements to the debate on sustainability relating to environmental and health issues, which cannot be separated from social, economic and political issues. To do so we have taken as the pivotal point issues that are directly related to the intensity and extent of the transformations that our civilization has been causing in ecosystems, thereby placing the life and health of species in danger, which includes humans, and obliging us to reflect critically on the limits of the current development model.

THE XXTH CENTURY AND ITS INTENSE AND EXTENSIVE SOCIO-ENVIRONMENTAL TRANSFORMATIONS

As from the time of the Industrial Revolution, and particularly between the end of the XIXth century and throughout the XXth century, the growth and expansion of production processes with the transformation of energy and materials used for the production of raw materials and consumer goods became enormous and was accompanied by a process of growth in the population and its urbanization (FREITAS e PORTO, 2006).

Part of the growth of the global economy was related to the great increase in the world's population throughout the XXth century, going from 1.5 billion in 1900 to more than 6 billion in 2000 (MUSSER, 2005; COHEN, 2005). The urbanization of the population has its origins in the Industrial Revolution, which started great migratory flows to urban areas that provided abundant labor, economies of scale, a greater sharing in the use of resources and infrastructure and production and commercialization opportunities. If, at the start of the XXth century, nearly 13% of the world's population lived in urban areas, currently it is 50% globally and in Latin America, North America and Europe it is more than 70% (although urban areas cover a mere 2.4% of the land surface) (McNEILL, 2000; WRI, 2005)

The growth of the economy and the urbanization of the population were accompanied by a greater demand on ecosystem services, for water and energy consumption and for the production of food, fibers and wood, for example. Along with the transition process to an industrialized economy there was a growing economic integration between sectors and countries, leading to the process that has been recently called globalization, and which represented greater global pressure on ecosystems and their services (FREITAS and PORTO, 2006).

In this process the rapid growth of global markets came accompanied by growing social and economic inequity in the world, as well as environmental degradation, which have contributed to the emergence of problems like global warming, a reduction in the ozone layer, the loss of biodiversity, the depredation and pollution of natural resources and the extensive process of deforestation and desertification, to mention just a few examples (FREITAS and PORTO, 2006).

The globalization of environmental degradation and social inequities have placed in check two equally important and interdependent dimensions that are the basis of the original definition of sustainable development. They threaten both access to natural resources and to a healthy environment, like equity in the distribution of income and goods in a way that satisfies the needs of present and future generations (BORGHESI e VERCELLI, 2003). Therefore, even though the transition to an industrial society and the globalization process have resulted in economic growth and an increase in per capita income, they threaten the environmental sustainability of the planet, with consequences for the health and well-being of its populations (FREITAS and PORTO, 2006).

As we can see in **Table 1, i**n the period between 1890 and 1990 the world economy grew 14 times, industrial production 40 times, the use of energy 16 times and the production of coal 7 times. Throughout the XXth century there were intense economic transformations and economic activities per capita grew by approximately 4.5 times; just in the period between 1960 and 2000 the global economy grew more than 6 times (MEA, 2005)

The industrialization process and the development of the global economy are based on a logic in which short term growth takes precedence over long term growth, which affects ecosystems and degrades the natural capital (the services offered by ecosystems). This logic is stimulated and favored by the fact that national accounts do not explicitly record the environmental costs of this growth in the global economy, since the main indicator, GDP, treats the quantitative growth of the economy (growth) as a synonym for qualitative improvement (development) (BELLEN, 2005).

The objective of this economic growth was not the qualitative improvement of the lives of billions of humans who were on the margins of this unfair process. In 1981 there were 1.5 billion living in extreme poverty (on less than US$1 per day), but this reduced to 1.1 billion in 2001. This reduction was greater in East Asia (it went from 796 million to 271 million in the period), less in South Asia (going from 475 million to 431 million in the period) and non-existent in Latin America and the Caribbean, the only region that recorded an increase in the absolute number of humans living in extreme poverty, going from 36 million in 1981 to 50 million in 2001. On the other hand, while the number of humans living in extreme poverty reduced (less than US$1 per day), between 1990 and 2001 the number of those living on less than US$2 per day grew, going from 2.655 billion to 2.763 billion. (POLAK, 2005; SACHS, 2005).

So GDP, the main indicator of a country's wealth, only measures the cash flow resulting from economic activity in general (the annual worth of the market for final goods and services in a country, after adding in all exports and deducting imports) and is not a balance sheet that has assets and liabilities. Therefore, the impact upon ecosystems and the degradation of the natural capital (services offered by the ecosystems), even though they signify the elimination of an asset (cutting down forests) may mean a source of income in the long term for thousands of workers. At the same time GDP does not measure either the income or the well-being of a country's population. The concentration of income, expenses with the negative consequences of the production processes (including expenses with health services for sick workers and those that suffer accidents in the production process) and the loss of well-being resulting from environmental degradation are positively computed (DALY, 2005).

In the last century, and particularly over the last 50 years, humans have globally changed ecosystems more rapidly and more extensively than at any other period in history. This process has resulted from the growing demand for the provision of services from the ecosystems, associated with the industrialization process and the growth of the global economy. Therefore, the material (provision, regulation and support) and non-material (cultural and religious) services of ecosystems have been increasingly degraded, or used in an unsustainable way. According to the results of the MEA (2005), approximately 60% (15 of the 24 ecosystem services identified) are being degraded, which includes provision services (water and food) and regulation services (control of air and water quality, regional or local climate, natural disasters and pests), as can be seen in **Table 2**.

One of the most significant changes in the structure of ecosystems was the transformation of approximately 1/4 of the planet's surface into cultivated systems. This process started in the XVIIIth and XIXth centuries, but intensified as from the Second World War. The result is that currently more than 1.2 billion hectares of land with vegetation cover (an area as large as China and India together) have been significantly degraded. It is expected that over the next 50 years the demand for grain will grow by between 70% and 85%, with the consequent impact on the demand for water, which will grow by between 30% and 85%, since 70% of it is used in agriculture. This means that the conversion of areas of forest cover into agricultural land will tend to continue, with a projection that by 2050 between 10% and 20% will occur primarily in developing countries. Two aspects must be observed in this process. First, food security will not be achieved and malnutrition will not be eradicated, and in fact will get worse in some regions, despite the growth in the supply of food and diversification in the diet. Second, this process of conversion of forest areas into agricultural land, with the consequent environmental degradation, will end up compromising the very expansion of provision services and food production (WRI, 1992; POLAK, 2005; MEA, 2005).

With regard to the first aspect (food security), despite the increase in production per capita of food over the last 40 years, it is estimated that 865 million people were undernourished between 2000-2002, 32 million more than detected in the period 1995-1997; they are concentrated in areas like South Asia and sub-Saharan Africa, regions were the increase in food production per capita was smaller. Among those who are hungry in the world, 50% are small rural land-owners, 20% are country people without land and 10% are shepherds, fishermen and forest dwellers. The other 20% are poor urban dwellers. The Green Revolution was projected to increase food supply and not to eradicate poverty or hunger (POLAK, 2005; MEA, 2005).

With regard to the second aspect (environmental degradation), the expansion of cultivated systems has been contributing to transforming the structure (habitats and species present in a particular location) and the processes of ecosystems, including biogeochemical cycles, like those of phosphorous, nitrogen and water. As the capacity of ecosystems to provide services derives directly from the operation of these natural cycles that are related to the support services of the ecosystems, if they are compromised this ends up threatening environmental and health sustainability (PIMM and JENKINS, 2005; MEA, 2005).

With regard to the phosphorous cycle, from 1960 to 1990, the use of fertilizers containing phosphorous and the accumulation rate of phosphorous in agricultural soil grew by nearly 3 times, thus contributing to the fact that the current flow of phosphorous into oceans is three times the basal rates. Even with the decline in its use over the last few years, phosphorous still persists to a great extent in the environment, and may remain in the soil for decades (MEA, 2005).

With regard to the nitrogen cycle the quantity of reactive or biologically available nitrogen, created by human activities, grew nearly 9 times between 1890 and 1990. The majority of this growth occurred in the second half of the XXth century and was associated with the increasing use of fertilizers. In relation to the flow of reactive nitrogen (biologically available), human activities contributed to doubling the rate of creation of nitrogen on the earth's surface, with more than half of all synthetic nitrogenated fertilizers (manufactured for the first time in 1913) being used since 1985. The flow of reactive nitrogen in the continents will tend to grow by up to 2/3rds by 2050, with most of it occurring in developing countries, where the agriculture area will expand. Among the environmental and health consequences resulting from this process we would highlight the eutrofication of fresh and coastal water, the the acidification of fresh water and terrestrial ecosystems, the loss of biodiversity, a loss of agricultural productivity, destruction of the ozone in the stratosphere, an increase in the incidence of skin cancer, cataracts and possible interference in the functioning of the immune system, in addition to asthma, allergies and pulmonary and cardiac diseases (MEA, 2005).

With regard to the water cycle, taking it from rivers and lakes for use in irrigation, or its urban and industrial use doubled between 1960 and 2000, with approximately 70% being used in agriculture. At the same time that cultivated systems demand great quantities of water (for example, to grow 1kg of grain requires almost 1,000 liters of water), extending their area by converting areas with vegetation cover compromises the very availability of water on the planet, because forest systems regulate approximately 57% of the total water available for consumption (MEA, 2005; POLAK, 2005). Furthermore, the use of fertilizers in agriculture compromises water quality and affects nearly 5 billion humans who live close to cultivated systems (MEA, 2005).

Associated with agricultural activities and the production of energy, the construction of major reservoirs has doubled or tripled the time the water stays in the rivers (the average time that water takes to reach the oceans). Considering that between 1960 and 2000 the storage capacity of reservoirs quadrupled and the capacity of hydroelectric power stations doubled it is estimated that the amount of water stored in major reservoirs is three to six times the quantity that flows naturally in natural rivers (excluding natural lakes). The construction of reservoirs and other structures along rivers has affected the flow by up to 60% in the major river systems of the world, thereby reducing the flow in some of them, like the Nile, Yellow and Colorado, to the extent that they no longer flow into the oceans as in the same way that they used to (MEA, 2005).

On the one hand we witness the depredation of aquifers and the pollution of underground and surface waters, coupled with global water consumption, which exceeds the long term supply rates of the same. On the other hand, large reservoirs and other structures along rivers, also used for irrigation purposes in agricultural activities, has been significantly altering the water cycle. Both processes have been threatening the future availability of fresh water for economic food production activities and for human consumption, thereby aggravating even further the scarcity of water that currently affects from 1 to 2 billion human beings in the world (MEA, 2005).

The extensive and intense process of conversion of forest areas to help the ecosystems to offer provision services, such as agriculture and cattle raising, has had consequences on the capacity of water and genetics (biodiversity) provision services, as well as on the regulation of ecosystems, like the capacity to regulate air quality, the climate, the water cycle, erosion, diseases and pests, natural dangers, water purification and waste treatment (MEA, 2005).

Among the provision services, we would draw attention to the fact that the distribution of the species on earth is becoming increasingly more homogenous, meaning that the differences between the group of species in a particular location on the planet and the group from another location are, on average, decreasing. Two factors have been contributing to this trend. The first is the extinction of species from certain regions. The second is the rate of invasion or the introduction of exotic species, which has been intensifying with the growth of trade and the increase in the speed of global transport that either eliminates altogether, or reduces natural barriers. Both factors have been contributing to the global decline of genetic diversity, which is more accentuated in cultivated species. If, on the one hand, changes in ecosystems necessarily affect species, we cannot ignore that on the other, these alterations in the composition of species affect ecosystem processes (EPSTEIN, 1995; LOPES, 2004; PIMM and JENKINS, 2005).

Demand for the maintenance of biodiversity as a source of materials that can be traded, generate foreign exchange for countries and create jobs and income, as well as providing benefits for human health and well-being, is growing, as can be seen in **Table 3**.

Table 4 shows how this process of conversion of the forest areas into cultivated systems has been increasing vulnerability in relation to the loss of biodiversity, mainly plants and mammals, in Latin America, the Caribbean, Asia, the Pacific and Africa, meaning not only alterations in the composition of the species and their ecosystems and changes in their processes, but also the future loss of billions of dollars in foreign exchange for countries, jobs and income, as well as environmental benefits for human health and well-being (GEO, 2002).

Deforestation modifies the structure of ecosystems, often resulting in the fragmentation of habitats into small patches separated by agricultural activities or human populations. As a consequence, a modification occurs in the structure of the vegetation, impoverishment of the animal and vegetable species and an alteration in the genetic diversity and composition of the species in various locations, in addition to the greater vulnerability of the animals and plants in each fragment that may diminish until they become extinct, as well as being affected by invading species. The consequence of this process is an alteration in the composition of host species that live in the environment and in the ecology of vectors and pathogenic agents. When combined with mobility and contact by non-immune populations, it has been contributing to the emergence of diseases like hemorrhagic fever, with cases of death in various countries (EPSTEIN, 1995; LOPES, 2004; PIMM & JENKINS, 2005). Examples of some of these diseases can be found in **Table 5**.

The intense and extensive changes that have been occurring in terrestrial ecosystems, particularly as from the conversion of forest areas into cultivated land, and the increase in urbanization, which is getting closer to or invading the forest areas, have been contributing to change not only the provision capacity of the ecosystems, but also, and principally, their capacity for regulating diseases. **Table 6** gives a series of examples of infectious diseases that are related to changes in ecosystems, which have been playing an important role in the emergence and re-emergence of many illnesses. We cannot ignore the fact, however, that in other situations these same changes have been contributing to reducing the incidence of other illnesses (SUTHERST, 2004; MEA, 2005).

The extensive process of converting forest areas into cultivated land areas, the alterations in ecosystems and the loss of biodiversity that accompanies them, with their consequent direct and indirect effects on the health and well-being of present and future generations, are all part of the logic of global economic growth, with its transition to an industrial and urbanized society.

These transformations cannot be disassociated from the intense changes that have occurred throughout the XXth century and that resulted in the growth of the economy and in its globalization process, accompanied by a fourfold increase in the world's population, which started being concentrated nearly 13 times more in urban areas, with a strong impact on the services of the local, regional and global ecosystems, caused by the growing demand for water and energy consumption and the production of food, fibers and wood, for example (MEA, 2005).

The world urban population grew from 200 million in 1900 to 2.9 billion in 2000 (almost 50% of the world's population) and the number of cities in which the population exceeds 1 million went from 17 in 1900 to 388 in 2000 (almost 23 times more). In regions like North America, Europe, Latin America and the Caribbean the urban population exceeded 70% and there is a tendency that by 2030, in regions like Africa, Asia and the Pacific, it will exceed 50% (MEA, 2005; GEO, 2002).

Urbanization of the world's population is a growing tendency and it has its origins in the Industrial Revolution, which started the great migratory flows to urban areas in search of work, access to the food that had become scarce in rural areas, to services, like health and education, as well as better opportunities and living conditions. Urban areas were vital for industrialization and economic growth, since they provided large amounts of cheap available labor, economies of scale and a greater sharing in the use of resources and infrastructure and production and trading opportunities. At the same time, they have a strong impact on the environment and health, principally in industrializing countries.

In less industrialized countries, the urban areas combine the environmental problems of health that are typical of poverty (particularly respiratory diseases and enteric infections) with those related to precarious housing conditions (sanitation and the supply of water suitable for human consumption) and unregulated industrialization, which results in high levels of atmospheric pollution and toxic waste (McMICHAEL, 2000; FREITAS et al., 2002).

In 2002, 81% of the world's urban population had access to suitable sanitation and 95% to the supply of suitable water. However, comparing industrialized countries with those with lesser levels of industrialization, the percentages fall to 73% and 92%. Half of the urban population in Africa, Asia, Latin America and the Caribbean is affected by one or more illnesses associated with inadequate sanitation and water supply, and these same conditions, combined with precarious hygiene conditions, account for approximately 1.7 million of the world's deaths. These conditions contribute to the fact that while the rate of child mortality per 1,000 live births is 15 in industrialized countries in countries that are industrializing is nearly 4 times more, at 59 per 1,000. (WRI, 2005; MEA, 2005).

Besides the problems related to sanitation and the supply of water suitable for human consumption that were typical of the first phases in cities after the Industrial Revolution, we can today add the problems related to chemical pollution that affect the soil, atmosphere, waters and food chain in urban areas and beyond. The worldwide commercialization of organic chemical products, for example, grew between 1950 and the 90s by more than 5 times, going from 63 million tons in 1950 to more than 300 million tons in the 90s. This growth, the result of an intensive industrial production logic in urban areas, which blighted them with the atmospheric pollution coming from the plants, with industrial effluents contaminating the rivers and with solid waste contaminating soil and underground water, has been accompanied by a significant increase in consumption and pollution beyond the urban areas, affecting rural and forest areas. From the cumulative global consequence of many environmental pollutants, like PCBs and DDT, which when carried through the environment affect humans, via the food chain, in places that are distant from their production and source of contamination, to substances with endocrine-disruptive potential that affect both wild life and humans, we have witnessed a global contamination process that has been altering the chemical composition of waters, the soil, the atmosphere and the planet's biological systems, placing in danger the health of humans and the planet's life support systems. Considering that since the 1972 Conference, the world's chemical industry has grown 9 times, at an annual rate of growth of nearly 3%, with a tendency that production and trade will grow over the next 30 years, it is expected that there will be a global increase in the levels of environmental contamination and of humans exposed to its risks. (GEO, 2002; FREITAS et al., 2002)

Urban areas must be seen as vast unprecedented processors in nature, consuming food, raw materials and energy for their populations and economic activities and producing goods, waste and pollution. A study carried out in 29 Baltic cities showed that their consumption of food, wood and fibers would require an area 200 times greater (considering the area necessary for planting food and supplying wood and raw materials) than the total area of all the cities in question. Just to assimilate the products produced in them, like nitrogen, phosphorous and carbon dioxide the area that would be necessary to do so varied between 400 and 1000 times more than the area of the cities. Therefore, while urban areas occupy a small percentage of the global area (3% of the land surface area), they concentrate huge population contingents with great power for consuming and industries that are natural resource intensive, resulting in the appropriation of an area much more extensive to meet their demands for water, raw materials and energy for consumption and production, as well as for absorbing their pollutants and waste (BELLEN, 2005; DECKER et al., 2000).

The increase in the incidence of obesity, a global epidemic, is fairly emblematic of the imbalance associated with the urbanization process and with how urban areas and their inhabitants are constituted into vast consumption processors of food, raw materials and energy. This results from the unbalanced combination of growing access to processed foods that accumulate energy and a decline in physical activities in work, leisure and domestically, thereby contributing to the increase in the risk of high blood pressure and type II diabetes. Therefore, while obesity does not directly result from environmental changes, it is not disassociated from the intense and broad process of urbanization that has been forcing extensive degradation on ecosystems and alteration in the very ecology of humans with the introduction of new cultural values and habits, as from the Industrial Revolution and progressively spread throughout the world, thereby contributing to present and future changes in the profile of health, morbidity and mortality (McMICHAEL, 2000). It is no coincidence that cardiac disease and strokes, which were among the 10 main causes of the loss of years of healthy life in 1990, will tend to occupy the first and fourth positions, respectively in 2020, as can be seen in **Table 7** (BLOOM, 2005).

Another great cause of the loss of years of healthy life is also related to the vast consumption of raw materials and energy resulting from the process of industrialization and urbanization associated with alterations in the ecology of humans and new cultural values and habits. In 2000 there were 750 million automobiles in the world, resulting in the growing economic and political power of the automobile industry with the desire for mobility, comfort, well-being and status on the part of consumers. One of the consequences of this process on our health is the nearly 750,000 traffic accident deaths every year, which contribute to the fact that vehicle accidents will tend to go from the 9th place they occupied in 1990, as the cause of the loss of years of healthy life, to 3rd place in 2020 (see **Table 7**). In addition to the morbidity and mortality caused by vehicle accidents, there is also the urban pollution caused by these automobiles, principally in cities in developing countries; it is estimated that nearly 130,000 premature deaths and 50 to 70 million incidents related to respiratory diseases occur every year as a consequence if urban pollution. (McMICHAEL, 2000)

Automobiles, almost all of which use fossil fuels and contribute a 1/4 of the global emissions of carbon dioxide, are emblematic of the potential impact on health and ecosystems of this choice of energy, and the great inequalities associated with economic growth, industrialization and urbanization at the global level. In 1998, in North America, the number of automobiles per 1,000 people was 742, more than twice what it was in Europe (324 per 1,000 people) and more than 7 times what it was in Latin America and the Caribbean (105 per 1,000 people). Comparing the USA with India, fossil fuel consumption is nearly 30 times greater. This imbalance in the number of automobiles is mirrored in the consumption of fossil fuels. In 1999, in North America consumption was 5.3 tons per capita, while in Europe it was 2.3 and in West Asia, 1.6. The concentration of automobiles and the consumption of fossil fuels in the most industrialized countries is also reproduced in the emissions of carbon dioxide per capita (kgs per person), with North America, in 1999, being responsible for more than 19,000, followed by Europe and West Asia, with more than 7,000 each (WRI, 2005; GEO, 2002; LOVINS, 2005). This imbalance is structural in contemporary industrial societies and is reproduced in the different environments of social life, as shown in **Table 8**, which provides some of the aspects recently highlighted in a warning given by Earthtrends that compared, at the extremes, the richest and poorest countries (WRI, 2006)

If the actual tendencies are maintained, in which the consumption of fossil fuels is feeding a development model that is structurally unjust, we end up by overstretching the absorption capacity of the earth and the oceans, since carbon dioxide is emitted 3 times faster than the capacity of the oceans and earth to absorb it (GEO, 2002; MUSSER , 2005; LOVINS, 2005).

Since 1750 the atmospheric concentration of carbon dioxide has grown by nearly 32% (from 280 ppm to 376 ppm in 2003), having as its source not only the burning of fossil fuels, but also changes in the use of soil. Approximately 60% of this growth (60 ppm) has occurred since 1959 and, if we extrapolate the current trend, in the USA, alone, 28 million barrels of oil per day will be consumed in 2025. Considering historic emissions of carbon dioxide from 1900 to 1999, 79% is found in the most industrialized countries, with just the USA being responsible for 30.3% of these emissions. Although the urbanized population in industrialized countries represents only 1/5th of the world's population, it contributes more than ¾ of all carbon dioxide emissions. In industrializing countries, with 4/5ths of the world's population, the volume of emissions has been growing rapidly (WRI, 2005; MEA, 2005; LOVINS, 2005).

This current situation regarding the emission of carbon dioxide and the trends contribute to the fact that by the end of the XXIst century climactic changes will be the driving force in changes in the services of ecosystems and the loss of biodiversity. Projections from the IPCC through 2100 point to a rise in the average temperature of the earth's surface of between 2.0 and 6.4º Celsius over pre-industrial levels; just a 2.0^{o} rise is expected to have a major impact on the services of ecosystems. With this rise in temperature there is a tendency that the number and seriousness of events such as floods, landslides, hurricanes and extreme temperatures (extreme heat and extreme cold) will increase, which will overstretch the local response capacity and demand external assistance (national and international) (see **Table 9**).

Among the extreme temperature events the exposure of populations to heat waves, principally in the centers of large cities where the temperature normally tends to be higher because of the islands of heat created by buildings and asphalt, is expected, with an impact principally on the mortality rate of the elderly. For events such as (hurricanes, floods, landslides), this Table is worrying when we consider that populations have been increasingly occupying areas and regions that are vulnerable to natural disasters (coastal and dry areas) and that the number of people needing external help with regard to these events has quadrupled over the last forty years. It is particularly worrying as far as coastal areas are concerned, when we consider that there are projections of an additional rise in the sea level of between 8 and 88 centimeters between 1990-2100, that nearly half the major cities in the world (those that have more than 500,000 inhabitants) are located within 50 km of the coast and that the population density of these cities is nearly 2.6 times greater than the density of inland areas of the continents. This situation is worrying for public health, given that physical, microbiological and psychological consequences for human health are expected as a result in the rise in sea level and the population displacement (MEA, 2005; McMICHAEL, 2000).

In addition to these direct consequences others are expected, like the increase in the incidence of respiratory diseases from growing exposure to photo-chemical and allergenic pollutants (spores, fungi, etc), as well as an alteration in the intensity and the variety of infectious diseases related to vectors (malaria, dengue fever and yellow fever, for example) (see **Table 6**), which will extend the radius of action on the continents and at altitude in all continents because of the rise in temperature. Other indirect effects on human health and well-being are expected, like an alteration in the intensity and variety of illnesses related to the pathogenic agents present in food and water, as well as the regional decline in agricultural productivity, mainly in populations that are resource-poor (South Asia, Northeast Africa and Central America)

From current world trends, the population should reach 9 billion in 2050 (the population will be greater, more urbanized, will grow more slowly and be older), GDP should increase by between 3 and 6 times and consequently there will be an increase in the consumption of natural resources and environmental degradation, putting pressure on the planet's limits (MEA, 2005). However, the growth in population, economy and environmental degradation will continue not being equal for all.

If in 1950 the population of the less developed regions in the world represented nearly twice the population in more developed regions, today it represents 5 times more and projections point to the fact that in 2050 this proportion will be 6 times. If today a 1/5th of the global population, living in the most industrialized countries and with a higher *per capita* income, have 86% of the GDP, 82% of the exports to the global market, 68% of foreign investments and 74% of the telephone lines, in the other 4/5ths of the population, who live in less industrialized countries, we find the reverse situation. More than a billion of the global population, 1 in every 6 inhabitants on the planet, live on less than US$1 per day and are unable to satisfy some or all of their basic needs, like adequate nutrition, uncontaminated water, safe shelter and sanitation, as well as access to health care, because they are on the margins of public health, education and infrastructure services. If we double the figure to less than US$2 a day, which still represents extremely precarious living conditions, the number more than doubles, going to more than 2.7 billion inhabitants. In terms of lives lost, this means that every day more than 20,000 people die for lack of food, drinking water, medication or other essential necessities. A child born in sub-Saharan Africa has 20 times more chance of dying before it reaches 5 years old than a child born in an industrialized country, and this disparity is greater than it was a decade ago. During the 90s, 21 countries fell in the IDH ranking, 14 of these in sub-Saharan Africa (MEA, 2005; GEO, 2002; COHEN, 2005; MUSSER, 2005; SACHS, 2005).

Some 20 years ago, in 1987, the Bruntland Report pointed out that among the success factors of humanity were the decline in infantile mortality, the increase in life expectancy, the increase in the percentage of adults that know how to read and write, the increase in the percentage of children going to school and the increase in global food production at a faster rate than population growth. Among the failures it made a distinction between social and environmental ones. Among the social ones it mentioned the absolute number of those starving and illiterate in the world, the increase in the number of those that do not have good quality water and housing and the widening of the gap between rich and poor nations. Among the environmental failures it highlighted the fact that environmental changes threatens to radically modify the planet and the lives of many species, the desertification of productive lands, the destruction of forests, acid rain, global warming, the hole in the ozone layer and chemical pollution (CMMAD, 1991).

Since the Second World War and particularly as from the end of the 80s, when the constitution of an environmental agenda gained prominence in the globalization process, we have seen economic growth and a rapid integration of markets, accompanied by growing environmental degradation and inequity in the distribution of income between countries and within countries. This economic growth logic has proved to be unsustainable from the environmental and human health and well-being points of view. The current logic of blind economic growth, includes expenditure on the undesired consequences of production and the consumption of goods as positive values. If we start to compute the loss of well-being resulting from the concentration of income and environmental degradation as social and ecological debts, while the GDP per capita of a country like the USA grew from US$ 20,000 to almost US$40,000 between 1950 and 1990, the sustainable well-being index per capita practically stagnated, going from US$ 10,000 to little more than this (DALY, 2005). If this is the situation in a country like the USA, many countries have experienced only an increase in their social and ecological debts, with the vast majority of their populations having to pay the price in terms of their health and life, as well as environmental degradation, in order to sustain an economic development model that is structurally unfair and far from achieving the necessary sustainability in health and the environment for the well-being of humans and the necessary guarantee of ecological integrity for life support systems.

FINAL CONSIDERATIONS

Starting with an ecosystemic perspective, we have tried to show in this text how the current economic development model, whose roots lie mainly in the Industrial Revolution, has meant an intensive and extensive process of industrialization, urbanization and growth of the population and economy that have brought immense advances, but also countless major challenges, from the point of view of environmental and health sustainability. If we consider, for example, that the global growth of GDP per capita, the reduction in infant mortality and the increase in life expectancy are good success indicators of this model, and that all we need to be do is to make a few corrections in income distribution and improve environmental conditions in those cities where infant mortality is still high and life expectancy is still low, then we merely have to develop public policies that are focused in such a way that they reach the most affected regions and the most vulnerable social groups, like the billion poor and wretched. If we consider, for example, not only that the logic of economic growth, by its very nature and dynamic, is socially unfair and environmentally results in the degradation of ecosystems, but also that it has been wasting lives and destroying life support systems, making the possibility of local, regional and global collapse and non-linear changes that have consequences for our health, lives and our very civilization everyday more real, then we need to develop public policies that are broader in their territorial and temporal extension, in addition to being integrated in their diverse dimensions, as well as to introduce changes in the direction the current development model is taking. The basic question at the heart of both alternatives is, up to what point it is possible to develop one or the other and how much time do we have to do this?

Table 1: Changes that transformed the world between 1890 (=1) and 1990.

Industrial production	40
Marine fishing	35
Carbon dioxide emissions	17
Use of energy	16
World economy	14
World urban population	13
Availability of reactive nitrogen	9
Coal production	7
Air pollution	5
Irrigated areas	5
World human population	4
Mammal and bird species	0.99
Forest areas	0.8
Blue whale population	0.0025

Source: McNEILL, 2000; MEA 2005.

Table 2: Global conditions of the provision and regulation of ecosystem and cultural services, as evaluated in the Millennium Ecosystem Assessment. (continues)

Ecosystem services	*Sub-categories*	*Conditions*	*Observations*
Service provision			
Food	Crops	⇧	Substantial increase in production
	Cattle	⇧	Substantial increase in production
	Fishing activities	⇩	In decline because of over-fishing
	Aquaculture	⇧	Substantial increase in production
	Non-cultivated food	⇩	Production declining
Fibers	Wood	+/-	Loss of forest in some regions, growth in others
	Cotton, silk and hemp	+/-	Production of some fibers declining and others increasing
	Firewood	⇩	Production declining
Genetic resources		⇩	Loss due to extinction and loss of genetic material of vegetable species
Biochemicals, natural and pharmaceutical medication		⇩	Loss due to extinction and over-planting
Water	Fresh water	⇩	Non-sustainable use for human and industrial consumption and agricultural production; amount of hydric energy stable, but reservoirs increase the use capacity of this type of energy

Table 2: Global conditions of the provision and regulation of ecosystem and cultural services, as evaluated in the Millennium Ecosystem Assessment. (conclusion)

Ecosystem services	*Sub-categories*	*Conditions*	*Observations*
Regulation services			
Regulation of air quality		↓	Decline in the capacity of the atmosphere to clean itself
Regulation of climate	Global	↑	Sources of carbon sequestering as from the mid-XXth century
	Regional or local	↓	Preponderance of negative impacts
Regulation of water		+/-	Variation depending on changes and location of ecosystems
Regulation of erosion		↓	Increase in soil degradation
Water purification and waste treatment		↓	Decline in water quality
Regulation of illnesses		+/-	Variation, depending on changes in ecosystems
Regulation of pests		↓	Natural control degraded as a result of the use of pesticides
Pollenization		↓	Apparent global decline in the abundance of pollenizers
Regulation of natural dangers		↓	Loss of natural barriers (wetlands, mangrove swamps)
Cultural services			
Spiritual and religious values		↓	Rapid decline in holy places and species
Esthetic values		↓	Decline in the quantity and quality of natural land
Leisure and ecotourism		+/-	More areas accessible, but very degraded

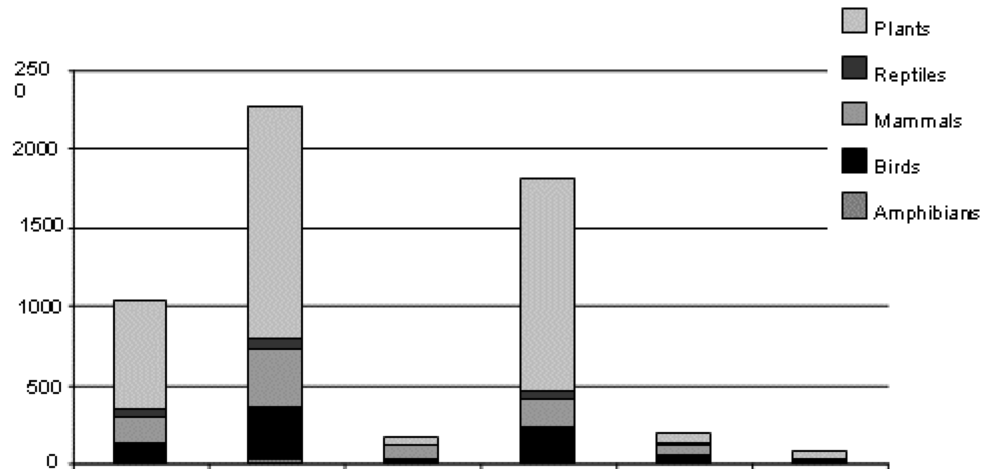
Source: MEA, 2005
Observations: For basic provision services the MEA defines "improve" as the increase in production of a certain service due to changes in the area where the service is provided (expansion of agriculture, for example) or an increase in the production per unit of area, referring to the benefits for humans. In the same way "degradation" is defined when the current production or use exceeds sustainability levels, reducing the benefits to humans, whether because of an alteration in the service (the loss of mangrove swamps reduces protection against storms) or because of pressures that exceed the limits (pollution exceeds the capacity to maintain water or air quality). In this perspective and according to the MEA, the eradication of a vector that transmits diseases to humans may be seen as a benefit and not as a loss to ecosystems.

Table 3: Synthesis of the Current Situation and Bioprospecting Trends in Major Industries.

Industry	Current involvement in bioprospecting	Expected bioprospecting trend	Social benefits	Commercial benefits	Sources of biodiversity
Pharmaceutical	Cyclical trend	Cyclical trend with possible growth	Human health	+++	P, A, M
Botanical	High	Growing	Human health	+++	P, A, M
Cosmetics and personal care	High	Growing	Human health Human well-being	+++	P, A, M
Bioremediation	Variable	Growing	Environmental health	++	Mainly M
Protection of grain and biological control	High	Growing	Food supply Environmental health	+++	P, A, M
Biomimetics	Variable	Growing	Environmental health	++	P, A, M
Biomonitoring	Variable	Growing	Environmental health	+	P, A, M
Horticulture and the grain and seed industry	Low	Constant	Human well-being Food supply	+++	P
Restoration	Medium	Growing	Environmental health	++	P, A, M

Key: +++ = billions of dollars; ++ = millions of dollars; + = profitable, but with variations.
P = plants; A = animals; M = microorganisms
Source: MEA, 2005

Table 4: Total number of species (amphibians, birds, mammals, reptiles and plants) vulnerable to extinction per region in the world, 2000.



	Africa	Asia + Pacific	Europe	Latin America + Caribbean	North America	West Asia
Plants	695	1471	42	1360	72	52
Reptiles	34	74	12	49	17	0
Mammals	173	356	71	178	62	19
Birds	118	335	30	212	32	17
Amphibians	13	32	8	17	16	0

Source: GEO, 2002

Table 5: Emerging diseases from identification data of the causing agent or when re-emergence was significant.

1973	**Rotavirus**
1977	Ebola virus
1977	Legionnaire's disease
1981	Toxic shock syndrome
1982	Lyme's disease
1983	HIV/Aids
1991	Tuberculosis resistant to multiple drugs
1993	Cholera caused by 0139 strain
1994	Cryptosporidiosis
1998	Bird influenza
1999	West Nile virus
2003	Severe acute respiratory syndrome
2004	Marburg virus

Source: Bloom, 2005.

Table 6: Examples of Infectious Diseases related to Changes in Ecosystems.

Disease	Cases per year	(Proximal) Emergence mechanism	(Distal) Driving force of emergence	Geographic distribution	Expected variation as a result of ecological changes
Malaria	350 million	Invasion of niches Expansion of the vector	Deforestation Water projects	Tropical (America, Asia and Africa)	++++
Dengue fever	80 million	Expansion of the vector	Urbanization Precarious housing conditions	Tropical	+++
Leishmaniosis	12 million	Transfer of the host Alterations in *habitats*	Deforestation Agricultural development	Tropical (Americas, Europe and Middle East)	++++
Lyme's disease	23,763 (in 2002 in the USA)	Extinction of predators Loss of biodiversity Expansion of reservoirs	Fragmentation of habitats	North America and Europe	++
Chagas disease	16 to 18 million	Alteration of habitats	Deforestation Urban expansion and occupation of endemic forest areas	Americas	++
Japanese encephalitis	30 to 50 mil	Expansion of the vector	Irrigated rice fields	Southeast Asia	+++
Hemorrhagic fevers (Guaranito, Junin and Machupo)	-	Loss of biodiversity Expansion of the vector	Monoculture in agriculture after deforestation	South America	++
Hantavirus	-	Variations in population density of natural food sources	Climactic vulnerability		++
Human rabies	-	Loss of biodiversity Alteration in host selection	Deforestation Mining	Tropical	++
Schistosomiasis	120 million	Intermediary expansion of host	Reservoir building Irrigation	America, Africa and Asia	++++
Cholera	-	Increase in surface temperature of sea	Climactic changes and variability	Tropical (global)	+++

Key: + = low; ++ = moderate; +++ = high; ++++ = very high
Source: MEA, 2005

Table 7: Main causes of loss of healthy years of life because of injuries, diseases or premature death.

Position	1990	Projection for 2020
1	Pneumonia and other respiratory infections	Cardiac diseases
2	Diarrheic illnesses	Depression
3	Birth illnesses and in the newborn	Vehicle accidents
4	Depression	Stroke
5	Cardiac diseases	Emphysema and bronchitis
6	Stroke	Pneumonia and other respiratory infections
7	Tuberculosis	Tuberculosis
8	Measles	War
9	Vehicle accidents	Diarrheic illnesses
10	Congenital diseases	HIV

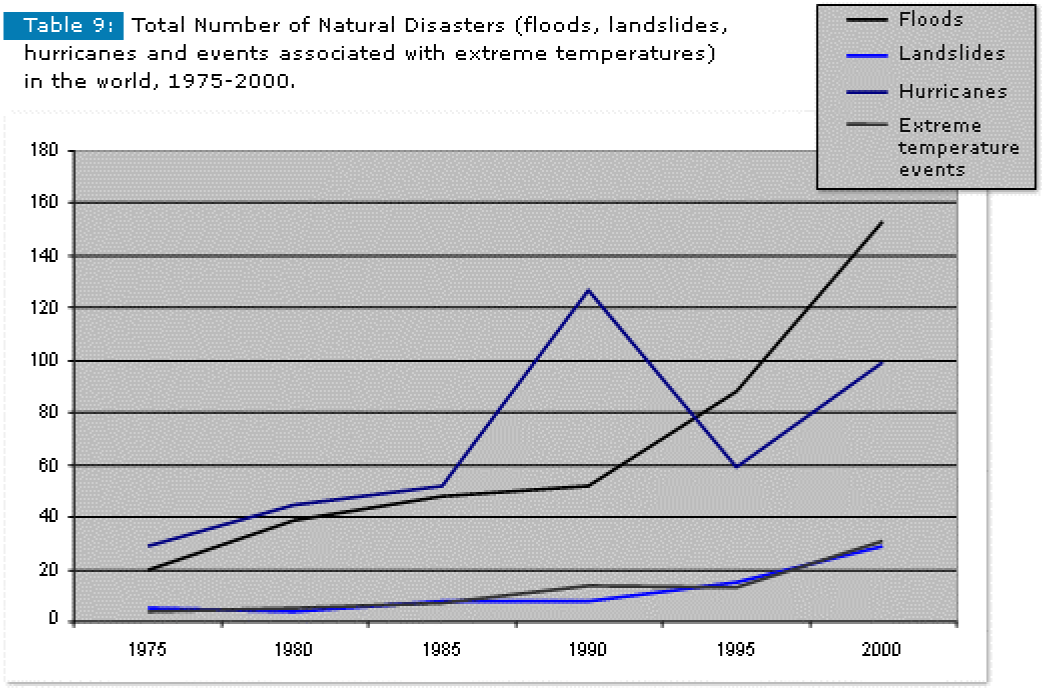
Source: Bloom, 2005.

Table 8: Comparison of demographic indicators, health, education and consumption, between countries with high and low per capita income.

	Countries with high income	Countries with low income
Total population	972 millions	2,7 billion
Population density	31.1 inhabitants per km²	83.4 inhabitants per km²
Life expectancy	80 years	61 years
Population with access to		
Water suitable for human consumption	100%	76%
Adequate sanitation	100%	36%
Literacy rate	99%	64%
Annual emissions of CO_2 per capita	13 tons	1 ton
Annual consumption per capita		
Meat	94 kg	9 kg
Water	970 m³	556 m³
Energy	5.4 tons of oil (equivalent)	0.5 tons of oil (equivalent)

Source: Earthtrends, 2006.

Table 9: Total Number of Natural Disasters (floods, landslides, hurricanes and events associated with extreme temperatures) in the world, 1975-2000.



Source: GEO, 2202.

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