ENVIRONMENTAL EDUCATION AND AWARENESS

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Summary

Our common future depends on our ability to live in accordance to the carrying capacity and limits of our planet. Practically, that means that we should change our behavior: every country, every state, every city, and every person. The best way to do it is to

educate people so that everyone could voluntarily change his or her lifestyle and be more friendly to the environment. Environmental education and awareness cannot exist one without the other; to be environmentally educated means to be aware of how to live in peace with the Earth and vice versa. Let the education and awareness spread throughout the world, since this is our only chance to safeguard the future.

1. Introduction

Throughout history the connections between human societies, ecosystems, and the geophysical environment have changed many times, sometimes gradually, sometimes very fast and sharply. More than 2 million years ago the human population was very small, and, more importantly, it grew very slowly, at a snail's pace. Humans were one of many species of mammals that spent all their lives in close contact with nature. Human existence depended on many natural factors, and life was dangerous. The birth rate was very high but mortality was extremely high too, so the population did not grow quickly.

Humans were in that time more like animals than modern human beings. They could kill and eat animals, but animals could kill and eat them too. In bad weather, they suffered from cold, strong wind, and rain; if hunting was unsuccessful, they starved. According to different estimates, 2 million or 2.5 to 2.7 million years ago, *Homo habilis* appeared, who could use simple tools made of stone or wood. Then *Homo erectus* appeared, who could walk upright, and whose brain weighed about 1 kilogram. It was found that 500,000 to 600,000 years ago humans started to use fire. *Pithecanthropus erectus* (now regarded as synonymous with *Homo erectus*) used speech to communicate.

The period from 200,000 to 40,000 years ago was the period of the Neanderthals. The most remarkable fact about Neanderthals is that they hunted collectively. Their brain was as heavy as ours, about 1.5 kilograms. They lived in colonies and adhered to primitive rites, so they were rather like *Homo sapiens*, a species which appeared in its present form about 40,000 years ago. It is believed that large animals (including mammoths) disappeared mainly due to humans, and this was the first sign of the growth of human power. Some scientists suppose that it was the first crisis caused by human activity—all large ungulates were eaten, resulting in a certain decrease in population. Another consequence of this situation was the development of agriculture. Perhaps it was the only way to survive; anyhow, humans found a way and became farmers, in addition to being hunters, and rose to a higher stage in human evolution.

During the New Stone, Bronze, and Iron Ages the human population was still increasing slowly, and it only reached 300 to 400 million people in the Middle Ages. There was then a great decrease due to Black Death: almost half the population of Europe died as a result of the plague. But population growth has assumed exponential characteristics since that time, and Thomas Malthus expressed great concern about this process in his *Essay on Population*, published in 1798. He wrote that accelerating population and industrial growth were raising demands for food faster than agriculture could respond. He argued that human population would increase exponentially (or "geometrically," in his term), while the available land, food, and material resources would increase arithmetically. It was the first time that the problem of limits was appreciated and studied from a scientific point of view.

Malthus carried out a full analysis of the social and economic situation, but he could not foresee the Industrial Revolution, the development of agricultural technologies capable of quadrupling yields achieved by traditional farming methods, the spread of health services, and new achievements in the area of medicine. Thus, the population is still growing, and the pace of this growth has quickened, taking 130 years to reach the second billion, thirty years for the third and fifteen years for the fourth. Now we can see that the last ten years have brought an additional billion people, and the world population now has passed the 6 billion mark. If the population growth rate remains at 1.7 percent per year, according to different estimates, we will have a population between 8 and 10 billion by the year 2025.

The Industrial Revolution led to great increases in human technological power, which made it possible to provide high living standards. However, such a revolution did not take place in all parts of the world simultaneously, so now we have the more developed North and the less developed South. It should be mentioned that now nine out of ten newborn children are in the less developed countries (LDCs) and only one out of ten in the more developed countries (MDCs). According to some forecasts, over the next fifteen to twenty years this situation will become worse and nineteen babies out of twenty will be born in the LDCs. It means that the majority of the global population will live in countries with low living standards, in countries that are the providers of raw materials, resources and, possibly, cheap labor, while the minority of the population will consume these resources and live in countries with highly developed technology, huge capital assets, and high living standards.

Using new technologies, machines, and mechanisms, humans became as powerful as geological forces: perhaps more so, because geological forces have created landscapes and geosystems over millions of years while humans are able to change them in just a few years or decades. Humans are able to change relief, remove mountains in one territory, and create artificial landscape forms out of waste material in another. They are able to change the directions of rivers and build long channels in the deserts. The power of technology is great, but, unfortunately, in most cases this power leads to the destruction of natural systems. MDCs, with their technologies and capital, manage nature to meet their level of consumption and to support high living standards, while LDCs are forced to exploit nature for survival despite the threat of future consequences. Now we can see that human influence on the environment is very severe and has become a matter of global concern. It is a fact that nowadays human activity can destroy natural cycles and ecosystems. There are many examples of this process: deforestation, especially in rain forests; ozone layer depletion; global warming; species extinction and loss of biodiversity; chemical and thermal pollution; soil degradation, and many others. In some cases the changes are irreversible; in other cases we can improve the situation by the reconstruction and restoration of destroyed systems. Humans must realize and solve this problem for the survival not only of our generation but also future generations.

The only solution is to change human behavior from destruction to living in harmony with nature. Every citizen of every state should know what he or she can do: what is better, what should not be done, which is most important, and why. We suggest that the best way for people to learn this is through relevant education. Education helps us find answers to the questions "What?" "Why?" and "How?" We believe that the next step will be appropriate awareness, so the person who knows could really change his or her behavior.

If we want to prevent global system destruction, and to create a system in which nature and humans co-operate, we need to understand the main principles of the functioning of the biosphere and to learn how to live in accordance with these principles. It means that the rate of natural resource consumption should not exceed the rate of its renewal; the rate of land degradation should be lower than the rate of new soil formation and the amount of chemical and heat wastes should be reduced to the quantity that the environment can absorb and neutralize. If we act in accordance with such limits, it means sustainable living: that is, living without excessive anthropogenic environmental impact.

We can continue the list of actions that we should or should not take, because the world around us is finite; material resources are finite, the biosphere's carrying capacity is finite, and land and its fertility are finite too. Every activity on the planet is limited by these environmental constants. If we exceed the limit we inevitably face negative consequences in future. If we cut down more trees than we can grow during the same period of time, sooner or later the forest area will decrease and disappear. If we produce more carbon dioxide than the environment can absorb, the concentration of this gas will increase, causing global warming, a process that is probably already under way. If we overload arable land or pasture, the soil will be destroyed and the production of essential quantities of food will become more and more difficult. All these problems are very topical today. Some of them are local problems, which can be solved locally, but most of them, like deforestation, acid rain, the greenhouse effect, and so on, are global problems, which can be solved only by global co-operation.

Human perspectives depend on the right decisions of our generation and future generations as well. In general, people in MDCs are familiar with environmental problems. There are many environmental movements, organizations for nature protection, and green societies. Some special environmental educational programs started ten or twenty years ago have already brought visible results. But there is a great gap between having knowledge, or being well educated, and changing the stereotypes of our behavior in accordance to this knowledge—that is, to be aware. We need to continue environmental education programs not for education itself but to obtain real awareness, so any person should feel himself or herself as a citizen of the planet, with great technical power but with extreme care and prudence by virtue of this power, and a citizen, responsible for his own activity, not a master.

The situation is more complex in LDCs. When people are starving, they cannot care for the environment. They need to survive first of all, and only then can they spend money and time to protect nature. As we said, most of environmental problems are impossible to solve locally, so the situation in LDCs is a global problem and should be solved by the joint efforts of MDCs and LDCs. MDCs have to help LDCs to develop their economies and technologies to attain worthy living standards and to save their natural systems at the same time. All the rich countries must understand that without such help, LDCs will destroy natural systems to a great degree in their struggle for survival. The most vivid example is Brazil and its practice of complete felling of the rainforest, at a frightening rate.

The development of economies and technologies should be accompanied by development of an educational system. Beginning with traditional elementary education, such as reading, writing, and arithmetic, for all social groups, we need to educate people about the environment. Permanent support to such programs by MDCs can help people not only to obtain environmental knowledge but also to get an awareness of the basis of this knowledge.

It should again be emphasized that awareness is most important, because education itself does not guarantee change in people's behavior. Education without awareness can only provide knowledge, a set of facts and ideas, which can remain a "dead stock." Education is the means by which real awareness can be obtained.

2. Contents of Education and Awareness

What contents should be included under general education for all ages and social groups? First of all, knowledge must be provided, not merely in terms of odd facts and theoretical functions and equations without practical applications. Knowledge must serve as a basis for everyday practical life, so it has to be integral, be associated with practice, be up to date, and include all important fields of human activity. It means that everybody, independently of his or her profession or future perspectives, should have basic information in such areas as chemistry, physics, biology, environmental science, sociology, and modern scientific achievements, as exact sciences as well as the humanities.

Another important part of education is knowledge about our planet, its structure and biological resources, its sources and sinks, and the limits of the biosphere.

We can divide these limits in two large groups. The first consists of strict limits, which should not be exceeded because they will cause an irreversible destruction of ecosystems and natural cycles, so we can call them critical limits; the second are non-strict limits, defined by different ranges, for example, current living standards, level of energy consumption, food production and consumption, and so on.

The problem is how to estimate these limits. Theoretical estimation based on computer modeling can give us only the power of the limit value, not the exact value. So we can use estimates obtained from simulation models only as a very rough approximation. What about experimental corroboration? "Why not try to approach the critical limits and confirm the theory by experiment?" The only answer is: "No experimentation with the global system!" The reason is simple: any of these experiments could become our last experiment, and the last of our actions, because if we exceed any of the critical limits the consequences will be grave. Exceeding the critical limits means the destruction of the global system sooner or later, in any case. The biosphere can exist without humans, as it precedes their appearance on the Earth, but humans cannot exist without the biosphere.

Another problem is which limits are critical and which are not. We do not know exactly, and nobody knows. And again, there is only one right approach—if we do not know of what kind the limit is, we have to consider it as a critical one. No problem, if the limit we regarded as critical is actually non-critical: nothing serious will happen. But we must not allow the situation to arise when we can miss a critical limit and exceed it.

We have to be aware of some features of the limits of nature. When we use the term "critical limit" we suppose that it is constant during a human lifetime or the lifetimes of a few generations. But in the case of much longer periods of time, say thousands and millions of years, this limit may not be constant and can vary. For example, atmospheric composition has changed over the course of different geological eras. Primary atmosphere did not contain oxygen but consisted of methane (CH_4), salt (NH_3), carbon dioxide (CO_2), hydrogen (H_2), and water vapor, which meant it was a reduction medium. No oxygen meant no ozone generation, and the absence of an ozone layer in the stratosphere, so the ultraviolet (UV) radiation was extremely intensive. During Earth's history this situation has changed. One of the most significant early global changes was the appearance of oxygen in the atmosphere, as a result of the activity of ancient cellular organisms. When the oxygen concentration reached a value of about 1 percent, the protective ozone screen appeared. The CO_2 and O_2 concentrations and temperature varied in different geological eras. None of the mammals or oxygen-breathing animals or organisms could exist in the primary atmosphere, while ancient bacteria are still living on our planet and have been since long before the arrival of animals. Stratospheric ozone concentration seems to be a critical limit. The process of ozone generation is perpetual, and ozone (O_3) concentration is a result of a dynamic equilibrium. One of the important environmental problems nowadays is the depletion of the ozone layer because of the presence of CFCs in the stratosphere. The class of CFC compounds was created some decades ago. The molecules of CFCs destroy the ozone molecules in a chain reaction, so only one molecule of CFC can destroy up to 10,000 ozone molecules. This process disturbed the dynamic equilibrium towards depletion of stratospheric ozone, and the "ozone holes" appeared. Initial oxygen accumulation required millions of years. But to cause significant damage to the ozone layer took only a few decades.

Non-strict limits are variable; they can change from century to century, from year to year, even from week to week. For example, relatively high living standards in America 200 years ago were worse than modern ordinary living standards. The limit of poverty that was acceptable 100 years ago in Japan seems to be absolutely inadmissible now. Average consumption of food, energy, and material resources is much greater now than fifty years ago, and it is still changing depending on different factors. An example of rapid changes is the political and economic situation in Russia and other countries of the former socialist block. Ten or fifteen years ago these countries had a socialist economy, and people in most of these countries experienced the phenomenon of total goods deficiency. People had enough money but they were forced to spend much time searching for the things they wanted to buy. This phenomenon can be repeated in those countries where the transition to a market economy is in progress and where such transition presents some difficulties. But now, with higher living standards, the problem of shortage of goods arouses people's indignation and creates a social crisis, while fifteen years ago a protracted search for goods was considered normal.

Information about limits is one of the most important topics that should be included in the program of environmental education. Another important concept, which is in close connection with the ideas on limits, is system dynamics, based on negative and positive feedback, and different types of growth, from an elementary linear growth to a complex exponential one, that can be explained from the system dynamics point of view.

It was J. Forrester, the author of *Principles of Systems,* who formulated the fundamental theoretical propositions and then demonstrated its practical applications. Most real systems possess feedback loops. In some cases these feedback loops are not numerous and are easy to find and to understand. In other cases it is very hard to find the interconnections among different parameters and to describe them mathematically for future use in computer models.

Let us analyze the simplest possible system containing A and B parameters, and suppose that changing A will cause a change in B. Such a system is not closed; there is no feedback here as this interconnection arises when a change in B causes a change in A and thus, the cycle or the feedback loop. If we change A, parameter B will be changed, then it will in turn change A, which will change B again and so on. Depending on the type of interconnection between A and B, the system can demonstrate a tendency to stabilize its behavior by settling within the limits, or run away into a total collapse. A personal bank account with a fixed compound interest rate represents a system with exponential growth. Parameter A is the value of the deposit and parameter B is an absolute value of the fixed interest rate. Let A = 100 and the interest = 7 percent. At the end of the first year, parameter B makes 7 percent of 100, which is 7, and A becomes 107. At the end of the next year, B makes 7 percent of 107, which is about 7.5, and A becomes about 114.5; at the end of the third year, B is about 8 and A is about 122.5, and so on. After ten years the deposit becomes twice as much as the original. In the next ten years, the deposit will double again, and so on. This process is unlimited, and it is an example of exponential growth. Sometimes this type of behavior is desirable, like in the previous case of a personal bank account or, for example, exponential accumulation of scientific knowledge. Sometimes exponential growth is strongly undesirable or even means death—in the case of drug dependence, or the reproduction of cancer cells.

Most of the natural systems demonstrate a tendency to stabilize after any disturbance. If the air temperature is too high, we feel heat; our skin sweats to decrease the temperature of the skin. If the air temperature is too low, we start to shiver with cold. The result of the shiver as a process of muscular activity is warming, increasing the body's temperature. We can use any warm-blooded animal as an example of a system with feedback loops, which feature the ability to stabilize after some disturbance. It can be explained in terms of our two parameters A and B: if A increases, it causes change to parameter B, which causes the decrease of A so it aspires to achieve the original value, and vice versa. This type of feedback is called negative. The system, where increase of A causes the change of B, that causes further increase of A, is unstable. This type of feedback is called positive. One day such a system will reach some limit of growth.

There are only two perspectives: the first is the end of this system or its complete destruction; and the second is changing the system by changing the type of feedback from a positive type to a stable negative type.

The modern world is a world of consumption. We consume energy, food, and natural resources, and the rate of consumption increases exponentially, as does the generation of pollutants. We extract huge quantities of oil and iron-ore to make new machines and fuel for the extraction of more and more oil and iron-ore. This is an example of a system with positive feedback—as we have seen, an unstable system. Since the natural resources and the biosphere capacity are finite, exponentially increasing material flows will, sooner or later, exceed some of the limits. Thus the global system has only two choices. The first is to continue consumption: to use all the resources, everything accessible on the planet, until the end of the system. The second choice is to change the feedback loops from positive to negative, stabilizing the system by changing human behavior throughout the world. We hope that through education everyone will be able to understand this, and will be able to contribute to the transition to a sustainable world without exponential growth of material flows.

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