THE ANTHROPO-ECOLOGICAL APPROACH AS A BACKGROUND TO TECHNOLOGY

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I. Basic Principles of the Anthropo-Ecological System

The increasing damage to the biosphere needs a general theoretical and methodological approach to the solution of the relationship between further socio-economic development and the globally limited bio-environment. On the one side, there is the unrealistic idea of infinite exponential growth of the present economic development in a finite energo-material and time-space system, and on the other side the effort to stop any further development and return to a kind of natural economy. Humankind is looking for some strategy of sustainable development, but instead of general proclamations it is necessary to have basic theoretical and methodological backgrounds. According to our opinion one of the possible approaches could be the Anthropo-Ecological Approach, which was developed in the Institute of the Landscape Ecology of the Czechoslovak Academy of Sciences in the beginning of the seventies.[1,2,3]

Definition of the Anthropo-Ecological System

Two basic sub-systems – the natural and the artificial – are usually defined in the interrelation between man and bio-environment. We believe that already the initial problem of defining these systems must be approached in terms of their dynamism. That means the cognition of complex processes in time and space, during which the individual components of the system are restored and simultaneously further developed in complicated ecological ties. At the same time, however, the conditions of this development are restored and changed, too.

These processes take place between natural and artificial sub-systems which are inseparably interconnected. Therefore, it is impossible to draw any precise boundary between them. Moreover, these complex processes take place also inside both subsystems. In view of this dynamism, we regard as decisive the continuous renewal of both sub-systems in development process which is based on the reproduction logic. In principle it is this system: The natural subsystem of biological reproduction, while from the interaction with the human population results economic reproduction, which is the basis of the creation of the artificial sub-system.

- Biological reproduction can generally be seen as a complicated set of processes which continuously takes place between living organisms and their environment on the basis of energo-material flows and their transformations with the purpose of constant renewal and further development of the organisms and their relations.
- Economic reproduction can be defined as a set of constantly renewed and mostly expanding processes of production, distribution, exchange and consumption of goods satisfying the needs of the human population. In a sense it is an incessant flow of natural substance (matter) and energy transformed by human activity (work) into processes which are conditioned by one another in space and time.

A quite specific situation occurs when we try to include the human population in the system defined in this way. By its biological essence, human population is undoubtedly part of the natural sub-system and of the biological reproduction, but in terms of social relations and economic activity it belongs to the artificial sub-system and to economic reproduction. At the same time, it is precisely its conscious activity that sets the human population apart both sub-systems and lends it a specific transforming and partly regulating function in relation to them. Even as a specific sub-system, of course, it is also very closely interconnected with both the main sub-systems. We call the system defined in this way the Anthropo-Ecological System (AES). It is necessary to see the Anthropo-Ecological System as three inseparably interconnected sub-systems-spheres: biosphere, technosphere and anthroposphere.

Energo-Material Flows

The basis for all reproduction processes in AES are the flows and transformation of matter and energy in the closed – not isolated – global system of Earth, with a relatively constant energy input of solar radiation. An important fact is that matter circulates in nature in flows between abiotic and biotic systems, while it is constantly used and transformed anew on the basis of the laws of conservation of matter and energy. Commoner[4] concludes from this that nature does not know what man calls waste. What is waste within one link of the trophic chain is the source for the link that follows. The accumulation of some waste brings about the multiplication of what it consumes, or possibly sets in motion adaptation mechanisms which create new stages of development. The potential energy, on the contrary, cannot be used again to the full extent, due to the Second Thermodynamic Law.

With the development of human society, man started using the natural resources, based upon an `understanding' of natural laws in terms of adequate `scientific knowledge' to convert matter and energy into artificial sub-systems. This transformation means ever higher quantitative as well as qualitative changes in energo-material exchange with the bio-environment. The past few decades have been marked with an immense acceleration of these processes and with such quantitative concentrations due to urban development and industrialization and qualitative changes due to the creation of compounds and combinations of elements unknown to nature, that natural ecosystems are not able to cope with them. It is necessary to realize the basic fact that according to the law of conservation of matter and energy, all natural resources taken from Nature, with the exception of historical monuments and the slight volume of recycled waste, appear after transformation in the economic reproduction process `somewhere' in the form of wastes of all kind, solid, gaseous, liquid, radioactive etc. This `somewhere' of course means geographic space, that is soil, water or air, or possibly the transition from one medium to the other. That is what we call environmental pollution or degradation. The circular process of energo-material exchange between natural and artificial sub-systems, which is the basis not only of economic reproduction but also of the development of the whole anthropo-ecological system, is thus irreparably severed.

Importance of Information in the Anthropological System

Even if the role of information in the process of development is an extremely complex problem, some years of interdisciplinary discussion and research led us to the conclusion that it is necessary to take it as a basic factor of development, namely if it is approached in a qualitative form rather than as knowledge or cognition.

In biological development, information coming from the vicinity of an organism is the most important factor acting on the adaptation mechanisms. Interaction of organisms and environment results in the emergence of more complex structures on a higher information level for both internal (genetic) and external information. In addition, it results in the ability of receiving, selecting, storing and using the information for better adaptation to the changes of the environment (surrounding). The adaptability of the system also means higher efficiency of energy and material use from the environment. This is often most important for the survival of the organism in extreme conditions. It is obvious that the importance of information in the process of development is an extremely complex problem and that it cannot be simplified in this way. We believe, however, that it can be used as a heuristic aid for grasping the importance of information in the anthropo-ecological system since it gives rise to a series of essential questions of which the solution will undoubtedly require much further work in interdisciplinary investigation.

What is involved is the clarification of very complicated relationships between information, entropy and energy. If a more complex system is at the same time also a system with a higher degree of order, it is probably one with a higher 'content' of information, too. One problem is, however, how to measure and determine its degree-of-information level. We proceed from the consideration that the development toward more complexity had traversed a set of information influences, caused by the adaptation mechanisms, which then became genetically encoded into that higher complexity. The mutual interaction of information between the environment and the adaptation mechanisms of organisms influences the behavior of the latter toward the environment, resulting in the creation of mutual ecological relations and ties between the individual component parts of ecosystems, which develop in successive scales, and can only be disturbed by external influence or an 'information shock'. The complex systems with a higher degree of information are ready to survive as long as they have higher resilience to these shocks.

At the same time it is necessary to keep in mind the essential relations between information, matter and energy, which are inseparably interconnected. Information is not possible without its material substance, and its motion and change are impossible without energy. For this reason, we believe it is hardly possible to separate energo-material and information flows in the AES. On the contrary, it is necessary to observe these flows within and between reproduction processes in connection with their information essence.[5]

The development of any system, including an ecosystem, is possible only as a consequence of the supply of matter and energy from the environment. The growth of its negentropy–that is, its increasing degree of order–takes place to the detriment of the growing energo-entropy of the bio-environment. In the global system of the Earth the energy flow is secured by solar radiation. But in systems on a lower level of definition, the process of energy use and transformation is connected with the increasing entropy of the environment which is completed by solar energy. At the same time, the flow of matter and its transformation take place. The level of the transformation of matter and energy is influenced by the level of information in the system.

As long as man lives as a part of ecosystem, he will be able to make use of the entropy of the environment within the limits of natural laws, by acquiring knowledge of these laws, which means growing information. He started to transform increasing amounts of matter and energy on a higher level to the detriment of the environment. The result is an irreversible dispersion of matter and transformation of energy or use of the 'stored' energy in fossil fuels, which means increasing entropy of the whole natural system, the bio-environment or the ecosystems.

The question now arises as to what extent the growing content of information, leading to higher measures of complexity and order, can act against the growing entropy through higher efficiency of the use of matter and energy. In natural systems, this process can probably be observed in long-term development trends. The organisms with higher content of information – higher level of complexity – can better use the matter and energy from the environment, adapt themselves, and finally survive the changes and stresses caused by the environment. The complexity and diversity of the ecosystem play some role in the stability of the system, but we can suggest it as a higher degree of information level and complexity too.

In the relatively short period of human history, this trend of higher efficiency of matter and energy use is evident. Every marked change, especially in the use of energy, occurred as an essential reversal, which today we often call 'revolution' (e.g. agricultural, industrial, scientific and technological revolution). The system of economic reproduction is marked by an increasing degree of complexity (negentropy) at the costs of growing entropy of the environment. From this point of view it is a question of to what extent it is possible to regard the socio-economic development with growing negentropy as a progress, as long as it occurs at the costs of regress and growing entropy in the ecosystem. The understanding of energo-material and information processes is a very complicated but extremely important methodological question. Matter is limited by the volume of the Earth. The supply of energy is constant solar radiation. The only factor that can grow in the global system is the volume of information. It is obvious that if economic reproduction processes depend on matter, energy and information of biological reproduction, the two processes cannot be observed and assessed as separate ones. The process of economic reproduction cannot permanently exist to the detriment of growing entropy of the environment. If sustainable development has to be preserved, it is necessary to approach the whole Anthropo-Ecological System as one complex system, which has to converge to higher complexity and negentropy and a higher level of dynamic balance by the use of information.

II. The Anthropo-Ecological Approach to Ecological Problems

Our studies have shown that the actual solution to the problems of further development of human society in the limited Biosphere must be oriented on two basic levels:

A. The technological level, which applies the findings of natural sciences to technologies of extraction, production, distribution, transport as well as consumption;
B. The level of needed socio-economic conditions for the realization of technologies.

Solutions on the Technological Level

From the most general point of view it is necessary to orient scientific and technological research (growing information) in the AES on:

- Conservation and development of the reproducibility of biotic resources;
- prolongation of the usability of abiotic (non-renewable) resources.

From this point of view it is possible to define the following set of basic principles of the solution:

- in case of biotic processes, mainly agriculture and forestry, including the recirculation of biotic substances from farming, food production and consumption, preservation of natural conditions and development of biological reproduction and biotechnologies to prevent further expansion of ecologically unacceptable chemistry in agriculture and forestry;
- in case of abiotic processes, applying scientific research to:
    - material and energy–saving technologies during the production and service life of products;
    - the substitution of scarce resources by more available resources;
    - the use of renewable and non-traditional energy sources;
    - the low-waste technologies;
    - the recycling of production as well as consumption wastes of all kinds;
    - the recirculation of water and air in technological and cooling processes and using the waste-heat;
    - prolonging the service life of products; and
    - the transformation to environment-friendly and selective storing of waste that as yet cannot be recycled.

Solution on the Level of Socio-Economic Conditions

It is obvious that most of these principles and technologies are well known, not only from the environmental point of view but also for their economic effectiveness. Why then are they not introduced in the economic practice on a larger scale? We will try to outline at least some of the reasons:

- lack of ecological thinking, both of the public at large and among economists and decision-makers;
- inertia of the economic reproduction process, the changes of technological equipment, the level of manpower and the standard of scientific knowledge;
- branch limited approach to economic evaluation of environmental efficiency;
- economic theories have no adequate categories to express the value of natural resources and biological reproduction (works free of charge);
- inadequate economic tools, oriented to the end-of-pipe concept; and

- acceptance of the quality of the environment as a part of the normal living standard.

Conclusion

It is necessary to orient research towards development of such technologies which are based on the basic laws of nature, energo-material flows and growing content of information in the system, with the goal of achieving sustainable development. It is necessary to prepare the socio-economic conditions for the realization of these principles.

It is useless to know how if the political and economic tools are working against the realization in practice. It is, in the same way, of no use to prepare the best economic, political and educational conditions if there is no technological know-how.

References

1. Petz J., Stoklasa J., (1972) `Natural and Artificial System in Man's Living Environment' in Swedish - Czechoslovak Symposium on Ecology, Liblice, Institute of Landscape Ecology, Czechoslovak Academy of Sciences, Prague.
2. Blazek B., Petz J., Stoklasa J., (1973) `Anthropo-Ecological Decision-Making: On the Analysis of Implicit Assumptions Intervening Between Biological and Economic Approaches in Anthropo-Ecological Decision-Making', Svensk Geografisk Arbok, Lund 49, 1973, pp. 7-13.
3. Stoklasa J., (1979) `Anthropo-Ecological Approach as a Possible Method of Integration between Biological and Economic Development' in Methods and Strategy for Integrated Development, BOL.ONB/MaB UNESCO, Arlon, Belgium.
4. Commoner B., (1972) The Closing Circle, Bantam Book, New York.
5. Riedel R., (1973) `Energie, Information und Negentropie' in Die Biosphäre, Naturwissesnchaftliche Rundschau 26,10, pp.413-420.

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