JPRS: 18,046

OTS: 63-21294

11 March 1963

PHILOSOPHICAL QUESTIONS OF THE TRANSFORMATION OF NATURE

by G. F. Khil'mi

- USSR -

U. S. DEPARTMENT OF COMMERCE
OFFICE OF TECHNICAL SERVICES
JOINT PUBLICATIONS RESEARCH SERVICE
Building T-30
Ohio Dr. and Independence Ave., S.W.
Washington 25, D. C.

Price: $.50

FOREWORD

This publication was prepared under contract for the Joint Publications Research Service as a translation or foreign-language research service to the various federal government departments.

The contents of this material in no way represent the policies, views or attitudes of the U. S. Government or of the parties to any distribution arrangement.

PROCUREMENT OF JPRS REPORTS

All JPRS reports may be ordered from the Office of Technical Services. Reports published prior to 1 February 1963 can be provided, for the most part, only in photocopy (xerox). Those published after 1 February 1963 will be provided in printed form.

Details on special subscription arrangements for JPRS social science reports will be provided upon request.

No cumulative subject index or catalog of all JPRS reports has been compiled.

All JPRS reports are listed in the Monthly Catalog of U. S. Government Publications, available on subscription at $4.50 per year ($6.00 foreign), including an annual index, from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

All JPRS scientific and technical reports are cataloged and subject-indexed in Technical Translations, published semimonthly by the Office of Technical Services, and also available on subscription ($12.00 per year domestic, $16.00 foreign) from the Superintendent of Documents. Semiannual indexes to Technical Translations are available at additional cost.

PHILOSOPHICAL QUESTIONS OF THE TRANSFORMATION OF NATURE

[Following is a translation of an article by G.F. Khil'mi in the Russian-language periodical Voprosy filosofii [Questions of Philosophy], No. 12, 1962, pp. 57-62.]

1. Modern society has reached a phase in its development such that the problem of interaction between society and nature is acquiring a major importance for mankind.

Man has always taken from nature the resources he required -- energy, materials, food substances. For a long time, he utilized only an insignificant portion of his natural wealth and could therefore use nature without concerning himself about the restoration of its resources.

The present level of technical sophistication and the scale of modern society's economic activity permit only those means of utilizing nature which allow the regeneration of natural resources. Further social progress and expansion of social activity is possible only if the productivity of nature is increased. From a life-supporting environment and a storehouse of riches, nature must become the object of a scientifically-based economic activity.

Thus the transformation of nature and the means of increasing its productiveness become one of the central problems in science.

2. The problem of the transformation of nature is related above all to the energy requirements of man.

Man, as any other organism, must draw on his environment the necessary energy to support his existence. Not all forms of energy, however, are accessible to man. Only energy which has been stored and transformed by living substance in the biosphere can be directly accepted by the human organism. Thus the biosphere is the only channel by which energy from the environment enters the human body.

In drawing energy from the biosphere by means of direct biological activity, man regulates the supply of this energy through socially organized economic activity, using technical facilities and artificial energy sources. By his economic activity, man acts on nature and increases the supply of energy in the living matter of the biosphere, and regulates the energy flow into society. As the capacity of artificial energy sources increases, mankind will be forced to use the biosphere more and more as a converter of energy from artificial sources into biotic energy, i.e., into the chemical energy of organic compounds which can be admitted into the organism. In this fashion, artificial energy sources aid man in increasing the output of energy from the biosphere, but do not alter his requirements of energy from biotic sources and do not make man independent of the biosphere.

3. Population growth and increased consumption will make necessary greater and greater quantities of energy stored in the biosphere. In the next several decades the search for new sources of this energy will become one of the most essential tasks of science and technology. In

certain domains of the biosphere this task is even now of great importance.

The chief way of accomplishing this task is the transformation of nature with the aim of increasing the energy output of the biosphere and of the biosphere's supply of energy forms necessary for man. This requires interference by man with the growth of living matter on Earth by means of the creation of new forms of organisms having certain predetermined characteristics and the population of the globe with these organisms. New organisms or new hybrid organisms will require new environmental conditions for their own existence. To a significant extent, these conditions will be created and maintained through constant or periodic artificial modification of the physical state and chemical properties of the environment. There will come a time when man-made nature and the artificial devices which will influence it will blend into a unified whole. Having begun with a transformation of nature, man will ultimately be obliged to create an essentially new biosphere consisting of the physical environment, the organisms which populate it, and artificial devices which have been introduced into nature to control the physical environment and which in great measure create the latter.

Of course, another solution of the problem is also logically conceivable: the creation of a system of devices which would be set up on the Earth's surface and which would completely replace the biosphere; that is, these devices would take energy from external sources and convert it to forms which can be utilized by the human organism. However, the practical advantages of such a solution are not clear and, besides,

its possibility in principle is very doubtful and requires convincing proof. Indeed, a system of artificial devices to replace the biosphere will probably turn out to be more complex and less practical than a biosphere which, although re-made by man, is nevertheless perfected naturally in the course of a long development and evolution.

However, even if such a solution is possible in principle and feasible on some very high level of technology, conditions of life will necessitate beforehand a recourse to the first alternative -- the creation of a new biosphere through the transformation of the existing one. Mankind began to avail itself of this possibility on a negligible scale many centuries ago, cultivating the soil and sowing plants, and also by breeding domestic animals. We may expect that in the next few decades very effective ways of transforming the biosphere will be found, and that by the end of the century man will control the biosphere on a continental scale, if not on a global one.

4. It was pointed out above that the transformation of nature and the creation of a new biosphere by man can not be achieved simply by a modification of the composition and properties of living matter. The solution of the problem will inevitably require an artificial transformation of the physical and geographic aspects of the environment, as well as a modification of geophysical phenomena in large areas. Alteration of the physical and geographic parameters of the environment and changes in geophysical phenomena will be brought about in the following ways: creation of artificial reservoirs; irrigation of deserts; reclamation of swamp territories; elimination or alleviation of permanent frost; amelioration of soils and enhancement of

their fertility; increasing the yield of forest areas, particularly in northern regions; changing the course or hydrological conditions of rivers; changing or redistributing the influx of solar energy into the biosphere; control of precipitation through interference with cloud formations.

Also, the environment can be altered by introducing man-made new components into it, such as artificial reservoirs, dams, and powerful water-pumping installations, underground heaters for warming the soil (on the principle by which surface soil receives heat from below), artificial sources of light for influencing forests and other forms of vegetation by increasing the duration of daylight, etc.

In the foreseeable future, the surface of the Earth, the atmosphere, hydrosphere, and biosphere will be so full of man-made devices and constructions of large size that the Earth's envelopes will acquire new dimensions of reality and will be subject to special laws yet unknown to us. To predict these laws even in vague terms is the new and very important task of natural and earth sciences. Therefore, sciences which deal with phenomena on the Earth's surface and in the biosphere --i.e., geophysics, geochemistry, geography, plant and animal ecology, forestry, etc.-- face in the near future a transmutation into a complex of active sciences whose purpose is to transform nature in accordance with the best interests of mankind. This will require philosophical discoveries of new orientations in the natural sciences and in the methodological approach to new kinds of problems.

Certain characteristics of these new problems can already be

described at present.

5. In considering the possible new character of sciences having to do with the Earth's envelopes, it is necessary to point out the following at the very outset: from studies of nature as it is, we must turn to the planning of a new and more perfect nature which is required by mankind. Hence stems the primary task of natural sciences in their active aspect: the ability not only to disclose the laws of the behavior of an existing nature, but also to foresee the laws which will govern a projected nature which has not yet been created. If we lack means to accomplish such a task, we cannot even begin any substantial transformation of nature.

It should be also borne in mind that the accumulation of knowledge in sciences of the Earth's envelopes is insufficient for the solution of the problem. The directions in which these sciences have developed in the past were determined by other goals. To achieve new goals, it is absolutely necessary to re-orient the earth sciences.

Let us examine this question in more detail.

Many physical and chemical laws and relationships are universal, or invariant, in the sense that they are independent of configurations of matter. Such relationships describe the nature of phenomena as such regardless of the system in which they take place. The general laws of physics and chemistry reflect or express just this kind of invariant relationship. Thus, for example, no matter where the formation of water out of oxygen and hydrogen takes place, for one atom of oxygen there are always two atoms of hydrogen; wherever mechanical energy is

converted into thermal energy, Joule's law is always satisfied. But these relationships are by no means the only kind which obtains in the universe of matter. Many relationships depend not only on the nature of phenomena they describe, but also on the structure and organization of the system of matter in question. In nature as well as in machines there may be specific organizational, structural, and other laws (for example, a direct and inverse law in dynamic systems) in addition to mechanical, physical, and chemical laws. A great amount of attention is now being devoted to the study of such unusual laws, partly by virtue of the development of cybernetics.

The general laws of nature are unique, whereas actual systems of matter have individual properties unique to themselves which serve to define them. This distinction stems from the fact that the structure of such systems and the interactions among their components impose certain restrictions on the applicability of natural laws, and give rise to additional relationships between phenomena occurring in the systems. It is proper to call such relationships "structural" or "organizational". They are of enormous importance in technology, but are no less essential to objects and environments in nature as well. The scientific definition of any real object is in fact determined by the structural and organizational relationships which hold in that object.

Turning, for example, to geophysics, we must say that this science does not consist chiefly of the application of the general laws of physics to the study of phenomena on the surface and in the interior

of the Earth, but rather of the investigation of structural and organizational relationships between the geophysical phenomena. This is equally applicable to the relatively autonomous regions of the physico-geographical envelope and to the globe as a whole.

We know that if we alter the natural characteristics of a given territory by, for example, planting a forest, drying swamps, building artificial water reservoirs or watersheds, change the cloud-formation processes or the precipitation rate, modify the snowfall or accelerate the melting of snow in springtime, etc., we will substantially change the course of geophysical processes and the state of the physico-geographic environment. However, these changes cannot be in any way explained by the physical, chemical, biological or other laws of nature. Even after the above hypothetical changes have taken place, these laws will remain the same, but the phenomena will be different. This is because there will have been a change in the organizational relationships between phenomena, depending on the constitution of the material environment in which the phenomena are occurring.

In exactly the same way, if the distribution of oceans and dry land on Earth is altered, the physical laws which govern geophysical phenomena on the Earth's surface will remain unchanged. At the same time, atmospheric circulation, the ice-content of northern seas, ocean currents, the distribution and convection of heat in the atmosphere, the planet's moisture cycle, etc., will become considerably different. New relationships will arise, engendered by the new structure of the Earth's surface and not by a modification of the physical laws.

The planet as a whole also has specific structural and organisational laws which stem from its division into concentric geospheres which consist of hard substances, water, and gases. It is in the study of the organisational and structural relationships between physical processes in the Earth's envelopes that the real substance of geophysics lies, and not in the mere application of physics and physical laws.

At the same time, it is necessary to point out emphatically that the study of such relationships is at present the weak point of geophysics. The inadequacy of knowledge in this field makes it impossible for us to foresee possible changes in climate and geophysical phenomena which can take place after some more or less extensive modification of hydro-meteorological processes or even after an artificial transformation of the physico-geographic environment.

An intensification of research in this field is absolutely necessary if a transformation of nature is to be achieved. Indeed, in striving to achieve such a transformation we cannot count on changes in physical and other kinds of laws: such changes are impossible. The only means to such a transformation is an alteration of the constitution of nature --an alteration which will give rise to the desired new relationships between phenomena which take place after the alteration. A deliberate selection of means to the transformation of nature will require the construction of theories of transformation and, probably, experimental testing under natural conditions in large areas specially selected.

6. Let us now touch on the other side of the questions we have been considering.

In natural phenomena, it is not so much the form, taken by itself, of the movement of matter (a given form of movement is rarely encountered in a pure state) which is of importance, as the laws of interaction and inter-relation among various forms of movement (in biology, for example, the mutual interaction between the environment and the organism).

This general notion has a direct bearing on the problem of the transformation of nature.

It was stated above that the primary goal of a transformation of nature is the refinement and improvement of the biosphere (or the creation of a new biosphere) such that there will be an increased inflow of usable energy of biogenic origin from nature into society. But the biosphere represents a complex, composite object in which the physical environment and living substances are inseparably entwined in a single system. The origination of phenomena in the biosphere is not determined by physical laws or by the properties of biological forms of movement, if these two are considered separately and independent of each other. The basic character of the biosphere is that it is governed by laws which describe the interaction between the physical and biological forms of movement. On one hand, living matter to a considerable extent determines the micro-climate and geophysical conditions in the habitat of organisms, and on the other hand, it is well known that the activity of organisms and the structure of cell aggregates depend on physical conditions. It is precisely these inter-relations which determine the chief feature of the biosphere -- the fact that it is a self-regulating system. Closed loops of interaction between the physical

environment and living substances underlie the self-regulation of the biosphere.

Therefore, the unification of several branches of geophysics with biogeography and macro-ecology /orig.: biotsenologiya/ on the basis of certain notions of cybernetics represents an important research area in the development of a theory of biospheric self-regulation and in establishing scientific groundwork for a practical effort to transform nature. In short, it is necessary to create a new direction in scientific research, which may be called "biophysics of nature" or "biogeophysics".

7. The conversions of energy in the biosphere have long been of interest to scientists. The biosphere has the peculiar structural characteristic that it is a system of matter whose components, in addition to physical objects, include living substances. These living substances impart certain characteristics to energy phenomena in the biosphere; these characteristics must be studied carefully.

Robert Mayer, to whom the discovery of the law of conservation of energy is due, was the first to note that the presence of vegetation on the Earth exerts an enormous influence on energy transfer in nature.

The Earth's vegetation is the natural medium through which usable forms of energy enter from the biosphere, and in which this energy is stored. However, the influence of living substance on biospheric energy processes is not limited merely to the storage of externally-generated energy. V.I. Vernadskiy, who has made penetrating studies of the role of living substances in physical and chemical phenomena in nature,

noted, in extending the ideas of Mayer and others, that masses of living substances not only store energy, but also release energy to their immediate environment. The appearance and growth of the Earth's biosphere with its living matter, atmosphere, and soils should be considered with respect to energy as an emergence of a large-scale process of gradual storage of usable energy in the outer envelope of the planet, and in turn as a process of a reduction in the "generation" of non-usable, non-convertible, forms of energy on the Earth. It is in this sense that the biosphere can be interpreted as having an entropy-conserving or "neg-entropic" character.

Of course, all biospheric energy processes occurring at a given moment or over periods of geological time obey the laws of thermodynamics. However, the conventional laws of thermodynamics are not by themselves sufficient for a scientific analysis of these processes. The living matter of the biosphere forms the system by means of which a unique interaction takes place between energy and the (predictive) information contained in natural phenomena. We will not dwell on the detailed nature of this interaction here, but will note that an augmentation of the principles of thermodynamics with the notions of information theory can yield the logical tools necessary for the construction of a comprehensive theory of energy phenomena in material systems which include living substances --and, consequently, in the biosphere.

8. We have dealt chiefly with the theoretical problems associated with the general problem of the transformation of nature.

Those sciences which are related to the problem of the transformation of nature must turn, from the description of nature and the classification of its resources, to the planning of nature. Until the present, such a problem was almost beyond the scope of the natural and earth sciences; their development was only to a small extent directed to that goal. It seems that the importance of theory in the transformation-of-nature problem becomes very great; the criteria for the construction of such theory are essentially new, viz., the ability not only to explain phenomena, but also necessarily to predict with high reliability the course of the same phenomena under new, not yet empirically-observed conditions. Science has very little right to take risks and make mistakes in these questions; it is impossible to try out one method of transforming nature and then to turn to another method if the first fails to work. Therefore, it is necessary to have a theory of natural processes and phenomena which will be able to predict the course of the latter under natural conditions which have never before existed, and are merely envisioned. This requires a fundamentally new level of theoretical sophistication, which the natural and earth sciences do not yet have, and which must be immediately and vigorously sought. The state of theoretical knowledge, in our opinion, appears to be the bottleneck in the solution of the transformation-of-nature problem. By this we do not wish to imply that the description of resources and the study of the separate components of nature should be relaxed. These activities are necessary. However, such work will not be effective if it is not accompanied by the expansion of theoretical knowledge built on foundations

which are new in principle.

Theoretical knowledge extended in connection with the problem of the transformation of nature must shed light on the organizational relations between phenomena in the biosphere, on the laws of its self-regulation, and on the details of the mechanisms of energy conversions which take place in it. Such knowledge may be obtained from a synthesis of concepts developed in geophysics, geochemistry, geography, macro-ecology, forestry, and other sciences, employing at the same time modern ideas about self-regulating and self-structuring systems. In conclusion, it is necessary to emphasize that philosophers and theoreticians working in the natural and earth sciences face the task of solving grave methodological problems associated with the development of new approaches to the solution of the problems which are arising, and with the necessity of formulating new scientific concepts.

END

1176

CSO: 1872-N