

IS A SCIENTIFIC APPROACH TO THE  
ESCHATOLOGICAL  
PROBLEM POSSIBLE?

A LOGICAL ANALYSIS OF THE ECOLOGICAL  
PROBLEM IN THE WIDEST SENSE OF THE TERM

“ For there shall be days when you will say:  
Blessed is the womb which has not conceived,  
and those breasts which have not given suck.”

*The Apocryphal Gospel of Thomas (1)*

“ Oh man! why is the world becoming so narrow  
for you? You want to possess it alone;  
but if you had possessed it, it would not have  
been spacious enough for you:

Ah! this is the pride of the devil who has  
fallen from heaven into hell. ”

Jakob Böhme,  
*Aurora oder Morgenröte im Aufgang.*

And it so happens that the ecological problem has acquired apocalyptic resonance. Science faces a problem the solution of which requires not only the study of a phenomenon but also its forecasting on a large time scale and, above all, preventive action if we are to overcome its disastrous consequences. Such a confrontation cannot but change the direction of our cultural progress. Never before has science dealt with problems of such significance. Is it ready to solve them? In order to answer this question we must first understand (a) whether scientific forecasting is possible; (b) whether scientific ideas can influence social behavior; (c) whether the origin of the crisis can be scientifically analyzed and (d) whether a scientific approach to formulate objectives is possible. Below we shall try, if not to *answer* these questions, at least to discuss them. The problem is so serious that it should be discussed as freely and objectively as possible.

Our sole aim is to demonstrate that there may be another approach to the problem, one that differs from that recognized to date. We have adopted an axiomatic-narrative style for this article. Illustrations and arguments serve to elucidate our axiomatic statements. We do not prove anything and do not aim to convince the reader. It is up to him to regard our approach as right or not on the basis of his own experience and knowledge.

## I. LOGICAL ANALYSIS OF FORECASTING

Soothsayers,  
As lower down my sight descended on them,  
Wondrously each one seemed to be distorted,  
From chin to the beginning of the chest;  
For tow'rds the reins the countenance was turned,  
And backward it behoved them to advance,  
As to look forward had been taken from them.

Dante Alighieri, *The Divine Comedy*  
(translation by H. W. Longfellow)

Due to forecasting we have suddenly perceived the tragic aspect of the ecological crisis. And it therefore seems natural to start our discussion with a logical analysis of forecasting.

Formally, forecasting is nothing more than extrapolation.

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However, we always hope to get precise and definite ideas of the future on the basis of fairly vague notions of the mechanism which worked in the past.

Is scientific forecasting of this type possible? Strictly speaking, certainly not. In natural sciences only those structures are considered scientific which may be verified by the experiment. It is here that we find the demarcation line between scientific knowledge and unscientific constructions. This is not a positivism but a stand-point which determines the everyday life of a natural scientist. All of us are well aware of the difficulties connected with a formal definition of what is experimental testing of a hypothesis. Verification is logically inept; falsification, in terms of Popper, is logically clear, but far from being universally applicable. We might describe a large number of natural scientific constructions which have never been tested by falsification. Let us give an ecological illustration. In the USA an extensive study was carried out of five large eco-systems such as the steppe, the tundra etc. and mathematical models were built of up to 1000 parameters. To build each model experimental data were used, but the model as a whole could not be jeopardized by the risks involved in direct experimental testing. And these models cannot be relied upon (2). In forecasting, the comparison with reality can be made only the moment the prediction comes true. At the time of its formulation it cannot be tested *in principio* and, therefore, in its most general form it has *no scientific status*. But, despite all this, everybody is forecasting now: Western firms, the Pentagon, as well as our own scientometrists, economists and sociologists.

As for myself, I should like to discuss the following questions: In which way is forecasting possible? When does it become scientific?

Let us look at the facts concerning forecasting<sup>1</sup>.

1. Deterministic forecasting is possible if we are dealing with an isolated phenomenon whose mechanism is known, and if the forecast covers a period during which the system revealing the phenomenon in question remains stable. As an illustration celes-

<sup>1</sup> Here we would like to draw the reader's attention to the paper by G.R. Taylor (20) where the possibility of forecasting social changes is considered from a critical viewpoint.

tial mechanics may serve. However, here, too, initial conditions are given with uncertainty, and all data must be recalculated from time to time.

2. Engineering is also an example of calculated forecasting. In projecting a bridge an engineer forecasts its strength for decades. He bases his plans on his knowledge of metals and their properties; the resistance of materials to be used; statistics on similar constructions and the mathematical confidence that no major natural catastrophe will occur for several decades within the eco-system Earth. But despite his calculations being quite accurate, the engineer insures himself by widening the safety margin on the data obtained in a way which would be impossible for an economist or a sociologist.

3. In current scientific life forecasting is both possible and impossible. In the present day we clearly see the revolutionary nature of scientific development in the work of Popper and Kuhn. In times of progress, scientific concepts appear which enlighten programs of experimental research and predict new effects. In times of regression, old concepts become exhausted and hinder further advance. This has been discussed in numerous works (3, 4, 5, 6)<sup>2</sup>. But can one speak of forecasting even in times of progress? The future is not scooped from the past, as should be the case according to the concept of forecasting. Let us talk of a carnival of new ideas. One can speak of conjecture, of insight, but certainly not of forecasting.

4. From what has been said above, the absurd nature of forecasting based on expert estimates becomes evident. Which should one prefer: the majority, representing the established paradigm, or the minority seeking new methods? Are there means with which to distinguish new sprouts from the weeds which always accompany the growth of science?

5. Nevertheless our opponents will always produce numerous examples of successful forecasting of important social phenomena.

<sup>2</sup> The last paper gives a dramatic account of scientific forecasts for flying machines. There were favorable predictions by non-scientists, and very unfavorable ones. One of the latter was made by Newcomb, an outstanding mathematician and astronomer, in the days when the first experiment with the heavier-than-air apparatus was carried out, (The text of Newcomb's article is given as an appendix to Garfield (6).

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Such examples do exist. One of them, which is quite amazing, is given in the sentence quoted at the head of this article. Others, almost as amazing, were made by Nostradamus (7).<sup>3</sup>

Scientists sometimes make forecasts of the same type. But in what way do they differ from the un-scientific forecasts quoted above? Does the difference lie in the unscientific character of their arguments? And if the scientific forecasts were convincing from the standpoint of natural scientists, why are they not unanimously accepted in scientific circles and why do other scientists not learn to forecast on an analogous scientific basis in order to anticipate and possibly avoid future catastrophic manifestations of our culture?

6. Marxism, despite its popularity, did not generate mathematical models which would forecast social development unambiguously and in detail. The enthusiasm of American scientists in connection with mathematical models of economy proved impotent in practice according to Vasily Leontief, the founder of the trend (8). And if one wishes to speak seriously of social development, one can only affirm the certainty of its spontaneous nature. In other words, it is impossible to reduce to an algorithm all aspects of social development. This is not a simple statement of actual fact. We could also speak of the theoretical impossibility of solving such a problem, but this would cause us to deviate from the main theme. If the state of matters is such, it would seem natural to resort to probabilistic methods. But the processes under consideration are non-stationary and random and there is no strict mathematical theory for forecasting such processes. Many attempts have been made to solve the problem euristically (9) but with poor results. It is in fact only possible to consider short-term forecasts in this way.<sup>4</sup>

<sup>3</sup> Nostradamus (1503-1566) was a physician and astrologer. His "Centuries" are forecasts written in the form of imaginary travels in the future destinies of mankind. Here is one quatrain which came true during World War II:

The Church of God will be persecuted  
And the holy Temples will be plundered,  
The child will put his mother out in her shirt,  
Arabs will be allied with the Poles (N 554, p. 271)

The translator of the Russian edition saw in the last line the events related with the Six Day War. This interpretation, though arbitrary, is possible and in the interpretation of forecasts it seems nothing better can be done.

<sup>4</sup> These methods have an immense local importance, especially in Western

7. From a purely psychological aspect, each person perpetually forecasts something, predicts his future in taking a new job, getting married, or simply leaving home. We always live in two time-scales. Physically, we live in a narrow, point-like interval of time and mentally, in the sphere of consciousness, we live in the future and act for its sake. This bifurcation of time-scales is a noteworthy phenomenon of our culture; it is the source of inner disharmony. Such forecasts are always probabilistic (10) and essentially personal. It seems pertinent to mention here the field of initial concepts with a given distribution of probabilities and of a subjective, probabilistically given filter which reflects our system of preferences. To obtain the distribution of weights in the final forecast, one might use the well-known Bayes theorem. The reasoning will be analogous to that of section IV, where we shall discuss the probabilistic model of behavior. (Incidentally this may explain why the ancient Greeks, sober and rational as they were, used to consult the Pythian and thus introduce ambiguity to decision-making. They were well aware of the probabilistic character of human predictions (11) and such a mysterious and solemn ritual could well act as a stimulant to the mechanism of probabilistic forecasting, even triggering it off. So all this was not perhaps as absurd a practice as it seems in the present day.)

8. *Negative* scientific forecasts are undoubtedly possible. Drawing curves of growth on the basis of the data of the past, we may state with certainty what *cannot* happen if the rest of the system remains unchanged, and our statement will be mathematically well-founded. About fifteen years ago I constructed a curve of growth for the staff of an big research institute. The points perfectly fitted the exponent. The extrapolation showed that in 1980 the staff would increase to 82,000.

So our main conclusion must be that *only negative scientific forecasts are possible, if scientific forecasts are possible at all*. What I have said above is not a proof of this statement but

countries. The situation there is such that the pollution fines are very high, and at the same time firms try to keep close to the upper limit, otherwise technology becomes very expensive. So the situation calls for the forecasting of the consequences of spontaneous technological disarray due to the aging of equipment, uncontrollable change in the quality of raw material, change of meteorological conditions, etc.

its detailed exposition.

The idea of the inevitable ecological crisis is negative forecasting. The book by Meadows et al. (12) is attractive in its negative part for this very reason. As to the forecasts concerning remedies for the ecological crisis, they seem utterly naive no matter from what source they derive and not because we do not believe in human creative potential, but because any positive forecast presupposes the transition to zero or almost zero rate of growth. Such a necessity is obvious but it nevertheless brings forth a few questions. Is humanity, who lives within the paradigm of our culture, prepared to take this radical and decisive step? If so, where will it lead us? Is there not a danger that society may lose its vital potential? Contemporary science is absolutely lacking in the preparation needed to answer these questions. Let us try at least to outline below the related problems.

## II. COMPARATIVE STUDY OF CULTURES AS A MEANS OF COMPREHENDING THE PECULIARITIES OF OUR BEHAVIOR

It is natural to formulate the question: where is the source of the process whose end at present seems so gloomy? Is it the result of some inevitable human qualities, or a manifestation of specific peculiarities in our culture? While we remain in the framework of our culture, our behavior seems quite natural and the only one possible. But acquaintance with other cultures shows that this is not so. Here lies the significance and the fascination of philosophical anthropology.

If we choose the way of comparative historical analysis, it becomes quite clear that the problem of ecology in the wide sense of the term is a logical completion of the whole European *Weltanschauung*. Christianity followed the tradition the roots of which lie in Judaism and opposed man to nature, directing him to prevail over it. In the Bible we read

And God blessed them, and God said unto them,  
Be fruitful, and multiply, and replenish the earth,  
and subdue it: and have dominion over the fish of  
the sea, and over the fowl of the air, and over  
every living thing that moveth upon the earth.

(*Genesis*, 1, 28)

Hence it follows quite naturally that a society of Christian culture brought up on the Bible regards itself, while formulating its goals, as a formation independent of nature and, moreover, dominating it. The idea of human superiority over nature deeply penetrated the consciousness of society and opened the way to unrestrained development of technological civilization. The historical roots are now forgotten and the idea of human domination in relation to nature becomes self-evident independently of how this or that stratum of society treats religion.

This will probably become clearer if we try to consider, quite briefly, the traditions of another—Indian—culture (on the comparison of Indian and European cultures see 13). The notion of *karma* in India is that of a large system in which a human being is but a link in a long chain of events rooting in the remote past and related to the fates of all other live creatures. It is described by the Czech indologist Ivo Fisher as follows (14):

Belief in the rotation of life presupposed the permanently repeating return of any live creature, any individual, to the Earth. A human being was thus made equal to all other creatures, and according to some schools, to the world of plants as well. He was only placed on a higher step of development in the framework of the whole process but he was in no way the master of Nature or of live creatures dependent on his will. The rotation of life was regarded as an eternal and immutable law to which not only this world obeyed, but also everything living in the Universe... This, of course, greatly influenced the private life of individuals and society, too... Profound comprehension of the beauty of the surrounding world, amazing knowledge of the laws of the animal and vegetable kingdoms, and desire not to harm any manifestation of life were natural consequences of this idea.

We are, of course, far from believing that the solution of the ecological problem lies in resorting to ancient Indian concepts. In such a system, for instance, certain difficulties connected with the impossibility of controlling the birth-rate become especially prominent. Another important factor is the relative and historical character of those initial premises of our culture which, in a cursory survey, seem inevitably human. The roots of our culture go deep into the past and it is not easy to free oneself from its heritage. To proclaim oneself an atheist is not enough.



If this historical analysis is to be continued, it may be of interest to mention that Christianity, in fighting the paganism of the northern peoples of our country, came across concepts in which the pollution of nature by man was considered a most profound offence in that it was believed that nature endowed man with life. My father, an ethnologist and specialist in Ugro-Finnish culture, often spoke to me of this. He used to emphasize the powerful ethical tendency of pagan pantheism towards nature as a whole, which for a long time survived under cover of Christianity among the people of Komi, from whom he himself originated. In Western Christianity the love of nature and familiarity with flora and fauna was vividly displayed by Francis of Assisi. It was first perceived as a heresy, however, and only later was incorporated into catholicism. Bearing this in mind, let us now consider whether modern technological civilization could have appeared if the prevailing outlook of our society had been close to the views of Francis of Assisi, or even of nature-loving pagans? I do not think so. The quotation from Genesis cited above opened the way to our scientific and technological progress and thus has brought us, today, face to face with the problem of large-scale ecology. The life of peoples is marked by a succession of ideas which are passed down through the ages, becoming so familiar and unavoidably human that they go almost unnoticed.

In finishing this section, we would like to remark that G. S. Pomerantz has drawn our attention to a paper by the well known British historian and moralist A. Toynbee: *The Religious Background to Present Environmental Studies* (15) in which he develops ideas rather similar to those exposed above. In discussing ideological sources of the economic crisis he, too, ascribes an extremely important significance to the permission to dominate nature given to European culture by the Old Testament. In his conclusion, Toynbee writes that he considers that the remedy to mankind's present-day distress lies in reverting to the *Weltanschauung* of pantheism which is older than Christianity and was once universal.

To this we should like to add that the ecological crisis cannot be overcome simply through a transition to almost zero rates of growth; something more is needed, and that is a radical change of human attitude towards nature. This relates to deep, uncon-

scious cultural concepts. And how can a friendly attitude to nature be combined with limitations of the birth-rate?

### III. BOREDOM AS AN INDEX OF THE QUALITY OF CULTURE

Oh, thou heavy sorrow.  
Deadly, wearing  
Dullness

A. Block, *The Twelve*

If overcoming the ecological crisis means creating a new culture, this immediately brings forth the following question: what is the index of the quality of culture? One of the possible answers is *boredom*. We are quite aware of the fact that boredom is not one of the first on the list of social categories. However we would like to analyze this very category because it is easily exposed and human consciousness, both individual and collective, responds directly to it rather than to the deep and obscure phenomena which generate it.

Modern Western society is to some extent protected from boredom by the variety of opening vistas: by mass participation in the creative scientific process, by making one's career, by stuffing one's house with a multitude of complicated modern devices... by many other things. All this is carried out as a kind of game, adding piquancy to life and encouraging everyone to "do his best."

However this protection is not sufficient: boredom is coming to the fore, manifested in heavy drinking, drug addiction, unmotivated crime and hippy-like movements which lead a certain percentage of young people off the main road of cultural evolution. It can also be seen in senseless terrorism. Young people naturally react to boredom most acutely.

Almost all game situations in modern Western countries require a comparatively high rate of growth. What will happen, then, if it has to fall to almost zero? The loss of game situations is always the first sign of crisis in a culture.

It would be interesting to analyze cultures of the remote past from this aspect. We know, for example, that viable cultures did exist with zero rates of growth, such as the so-called primitive

(or ritual) cultures where society was protected from boredom by extraordinarily complicated ritual games. Humanity has now grown up, but the threatening question remains: is it possible to create a culture with a near-zero growth rate which would protect society from boredom?

#### IV. PROBABILISTIC MODEL OF SOCIAL BEHAVIOR

A discussion of the ecological crisis must naturally conclude by examining the possibility of creating a model of human social behavior. This model should allow us to foresee the behavior of an individual in the unusual conditions arising from a change in previous value concepts.

In the book by M. Nowakowska (16), the author formulates the interesting idea that human behavior may be described in terms of linguistics. With the use of the Bayes theorem we have ourselves, in a previous study, constructed a probabilistic model of language which allowed us to illustrate both the general irregularity of language (and word polymorphism particularly) and its logical components (17). I would like at this point to explain how such a model may be used to describe the motivations of human behavior.

Our system of judgements is constructed in the following way:

1. Human motivations are determined by a person's value concepts.
2. Value is not a category of formal logic. Logic deals with estimating the truth (or falsity) of a statement, but not its value.<sup>5</sup>
3. In our judgement *all* or *part* of a statement may acquire value if it can be associated with the idea of a *goal* or *aim* in this all or part.
4. Truth, if not associated with an objective, has no value.
5. The concept of "goal" should be formulated in a sufficiently forceful way to allow the construction of a value scale in

<sup>5</sup> In mathematical logic there exists a notion of the value of theorems. But, as a matter of fact, this is nothing but an estimation of their complexity.

the framework of this concept. Vague formulations such as “striving for survival” or “an aspiration for common good” are clearly insufficient. How can we be sure, for example, that a notion as vague as that of “the common good” is compatible with research aimed at changing the human genetic structure? And consequently how can we be sure that science should be developed in that direction?

6. The notion of an aim centered on *something* is in itself a metaconcept. Wittgenstein defined this sort of metaconcept as follows (18):

“The sense of the world must lie outside the world. In the world everything is as it is and happens as it happens. There is no value in the world and if there were it would be without value compared to what lies outside the world.”

7. The final aim of the existing world is a subject which could usefully be discussed only by someone *outside* the world itself, a sort of metaobserver in a position to examine judgements formulated in one of the natural languages on the behavior of numerous different worlds or on numerous and distinct versions of human behavior during the various stages of development of a single world. Such a metaobserver, beyond time and space and having at his disposal sufficient experience of the life of various other worlds, could also give a well-reasoned opinion on the question of modifying the human genetic structure.

8. The same difficulty is present in solving local problems. An optimal experimental design is nothing but a metastatement which can be of no interest until the terms of the experiment have been formulated in the natural language. The latter, in its turn, becomes possible only after experiment. Such is the paradox of experimental design, that branch of mathematical statistics concerned specifically with the selection of the best of such models. And how does one set about selecting the one which will prove to be the best? That is where the work of the researcher becomes exciting: he plays against nature, trying to guess which experimental strategy is the best before he knows the results of the experiment.

9. Pre-cybernetic science ignored the goal concept, considering it a theological matter. A metaobserver can be none other

than a demiurge, the Creator of Heaven and Hell and Prince of all the Worlds.

10. In the cybernetic system each live organism is an autonomous system capable of adapting itself continually to the changing world by spontaneously creating its own objectives in a process of continuous, or almost continuous, mutation. These are metajudgements of an uncertain character if one considers the inadequacy of the objective statements on which they are constructed.

11. From a metaobserver's standpoint, development of an autonomous system of adaptation will be regarded as comparable to walking on a multi-extremal surface, if we can put it that way. As is the case with many numerical methods where a function is pushed to its limit, this system may bog itself down in a logical ravine and perish. We know from history that certain cultures—that of ancient Rome, for instance—perished through their incapacity to free themselves from the trap into which they had been driven in the process of development. Other cultures—such as that of Japan and the Moslem East—managed to adapt themselves and survive under conditions outwardly quite alien to the initial concepts.

12. A situation of the "Great Inquisitor" type, in which the goal is rigidly fixed once and forever, cannot be founded since it is not a structure capable of spontaneous adaptation but a return to the privileged demiurge-like position.

13. The development of a society, even if guided by science, can be viewed only as a precarious walk along a hair-line between numerous crevasses, bearing in mind that a rigidly fixed distant objective is neither possible nor conceivable.

14. It can happen that an objective spreads in a given society like an infectious disease, and that to this type of phenomenon one can apply well-known mathematical models which biologists apply to epidemics. It is useless to seek a formally logical foundation for the origin of such an objective. In times of historic cataclysms the masses who rush forward towards new goals react under the impulsion of a blind faith. Only in retrospect does one marvel at a phenomenon such as the medieval Crusades. Perhaps in the same way future generations will be equally as astonished by the unrestrained consumption of our present-day culture. This

is a typical example of confusion between means and end.

15. These epidemic-like goals do not necessarily require catastrophic conditions. They spread equally quickly under peaceful conditions. Even in this country, despite the many protective measures directed against harmful ideas, complete sterility is far from having been achieved: young women who smoke, long-haired young men with guitars—none of this, implicitly or explicitly was foreseen by anyone. Nor can we explain why the number of applicants to higher educational institutions teaching exact sciences and engineering continues to decrease while that of applicants to humanistic faculties increases. The hippy movement in the West or, in the words of Reich (19), the “third consciousness” of America, can well be described as an “epidemic” phenomenon. This movement even does without dialectic expression: the misuse of language, contempt for it, is one of the essential components of this ideology. The intellectual field created by science and scientific enlightenment does not impede the spread of irrational ideologies. Again the “third consciousness” of America and fascism are proof of this statement. In the latter we have seen the most conscientious research workers seized by the wildest of ideas such as the serious investigation of such absurd problems as the military-technological application of “the concave Universe”.

16. The following traits characterize an epidemic: the suddenness of its outbreak; the possibility of a latent state erupting after a change in external conditions (in the case of biological infections this may simply be the change of meteorological conditions); an incubation period, that is to say a state without noticeable manifestations of outward symptoms, and its progress to an active state resulting in damage to vital centers of organism or society—in other words the paralysis of defence mechanisms against infection; inner exhaustion and progressive reduction of resistance to zero value; creation of increased mutagenicity (reflex adaptation to change), with the possibility of resistance continuing to be present—all these traits are characteristic both of virus-bacterial epidemics and of ideological contagion. The peculiarity of socio-ideological infections is that they prove to be a specific reaction to stability; society is afraid of boredom (as we have seen from section III) and in this factor lies the genetically built-

in mechanism which controls its development. At this point an analogy with immunity and production of protective antibodies is probably pertinent; in this case the germ carriers are the propagators of new ideas; they have an essentially negative value in that they oppose the existing ideas. The creation of immunity causes change in bacteria and viruses; weariness of previous ideas gives rise to new directions of thought. Many ideas which nowadays seem new, after a thorough analysis are found to be genetically related to ancient ones. The history of cultures might be regarded as palaeontology of ideas. The impact of science should be directed then not at the maintenance of the *status quo* but rather at creating favorable conditions for the development of rational mutagenicity.

17. If a new objective presents itself, the individual is required to make certain decisions on the basis of the system of postulates associated with his value concepts. Matters are somewhat complicated by the fact that the postulates in question have differing values which do not remain constant in time. The process of decision-making may in itself be presented as a two-stage procedure: the first stage calls for a general revision of the system of postulates—previously formed concepts, or prejudices, must change under the impact of the ideas arising in deliberating the new goal; this should be accompanied by a revision of the norms regarding postulate values. The second stage requires logical judgements constructed on the basis of a refined system of postulates, and thus the final decision or strategy of behavior is formulated.

As we have already said, the Bayes model lends itself perfectly to the first stage. We have already used this model to describe the way a man perceives the significance of a word in a given context from a field of possible meanings. The separate fragments of the semantic field are associated with the symbol word in the human consciousness, each fragment being associated with various possibilities which in turn are determined by the law of probabilities governing the semantic content. In the process of reading, each new presentation of the word or phrase in a particular context modifies the law of probabilities in as far as the context determines the new meaning. Thanks to the Bayes theorem we can even talk of the law of probability *a posteriori* which at the same time



takes into account both past and future human experience. The essential feature here is the revision of values—what may have had little probability according to the law of probabilities *a priori* may acquire considerably more weight after reading the new text.

Let us consider the Bayes theorem:

$$P(\mu|y) = KP(\mu)P(y|\mu)$$

In discussing the problem of value we may ascribe the following meaning to the different terms of the distribution function:  $P(\mu)$  is the law of probability *a priori* (applicable on a given segment) of prejudices relative to achieving objectives of type  $\mu$  (these may be said to represent the value attributed to separate segments in the semantic field of values associated with achieving goals of the type  $\mu$ );  $P(y|\mu)$  is the law of probability affecting the new distribution of the same values at the moment of deliberating the concrete problem  $y$ , related to the achievement of objectives of the type  $\mu$ ;  $P(\mu|y)$  is the law of probability *a posteriori* affecting the final distribution of values in the situation corresponding to the solution of the given problem  $y$ ;  $K$  is the normalizing multiplier: in a continuous model the squares defined by the curves given by the functions on the one side and the other of the sign of inequality must tend towards unity. The law of probability *a posteriori* for each problem resolved becomes *a priori* in solving the next problem of the same type. Below we shall illustrate the application of the Bayes theorem with a concrete example. Let us consider the manuscript of the book *Probabilistic Model of Language*, in which the probabilistic approach to language semantics, described briefly above, is dwelt upon in detail. This was sent by the author to a certain philosopher for review in a magazine. The manuscript was not strictly philosophical but the editorial staff, in order to insure itself against possible attacks, decided to check that there were no philosophical errors. For this purpose it chose a philosopher known to be particularly orthodox. His review allows us to get an idea of his personal interpretation of the function  $P(\mu)$  in the law of probability *a priori*, taking into account those requirements which, in his opinion, a good philosophical paper should satisfy (here  $\mu$  represents the field of values applicable in evaluating philosophical works). His system of value postulates seems to be so constructed



that a book will be judged “good” if much of its content is devoted to refuting the harmful philosophies of the capitalist West: machism, religion, or the manifestation of class struggle in modern times—against nationalism, for example. Furthermore, one can envisage the elaboration of the function  $P(y|\mu)$  bit by bit as the book proceeds. The reviewer could not but notice that above all the author develops his idea of the probabilistic model of language, discusses the interpretation of such a model, evokes the semantic scale of natural and artificial languages... At the same time he would see that the author touches but briefly upon the questions generally raised in criticizing machism but that, on the other hand, he is interested in the languages of religion and even mentions the specific features of Hebrew tradition—though this be only alluded to in passing. Finally one can imagine what the function  $P(\mu|y)$  would be, that is to say, the way the distribution *a posteriori* of the scale of estimates will look at the moment of evaluating the given, concrete problem  $y$ . Everything connected with the real content of the book is simply lost here since the prior distribution function which dictates the choice of criteria is arranged in such a way that it is ascribed a zero value. The posterior distribution function must be interpreted by the reviewer in such a way that his attention must be drawn to the author’s considerations on machism, religion and the fight against nationalism. Proceeding on the lines of these value concepts it is not difficult to arrive at the second stage and to formulate a verdict which will constitute a clear and coherent set of logical judgments concerning the merits and defects of the manuscript. All this will result in a review which condemns the manuscript as being of absolutely no scientific value: the author had neglected the considerable amount of material at his disposal for opposing machism... he resorts too often to religious texts, inadmissible for a Soviet scholar... he does not seem inclined to draw any conclusion favorable to the Russian language and scientific outlook, particularly inexcusable when all honest-minded Soviet citizens, including certain Jews working in our field, are fighting against Zionism...Although briefly citing Hebrew books which only transcribe consonants, the author does not even grasp *this* opportunity to refute criminal Zionist activities.

All these remarks concern a book which in no way pursues

political or propaganda objectives in that it is purely scientific, as is clearly understood from its subtitle, *Essay on the Relationship between Natural and Artificial Languages*. In the book the author develops a theory concerning language which is the result of a clear-cut preoccupation: he wishes to know in what way scientific language relates to everyday language; in what way scientific terminology should be constructed; how the role of mathematics should be conceived as a language used to describe the world around us; what value should be attributed to fuzzy semantics of every day speech, and to what extent people understand each other in the confusion such words engender. Without attempting to answer such questions, we cannot solve the problem of artificial intelligence, or that of man-computer dialogue. In order to resolve technical engineering problems, we must make use of all the information we possess on the human language, including that concerning cultures of the past. But the philosopher responsible for this review considered the text within a very limited field of vision. Nothing that the author could say concerning the points evoked had any interest for him. However, despite his very adverse opinion, the book was published by Nauka Publications without any major alterations, and was reviewed in the two principal Soviet philosophical journals—*Voprosy filosofii* (Problems of Philosophy) and *Filosofskie nauki* (Philosophical Sciences). It was received favorably for the simple reason that this time its readers were philosophers or linguists with different value concepts.

This story probably has the flavor of an anecdote, but it actually happened. Moreover, the editor-in-chief of the first journal took the review very seriously and, as a result, ordered that the manuscript should not be sent to the printers. As an example it is particularly interesting in that it shows the way in which absurd judgements may be reached by perfectly logical and reasonable methods: everything being explained by the fact that a system of postulates was used which was so narrowly constructed that it was incapable of solving a more broadly formulated problem. We believe that the case, far from being unique, illustrates a vast number of similarly incomprehensible decisions.

18. Our model should not be taken too literally. Far be it from us to think that intellectual advancement can proceed on

the basis of a series of revised judgements on the law of probability *a priori* or *a posteriori*. This is just an attempt to give a formal explanation to a complicated socio-psychological process the mechanism of which, quite frankly, escapes us. Let us rather consider a certain aspect of a complex system, a simple metaphor "everything happens as if". We know that in reality things do not happen that way, nor has anyone ever reasoned that way. The significance of the model is that it allows us to form an idea of the way in which those value judgements which escape formal logic are constructed: postulates are formed on which further judgements are based. The crucial role here is played by the background of the individual conscience which determines the system of prejudices. Now it is a characteristic of prejudices to manifest themselves in the presence of new evidence by reason of the clarity and familiarity gained as a result of numerous previously evaluated problems. It seems likely that, in solving new problems, prejudices may be subject to modification—if we bear in mind the Bayesian model—and that therefore cases such as the one we have just described may appear irrational in the eyes of an impartial observer. We believe that this is the kind of behavior to be expected when we come to discussing the problems of ecology at the highest level, particularly when their eschatological character becomes universally acknowledged.

#### V. THE ROLE OF SCIENCE IN RESEARCH AIMED AT FINDING A SOLUTION TO THE ECOLOGICAL CRISIS

It may be asked what has caused the dominant role of science, scientific activities and scientific outlook in our society to the point where all other manifestations of human spiritual life have been relegated to second place. The answer is quite simple if scientific development is juxtaposed to that of the evolution of the species. In biology, separate species, at least at the initial stages of their development, increase numerically following an exponential curve which, at a point where resources begin to run short, turns into a logistic, or S-like, curve with satiation. Observations show that the biological system is structured so that it transforms the earth to its own advantage, thus improving the environment which nourishes it. This process may be observed visually while travel-

ling in the mountains where we can see vigorous plants destroying rocks. Something of the kind is taking place in science. Publications, journals, the number of researchers—all this will continue to increase exponentially as long as resources are sufficient to provide for such a system.

And science, as a system, is capable of creating ecologically favorable conditions. Under its impact technology develops; technical progress brings new resources for scientific development, encourages new vocation, relaunches invention and patents.

Technological development influences the social outlook; brings about a new scale of values. The prestige values of the past—courage, independence, pride, poetry, fantasy, charity and mercy—all this fades into the background. Science in its progress transforms the surroundings to its own gain and is thus approaching the saturation point which will destroy it unless it succeeds in destroying the biosphere first.

If there is no exponential growth in science; if the scientific community begins aging without renewing itself (we are already observing signs of this); if new technological means necessary for a permanent intensification of experiment cease to be granted, the fate which menaces science will be inevitable.

At present we begin to note that scientific prestige is decreasing. This is especially evident in Western countries. (Much has been written on this subject and we do not wish to be repetitive.) Let us simply say that the prestige of exact and engineering sciences is waning—proof of this in the Soviet Union itself is the decreasing number of applicants to higher educational institutions of this kind. Men of science have realized, too, rather more intuitively than consciously, that something is wrong; that a serious crisis is overtaking science which could even be irreversible. And science is acquiring humanistic values. This tendency manifests itself in two ways. On the one hand, representatives of the exact sciences have begun to show interest in common human problems: language, thinking, psychology and anthropology. On the other hand, science is lending itself more and more to the solution of universal problems: the studies of oncology, psychiatry, planetary ecology. Very important is the use of science as a means of controlling social development and of forecasting that development. My article bears witness to this.

VI. CONCLUDING REMARKS

Thus we see that human social behavior, despite the rationalism of our thinking, tends to be irrational: ideas regulating social behavior are spreading like epidemics; the goal concept does not bear logical analysis; long-term forecasts, if possible at all, can only be negative; progress seems to be nothing but a walk on a multi-extremal surface from which there is no escape and where we continually risk catastrophe. Probably it is this same irrationalism, breaking through our rational thought, that makes life interesting and meaningful. Without it, it would have been possible to foresee and program everything—and all that would have been required of us would be to fulfil our task with patience and precision.

The uncertain character of social behavior creates a game situation. Scientific criticism, common sense—experience accumulated through the ages, logical analysis of situations, aesthetical concepts so profoundly part of us that they seem genetically built-in—all these may be but game constituents.

But who is our partner in the game? Can we play it alone? Such a game would be patience. In shuffling the cards the player himself generates the situation of randomness against which he measures himself. The rules allow us to discard useless cards but, if the game does not work out, the eliminated cards return to the pack to be reshuffled. Is this not what happens in human life? At moments of crisis, interest in old, forgotten ideas is renewed, the pack is reshuffled and the new game begins.

The ecological crisis is primarily an ideological crisis, the crisis of Western culture with its goal and value concepts. Present-day culture requires respiritualization. Nobody can tell from whence new ideas may come. We begin to understand strange, forgotten doctrines which surge back to life from the misty past.

The role of strict scientific thinking in solving the problems of ecology at a planetary level can only be one of strict, acute critical analysis of concrete situations and of the means which arise spontaneously for their solution. Critical analysis, if prudent but courageous, may stimulate human creativity before the crisis becomes irreversible.

Social development, even when influenced by science, can only

be likened to progress along the edge of a ravine, since long-term goals do not, and cannot, exist. And the change in cultural tendencies is, after all, no more than a change in the point on that multiextremal surface whence movement begins, which at the same time alters the inclination of the gradient because the objective itself has changed\*.

### Bibliography

1. *New Testament Apocrypha. Gospels and Related Writings*, v. I, Ed. by R. McL., Wilson, London, Lutterworth Press, 1963.
2. Mitchell, R., Mager, R. A., and Downhower, J., "An Evolution of Three Biomo Programs," *Science*, 192, 4242, p. 859-865, 1976.
3. Barber, "Resistance of Scientists to Scientific Discovery," *Science*, 134, p. 596-602, 1961.
4. Popper, K. "The Rationality of Scientific Revolution," *Problems of Scientific Revolutions: Progress and Obstacles to Progress in Science* (Ed. by R. Harré). The Herbert Spencer Lectures, 1973, Oxford, Clarendon Press, 1975.
5. Duncan, S. S., "The Isolation of Scientific Discovery," *Science Studies*, 4, p. 109-134, 1974.
6. Garfield, E., "Negative Science and The Outlook for the Flying Machines," *Current Contents*, June 27, p. 9, 26, 1977.
7. Leoni, E., *Nostradamus: Life and Literature*. New York, Exposition Press, 1961.
8. Leontief, V., "Theoretical Assumptions and Nonobserved Facts," *The American Economic Review*, 61, 1, p. 1-7, March 1971.
9. Box, G. E. P., Jenkins, G. M., *Time Series Analysis - Forecasting and Control*, San Francisco, 1970.
10. Feigenberg, I. M., *Mozg, psikhika, zdorovye (Brain, Physics, Health)*, Moscow, Nauka, 1972. (in Russian).
11. Lifshitz, M. "Critical Remarks on Modern Theory of Myths," *Voprosy filosofii*, 10, 1973. (in Russian).

\* The first paragraph of this paper was published in part in the magazine *Knowledge is Power*, No. 11, 1972. An abridged version of paragraphs III and V was published in the collection of articles "Value Aspects of Natural Sciences", reviewing the papers presented to the Central Board of Philosophical Seminars of the U.S.S.R. Academy of Sciences and to the local Committee of the C.P.S.U., Obninsk, 1973, p. 79. An adapted version of paragraph VI, destined for a wider range of readers, was published in the journal *Izobretatel' i ratsionalizator*, No. 7, 1977 (in Russian).

*Is Scientific Approach to Eschatological Problem Possible?*

12. Meadows, D. H., Meadows, D. Z., Konders, J., Behrens, W. W., III, *The Limits to Growth*, a Report for the Club of Rome, Project on the Predicament of Mankind. New York, Universe Books, 1972.
13. Nalimov, V. V., Barinova, Z. B., "Sketches on the History of Cybernetics. Predecessors of Cybernetics in Ancient India," *Darsbana International*, April 1974.
14. Fisher, I., *Bori Brahmani Lide*, Ctyri Tisicileti Hinduismu, Prague, 1964.
15. Toynbee, A., "The Religious Background to Present Environmental Studies," *International Journal of Enrvironmental Studies*, 3, p. 141-148, 1972.
16. Nowakowska, M., *Language of Motivations and Language of Actions*. The Hague, Mouton Publishers, 1973.
17. Nalimov, V. V., *Veroyatnostnaya Model Yazyka* (Probabilistic Model of Language), Moscow, Nauka, 1974. (in Russian).
18. Wittgenstein, L., *Tractatus Logico-philosophicus*, London, 1955.
19. Reich, C. A., *The Greening of America*. Toronto, Bantam Books of Canada, 1971.
20. Taylor, G. R. "Prediction and social Change," *Future*, 9, Oct. 1977, p. 404-414.