

## ENTROPY LAW, ECONOMIC PROCESS AND ECOLOGICAL CONSEQUENCES

A critical review of the debate of the seventies on the process of economic development in terms of ecological consequences is the subject matter of this paper. The point of departure has been an evaluation of the 'Entropy Law' as it is applicable to economic process in general. While embarking on the specific as distinct from the general, an attempt has been made to analyse the implications of the exercises done by the Club of Rome and others for identifying the necessary and sufficient conditions for eliminating high entropy states in the economic development at the global plane. The author has shown at least theoretically, that the eventualities prognosed in some of such exercises are fraught with dangerous consequences as far as underdeveloped countries are concerned. The solution of the problem of ecological imbalance cannot be unique in view of lop-sided developmental pattern of the world economy, historically given. Therefore, any discussion on ecological balance has to be focussed simultaneously on two distinct world planes developed and underdeveloped, and separate solutions have to be sought for distinctive planes of development. This is the main conclusion of the paper.

In the fifth century B. C., in Athens, during the time of Pericles the then civilised mankind faced an imminent catastrophe. There was such a shortage of timber that the population was perhaps thinking in terms of an imminent end of the world because the society was fast becoming incapable of providing a timber house for each household. In the middle ages again, when 'the year of 1000' was approaching, the European mind became convinced of the approach of the 'day of wrath' because the Apocalypse had supplied an answer "and when the thousand years had expired".<sup>1</sup> These are not the two events alone as we shall see in the history of human civilization when imminent or distant 'doomsday' was the main agenda in human thought. Economic and social conditions, resource depletion within the framework of historically specific approaches to economic development and activities and consequent imbalances both, ecological and social, provided the causal nexus to doomsday prophecies. The present time is no exception. The

purpose of this short paper is to lay bare an economist's standpoint or rather one of the important standpoints in the present controversy regarding resource and energy depletion at the global scale in the face of demarche to ensure a continuous exponential growth rates wherever practicable, in both the developed and developing segments of the world economy.

The point of departure in the arguments that follow has been the 'Entropy Law' in economic process, first expounded by the great economist, Nicholas Georgescu-Roegen. As is well known, the basic postulates of the Entropy Law could be summarised as follows: (a) heat always moves from the hotter to the colder bodies and not vice-versa. In other words, thermodynamical phenomena are unidirectional as opposed to the principle of backward and forward locomotion of classical or Newtonian mechanics. (b) There are two forms of energy: (i) free or available and (ii) bound or latent. "Like heat, free energy always dissipates into latent energy. The material universe, therefore undergoes a qualitative change, actually a qualitative degradation of energy."<sup>2</sup>

Since the entropy is unidirectional, the notion of time becomes very important. Transformation of free into latent energy is a function of time. There is a clearly defined, what Eddington called "the time's arrow" which directs the energy from a lower entropic to the higher entropic level and hence increases the disorder in nature. Therefore we come to the third postulate: "In nature there is a constant tendency for order to turn into disorder".<sup>3</sup>

But what is the connection between this physical law and the economic process and how is it relevant to an examination of the connection between man as an economic agent (not in isolation however) and ecological balance? Georgescu-Roegen has warned economic scientists about the possible outcome of ignoring the relation between the two processes, viz. the thermodynamic and the economic, because of certain basic characteristics of the latter process.

"The economic process, like any other life process, is irreversible (and irrevocably so), hence it cannot be explained in mechanical terms alone. It is thermodynamics, through the Entropy Law, that recognizes the qualitative distinction, which economists should have made from the outset between the inputs of valuable resources (low entropy) and the final output of valueless waste

(high entropy). The paradox suggested by this thought, namely that all that economic process does is to transform valuable matter and energy into waste, is easily and instructively resolved. It compels us to recognize that the real output of the economic process (or of any life process for that matter) is not the *material flow* of waste, but the still mysterious immaterial flux of the enjoyment of life".<sup>4</sup>

An inevitable consequence of this process is that sooner or later, the transformation of low to high entropy in the economic process would reach such a stage that the possibility of maintaining or recreating order in the midst of high disorder in nature would be impossible. In other words, if we consider disorder in nature as same as ecological imbalance, the unidirectional nature of economic process implies that at the point of highest disorder time's arrow would indicate the hour for sounding the death-knell of mankind or civilization. This begs the question: What about the capacity of replacement of means of production by nature of that already converted into waste? According to Georgescu-Roegen, the possibility seems quite remote, because to restore energy balance we have two types of sources: stock and flow. Whereas the solar energy is a typical example of flow, meaning thereby continuous supply for the next few billion years until it starts radiating heat at an unacceptable temperature of 1000°C, the resources of nature that are used in the economic process are to be regarded as stock which cannot be replenished. Theoretically of course they can be, but the time lag is so astronomically large that this rate of replenishment has no operational meaning. Human race because of resource gap is likely to face the envitable, that is, death. Therefore, the life of an individual and of our own race marches along the same path, e. g. disappearance from the globe. "Only we do not know when and why it (the disappearance of man) will come. It may be sooner than the optimists believe or much later than the pessimists fear. Consequences of the accumulation of environmental deterioration may bring it about, but some persistent virus or a freak infertility gene may also cause it"<sup>5</sup> This is the quality of Roegenian prediction. To make it more precise, let  $S$  denote the actual stock of resources on earth which can be exploited at different levels of technology. Let  $P_i$  and  $s_i$  be the population and the amount of depleted resources per person in year  $i$ . *It is assumed that there would not be an increase in the rate of growth*

*of replenishment of resources and that no new resources, substitutable at least, are discovered which means that development of science and technology would be within the closed domain of the present.* With these assumptions, let the total quantity of life measured in years of existence be defined by  $L = \sum P_i$  ( $i=0.. \infty$ ). Georgescu Roegen holds the view that  $S$  sets the upper limit for  $L$ , with the constraint  $\sum P_i \leq S$ . Therefore  $P_i=0$  for  $i$  greater than some finite  $n$  and  $P_i > 0$ , otherwise. The former value of  $n$  is therefore the maximum duration of the human species.

There are two glaring inadequacies in this static model of 'doomsday' or the total ecological imbalance. What is the nature of finiteness to this  $n$ ? Is it 5 billion years which period will elapse before the day temperature becomes  $100^{\circ}\text{C}$  (we do not know whether there will be night at all in those days). Secondly, the assumptions that this author has incorporated in the Roegian model which can be done by implication from the basic postulates of the model are extremely unrealistic. If one talks about time's arrow with a touch of fatalism, or a philosophy of preordained determinism, one reaches the above conclusion. But what has been the direction of time's arrow in the contribution of science and technology in the creation of new resources? And finally why are we interested in what would happen to us 5 billion years later or nay, even one billion years from now? Therefore we can discard Roegenian hypothesis as nothing but a far-fetched imagination devoid of any practical significance for the human civilization as a whole as far as the prediction of 'doomsday' is concerned. But as will be evident later, the diagnosis and implication of unidirectional pattern of resource depletion at the world scale have tremendous significance for the economies of the poor countries in their efforts at bringing a harmony between economic subjects and economic environment, that is, between man and nature.

But there was, in the recent past, a disturbing trend in the discussion on the problem of economic development and permissible ecological imbalance, mainly in the formulations of the so-called "Club of Rome". Even today, the controversy has not died down. According to the prediction in the 'Club of Rome' document, "The Limits to Growth" / the 'doomsday' is much nearer. By employing analytical models that are used in econo-

metrics and simulation approaches, a group of MIT scientists, with the help of a giant computer came to the conclusion that not only exponential growth but even growth has to be sacrificed in favour of equilibrium and stability.<sup>6</sup> Because, from the facts given in the document it is evident that the stock of non-renewable resources at the present rate of utilization cannot last more than 250 years. The only exception is in the reserves of coal which are likely to satisfy the needs of the world economy for about the next 2500 years. Even if we reduce the rate of growth or just remain satisfied with simple reproduction and not expanded reproduction, to use a Marxian terminology and assuming that the stock of these non-renewable resources has been underestimated by 400 per cent, the 'doomsday' is not likely to approach in the very near future but it cannot be postponed to a distant future either.<sup>7</sup> But the document assures us—the mankind, that there is no cause for extreme concern provided we pay heed to its final sermon—"If there is cause for deep concern, there is also cause for hope. Deliberately limiting growth would be difficult, but not impossible. The way to proceed is clear, and the necessary steps, although they are new ones for human society, are well within human capabilities. Man possesses, for a small moment in his history, the most powerful combination of knowledge, tools and the resources the world has ever known. He has all that is physically necessary to create a totally new form of human society—one that would be built to last for generations."<sup>8</sup> We are happy at least to know that the problem has been solved "for generations"—how many we do not know. But what has Georgescu-Roegen got to say on this? According to him "Vision of a blissful world in which both population and capital stock remain constant" is utopia because "the crucial point consists in not seeing that not only growth but also a zero-growth state, nay, even a declining state which does not converge towards annihilation cannot exist forever in a finite environment"<sup>9</sup> because the balancing mechanism for resource utilization in the face of a changing technology and stationary population is bound to collapse. Therefore the guarded optimism of Club of Rome is a utopian dream.

This is one side of the picture. A strong critique of the 'Club of Rome' document, W. Beckerman on the other hand goes as far as to say that the study was a 'brazen, impudent piece of

nonsense by a team of whizz-kids from MIT".<sup>10</sup> He contends that the whole approach of 'Limits to Growth' shows a failure to understand that logical mathematical analysis *by itself* i. e. without any empirical content is quite unable to say anything about the behaviour of the real world.

There is no doubt that if growth in the demand for finite resources like land continuously increases at a very fast rate, the supply is not likely to be available in such a situation. But thinking all resources to be of finite proportion is a logical error of the first kind. It is wrong to argue about the fact of mankind without appealing to empirical facts. This is the substance of rebuttal of the predictions of Doomsday men, i.e. the members of the MIT team.

But this argument alone cannot be complete refutation of the Doomsday model. Even if the conclusions are based on empirical facts, they do not provide a clear picture of future shape of things, especially of a not too near future, with any amount of certainty. The decline and fall of Roman empire or the emergence of some later powerful civilizations could not be foreseen from the empirical analysis of relevant factors in the height of glory of the former and lack of necessary conditions of the latter. Moreover, the question of challenge and response has not been taken into view at all. In spite of its prediction of a bleak and lifeless universe, the Club of Rome enthusiasts have at least sought solution which, according to them lay in planned measures, rather than by chance or catastrophe, founded on a fundamental change of values and goals at individual, national and world levels.<sup>11</sup> This is more a rhetoric than a prescription of remedy for total ecological imbalance in a condition of conflict of various types of interests in the globe. But Roegenian prophesy of the Doomsday, as has been pointed out is irrevocable. There may be piecemeal adjustments of 'negentropy', through a better information standard of the resource base in our globe, but his entropism does not contain an escape clause against complete catastrophe although at a distant future.

## II

Let us now examine whether the prognoses of Georgescu-Roegen and Club of Rome are as grave as they appear to be. It



would be worthwhile to consider at first whether from the viewpoint of physical science itself Doomsday is approaching fast. The best course would be to see what a physicist has to say about it. "If a system is highly ordered, its entropy is very low (the configuration is almost unique); there are many ways in which it can randomize itself. But when it is highly disordered (entropy high) the path back to order to the unique state is often difficult to find.

The seeming direction comes about because physical systems find it difficult to follow the path to the unique state. It could happen, but it would look peculiar, just as it looks peculiar to run a film backwards. Thus the statement of heat death, the statement that all things will become lukewarm, that entropy increases, that we cannot get energy out of the ocean and make the ocean colder are essentially statements of probability. All these things are possible, but improbable—so improbable that we are not surprised never to observe them."<sup>12</sup>

To support this contention one may add the Third Law of Thermodynamics or Nernst's Law as it is popularly known that there cannot be any heat death. It may be a piece of scientific optimism but it is a physical law nevertheless.

As has been mentioned earlier, this is not the first time that the fear of total ecological imbalance is haunting the minds of people. But in spite of such fears at the time of Pericles or in the first feudal era, economic growth took place with some forms of development side by side with all its faults. *It has to be noted* however that fear of the impending 'day of wrath' in 1000 A. D. was not a fear of ecological imbalance. In fact there was no such imbalance at all. Man and nature were in complete harmony as it were. There were no cyclopien machines or dark satanic mills. But the conditions of existence of mankind were appalling. As Marc Bloch has pointed out, under-nourishment among the poor majority and over-eating of the rich coupled with the "effects of an astonishing sensibility to what were believed to be supernatural manifestations" contributed to fanciful imagination of the approaching 'day of wrath'.<sup>13</sup>

Therefore, if we consider that the first 'Doomsday' prophecy was made in the fifth century B. C for fear of ecological imbalance we the mankind had to wait nearly another 2300 years since the day of Pericles to be warned about the next doomsday by an English parson named Thomas Robert Malthus. With 'exponential rate

of growth' of national economies, the gap between one prophesy of total ecological imbalance and another has narrowed down so much that we had to wait only one and three quarter of a century to get the verdict of Georgescu-Roegen and the Club of Rome. It is not the purpose of this paper to add just one more discussion to the Doomsday controversy but to analyse the real implication of the models in the context of development and under-development of regions in the world. The Malthusian Doomsday model evolved in the backdrop of an all embracing industrial revolution opening up possibilities for the first time in human history of satisfaction of needs of men. Malthusian theory of population, at this juncture of human history was a pointer to the danger of exploiting such a possibility. Malthus' 'Essay' appeared in the period of transition from feudalism to capitalism but he was afraid of completion of this transition process, consequently of a sweeping social change. His theory therefore was aimed at providing a new rationale to support the interests of the landed gentry and a decaying social order. "...the party to which Malthus belonged," a famous social thinker said, "was inimical to those peculiarities by which the 13th century was distinguished from the 18th; it considered those principles good on which the social order was based in all the previous periods of advanced social development. The arguments of the reactionaries defended not the essence of these principles but their medieval forms; for the moderate liberals there was the need of another theory which would disown oppressive medieval details, would show the necessity of only basic principles and would only admit a certain progress in their development. Such a theory appeared to be the result of the research of Malthus."<sup>14</sup>

But what is the implication of the latest models ?<sup>15</sup> If a simple reproduction model is envisaged in the sphere of global production as has been done by the Club of Rome, the gap in the degrees of development between industrially advanced and backward countries will remain as before in the relative sense and in absolute terms the gap will increase in terms of welfare of the people of the second group of nations. We are assuming away, of course, that there would be a complete change of heart of rich nations so that they would come forward to embrace the poor nations to establish a world government and world economy a la Jan Tinbergen. In the context of international capitalism today, stability and equilibrium in under-developed countries in preference to development is tanta-



mount to perpetuating a relation of dependence of the weak, poor and under-developed economies on monopoly capitalism at the centre. It is well known, that this relation of dependence further aggravates structural imbalance in developing countries.<sup>16</sup> Therefore the Club of Rome model of Doomsday has only supplied weapons in the hands of the defenders and ideologues of the philosophy of economic dependence ( not cooperation ) and international inequality. At the same time one is not inclined to agree with an author's criticism of the Roegenian model. " As an operational proposition " he says, " he and so far as its policy implications are concerned, the Entropy Law turns out simply to be another extreme form of Malthusianism... And the entropic prognosis for social policy is quite the same as the forebodings of Thomas Malthus and of all the prophets of doom who have followed in his footsteps for more than a century and a half ".<sup>17</sup>

This criticism of Roegenian pessimism would have been valid if the international economy were homogeneous in character. But as we all know, it is not so. There is a sharp distinction in the the levels of development between the rich and the poor nations. Therefore if the world has to experience a positive growth rate over time, as Georgescu-Roegen insists, there is nothing wrong in formulating a global plan of development in which the under-developed segments of the world take a positive growth path and on the other hand, its counterpart is asked to satisfy itself with a zero rate of growth. In such a model, assuming the unidirectional nature of time' arrow, dependent characer due to underdevelopment of a part of the world would be reduced. This is a healthier defence mechanism from the point of view of prolongation of our life in the universe and also from the point of view of bridging the gap between the affluent and the opposite at the international arena.

A point has to be mentioned however in the case of developed socialist countries of Europe. It is well known that in these countries one of the key components in national economic planning is growth of labour productivity through development of science and technology. The plan for realisation of this task is the one which ensures a condition of higher 'organic composition of capital' in production to use a Marxian terminology again. It is obvious that the higher is the organic composition of Capital, the more would be the pace of resource depletion. There is a mistaken notion among some theoreticians of socialist economy who fortu-  
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nately constitute a minority that development of productive force in a socialist economy is tantamount to development of technology alone, that is, increase in the organic composition of capital so that 'surplus product' (as opposed to 'surplus value' in capitalist economy, to use the distinction made by E. Preobrazhenskii) could be an increasing function of labour input both in the absolute and relative senses. If this becomes the accepted philosophy of development in already developed socialist countries, it would be an additive element in the consolidation of the character of dependency of under-developed countries on the developed counterpart of the world. In this regard one observation by Brus has immense significance. "In our understanding, "he says, "development of productive forces is increase in the capacity to satisfy broadly understood social needs. In certain circumstances it may turn out that for the development of productive forces understood in this way the unrestrained growth of production is less essential than the formation of a more appropriate structure of needs, such as would ensure harmony between the different sides of the human personality and would further the maintenance of equilibrium between man and his environment."<sup>18</sup>

One important point has to be borne in mind in this connection. A plan of growth of the under-developed segment of the globe is not *ipso facto* a plan of development of vast majority of the population within this segment. Experiences of development of under-developed countries in the recent past have pointed to this unsavoury conclusion. But at the same time, as is well known, there has emerged a new consciousness, or to be precise, a 'true consciousness' as opposed to the 'false consciousness' in the past regarding the question : What is economic development as far as countries like India are concerned? Today's preoccupation is to envisage a development that takes care of the aspirations of 'real men' or 'tormented men' in these countries as against of 'abstract economic individuals' which was the frame of reference hitherto in all planned economic activities in most of the third world countries. To satisfy the criterion of welfare of 'real man' some sacrifice has to be made in the abstract relation of harmony between man and nature. Because, as has been pointed out, in the ultimate analysis, the desired nexus between man and nature from the environmentalists' frame of reference do not usher in a 'cloud cuckoo land' where roasted chickens drop into the mouth of every one. If that had

been so, the conditions of men in different stages of human civilization would not have been so miserable by any standard. What the environmentalists forget and the political economists affirm is that man comes first and only then nature comes.

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# NOTES

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2. Georgescu-Roegen, N. — The Entropy Law and Economic Process, Harvard University Press, 1971, p. 129.
3. Ibid., p. 142.
4. Georgescu-Roegen, N. — Energy and Economic Myths. Pergamon Press, 1976, p. 9.
5. Ibid., p. 5.
6. Meadows, Donella H., et al. — The Limits to Growth Signet Book, 1974, p. 196.
7. Ibid., p. 65.
8. Ibid., p. 188.
9. Energy and Economic Myths, p. 23.
10. Beckerman, Wilfred.—“ Economists, Scientists and Environmental Catastrophe,” Oxford Economic Papers, November 1972, p. 327.
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12. Cooper, L. N.—An Introduction to the Meaning and Structure of Physics. Harper and Row, 1969, p. 354.
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14. Chernyshevskii, N. G.—*Osnovaniya politicheskoi ekonomii* (Principles of Political Economy), Pol. Sob. Soch. (Collected Works), Moscow, 1950, Vol. 9, p. 252.
15. Please also see Meadows, Dennis, L. ‘Alternatives to Growth I: A Search for Sustainable Future, 1977’ in which arguments in favour of a global ‘steady state economy’ have been presented. See also Daly, H. E. (Ed)—‘Toward a Steady State Economy. San Francisco, 1973, p. 14 for definition of the concept. It is nothing but what Marx called ‘a simple reproduction model’. Therefore the contention of the paper remains as it is because no novelty regarding the dimension of practicability in the economic future has been introduced in the two references cited above.
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