Trans. Inst. Indian Geographers
Vol. 3, No. 1, January 1981

THE CONCEPT OF ECOSYSTEM AND THE POSITION OF GEOGRAPHERS

ARABINDA BISWAS, Calcutta

ABSTRACT : The paper deals with the evolution of the concept of ecosystem and its applicability in geographic research. It seems that geographers are yet to arrive at a definite position with respect to the placement of man in his environment. There is an apparent dichotomy between two schools of thought, namely, the environmental detemnists and the probabilists. While the first tries to explain human behaviour in terms of natural endowments of a given region, the second envisages almost a random distiribution of economic activities vis-a-vis the natural ecological setting. The dichotomy is appreciably resolved within the framework of the ecosystem model. But the applicability of this model has several restrictions. First, 'ecosystem' has often been mixed up with environmental systems. Second although in certain cases the model reasonably explains human behaviour, particularly in premitive cultures, it has often been used in an analogous from without analysing the actual cause and effect relationships between ecology and economy. The ecosystem analogy has been used by scientists of different disciplines for better understanding of only the phenomenological relations among the components of social systems. The object of this paper is to highlight the necessity for incorporating the various factors and forces instrumental in creating the seeming randomness in human activities, historical, political, cultural and socio-economic, into a unifying system model within which the concept of eco-perception plays a vital role.

The Focal Problem

There is no end in sight of the debate on the fundamental questions that geographers often have to face during the course of their research. Such questions are related to the nature, limits, criteria and validity of geographical knowledge. That the debate is still on makes it evident that geographers, in spite of their sincere efforts for a century or so, have apparently failed to arrive at some definitive position as to the core of geography. The revelation has prompted even the stalwarts in the field to argue from a state of humility and defence. In her latest book, **Methods and Perspectives in Geography,** Professor Beaujeu-Garnier, though ardently supporting the integration of tradition and modernity in geography, has failed to suppress her despondency about the future of the discipline :

It may seem surprising that Piaget in his volumes on genetic epistemology (1950) and on logic and scientific knowledge (1968) does not even mention the word geography. However, as we have either failed to appreciate or misjudged current movements in the philosophy of science, it is only to be expected that we in turn should be ignored. Fundamental modern methods have not been the object of research or even of systematic evaluation across the whole field of geography, but have crept into the subject piecemeal and indiscriminately.

(Beaujeu-Garnier, 1976)

According to Beaujeu–Garnier, the unity in geography rests on a single theme, the linkages and interrelationships between man and his environment, but before the methodological implications of this unique viewpoint became clear, geographers lost themselves in a multitude of sub-disciplines and concepts which often contradict each other. This she calls the 'fundamental dilemma'–the hiatus between the amorphous core and the exterior entropy of specialisation, and gives her rueful opinion that if geographers continue in the same vein, geography will cease to exist. Antithetic of this rearguard stance of Beaujeu–Garnier was the desperation of Professor Fenneman when he urged American geographers, more than fifty years ago, to extend the field of geography than to cling to the defence of its limits. One can very well understand that both the defensive and the aggressive points of view are nothing but the two sides of the same coin i. e. an element of uncertainty prevailing among geographers. But, is methodological separatism the root cause of this restlessness? Is it not quite natural to expect growing diversities of interest and methods in a central field which by its own virtue is so vast and complex? It may be easy to conceptualise the field through the rather short terminology of 'man-nature interface', but it is the hardest of all jobs to define its limits or to enumerate all meaningful sub-areas of interests which can be tackled by methods and tools devised and applied exclusively by geographers. It may not be possible except by the master minds to portray on a single canvas the totality of human adaption to environment, for the linkages are multi–directional, interrelations complex and probabilities infinite. The individuals, therefore, are forced to look at specific problems and to narrow down the scope and methods to practicable limits and sometimes to borrow concepts and tools from allied branches of knowledge. Specialisation is thus inevitable and to harp too long on this aspect leads us nowhere, for surely this is not the root of the crisis.

The basic uncertainty seems to stem from an ideological issue rather than from a conflict of unity and diversity. The issue concerns the relative positions of man and environment. This is where modernity has really been challenging the tradition. Ever since Friedrich Ratzel (1891) introduced 'new directions in geography' (Brunhes, 1952), geographers have been continuously searching for a proper position of 'man' in relation to his environment. Take, for instance, the position taken by Elseworth Huntington (1915, 1945) in his climatic theory of civilisations, and place it against the position of Meinig (1962) who after tracing the development of the railway network in the Columbia Basin, resolves that physical environment has very little to do with the development and distribution of human economic enterprise.

Indeed, alongside this everlasting dichotomy, we have seen the emergence of a wide range of attitudes or schools of thought. The traditional viewpoint described by Hartshorne (1959) as **areal differentiation** has held considerable ground, while departures in the form of Carl Sauer's (1925) **landscape school,** or of the **locational school** of von Thunen (1875), Christaller (1933), Losch (1954), Hoover (1948) and others or of the **ecological school** of Vidal de la Blache (1922), Barrows (1923), Brunhes (1920), Theodorson (1961), Stapleton (1946-48) and others have only kept the debate alive. Now, it should be admitted that the ambiguities could not be removed simply because the schools overlap each other and we may have to cite the same authority with reference to the history of development of more than one school of thought. For example, if we ask ourselves 'which school does Jean Brunhes belong to, areal differentiation or landscape school?', We possibly cannot get at a definite answer. We may possibly identify a few other schools of thought but they never help us find out where exactly individuals differ in their approaches. The only yardstick seems to be the position ascribed by geographers to ' man ' in relation to ' nature '. The three different viewpoints which cover the world of attitudes in this regard, except those of the ecologists, are :

i) that environment controls human reactivities;
ii) that man is supreme and can disregard the role of environment; and
iii) that man and environment are equal but mutually exclusive forces.

In all the three cases, nature and man have been regarded as mutually exclusive forces whether they interact with each other or not. The assumption that the human and the non-human elements can function independently in spite of being together is the basic area of uncertainty in geography either in its traditional form or in its modern manifestations.

The only school of thought which tends to see man and nature as components of the same system is the ecological school. In doing so, geographers of this school have not only been able to avoid an unnecessary debate but at the same time hold out considerable promise for the development of a monistic framework in which geographical information can be arranged in an orderly fashion. But even this school is not free from internal contradictions of ideas, inadequacies of tools and restricted applicability. We shall discuss its nature and limits in subsequent parts of this paper.

Ecology and Ecosystem

A somewhat loose application of ecological concepts may be traced since the Friedrich Ratzel's anthropo--geographic approach in geography. In Germany, its development was restricted to the field of Political Geography only. In France, the Ratzelian approach received its widest support in the works of Jean Brunhes, Vidal de la Blache and Max Sorre during the second quarter of the twentieth century.The developments in France subsequently effected all-other schools of thought in geography in different ways including even the protagonists of the locational school. But in much of the works of the French geographical school or of the landscape school, the term ' ecology ' has been made synonymous with environment. The ecological viewpoint, therefore, has often been mixed up with environmentalism. In fact, a more accurate characterisation of the ecological approach should necessarily take into consideration the distnctive element in the approach i. e. the assumption that man and environment are inseparable from one another and are costituents of the same organic system.

Of late, we have been frequently coming in contact with a wide range of terms used by geographers as well as non--geographers, —terms that are basically connected with theories on organic linkages between man and nature. ' Ecology, ' the term which has been most abundantly used by botanists, zoologist, geographers, anthropologists and even economists refers to the division in biology that treats the relationships between organisms and their environment.

As back as 1870, Ernst Haeckel, the German biologist defined ecology as :

the body of knowledge concerning the economy of nature — the investigation of the total relations of the animal both to its inorganic and to its organic environment; including above all, its friendly and inimical relation with those animals and plants with which it comes directly or indirectly into contact in a world, ecology is the study of all the complex interrelations referred to by Darwin as the conditions of the struggle for existence.

The term has been interpreted in later periods from different viewpoints. The British ecologist Charles Elton defined it as " scientific natural history ". Frederic Clements considered it to be " the science of the community " while Eugene Odum called it " the study of the structure and function of nature ".

That ecological explanations have entered a large number of fields outside the purview of biology owes to the fact the ecologists themselves have often moved beyond the bounds of ecology, as stated by the British ecologist Macfadyen (1975) :

It must be admitted that the ecologist is something of a chartered libertine. He roams at will over the legitimate preserves of the plant and animal biologist, the taxonomist, the physiologist, the behaviourist, the meteorologist, the geologist, the chemist and the sociologist; he poaches from all these and from other established and respected disciplines. It is indeed a major problem for the ecologist in his own interest, to set bounds to his divagations.

We must admit that this libertine character of the ecologist has played a useful role in the diffusion of the guiding principle of ecology i. e. **ecosystem** into so many other branches of knowledge including geography.

The term ' ecosystem ' in its proper sense has been explained by Kormondy (1974) in the following words :

Ecological relationships are manifested not in a vacuum but in physico-chemical settings, sets of non-living or abiotic environmental substances or gradients. These include basic inorganic elements and compounds, the by-products of organism activity or death. They also include such physical factors and gradients as moisture, winds, currents and solar radiation with its concomitants of light and heat. It is against this abiotic backdrop that the biotic components - plants, animals, and microbes - interact in a fundamentally energy - dependent fashion. The abiotic physico-chemical environment and the biotic assemblage of plants, animals and microbes comprise an ecological system, or ecosystem in which ecological kinship is demonstrated.

In geography, organismic explanations of natural phenomena date back to early nineteenth century when Butte (1808) described the earth as a functioning organism (Stoddart, 1969). Its subsequent developments in Germany and France have already been mentioned. In England, the organismic explanation found a strong protagonist in Herbertson (1913) during the early part of the present century when he declared that natural regions are really functioning taxonomic associations of inanimate and living matter, possessing definite orderly changes of forms.

In America, during the first quarter of the present century human ecology partially replaced a discredited human geography (Stoddart 1969) and by the ' fifties the trend became dominant among the Chicago urban sociologists. Still more recent signs of enthusiasm along the line are traceable in the wide awareness in the contemporary world of the problem of balanced utilisation of natural resources, town-country relations, environmental pollution, population explosion and the like phenomena, frequently cited not only by geographers but by all other experts who prefer to side with environmental scientists. We shall come back to the problem in a subsequent part of the paper, but at this point of the discussion, what interests us is the vast and ever-expanding sphere of application of the concept. It is needless to point out that it has been possible because the logical force of the concept derives itself from the causal connectivity of matter and energy to be traced in systems and sub-systems that exist in reality, while its ramification in geopolitics, sociology and human and social geography is more an act of faith of the scientist concerned than of experience. Thus ecosystem is a model of both reality and analogy; its efficiencies and deficiencies are determined likewise.

Ecosystem as Reality

The ecosystem concept has found a somewhat wider application in those branches of geography which do not include, in their purview, the human aspects of the subject or bear only indirect and sometimes remote connection with the human world. This has been possible because in these fields the model can very well be tested against systems and sub-systems which exist in nature. One of the more widely recognised examples of real natural systems is the system of energy flow. Biological activity involves the utilisation of radiant solar energy and its transformation into chemical form through photosynthesis and to mechanical and heat forms through metabolism. The conversions are fundamental to the energetics of organisms and ecosystem. Raymond Lindeman (1942) is perhaps the most celebrated name associated with the study of energy dynamics which he termed trophic dynamics. Working on the autotroph-based ecosystem in Cedar Bog Lake, Minnesota, he made it clear that the energy captured by autotrophs from the solar source flows only along a unidirectional path from the primary producer to the ultimate consumer and never the opposite way. The implication obviously is that the collapse of a trophic level in the system would immediately destroy all the lower trophic levels.

Biogeochemical cycles and connected ecosystems form another most important field of interest from the point of view of the ecologists as well as geographers. The hydrologic cycle which involves an interchange between the earth and the atmosphere by way of precipitation, evaporation and transpiration (Hutchinson, 1957) forms the basis of study in climatology, meteorology, hydrology and related fields. In Pedology, the existence of nitrogen cycle, carbon cycle, and sulphur cycle can hardly be overlooked. These principles have led to remarkable developments in agricultural research and have opened up prospects of utilisation of the plant-bacteria relationships for creating more stable and more productive agricultural systems.

Ecology of population constitutes a third major area in which there has already been a significant amount of research on biotic potential, death rates, age structure, the influence of abiotic factors on population size, parasitism and predation, competition and other factors which govern the natural law of population growth of organisms including man.

Ecosystem as Near - Reality

The direet causal linkages between matter (living and nonliving) and energy as illustrated from trophic dynamics nitrogen cycle, population self-regulation etc. constitute only micro-systems which in no case occur in isolation. They occur in an assemblage that may consist of broomsedge, field mice and weasel populations, while a few feet distant the assemblage may consist of population of herbs, rabbits and fox. Attention thus must be turned to a consideration of the characteristics and properties of the assemblages of species populations, of ecological communities (Kormondy, 1974).

Thus from really operative micro-systems the ecologist is drawn towards the analysis of terrestrial communities - much the same field as of geographers. There is another reason why the ecologist must go beyond the bounds of the too simplified relationships of energy, nutrient and population. This is the awareness that social organisation of species has a significant role to play in the growth of population (Wynne Edwards, 1964).

The ecologists have shown major interests in identification of the phyto-ecological zones of the earth and have tried to explain the total set of interrelations obtaining in inter-zonal and intra-zonal levels, but very often they have been compelled to stop after identifying the broad phenomenological relationships, the causal connections being yet uncertain except in specific micro-level forms of analysis. This should not, however, convey any misconception that causal connections are absent, they are only to be discovered, and one would perhaps agree that discoverable principles are inexhaustible in number.

The phyto-ecological zones, therefore, can be conceived as near-realities in that their entities are rarely challenged while the causal relationships both within and outside their provinces are not well formulated by laws.

In geography, one can cite a good number of cases where the near-reality conditions are satisfied. Take for example, geomorphology; the sub-discipline is thoroughly dominated by the idea of systems of various taxonomic orders, of cyclical and epicyclical changes of landscape, and of total integration between the whole and the parts. It has been often pointed out that the Davisian eoneept of 'cycle of erosion' (1899) bears a close resemblance to Clement's (1939) 'succession model of plant community,' developed at a much later date. A great deal of discussion may still continue on this aspect, but let us resolve for the present that models relying on the principles of ecosystem can claim a good deal of success in areas where researchers are not confronted with great complexities of human perception and decision making.

The Ecosystem Analogy

Where ecosystem provides for a model of reality in physical aspects of geography and peripheral branches of knowledege, its application in social, human and economic geography and a few other subjects is possible only as an analogue model. We have already recorded the trend of the urban sociologists of Chicago who have sought to explain social and economic organisations of man through the analogy of organic mechanisms in nature.

The ecological view of geographic forms was extended to the discussion on city and its social and physical environment, first by French geographers and then by Patrick Geddes (1890-1925) who put it before a band of city planners in Europe and America that the harmonious relations of city and its internal zones with its regional environment should form the basis of urban planning. The views of Patrick Geddes received maximum support in Lewis Mumford's **City in History**. While Patrick Geddes was busy in establishing his idea of city-region organic linkage, Richard M. Hurd (1903) prepared a ground for conciliation between the environmentalists and behaviourists by stating that while the city can be conceived as a living organism in the Spencerian way, the final basis of human actions is psychology.

The human ecology school developed around the viewpoint of Ezra Park (1921) and H. H. Barrows (1923) failed to create a sustaining impression among American geographers except Carl Sauer and the Berkeley school. In England, Sir Reginal Stapleton, through his wide experience in the field of English agriculture, as Director of the Welsh Plant Breeding Centre, became convinced in the principles of integration between nature and man as well as of the part played by man's conscious memory in chosing his path of development. These principles he organised systematically in his manuscript on **Human Ecology** during 1946-48 (Published in 1964 in book form edited by Robert Waller).

It is needless to mention that the ecosystem analogy, wherever applied in the field of economic, human or social geography has not been as successful as in the cases cited in the previous section of this paper. The reasons are various.

First, we should not fail to note that although the basic principles in such analogies point to the harmonious relation between man and his environment, the logical construct has faild to uphold the principles with the proper spirit in tact. Among the human ecologists themselves, major divergences of attitudes exist in this regard. The urban sociologists and human ecologists accept the model primarily on the basis of relationships to human communities only and although they frequently refer to environment influences, they only establish the fact of man's alienation from nature. The French school, on the other hand, have over-emphasised the role of nature in the evolution of cultural landscape.

Second, causal connectivity which is a fundamental assumption behind the concept of ecosystem remains vague in almost all organic analogies in geography and sociology; correlations rather than actual causal relations have become the main concern and empiricism has prevailed.

Third, as has been rightly claimed by Meinig (1962) and Morrill (1963), there are basic uncertainties in human behaviour pattern that we cannot overlook. Although it is far from being scientific to accept the randomness of human activities, one must recognise in full the complexities of human psychology and motivations. They are much more complex than, say, the mechanism by which bacteria transfer nitrogen to plants. Human motivations and the variety thereof do not stem automatically from only the organic mechanism of human body, for all of man's desires and activities are the outcome of his being a member of a ' society ' which has its own goals of attainment fixed in terms of its own tradition, its interaction with the outer world its own technology to evercome resistance from the non-human world and in terms of a number of other factors. It is possible, of course, to argue that all such factors are not outside the scope of systemic integration of culture and environment and the dialetic changes of initial adaptive forms brought about by changing time and its variable Impact on human communities, it has to be admitted that no systematic explanatory model has so far been capable of incorporating within its framework the full sequence of dialetical changes in human adaptive forms. The essentially non-biological element in human motivations, be it of classes or groups, which may be called the ' social purpose ' of human activities has remained mostly beyond the operational scope of the ecosystem model. Thus organic analogies are likely to and in reality do produce incomplete analysis of the varieties of the economic activities of human communities and the spatial forms associated with them. They may even lead to serious misconceptions about the realities and may suffer from the proneness to sidetract the central issue and to distort the real picture.

Prospective Areas of Application

In spite of the points raised above as a qualified criticism of the ecosystem approach, when applied in purely human and social fields of enquiry, one can cite a good number of cases where the concept has produced appreciable understanding of the actual relationships between human communities and their immediate surroundings. The Pleistocene Man – one of Carl Sauer's objects of study may very well fit into an organismic system model (cited by Stoddart, 1969). Stoddart also cited example from Daryll Forde's **Habitat Economy and Society** (1934), but Forde himself took quite a different position when he said,

> Between the physical environment and human activity there is always a middle term, a collection of specific objectives and values, a body of knowledge and belief; in other words, a cultural pattern. That the culture itself is not static, that it is adaptable and modifiable in relation to physical conditions, must not be allowed to obscure the fact that adaptation proceeds by discoveries and inventions which are themselves in no sense inevitable and which are in any individual community; nearly all of them, acquisitions or impositions from without.

Admitted that external forces do influence cultural patterns and thereby the adaptive modes of communites, one must at least theoretically recognise that such forces have greater impacts on modern societies than on primitive people and economies, busy with solving the problems of food, clothing and shelter. It will be wrong to assume that even in the cases of primitive societies and economies, the ecosystem approach can be applied in a full proof way for the very simple reason that " no human community has lived in prolonged and absolute isolation " (Forde, 1934) and that complexities added through technological and cultural assimilation are to be found everywhere. But what is really needed is the fulfilment of the near-realistic conditions as in the case of the biotic communities which imply causal relationships although in an obscure fashion.

Ecosystems, touching upon realities, may be identified in areas of primary occupation, because man in these occupations is bound to face either environmental resistance of natural advantages in his day to day life in a more realistic way than does a member of an urban or industrial society. Agriculture is undoubtedly one such field where all interactions among physical, cultural, technological and economic forces are reduced to concrete shape in the mode of utilisation of soil which is a living body, adjusting itself cotinuously in response to the activities of all organisms living on it as well as influencing the life-styles of those organisms in turn. Part of an agricultural system surely can be explained by the principles of causal connectivity between man and his environment, while a great deal of the remaining part can be explained through a deductive syllogistic framework. The rest where external forces really reshape the endemic modes of production may, however, remain unsolved unless the universal system is analysed in detail.

The ecosystem concept has been successfully employed to examine land-use patterns and agricultural systems (Simmons, 1966) particularly in primitive modes of living. It has been claimed by Harris (1969) Geertz (1963) that the agricultural systems in primitive economics resemble natural ecosystems. But the concept has failed to account for the wide range of choice exhibited by farmers of the modern society in terms of crop-combinations and production techniques. On the other hand, it has also been claimed that natural systems are more stable than managed systems and their biological productivity may be higher in certain cases (Munton & Morgan, 1971). The aspect of stability of the natural system has been considered by some as a mark of superiority over highly commercial and more specialised agricultural systems which may create serious imbalances in nature's own economies'Established systems of farming have often been introduced wholesale into physical environments which have proved to be totally unstable' (Munton & Morgan, 1971). Imbalances between the natural systems and the commercial systems ofproduction have had various effects such as increasing deterioration of soil fe rtility, soil erosion, floods, pesticide pollution, increasing aridity and so on. In a recent publication on ecological problems, Lynn White, Jr. (1967) claims the historical root of the crisis lies in the Christian dogma that " No item in the physical creation had any purpose save to serve man." We do not know whether it is the Christian belief or something else, but surely the capitalist farming systems of the Occident have always been apathetic towards the idea of balanced utilisation of land, conservation of resources and preservation of plant and animal life. Thus " except where soil erosion has been a major problem, the ecological approach to the understanding of the functioning of agricultural systems has had few adherents " (Munton & Morgan, 1971). The growing realities of severe regional problems have definitely compelled men of science to raise alarm and more so in the western world. Even the economists of the Western world today have been focusing these problems. We may cite the papers edited by Peter Bohm and Allen Kneese on **Economics of Environment** (1971) which include the theory and policy for protection of environment, measurement of value, environmental degradation and operational management methods. But very little have been studied as yet and lesser still has been translated into action by the capitalist systems. Nevertheless in the underdeveloped economies, the principles of ecosystem can encourage reserches on estimation of the greatest biological output from alternative crop-mixes without over-exploiting the environmental resources.

Unfortunately, the ecosystem model has not been used even in the under-developed world either in academic research or in applied fields. The basic difficulty lies with the problem of measuring accurately the energy flows and movement of matter within the system (Macfadyen, 1964). More, over, the geographers' particular problem is that the methodological implications and the potentials of the concepet get mixed up when they have to deal with the social aspects such as castes, literacy, tenancy and the socio-political framework which no doubt have cognizible effects on agricultural systems or any other social mode of production for that matter. The problem of dualism reappears at this point and acts as a disincentive for geographers to rely on ecosystems.

Eco-Perception

The only concept in geography which can possibly make up for the inadequacy of a narrowly defined ecosystem model is that of ecoperception or environmental perception. The concept implies that the utilisation of resources by individuals and communities depends primarily on their capacities to appreciate the productive values of the resources at their disposal. The intrinsic qualities of the resources play rather a minor role in the game of decision-making.

For example, does a farmer on light land view a medium silt soil as heavy land ? Similarly, does a farmer on clay land views medium silt soil as light land ? More interestingly, do both farmers view the productive capacities of a medium silt soil as the same ? It would be tempting to conclude 'no' but conclusive evidence would be hard to obtain since any farmer's evaluation of land quality would also be determined by his perception of the farm's other resources and the returns to be obtained from them as a whole. Furthermore, it is well-known that able farmers obtain greater returns from the same land type than their less able neighbours, often through a more intensive use of the same land resource (Munton & Morgan, 1971).

Perception is thus a trem which nearly stands for economic status of the entrepreneur. Perception studies applied in agricultural geography have produced enterprising results in various places. The flood risk aversion of farmers studied by Burton (1962) in the Gerat Plains of USA and the drought risk hazards studied by T. F. Saarinen (1966), have established that the farmers' perception of their environment helps them predict the hazards beforehand and to react immediately to minimise wastage of capital and labour.

It is evident that geographers are inclined to define 'perception' as the instinct of man strengthened by his experience of work involvement in particular fields and differentiated also in terms of his economic and technological abilities. But in reality very few geographers have studied in detail the roles of different economic or social classes in changing the surface of the earth and the respective levels of their integration with or alienation from the natural systems which might have initially conditioned the direction of change. Mere technoeconomic considerations may not be adequate for incorporating all such variations into a consistent perception model. More often than not, one has to look into the historical process to which the initial adaptive modes have been exposed, as well as into the political framework, within and outside the systems and sub-systems, which has supported, inhibited or moulded the perception and enterprise social groups and economic classes. We may, for instance, refer to the history of tea plantations in Assam which had to depend heavily on labour supplied from the tribal areas of the Chhotanagpur Plateau rather than from the inhabitants of the most proximate environment or the immediate neighbourhood. It is true that the colonial planters were never favourably disposed towards employing local labour. But it should also be noted that the local labour force also did not show any tangible interest to get employed in the plantations. Similar instances can be cited from the history of colonisation of different areas, but contrary situations are not also uncommon. Let us, for instance again, look at the history of colonisation of Lower Burma side by side with that of the Sundarbans. The Burmese population did not initially respond to the opportunities created by the opening up of the Irrawaddy Delta for commercial rice culture and Tamil labourers had to be mobilised. But in the case of the Sundarbans, practically the entire farming community of Bengal, from the landed gentry to the landless poor, participated in the process of economic exploitation of the virgin lands as soon as land settlement was initiated. The non-participation of the Burmese population can perhaps be interpreted better if we remember that the cultural heart of Burma, through ages, was at Mandalay in the dry central part of the country and that the traditional Burmese mode of cultivation was dry-farming. It is only after independence that the hub of activity in Burma has been slowly shifting towards Rangoon in Lower Burma.

Traditional culture, history, poltical situation and economic behaviour then build up on one another and account for the changing perceptions of societies, their behaviour, enterprise and the resultant cultural landscapes. Attempts at incorporation of all such factors and forces into a comprehesive model based partly on the ecosystem approach and partly on the principles of environmental or eco-perceptions, therefore, appear worthwhile. The initial natural system which may still be traceable in pockets of the otherwies complex present day landscape or in particular practices in the present day techniques of production need be identified meticulously and distinguished from the rest of the system, to be tested against a near-realistic ecosystem model; while the increasing break-down of the system into sub-systems leading to increasing spatial differentiation can be attributed to changing perception levels of social groups and can be tested against the ecosystem analogue. The net advantage of the application of the principles of eco-perception, is that it helps geographers to identify human activities as social activities and to recognise the reality that the human community is not a homogeneous body of mere organisms, but that it is differentiated both spatially and structurally, with different groups and classes striving to attain different goals in different environments.

References

Barrows, H. H. (1923) : " Geography as Human Ecology ", *Annals of the Association of American Geographers*, **13**

Beaujeu - Garnier, J. (1976) : *Methods and Perspectives in Geography*, English translation by Jennifer Bray, (New York).

Bohm, P. & A. Knesse (1971) : *Economics of Environment.*

Brunhes, J. (1920) : Human Geography : *an Attempt at a Positive Classification : Principles and Examples*, edited by I. Bowman and R. E. Dodge, (London).

——— (1952) : *Human Geography* (abridged), (London).

Burton, I. (1962) : " Types of Agricultural Occupance of Flood Plains in the United States " Department of Geography, University of Chicago, *Res. Pap.*, **75**

Butte, W. (1808) : *Die Statistik als Wissenschaft*, (Landshut).

Clements, F. E. (1928) : *Plant Succession and Indicators,* (Washington).

Clements, F. E & V. E. Shelford (1939) : *Bio-ecology,* (New York).

Christaller, W. (1933) : *Die Zentralen Orte in Suddeutschland,* English translation by Englewood Cliffs, 1966, (New Jersey).

Darwin, C. R. (1859) : *The Origin of Species by Means of Natural Selection or the Preservation of Favoured Races in the Struggle for Life,* (London,) the sixth edition, 1951.

Davis, W. M (1899) : " The Principles of Geomorphology ", *Geomorphological Journal,* **14.**

Elton, C. S. (1927) : *Animal Ecology,* (New York).

Forde, C. D. (1934) : *Habitat, Economy and Society : a Geographical Introduction, to Ethnography,* (London).

Geddes, P. (1915) : *Cities in Evolution,* (London).

Geertz, C. (1963) : *Agricultural Involution : The Process of Agricultural Change in Indonesia,* (Berkeley).

Haeckel, Ernst (1870) : *Generelle Morphologie der Organismen,* first published in 1866, (Berlin).

Harris, D. R. (1969) : " The Ecology of Agricultural Systems ", *Trends in Geography,* edited by R. U. Cooke and Johnson, (London).

Hartshorne, R. (1959) : *Perspective on the Nature of Geography,* (London).

Herbertson, A. J. (1913) : " The Higher Units : a Geographical Essay ", *Scientia,* **14.**

Huntington, E. (1951) : *Civilisation and Climate,* (New Haven).

——— (1945) : *Mainsprings of Civilisation,* (New York.)

Hurd, R. M. (1903) : *Principles of City Land Values,* (New York).

Hutchinson, G. E. (1957) : *A Treatise on Limnology,* **Vol. I** (New York).

Hoover, E. M. (1948) : *The Location of Economic Activity,* (New Yok).

Kormondy, E. J (1974) : *Concepts of Ecology,* (Delhi).

Lindeman R. L. (1942) ; " *The Trophic Dynamic Aspect of Ecology* ", *Ecology* **23.**

Losch, A. (1954) : *The Economics of Location,* English edition, (New Haven).

Macfadyen, A. (1957) : *Animal Ecology : Aims & Methods.*

——— (1964) : " Energy Flow in Ecosystms and its Exploitation by Grazing " Grazing in Terrestrial and Marine Environments, *Symposia of the British Ecological Society,* edited by D. J. Crisp.

Meining. D. W. (1962) : " A Comparative Historical Geography of Two Railnets : Columbia Basin and South Australia ", *Annals of the Association of American Geographers,* **52.**

Morrill, R. L. (1963) : " The Development & Spatial Distribution of Towns in Sweden, a Historical Perspective Approach" *Annals of the Association of American Geographers,* **53**.

Mumford, Lewis (1961) : *City in History,* (London).

Munton, R. J. & W. B. Morgan, (1971) : *Agricultural Geography,* (London).

Odum, E. P., (1959) : *Fundamentals of Ecology,* (Philadelphia).

——— (1962) : " Relationship Between Structure and Function in the Ecosystem ', *Japanese Journal of Ecology,* **12**

Park, R. E. & E. W. Burgess (1921) : *Introduction to the Science of Sociology,* (Chicago).

Piaget, J. (1950) *Introduction a 1 ' Edistemologie Genetique,* 3 vols., (Paris).

——— (1968) : *Logique et Connaissance Scientifique,* (Paris).

Ratzel, F. (1891) : *Anthropogerographie : Der Geographische Verbreitung der Menschen,* (Stuttgart).

Saarinen, T. F. (1966) : " Perception of the Drought Hazard on the Great Plains ", *Res. Pap* **106,** Department of Geography, University of Chicago.

Sauer, C. O. (1925) : The Morphology of Landscape : *University of California Publications in Geography*, **2** (**ii**).

Simmons, I. (1966) : " Ecology and Landuse ", *Transactions and Papers*, Institute of British Geographers, **38.**

Sorre, M. (1962) ; " The Role of Historical Explanation in Human Geography " *Readings in Cultural Geography*, Edited by P. L. Wagner & M. W. Mikesell, (Chicago).

Stapleton, Sir Reginal (1964) : *Human Ecology*, edited by Robert Waller, (London).

Stoddart, D. R. (1969) : " Organism & Ecosystem as Geographical Model ", *Integrated Models in Geography*, edited by R. J. Chorley & P. Hagget.

Theodorson, G, A. (1961) : *Studies in Human Ecology.* (Evanstone).

Thunen, J. H. Von (1875) *: Der Isolierte Staat in Beziehung auf Landwirtschaft und Nationlok-konomie :* Third edition, (Berlin).

Vidal De la Blache, P. (1922) : *Principes de Geographie Humaine,* (Paris).

White, L., (1967) : " The Historical Roots of our Social Crisis ", *Science* **155.**

Wynne-Edwards, V. C. (1964) : " Population Control in Animals ", *Scientific American*, **211** (*June*).

Address of the author

Dr. Arabinda Biswas, Deputy Director, Food Systems and Society, CRESSIDA, Calcutta.