

GEOGRAPHY

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The book of Genesis contains perhaps the best-known account of man-environment relationships. It provides an explanatory cosmology necessary for the security of the human psyche and a normative prescription for the management of the global ecosystem "be fruitful and multiply, and replenish the earth, and subdue it".

In seeking to provide an orderly and explanatory description of the earth as the home of man in times of rapid population growth and environmental degradation, the needs for credible theory and effective prescriptions are urgent. The theory must be able to bear the weight of modern scientific evidence and intellectual scepticism, and the prescriptions must show practical ways to contain the hazards and stresses of global environmental change. From the Book of Genesis to the Origin of the Species, it is man's understanding of himself and his environment that is the key element in the formulation of theory. In this paper, we give a highly condensed account of three main strategies adopted in academic geography in its search for theoretical insights and practical remedies. This record is both revealing of geographical contributions and of the gaps that remain. It permits a broad overview of the evolution of major concepts. These are drawn together and illustrated with reference to natural hazards research and lead to a main conclusion that it is through study of man's cognition of the man/environment relationship that further theoretical advance is to be expected.

The Personality of Geography

The origins and characteristics of an academic species are no more accidental than the stripes of a zebra or the neck of a giraffe. While anatomically bizarre, they have high functional value in a given environment. Thus, the inclusion of map-making, physical geography, or more recently quantitative and behavioral geography, in the anatomy of *homo geographicus academicus* bears witness to the field's adaptive capacity from its antecedents in classical and renaissance exploration to its present influential role in environmental studies.

Modern geography has its roots in geographic exploration and voyages of discovery. The collection and organization of data about the physical and cultural aspects of new worlds became closely associated with cartography and surveying. The link is still with us; geographers are not only interested in other countries—they also

characteristically organize their data in terms of spatial distributions. Hence, modern geography brings to contemporary environmental studies a concern for the state of the global environment, some tools for dealing with it, and a sensitive awareness of variations in space that mitigate against easy or facile generalizations.

By the nineteenth century, when geography was beginning to be established as a university discipline (the chair in Berlin was established first in 1820), academic geographers were concerned with the application of scientific method to the study of man-environment relations over the whole of the known world. The influential position of environmental determinism in geographic explanation came as a result of the enthusiasm for global synthesis at a time when the establishment of the first chairs in geography provided the opportunity.

The man-environment theme as a central focus in geography appeared very early in the subject's modern academic development. Mackinder, holder of the first chair at Oxford, defined geography in 1887 as "the science whose main function is to trace the interaction of man in society and so much of his environment as varies locally".¹ And the first graduate geography department to be established in North America opened in 1903 in Chicago with the announced purpose of providing a bridge between the natural and social sciences.² The reasons that led to the establishment of academic geography in the universities were not unlike the arguments often advanced today for the creation of programs of environmental studies; namely recognition of a need for synthesis, for developing more integrated and holistic views and methodologies for the study of man in his environmental setting.

The tradition of global exploration and the ambitious aspiration to integrate physical and social sciences have given geography an intellectual legacy of strong empirical traditions and a distrust of single factor explanations as well as the loose organization of a "confederacy".³ Such a confederacy has the advantage that theories and methods developed in other disciplines can be rapidly absorbed within one part of the discipline--such as economic theory into economic geography or thermodynamic laws into geomorphology. It may, however, have reduced the chances for indigenous theoretical advance by encouraging the expectation that theory can be borrowed from elsewhere.

The inclusion of physical geography with its geomorphic, biogeographic and climatic components has helped to ensure that geography retains a close involvement with the natural sciences in spite of the strong drift towards the social sciences in recent decades. The geographic approach to man-environment relations has for a long time been environment-based. The dangers of this mixing of the physical and social sciences can be seen in the more extreme forms of environmental determinism and naive applications of physical models to social phenomena. On the other hand the inclusion of human geography with its social, cultural, economic and political components has encouraged geography to remain sensitive

to the complexities of human behavior. Geographic explanation, therefore, is almost always multifactorial and unsuited to the parsimonious and elegant sorts of explanations usually preferred as theory. Thus, geography as an environmental science tends to be empirically based and data oriented, placing a high value on field-work, direct observation and experience. It is likely that new geographic theory for man and environment, as genetic theory in biology, will come more from insight produced by experience and synthesis than by abstraction.

Trends in Geographic Thought

Underlying all geographic thought in the man-environment realm is the satisfactory resolution or nimble sidestepping of two fundamental questions:

1. The degree to which the social and physical phenomena that comprise the man-environment relationship can be considered alike and subject to the same laws of cause and effect.
2. How generalizable are the varied expressions of man-environment relationships; what aspects transcend the uniqueness of geographic area and historic time?

These are, of course, the recurrent problems of all the social sciences, but they had and continue to have a special expression in the three broad strategies pursued by geographic scholars.

These strategies for the most part were unrecognized by their practitioners but emerge in the reflective wisdom of hindsight. One has been a direct frontal attempt to develop theory in the thesis of environmental determinism and the antithesis of possibilism. A second strategy has been to find theories elsewhere, and to attempt to transfer them to the man-environment domain. A third strategy has been to become highly specialized in one aspect of the man-environment interaction and to evade or defer considerations of theory.

Strategy I. The Environmental Determinism Thesis

The environmental determinism thesis states that human affairs (particularly cultural resource use and social organization) are constrained or controlled by physical environmental factors. Early geographic determinists generally accepted the notion that physical cause could give rise to social effect without examining its philosophical implications very closely. In its more grotesque form, this acceptance produced such statements as:

Basalt is conducive to Piety (Kirchoff)

and

The inhabitants of basaltic regions are difficult to govern, prone to insurrection, and irreligious. Basalt appears to be an agent, through hitherto unacknowledged, in the rapid spread of the Reformation. (Soulavie)⁴

In its more reasoned application, much useful geographical research has been conducted implicitly under this banner. Empirical

evidence of different societies' ways of life and achievements in different physical settings has been collected, and the statistical and spatial correlations thus demonstrated are used to infer environmental controls, sometimes in a mechanistic and invariant way. The degrees and kinds of environmental control or constraint suggested have included: circumscribing types of resource use, determining types of social organization and the defining or limitation of intellectual and creative abilities.

Some significant values in the formulation of the determinist thesis were a belief in an intelligently controlled universe; a confidence in the values and development of one's own society; and a desire to apply scientific method to the explanation of both physical and social phenomena. The teleological argument has underlain some of the most important inductive contributions, including the major nineteenth century work of Karl Ritter (1779-1859).⁵ A confidence in one's own society has led to environmental determinism being used to explain the superiority of one culture (usually western society) vis-a-vis another. Thus Hegel discussed the stagnation of tropical societies in terms of their disadvantageous climates,⁶ and Ritter was influenced by him in arguing that Asian societies were constrained by physical environmental factors. Friedrich Ratzel (1844-1904), another early German geographer, discussed the relative backwardness of African societies using the same thesis.⁷ His ideas, tempered in his second volume, were made more rigid when applied to the corollary argument of proving the superiority of western society by later geographers such as Ellen Churchill Semple and Ellsworth Huntington in North America⁸ and T. H. Buckle in England.⁹ The adverse intellectual reaction to such ideas has led to an almost complete neglect of environmental factors in the economic development literature.¹⁰

These discussions of environmental determinism were concentrated at a global or continental scale. They can be seen as a conjunction of nineteenth century expansionist ideology and the concern with scientific method. The desire to reach law-like generalizations about the behavior of the natural and social world permeated all the disciplines and is epitomized by Humboldt's *Cosmos* or Darwin's *Origin of Species*.¹¹ What Ritter or Ratzel or Buckle tried to achieve within geography was very similar in scope. But unfortunately for their scholarship, they had to address themselves to man's moral and cultural capacities, as well as his biology, in the context of imperialism.

The scale at which the data has been used has influenced the way in which the determinist thesis has been expressed. Analysis at a global scale has inevitably led to large scale physical factors in the environment being isolated as the significant ones - particularly climatic and topographic differences; hence the terms "climatic determinism" and "geographical determinism".

At this scale the power of environmental determinism in the structure of geographic explanation is most evident. It combines

the virtues of scientific explanation and the use of middle-range factors - that is, factors like climate, relief, soils, drainage, and ecological variety, which are neither as general as universal biological or psychological factors nor as specific as regional "personalities". They are empirically known to be differentiated enough over the earth's surface to theoretically be able to give rise to the range of differences observed in the man-environment relationship between social and cultural groups.

A similar line of reasoning, but at a more detailed scale, has produced a different version of the same paradigm in which the intermediary factors of "work" or livelihood system is stressed as the significant determining factor in the cause and effect relationship which is characterized as place-work-people.¹² This has since become a time-honored structure for geographic method and related social sciences.¹³ In this scheme, societies are categorized on the basis of their principal livelihood system (e.g. pastoralists or agriculturalists). Within each category, environment or "place" is hypothesized as a determinant of the "people", family or social organization through the necessary intermediary of "work". Thus, given that man must use the physical environment's resources to supply his needs, the type of environment constrains the way in which he can use it, and his resource use in turn influences the social structure he develops. This useful methodological framework was made more theoretically rigid by later scholars who implied a necessary sequential development of society through stages from "primitive" to "advanced" of resource use.

The universality of cause and effect came to be revised after 1920 by a gradual rephrasing of the "crude determinism" into "stop and go determinism", "probabilism" and "possibilism" - each of which gave man a greater say in his own environmental destiny. For Griffith Taylor,¹⁴ man was provided by the country with an economic plan but could act as a traffic policeman in regulating the pace but not the direction of events. For Febvre, the emphasis was on choice:

"There are no necessities, but everywhere possibilities, and man as master of these possibilities is judge of their use."¹⁵

For O. H. K. Spate, determinism became "probabilism" with some alternatives more likely than others.¹⁶

Concern with the consequences of uninhibited exploitation of the environment led some earlier geographers, notably G. P. Marsh,¹⁷ to stress that man also affects the environment. Environmental determinism thus becomes stated as a feedback mechanism consequent upon man's earlier choices, in which in destroying the environment, man destroys himself. Although the argument is formulated very differently from those of simple determinism, it still contains the notion that the environment ultimately controls man.

Strategy II. The Transference of M/M and E/E Theory to M/E Theory.

Nowhere does the confederacy of geography reveal itself more

than in efforts to apply models and theories developed in other contexts to the analysis of physical and social interaction. Three types of theory can be specified as M/M, E/E, and M/E. M/M theory is principally concerned with man's behavior in relation to man. E/E theory is directed at explaining the relationships among natural and biological phenomena excluding man himself. M/E theory deals with man-environment relationships. The models and theories that have most influenced M/E theoretical formulations in geography, from the physical and biological sciences, have been those of evolution, gravity, diffusion and systems and, from the social sciences, models of economic and psychological man.

Darwinian theory entered geography both through its geographical application to E/E questions in physical geography and biogeography and in its direct transference to M/E theory in geopolitics. In physical geography, W. M. Davis applied an evolutionary framework to the sequential development of whole landscapes of slopes and river basin systems in his three-stage scheme of youth, maturity and old age.¹⁸ A similar model was developed for vegetation succession of ecological communities such as grasslands or coniferous forests, with the end point of the succession defined as the "climax" rather than senility.¹⁹ The geopoliticians transposed the evolutionary process of natural selection to political interaction of nation states in relation to their locational characteristics.²⁰ They argued that nations, like species, were always potentially in conflict with one another, so that as one state thrives another must decline, and ultimately evolutionary advantage was secured through location vis-a-vis the Euro-Asian "heartland".

Two of the most important physical models which have been applied to M/E theoretical development have been gravity models and diffusion models (the latter also having received empirical sophistication through its application in sociology and epidemiology). Gravity models have been developed of the interaction between cities, which is defined as a function of the populations (or mass, areal size, or wealth) of the two settlements divided by the distance between them. The interaction has been measured in terms of numbers of telephone calls, volume of mail or passenger traffic passing between them.²¹ Similarly, the concept of diffusion from a central point has been used to model human migration and the spread of ideas with an increasingly sophisticated view of social behavior and its variables.²²

Systems theory has provided geography with a methodology ideally suited to its needs and has been widely adopted in physical and human geography to analyze E/E and M/M problems.²³ Systems models are being developed for the response of society to environmental hazards and the management of natural resources, both of which are central processes in the man-environment relationship. A systems approach to M/E theory was preceded in geography by an earlier development of a more limited inter-relationship model, exemplified by the notion of geography as human ecology.²⁴

In applying M/M theories to man-environment relations, geographers have been trying to bring Economic Man and Psychological Man face to face with his real, highly differentiated environment. In the development of locational theory, Economic Man is first set on a uniform plain which becomes differentiated by the imposition of obstacles (rivers, mountains) and points of special attraction (river crossings, mineral deposits) in von Thunen's models of agricultural location.²⁵ In an increasingly sophisticated series of industrial and settlement location models, the "land" of classical economic theory becomes a set of inputs variously interpreted in terms of level of technology, ease of access and perceived utility. The "uniform plain" becomes measured in terms of friction of distance along a limited transport network.²⁶ A recent development has been to model the social consequences of locational differentiation by examining the distribution and relative accessibility of goods and services to economically privileged and underprivileged groups within a city.²⁷

At the same time, developments in perception and behavioral geography have tried to endow Psychological Man with a sense of place and social justice. The transference of M/M theory in psychology to the geographical analysis of man-environment relationship has marked an important turning point in geographic thought -- away from its environmentally based approach to the M/E interaction -- towards viewing it from the perspective of man. This change in perspective was accompanied by the development within geography of the concept of the "behavioral" or "cognized environment".²⁸

Strategy III. The Circumvention of Man-Environment Theory.

Academic geography scarcely had an opportunity to become established before the reaction to global environmental determinism set in, and the man-environment problem was declared intractable. In its place geography erected regionalism, physical geography, the *landschaft* and "areal differentiation" schools - and more recently spatial analysis and quantification.

Regional geography marked a methodological retreat towards the concept of the uniqueness of place and an abandonment of nomethetic aspirations. From its earliest conception in the studies of the French "pays" by de la Blache, it contained the important notions of sequent occupation giving rise to the "personality" of an area, and of the transactional nature of the man-environment relationship:

It is the art of seeing how land and life have come to differ from one part of the earth to another
The designation of "personality" applied to a particular part of the earth involves the whole dynamic relation of life and land.²⁹

The failure of both regional geography and the corollary tradition (which stressed that geography should concern itself primarily with those parts of the landscape which are tangible and

visible) for M/E theory was that classification dominated explanation. The description and classification of unique areas was also a dominant theme of the "areal differentiation" school as expounded by Hartshorne.³⁰ The comparative statistical methods used (see an early paper by De Geer)³¹ led eventually on to quantification in geography.

It was a readvance towards the goal of scientific method and nomothetic geography that dramatized the major catharsis experienced in the late 1950's and early 1960's described as "the quantitative revolution".³² Following the abandonment of environmental determinism and convinced that the Olympian efforts at regional synthesis were leading nowhere as far as theory was concerned, geography was ripe for redefinition as a spatial science; the analysis of locations, networks and flows.³³

If the old geography sought to describe everything on the earth's surface without knowing why and wrestled unsuccessfully to comprehend man and environment relations in terms of unique regions, then the new geography sought to gain greater academic respectability by demonstrating its mastery of quantitative methods, the employment of reductionist and analytical models and the application of these to the most readily quantifiable variables within reach. *Locational Analysis in Human Geography, Network Analysis in Geography, and Models in Geography* exemplify much of the best that the revolutionary geography was able to achieve.³⁴ In its most extreme form, geographic explanation came close to topology and analytical geometry.³⁵ The fundamental work on distributions, shapes and patterns took both environment and man out of geography and left only dots, lines, shapes and equations.

For several years the new found rigor swept all before it, but a decade later quantification and spatial analysis have become the embattled old guard defending the revolution they had brought about. Positivism was embattled on two fronts; from the idealism and phenomenology of those exploring their own and others' perceptions of the world and from the radical underpinnings of the social activism of the sixties.³⁶ These dramatic reversals in temperament are symptomatic of a deepseated tension within geography between its aspirations for rigorous explanation and its sensitivity to empirical reality, especially to the complexity of the social and physical environment. The various strands of this latest of the "new geographies" are coming together as the cognitive reformation.

The Cognitive Reformation

From the late 1960's onwards, new currents of thought in geography have flowed strongly in the direction of environmental perception and behavior. A dominant intellectual debate has been about how man sees and understands his environment and how this relates to behavior. The various strands of environment perception can now be seen to be converging around the concept of cognition. The older tradition of environmental determinism and possibilism

and the specialized fields of geography developed to circumvent the environmental impasse are all under re-examination in terms of how man understands the man-environment relationship. Thus, the field of geography is being re-formed. This reformation does not imply the rejection of the pre-existing accomplishments, by whichever strategy they have been achieved, but rather their reorientation towards the fundamental geographic paradigm of man-environment relationships. From this perspective, geography is now well placed to contribute to the growing edge of man-environment theory.

In the thrust of the quantitative revolution an intense interest in theory in geography was generated. In turn a growing dismay was felt with the geometric abstraction and reductionism of such theory. It was to this concern that the cognitive reformation reasserted the centralism of persons and their view of the world. The antecedents of the reformation can be seen as early as the 1920's in the interactional concepts of man and environment contained in Barrow's *Geography as Human Ecology*³⁷ and in the 1940's in White's early work on human adjustment to floods.³⁸ The concept of the "behavioral environment" and the importance of "perceived environments" or "world views" were given formal expression in the 1950's and early 1960's in the geographical literature.³⁹ Research in environmental perception received impetus from two sources - research in resource management and in cultural geography -- both of which had come face to face with the need to understand how man understands his environment. It also drew on two fields outside geography: a political science view of international relations as "cognitive behavioralism"⁴⁰ and a sociological view of resource use as a function of ecological possibility, economic feasibility and cultural adaptability.⁴¹

The 1960's witnessed two important steps towards the reformation: the increased understanding and input of psychological concepts and methodology; and the growing practical applications to which the research was directed. A continuing dialogue between psychology and geography has led to the application of theories such as construct theory and attitude theory and related techniques such as repertory grids, attitudes scales, semantic differential, T.A.T. tests and I-E sentence completion tests to the study of environmental perception.⁴² The process has not been without its dangers, mainly those of: trying to make inferences about societal behavior from the use of clinical techniques designed to test individual response; borrowing techniques developed within the framework of a specific psychological theory without considering whether the theory itself is an appropriate model of human behavior; and blunting psychological tests by not controlling their context or by changing (usually shortening) their form. These failings may be explained, if not excused, by the urge for quick and practical prescriptions in the face of environmental threats and empirical bias towards carrying out studies in "real world", i.e., field rather than laboratory, conditions.

The types of problems which have been considered in cognitive geography vary in scale from the environment as personal space, to urban images and perception; from routes to landscape perception and the images held about distant places (mental maps). The environment has been viewed in terms of its quality, stress, barriers, and stereotypes.

In its concern with the effect of urban form on social interaction and individual decision-making as well as people's identity with neighborhoods, environmental perception in geography became more practically involved in architectural psychology and urban planning.⁴³ A second practical outcome of the cognitive reformation is the increasing role played by geographers in environmental science, particularly national planning of resource use and environmental impact, and international programs of environmental management.⁴⁴ The importance of the cognitive view being put forward by geographers in the context of environmental management is that it induces a much more self-critical perspective by scientists themselves and underwrites the need to incorporate the values and preferences of laymen in a hitherto scientist-administrator dominated arena.⁴⁵

The Evolution of Geographic Concepts of Man and Environment

Geography's most important contribution to man-environment theory lies not in any single theoretical model, classification, or thesis, but in its gradual evolution towards higher-order concepts of the man-environment relationship, which are necessary prerequisites for theory to be developed. This conceptual evolution is presented in the form of a chart (figure 1) in which the vertical dimension is changing definitions of environment (represented by four categories - the *natural*, *physical*, *cognized*, and *total human environments*) and the horizontal dimension is the conceptual development of the nature of the relationship (from mechanistic *subject-object*, to *interactional* to *transactional*).

Human
and A

HUMAN ADJUSTMENT TO FLOOD HAZARD: THEORETICAL MODELS



Figure 2A. $s-o$ Model: Traditional Determinism
 $e \cdot m$

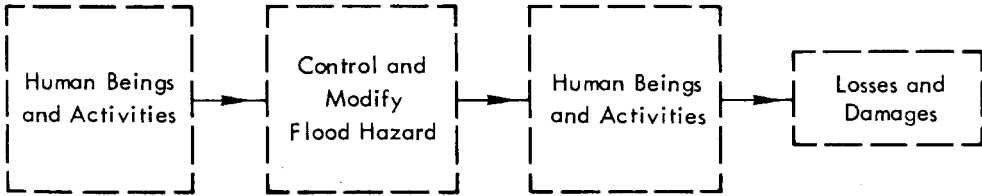


Figure 2B. $s-o$ Model: Technological Fix
 $m \cdot e$

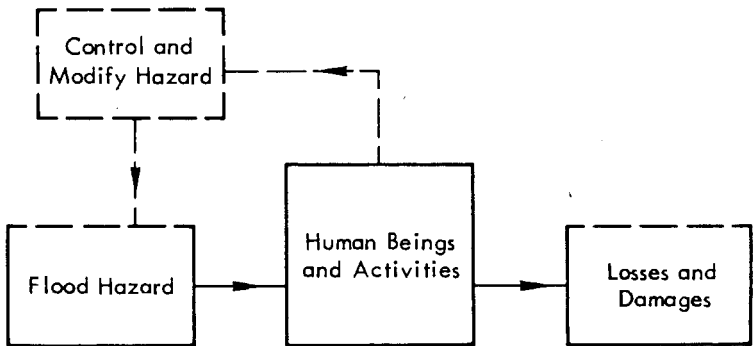


Figure 2C. I Model: Negative Feedback
 s

The *natural environment* includes only those components whose origin is independent of man, although they are almost all to some degree modified by man. These land, air and water variables also share the characteristic of being viewed and measured as sets of objective phenomena. The *physical environment* includes all the components of the natural environment and in addition all the tangible world, including the works of man. For geography this means specifically the inclusion of components such as transport networks and cities. Both these concepts assume the existence of an external reality which can be measured, demonstrated and experimented with in a replicable fashion.

The *cognized environment* is defined not in terms of objective reality but as man's understanding, or perception, of it. The focus of inquiry, therefore, shifts from the physical world to the cognitive structuring of environmental stimuli and how these cognitions are affected by physical, social and cultural variables. The idea of the *total human milieu* so far eludes scientific method and brings us closer to philosophy or metaphysics. It views the environment not just through the filter of man's cognitive structure but as inseparable from it. It takes its cue from Mead's view that an objective view of the environment as independent of man is impossible since it is only definable as the "environment" in relation to man.⁴⁶ Similarly, Dewey and Bentley⁴⁷ have stressed that what constitutes a stimulus is always relative to, and defined by, the response. Thus in the classic example, no one exists as a buyer or seller except in and because of the transaction in which both are engaged. In Dewey and Bentley's terms there can be no distinction between the knowing (man) and the known (environment). The implications of this concept are that the focus of inquiry should be not on the states of man and environment but on the processes that are operating between them. The problem lies in trying to operationalize it. So far geography has failed to integrate explicitly any more than two of the three components of the total human environment (the physical world, the society of man, and man's cognitive understanding), with the third being left implicit or forgotten.

Geographic conceptualization of the man-environment relationship has similarly progressed along a dimension of increasing complexity towards a *transactional* notion (T) through mechanistic *subject-object* (S-O) and *interactional* (I) stages. Like the concepts of the environment, the definition of the relationship has progressed as information and the technical ability to handle more complicated interrelationships has increased. In a general way, therefore, the direction of changing concepts is a historical sequence. It is also a movement from mechanistic to progressively more probabilistic approaches, from uni-directional causality to systems analysis.

In *subject-object* theories the man-environment relationship is viewed as a uni-directional one in which the environment affects man (S-O_{e-m}) or vice-versa (S-O_{m-e}). The idea of feedback is either not recognized or is implicit rather than being formally expressed. *Interactional* relationships involve explicit feedback

between man and the environment. Such theories tend to emphasize either the relationship at one state in time and to express it in equilibrium terms (I_s or static interactional theory); or they are more concerned with changes through time and stress a dynamic relationship (I_d).

The concept of *transactional* relationship is closely related to the concept of the total human environment.⁴⁸ They are ways of expressing the same theoretical approach which transcends a mechanistic, dichotomous view of man and environment in favor of a holistic, transactional one. The problem is, again, how to proceed from a vague statement of ideal to a working theory. Our concept of total human environment requires a transactional concept of the man-environment relationship and vice-versa.

In figure I the geographic strategies can be seen within the general framework of the evolution of geographic thought. In the chart, environmental determinism is located like a symbolic touchstone in one corner. It was first formulated within the concept of the environment as completely external to man - that is, the *natural environment*. Later determinists like Huntington considered the effect not only of the natural climate on man but also the climate he himself helped to create within cities and buildings, or the *physical environment*.

In the second strategy, the transfer of E/E theory is represented in diffusion theory, random processes, growth models and modified ecosystems. In the transfer of M/M theory, economic man looms large in central place theory and benefit-cost analysis; psychological man in man-milieu hypotheses and stimulus-response learning theory. The strategy of circumvention includes studies of locational differentiation, regional traits, landscape and the tools of spatial analysis transferred from the physical and social sciences.

The cognitive reformation moves across the cognized environment, evolving in complexity of explanation, encompassing milieu or place, space, and resources. In so doing it has sometimes been in danger of becoming the old determinist emperor in new clothes with the *cognized environment* fulfilling the role originally cast for the *natural*, and then the *physical environment*.

An Application to Natural Hazard Research

To illustrate the development of geographic ideas about the environment from subject-object (S-O) relationships in the natural environment towards the interactional (I_d) in the cognized environment we draw on a body of geographical and related research on floods and other environmental hazards.⁴⁹

In the traditional determinist view, floods are events in the natural environment that impinge upon human society and cause damage, injury and loss of life (figure 2A). This is an S-O relationship of the e-m kind. An alternative view, much in evidence in recent decades, is that man armed with a powerful technology can control and contain the forces of nature (figure 2B). This is an S-O relationship of the m-e kind. Taken together these two S-O

relationships can be combined into an interactional model by the provision of a negative feedback loop, to reflect attempts at control of the hazard (figure 2C).

Capable of simple statement and formulation, these theories contain much practical import for how man seeks to manage floods or harmonize society and hazards. When the relationships implied in figure 2C are examined in a longitudinal fashion,⁵⁰ it appears that the results of control and modification methods are contrary to common-sense expectations. Instead of the expected reduction in damage over time, an increase has occurred. The dampening effect on the flood hazard by control works is found to provide positive feedback to human beings and their activities, and works as an incentive to amplify the growth of population, property and activity in the flood plain. This growth has in some instances more than offset the reduction in the expected flood losses achieved by control works. Other policies of relief and rehabilitation designed to distribute losses and damage came into play and have had the effect of further reinforcing the growth in damage and damage potential (figure 3A).

HUMAN ADJUSTMENT TO FLOOD HAZARD: THEORETICAL MODE

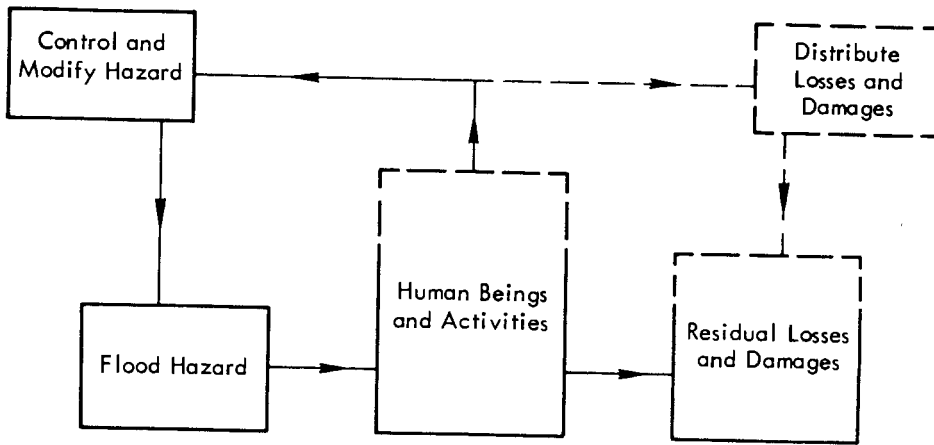


Figure 3A. I_d Model: Positive Feedback

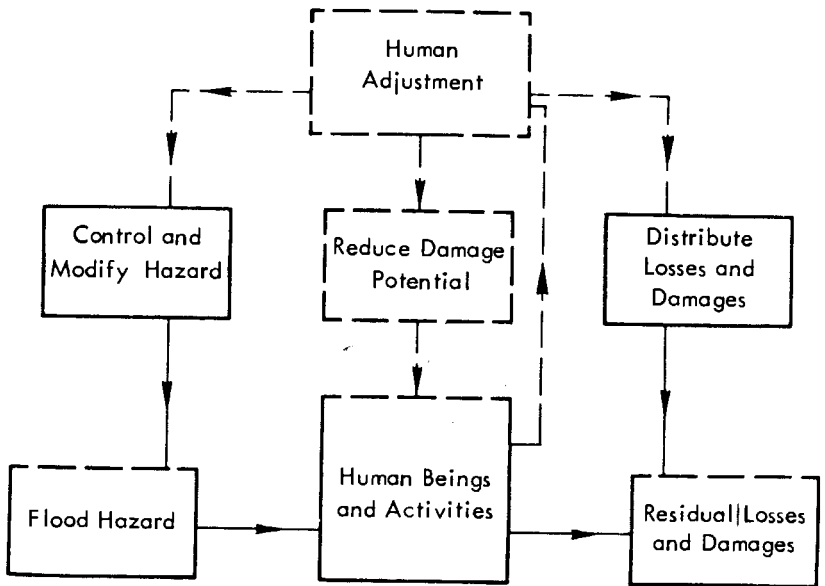


Figure 3B. I_d Model: Multiple Negative Feedback

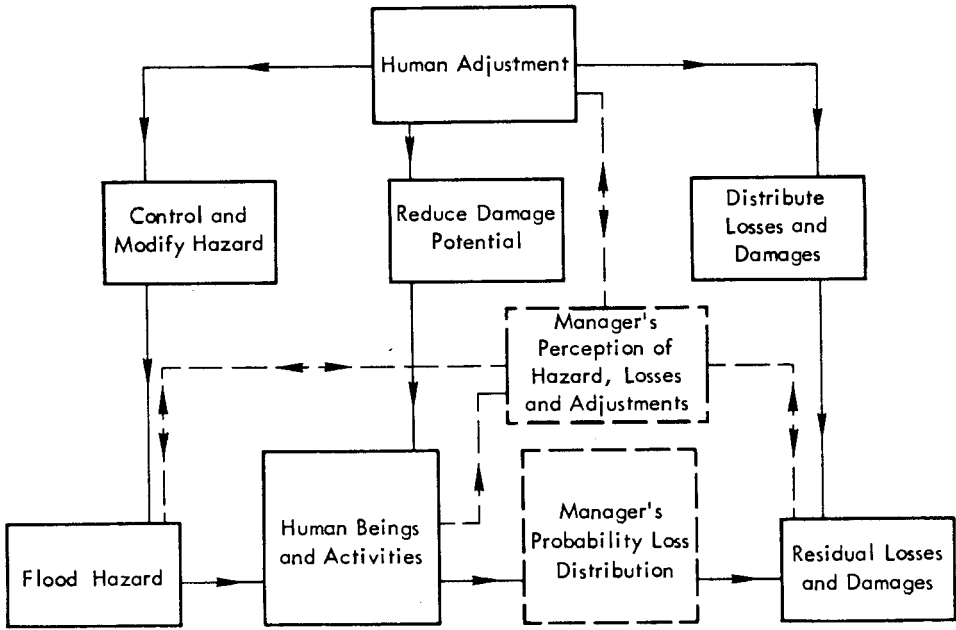


Figure 4A. I_d Model: Multiple Feedback; Cognized Environment

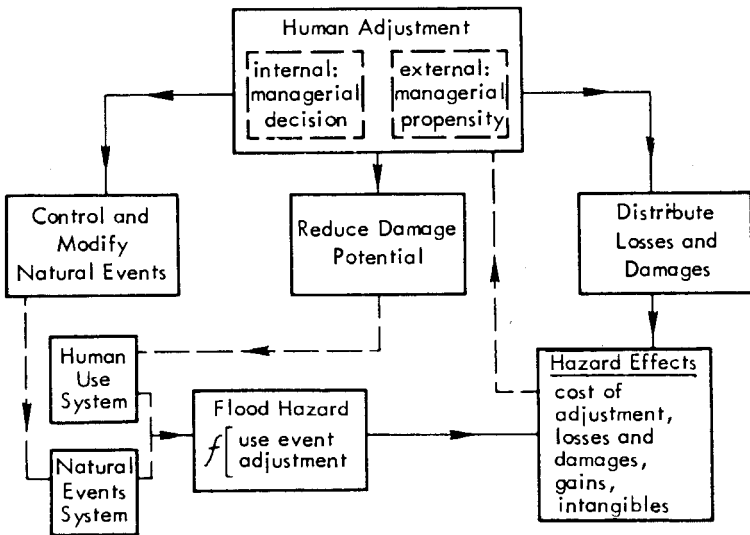


Figure 4B. I : Multiple Feedback; Cognized Environment; Hazard Interaction Systems Model of Human Adjustment.

HUMAN ADJUSTMENT TO FLOOD HAZARD: THEORETICAL MODELS

These findings from empirical research have resulted in further refinements and have been reflected in significant shifts in public policy. Spurred by a need to develop a new policy that would be more successful in reducing flood losses, a multiple means set of alternatives is specified⁵¹ and its structure is depicted in figure 3B.

Consideration of the factors that enter into the choice process has led to the adoption of a cognitive view of hazard (figure 4A)⁵². Recent elaborations of the model⁵³ describes the hazard not as a separate event in nature, but as the product of a joint probability of a given level of adjustment in the human use system and an extreme event in the natural environment (figure 4B). The latest model in the sequence is still unsatisfactory in some respects. It fails to relate hazard adjustment to everyday place and work activity, to account for fundamental choices of location or livelihood, and to distinguish effectively between individuals and collectives. It relies on rational explanations employing cognized hazard environments and fails to encompass more complex visions of man. Work now in progress deals more explicitly with these shortcomings,⁵⁴ but further major advance would be facilitated by the development of a unique theory of man and environment. In the pressing question of how to minimize the losses from environmental hazards, and how to avoid the generation of new disaster potential, progress both practical and theoretical lies in the direction of knowing how the relationships and processes are understood by scientists, decision-makers and the general public.

Toward a Unique M/E Theory

Geography, unusual in its position in both the social and natural sciences, still aspires to a unique theoretical formulation. The man-environment relationship deserves its own theory, not simply the transfer of other theoretical models to problems of man and environment. These can be useful, but are eventually unsatisfactory. To hope to find an orderly and explanatory description of the earth as a home of man in the models of natural and physical science is to risk either mechanistic explanation, reductionist description, or extrapolation to mankind of the ethics of the animal world. Similarly, to rely on the orderly and explanatory descriptions in the models of economic and psychological man is to imbue the environment with anthropomorphic character, or to relegate it to the status of a "sink", "black box", or featureless plain.

To make the environment comprehensible without making it human and to comprehend humans without atomization is the challenge implicit in man-environment theory. In the spirit of the cognitive reformation, our preference is to focus on how men understand their relationship to environment, the cognition not of environment or men but of the form of the relationship between them. And in the spirit of our long empirical and inductive tradition, our preference is to turn to the richly variegated geographic lore for the systematic comparison across societies and environments of

such cognized relationships. To seek to acquire such knowledge is to repeat the risk taken in the Garden of Eden. The consequence of that knowledge according to the Book of Genesis was that "the eyes of them both were opened, and they knew they were naked".

CONCEPTS OF ENVIRONMENT	MAN-ENVIRONMENT RELATIONSHIPS				
	SUBJECT - OBJECT (S - O)		INTERACTIONAL (I)		TRANSACTIONAL
	ENV. → MAN (E → M)	MAN → ENV. (M → E)	STATIC (I _s)	DYNAMIC (I _d)	
NATURAL ENVIRONMENT	Determinism ¹	Locational differentiation ⁵ Modification ²	Regional traits ¹⁰	Diffusion theory ⁹	
PHYSICAL ENVIRONMENT	Growth models ⁶ Anthropogeography ³ Geopolitics ⁴	Central Place theory ⁷	Random processes ⁸ Landscape ¹¹ B - C models ¹³ Modified ecosystems ¹²	Hydraulic civilization ²¹ Challenge ²² Response ²²	
COGNIZED ENVIRONMENT	Man - milieu hypothesis ¹⁸ S - R Learning theory ²⁰	Resources as Cultural appraisal ¹⁶ Environmental perception ¹⁹	Place, Work, Folk ¹⁴ Human ecology ¹⁵	Leisure theory culture change ²³	
TOTAL HUMAN MILIEU					

Figure 1. A Matrix of Man-Environment Relationships

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FOOTNOTES FOR FIGURE I

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