Introduction

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Who would not choose to follow the sound of running waters? Its attraction for the normal man is of a natural sympathetic sort. For man is water's child, nine-tenths of our body consists of it, and at a certain stage the foetus possesses gills. For my part I freely admit that the sight of water in whatever form or shape is my most lively and immediate form of natural enjoyment: yes, I would even say that only in contemplation of it do I achieve true self-forgetfulness and feel my own limited individuality merge into the universal.

(Thomas Mann: *Man and his Dog*)

1. 'Physical' and 'human' geography

Perhaps it is of the nature of scholarship that all scholars should think themselves to be living at a time of intellectual revolution. Judged on the basis of the references which they have cited (Stoddart, 1967, pp. 12–13), geographers have long had the impression that they were the immediate heirs of a surge of worthwhile and quotable research. There is good reason to suppose, however, that geography has just passed through a major revolution (Burton, 1963), one of the features of which has been profoundly to affect the traditional relationships between 'physical' and 'human' geography.

Ever since the end of the Second World War drastic changes have been going on in those disciplines which compose physical geography. This has been especially apparent in geomorphology (Chorley, 1965a), where these changes have had the general effect of focusing attention on the relationships between process and form, as distinct from the development of landforms through time. In the early 1950s geomorphologists, especially in Britain, were able to look patronizingly at the social and economic branches of geography and dismiss them as non-scientific, poorly organized, slowly developing, starved of research facilities, dealing with subject matter not amenable to precise statement, and denied the powerful tool of experimentation (Wooldridge and East, 1951, pp. 39–40). It is true that by this time most geographers had long rejected the dictum that physical geography 'controlled' human geography, but most orthodox practitioners at least paid lip service to the idea that there was a physical *basis* to the subject. This view was retained even though traditional geomorphology had little or nothing to contribute to the increasingly urban and industrial preoccupations of human geographers (Chorley, 1965b, p. 35), and its

place in the subject as a whole was maintained either as a conditioned reflex or as increasingly embarrassing grafts on to new geographical shoots. American geographers, who had largely abandoned geomorphology to the geologists even before the war, tended to look more to climatology for their physical basis. However, despite the important researches of Thornthwaite and of more recent work exemplified by that of Curry [1952] and Hewes [1965], the proportion of articles relating to weather and climate appearing in major American geographical journals fell more or less steadily from some 37% in 1916 to less than 5% in 1967 (Sewell, Kates, and Phillips, 1968). Even in the middle of the last decade Leighly (1955, p. 317) was drawing attention to the paradox that instructors in physical geography might be required to teach material quite unrelated to their normal objects of research.

The problems of the relationships between physical and human geography facing Leighly were small, however, compared with those which confront us today. Little more than a decade has been sufficient to transform the leading edge of human geography into a 'scientific subject', equipped with all the quantitative and statistical tools the possession of which had previously given some physical geographers such feelings of superiority. Today human geography is not directed towards some unique areally-demarcated assemblage of information which can be viewed either as a mystical *gestalt* expressive of some 'regional personality' or simply as half-digested trivia, depending on one's viewpoint. In contrast, most of the more attractive current work in human geography is aimed at more limited and intellectually viable syntheses of the pattern of human activity over space possessing physical inhomogeneities, leading to the disentangling of universal generalizations from local 'noise' (Haggett, 1965). Today it is human geography which seems to be moving ahead faster, to have the more stimulating intellectual challenges, and to be directing the more imaginative quantitative techniques to their solution.

One immediate result of this revolution has been the demonstration, if this were further needed, that the whole of geomorphology and climatology is not coincident with physical geography, and that the professional aims of the former are quite distinct from those of the latter. This drawing apart of traditional physical and human geography has permitted their needs and distinctions, which had previously been obscure, to emerge more clearly. Perhaps the distinctions may have become too stark, as evidenced by current geographical preoccupations with a rootless regional science and with socio-economic games played out on featureless plains or within the urban sprawl. Perhaps this is what the future holds for geography, but it is clear that without some dialogue between man and the physical environment within a spatial context geography will cease to exist as a discipline.

There is no doubt that the major branches of what was previously called physical geography can exist, and in some cases already are existing, under the umbrella of the earth sciences, quite happily outside geography, and that they are probably the better for it. It is also possible that this will be better for geography in the long run, despite the relevance to it of many of the data and certain

of the techniques and philosophical attitudes of the earth sciences. In their place a more meaningful and relevant physical geography may emerge as the product of a new generation of physical geographers who are willing and able to face up to the contemporary needs of the whole subject, and who are prepared to concentrate on the areas of physical reality which are especially relevant to the modern man-oriented geography. It is in the extinction of the traditional division between physical and human geography that new types of collaborative synthesis can arise. Such collaborations will undoubtedly come about in a number of ways, the existence of some of which is already a reality. One way is to take a philosophical attitude implied by an integrated body of techniques or models (commonly spatially oriented) and demonstrate their analogous application to both human and physical phenomena (Woldenberg and Berry, 1967; Haggett and Chorley, In press). Another way is to assume that the stuff of the physical world with which geographers are concerned are its resources – resources in the widest sense; not just coal and iron, but water, ease of movement, and even available space itself. In one sense the present volume represents both these approaches to integration by its concentration on the physical resource of water in all its spatial and temporal inequalities of occurrence, and by its conceptualization of the many systems subsumed under the hydrological cycle (Kates, 1967). In the development of water as a focus of geographical interest the evolution of a human-oriented physical geography and an environmentally sensitive human geography closely related to resource management is well under way.

2. Water as a focus of geographical interest

Water, Earth, and Man, both in organization and content, reflects the foregoing attitudes by illustrating the advantages inherent in adopting a unified view of the earth and social sciences. The theme of this book is that the study of water provides a logical link between an understanding of physical and social environments. Each chapter develops this theme by proceeding from the many aspects of water occurrence to a deeper understanding of natural environments and their fusion with the activities of man in society. In this way water is viewed as a highly variable and mobile resource in the widest sense. Not only is it a commodity which is directly used by man but it is often the mainspring for extensive economic development, commonly an essential element in man's aesthetic experience, and always a major formative factor of the physical and biological environment which provides the stage for his activities. The reader of this volume is thus confronted by one of the great systems of the natural world, the hydrologic cycle, following water through its myriad paths and assessing its impact on earth and man. The hydrologic cycle is a great natural system, but it should become apparent that it is increasingly a technological and social system as well. It has been estimated that 10% of the national wealth of the United States is found in capital structures designed to alter the hydrologic cycle: to collect, divert, and store about a quarter of the available surface water, distribute it where needed, cleanse it, carry it away, and return it to the natural system. The technical structures are omnipresent: dams, reservoirs, aqueducts, canals,

tanks, and sewers, and they become increasingly sophisticated in the form of reclamation plants, cooling towers, or nuclear desalinization plants. The social and political system is also pervasive and equally complex, when one reflects on the number of major decision makers involved in the allocation and use of the water resources. White has estimated that for the United States the major decision makers involved in the allocation and use of water include at least 3,700,000 farmers, and the managers of 8,700 irrigation districts, 8,400 drainage districts, 1,600 hydroelectric power plants, 18,100 municipal water-supply systems, 7,700 industrial water-supply systems, 11,400 municipal sewer systems, and 6,600 industrial-waste disposal systems.

This coming together of natural potential and of human need and aspiration provides a unique focus for geographic study. In no other major area of geographic concern has there been such a coalescence of physical and human geography, nor has there developed a dialogue comparable to that which exists between geographers and the many disciplines interested in water. How these events developed is somewhat speculative. First, there is the hydrologic cycle itself, a natural manifestation of great pervasiveness, power, and beauty, that transcends man's territorial and intellectual boundaries. Equally important is that in the human use of water there is clear acknowledgement of man's dependence on environment. This theme, developed by many great teachers and scholars, (e.g. Ackerman, Barrows, Brunhes, Davis, Gilbert, Lewis, Lvovich, Marts, Powell, Thornthwaite, Tricart, and White), is still an important geographic concern, despite the counter trends previously described. Finally, there is no gainsaying the universal appeal of water itself, arising partly from necessity, but also from myth, symbol, and even primitive instinct.

The emergence of water as a field of study has been paralleled in other fields. In the application of this knowledge to water-resource development, a growing consensus emerges as to what constitutes a proper assessment of such development: the estimation of physical potential, the determination of technical and economic feasibility, and the evaluation of social desirability. For each of these there exists a body of standard techniques, new methods of analysis still undergoing development, and a roster of difficult and unsolved problems. Geographers have made varying contributions to these questions, and White reviewed them in 1963. Five years later, what appear to be the major geographic concerns in each area?

Under the heading of resource estimates, White cites two types of estimates of physical potential with particular geographic significance. The first is 'the generalized knowledge of distributions of major resources . . . directly relevant to engineering or social design'. While specific detailed work, he suggests, may be in the province of the pedologist, geologist, or hydrologist, there is urgent need for integrative measures of land and water potential capable of being applied broadly over large areas. The need for such measures has not diminished, but rather would seem enhanced by developments in aerial and satellite reconnaissance that provide new tools of observation, and by the widespread use of computers that provide new capability for data storage and

analysis. In the developing world the need is for low-cost appraisal specific to region or project.

A second sort of estimate of potential that calls upon the skills of both the physical and human geographer is to illuminate what White calls 'the problem of the contrast between perception of environment by scientists . . . (and) others who make practical decisions in managing resources of land and water'. These studies of environmental perception have grown rapidly in number, method, and content. They suggest generally that the ways in which water and land resources receive technical appraisal rarely coincide with the appraisals of resource users. This contrast in perception is reflected in turn by the divergence between the planners' or technicians' expectation for development and the actual course of development. There are many concrete examples: the increase in flood damages despite flood-control investment, the almost universal lag in the use of available irrigation water, the widespread rejection of methods of soil conservation and erosion control, and the waves of invasion and retreat into the margins of the arid lands. Thus a geography that seeks to characterize environment as its inhabitants see it provides valued insight for the understanding of resource use.

In 1963 White differentiated between studies of the technology of water management and studies of economic efficiency. Today one can suggest that, increasingly, technical and economic feasibility are seen as related questions. The distinction between these areas, one seen as the province of the engineer and hydrologist, the other as belonging to the economist and economic geographer, is disappearing, encouraged by the impressive results of programmes of collaborative teaching and research between engineering and economics (e.g. at Stanford and Harvard Universities). In this view, the choice of technology and of scale is seen as a problem of cost. The choice of dam site, construction material, and height depends on a comparison of the incremental costs and of the incremental benefits arising from a range of sites, materials, and heights. This decision can be simultaneously related through systems analysis to the potential outputs of the water-resource system.

The methodology for making such determinations has probably outrun our understandings of the actual relationships. The costs and benefits of certain technologies are not always apparent, nor are all the technologies yet known. Geographic research on a broadened range of resource use and specific inquiry into the spatial and ecological linkages (with ensuing costs) of various technologies appears to be required. Indeed, as the new technologies of weather forecasting and modification, desalinization, and cross-basin transport of water and power expand, the need for such study takes on a special urgency.

Finally, there appears to be a growing recognition that much of what may be socially important in assessing the desirability of water-resource development will escape our present techniques of feasibility analysis for much time to come. The need for a wider basis of choice to account for the social desirability of water-resource development persists and deepens as the number of water-related values increase and the means for achieving them multiply. A framework for assessing social desirability still needs devising, but it could be hastened by

careful assessment of what actually follows water-resource development. There is much to be learned from the extensive developments planned or already constructed. However, studies such as Wolman's [1967] attempt to measure the impact of dam construction on downstream river morphology or the concerted effort to assess the biological and social changes induced by the man-made lakes in Africa are few and far between. Studies built on the tradition of geographic field research but employing a rigorous research design over an extended period of observation are required. Geographers, freed from the traditional distinction between human and physical geography and with their special sensitivity towards water, earth, and man, have in these both opportunity and challenge.

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