

## THE GROWTH OF PHYSICAL GEOGRAPHY, THE INDIAN SCENE AND THE AGENDA FOR FUTURE

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From the days of Peschel (1826-1875), one of the founders of modern Physical Geography to the contemporary phase of geographical scholarship, almost on the threshold of the 21st century, there has been a tremendous change in the content and methodology of the discipline. For over a century, not only has knowledge multiplied, often exponentially, but new tools of analysis have been added to the field-kit of physical geographers. The subject has grown following researches in cognate fields like geology, meteorology, biology and soil science, on which physical geography of the type we are doing today, not only depends for its sustenance but also for its growth. It must be acknowledged at once that the principles of physical geography are largely derived from the advances in Geology, meteorology, oceanography and bio-science, and the extension of the principles developed in these fields and their adoption in a spatial frame are what we label as advances in physical geography. Admittedly, physical geography, devoid of the basic parameters of mass and energy, cannot pretend to cope up with the cascading mass of researches on cloud physics, mathematical treatment of plate-tectonics, advanced biological researches or physics of rivers, always borrowing the established facts or sometimes even

fiction, to add to its growing mass and bolster its own image.

The limitations of the discipline are not intended even remotely to suggest that the subject has outlived its utility, there is no purpose in pursuing it or that it should be jettisoned overboard. Far from it, the subject has a long standing tradition and at a sub-altern level of landscape relationships or human response, not only proves immensely useful, but provides a background to those who want to enter a higher realm of research in some specified field. Behind the frontiers of penetrating research, the need for academic management and the simplified presentation of the researches in the frontier areas, is what physical geography has been doing and can do even today very effectively, handled as the subject is not by layman, but a specialist in his own right, a specialist of the type who has enough knowledge and training to present the latest findings in an intelligible language.

### EARLY PHYSICAL GEOGRAPHY :

The reflection of the foregoing can be seen in the general geography of Varenius, whose presentation of the generalized account of the contemporary state of knowledge, which included the heliocentric view of Copernicus and Kepler, so impressed Newton that he himself edited its two latin editions and had them published at Cambridge (1672-1681).

The physical geography, as we know today, took a couple of centuries to crystallize when in 1879, the 'Physische Erdkunde' of Peschel was posthumously published. The last quarter of the XIX-th and the first quarter of the XX-th century, a period spanning half a century, may be aptly termed as the embryonic stage of physical geography, with inter and intra continental divergence of views not only about the content but even about the nomenclature of the subject. Under the influence of the very influential geologists like Powell (1896), Physical geography in the United States started with what was commonly known as Physiography. Some of the early texts on physical geography produced in the U.S. were titled as physiography (Salisbury 1907, Tarr and Martin - 1912). Even in the U.K. physical geography writings appeared as physiography (Huxley - 1877, Herbertson-1901). The French School, in contrast, retained its bias to geography, and following Supan (1884) and Peschel (1879) adopted physical geography as the expression for all non-human features on earth. The two leaders of physical geography in France, de Lapparent (1896) and de Martonne (1909), but particularly the latter, advanced physical geography as an essential part of the whole geographical study of an area (James p. 251). His major work - 'Traite' de Geographie Physique published in 1909 in one volume of 910 pages was later expanded and revised in three volumes. Martonne's contribution to physical geography yet remains unsurpassed and his view of physical geography rests essentially on his perspective of the nature of Geography. It is different from Physiography, physical geology, or physischen Erdkunde; it is physical geography as we understand today. The last decade of the XIX and its extension into XXth century, till the beginning of the First World war, was the most promising period for a very rapid growth of physical

geography, when the basic principles of the discipline were laid down. The British geography, and more so the British physical geography had a turbulent beginning, not excluding the feuds and intrigues of other earth scientists, which early geographers, particularly Mackinder had to overcome. Geography in the years between 1870 and 1900, thus, encountered many difficulties, before emerging triumphantly as an independent field of knowledge (Stoddart-1986), and for largely teactical reasons the New Geography came to emphasize physical geography as the main concern.

#### **PHYSIOGRAPHY, GEOMORPHOLOGY AND PHYSICAL GEOGRAPHY :**

The term physiography used in the United States, sometimes in the sense of geomorphology, a term that got currency only in 1895, and sometimes to imply non-human world of nature, was ultimately replaced by physical geography, an all comprehensive term, and geomorphology remained solely concerned with the segment of landforms. The first standard text in the English speaking world, supposedly an updated version of Huxley's physiography, was written by Lake (1915). It was a representative text of physical geography as taught in British universities and enjoyed currency for over half a century. Physiography, which held a dominant position for over a quarter of a century was replaced by a general physical geography, at the undergraduate level and more advanced courses in geomorphology, climatology and occenaography at the post-graduate level. The advances in the knowledge of oceans and atmospheres leading to the growth of oceanography and meteorology, had a corresponding impact on physical geography

where climatology and geography of oceans developed as independent branches.

### FROM LAKE TO CHORLEY :

These two familiar geographers from Cambridge represent the early and late twentieth century physical geography. Philip Lake who was appointed Reader at Cambridge in 1919, represents the early British physical geography, as is seen from his book on Physical Geography which had a large lease of popularity and remained in print for fifty years. Chorley (1971), presently Professor at Cambridge, on the other hand, represents the contemporary idiom in physical geography, where he applies the general system theory to geomorphology. The changing nature and the growth of physical geography during the last seventyfive years can also be easily seen through representative text books written periodically.

The three books compared here are :

1. Lake, P, (1915) : Physical Geography
2. Finch (1942) : Elements of Geography
3. Strahler A.N. (1951) : Physical Geography
4. Strahler A.N. (1978) : Modern Physical Geography.
5. Thompson, R.D. & others (1986) : Processes in Physical Geography.

There are certain constant features of the subject which remained central to the theme of physical geography. These include landforms, weather and climate and finally ocean movements. Lake's book on physical geography included wind systems, rock weathering, sea landforms and ocean waves and currents. Surely, atmospheric physics, and physical oceanography had not made their impact, and landforms were confined to the work of running water, wind

and glaciers. The subject grew steadily, though without a major breakthrough.

A comprehensive text on 'physical geography' written by Finch and Trewartha (1936, 42, 1949), included principally two themes viz. (i) weather, climate and their distribution and (ii) the origin and description of different landforms in the Davisian mould. When revised in 1949 by the authors themselves, it transformed the section on weather and climate in view of the advances in physical climatology, and included discussion of air-masses, fronts, and the types and significance of storms. But what is significant is the authors belief that "Characteristically physical geography has a humanized perspective, for it is usually an analysis of the whole natural equipment of a region, or some element of it, in terms of its resource potential for human use. "This led them to include a section on 'Earth Resources', a rare feature of any other text on physical geography. Usually, the water, vegetal and soil resources are discussed as elements of natural environment, under hydrology, bio-geography and geography of soils.

After the second world war when Strahler produced the book on physical geography, he divided it into 4 parts, the first part being an introduction titled 'Earth as a Globe'. The three substantive parts were : (i) Atmosphere and oceans (ii) Climate, soils and vegetation, and (iii) Landforms. Vegetation and soils were not considered separate parts. Strahler in 1951 did not consider biosphere as a specific area of study, though in his second edition of the book (1960) introduced the idea of ecological perspective, borrowing it from Dansereau. Soil and soil forming processes occupied a mere 25 pages which also included soil groups, though it must be admitted that Strahler was familiar with the 7th approximation of the US Department of Agriculture and discussed it

briefly in his book. The picture changed radically when it came to 1978 edition of the book. The profiles of great soil group and the quantitative analysis of landforms, were the fresh inclusions. Strahler substituted his 'weather and climate' by changing his focus from **description of weather elements to energy systems** reflecting changing emphasis on concepts of the earth's surface environment, related to radiative and other exchanges of heat and a global budget. Climatic regimes, soil water budget and structure and environment of vegetation and its world distribution are the additional themes included in the revised edition : yet, there is no mention of satellite meteorology, remote sensing, environmental and eco-systems, biogeography or the all pervading plate tectonics.

#### **PROCESSES IN PHYSICAL GEOGRAPHY :**

**A new physical geography :** Following the advances in Geomorphology, particularly the knowledge of the fluvial systems, including channel hydrology and mechanics of transport and an overall advance in the general circulation of the atmosphere on the one hand and the geohydrological processes on the other, there has been a change of focus leading to a process oriented physical geography (Thomson *et. al* - 1986).

The physical geography at the undergraduate level today is as concerned with the processes operating in the bio-physical environment as with each of its specialized components like geomorphology, climatology or hydrology. What was earlier climatology appears as 'Atmospheric Energy and mass systems, It discusses the mass and energy inputs, vertical motion and mass/energy changes, atmospheric circulation system, the upper air charts, and

many such themes, including the strength of materials and their stress - strain behaviour. Similarly the discussion of the 'Energy Flow in the Eco-system' or of Biogeography, Ecology and Ecosystems suggests a radical departure from traditional description of landforms and vegetation.<sup>1</sup>

Thus changes in the content and approach to physical geography are not only confined to the specializations that have grown out of the trunk of physical geography, but are also reflected in a changing emphasis on the processes. The advances in congnate disciplines demand an acquaintance with the basic elements of Science. New words and ideas have entered into the field. Paradigm and parameter, matrix and linkage, ecosystem and the trend surface, have assumed a common-place usage. Precision is now more important, perception is indispensable and prediction has entered the realm of the probability. Precision has meant increasing role of mathematics, starting with statistical probaility. Mathematical modelling, yet to make its impact on physical geography, not so much because of its inadequacy as a tool but because of the dearth of experise, is sure to surface as a sign of further advance in the area, that can impart it a great measure of respectability.

#### **ADVANCES IN BRANCHES OF PHYSICAL GEOGRAPHY :**

**Geomorphology :** By far the oldest and the most commonly taught, researched and practised branch, it has made tremendous strides in the last 25 years. Much of the contribution in the field has come from non-academic geomorphologists. One of the earliest contribution that established a clear departure from the Davisian School of Geomorphology

1. See the contents of the book 'Processes in Physical Geography' R.D. Thompson and Others, Longman, London 1986.

practised by Wooldridge, Linton and Baulig, was made by Horton (1945) who initiated the quantitative analysis of fluvially eroded landforms, followed by Strahler (1950, 1952, 1956, 1957, 1958, 1964) and Schumm (1956, 1960, 63, 72, 77). Strahler is credited with the introduction of what was subsequently known as dynamic geomorphology, looking at the subject from the physical perspective of mass energy, stress and strain, and the changing state of energy. The echo of Strahler's dynamic geomorphology could be heard not only among the geomorphologists of U.K. through Chorley, who was trained at Columbia, but also among the hydrologists of the United States. The geologists, led by Krumbein (1959, 65, 70) made increasingly greater use of statistical techniques. While field work still remains the core of the subject, the emergence of quantification and application of statistical techniques have bewildered the traditional geomorphologists treading the terrain with his field equipment, his speculative mind absorbed in landscape interpretation. Of all the branches, fluvial system has received the most frequent statistical treatment, much of it two dimensional, dealing with drainage network, channel properties, channel hydrology, erosion and sedimentation. The systems approach, pioneered by Strahler (1950) and demonstrated by Chorley (1971), though widely recognized is not yet widely used. Correlation of different variables, both static and dynamic, use of indices, and the application of accepted hydrological equations are the most common applications of quantitative methods. Mathematical models, far beyond the competence of geographers, have not arrived on the scene, though in specific cases hydrologists or soil scientists use it. Fluvial geomorphology is an interface area shared by Geographers, geologists, civil engineers and hydrologists, and pooling together of the skill and contributions of these

professionals has made available to geomorphologists, techniques and findings that can be effectively employed in further researches. Aerial photographs in geomorphology have been used for long, and the availability of satellite imageries with greater clarity and a much higher level of resolution has made field-work easier, spawning at the same time, a generation of geomorphologists, particularly in developing countries, who are likely to mistake descriptive account of terrain from the satellite imageries for geomorphology that is largely genetic and process-oriented.

The dynamic aspects of weathering, erosion, sediment-transport and process of deposition have become far more important than terrain analysis or qualitative discussion of landform processes. The entire fluvial system with its interdependent components and functional relationships occupies a focal point in the broad spectrum field of geomorphology. Coastal morphology, delta and estuarine sedimentation, changing nature of shoreline and sea-level changes, and eustatic terraces which are often, though not invariably, related to sea-level changes are much in vogue. The equilibrium between coastal erosion and sedimentation is important not only from the point of view of land as an economic resource, but more because the coastal zones are areas of intense human interaction. Navigation, international trade, defence, fishing, recreation, siling of ports and harbours - all these depend on coastal processes.

Field experiments in geomorphology have progressively attained the same importance as laboratory work in other sciences. Field experimentation can take one of the several forms : it could confine itself to measuring of the processes in nature like measurement of stage, discharge and sediment load in a river,

or that of soil loss in the field, or it could be a simulated experiment on a smaller scale.

A reasonably well founded understanding of landforms rests not only the identification and description of the landforms, but also of the processes responsible for producing these landforms and shaping them as they exist today. The principle of uniformitarianism only explained the history of landforms, but the existing landforms are the result of a number of variables, working at cross purposes at different rates at different times. The relationship between these factors is vitally significant as they create a variety of land forms. These two approaches, one historical and other emphasizing contemporary causal relationships, are equally important. The past sometimes may be holding the clue to the landforms that are not adequately explained by the present. Thus there may be inherited landforms from a different environmental situation or they may exclusively reflect the impact of the present morphogenetic processes.

#### **APPROACHES TO GEOMORPHOLOGY:**

The four approaches both to the study of or explanation in geomorphology can be expressed in four words : uniformity (after Hutton), evolution (after Davis), systems (after Bertalanffy, Strahler and Chorley), and complexity.<sup>1</sup> The complexity approach is inclusive in the systems approach, and it could not be an approach in the real sense. It only means that any single approach is inadequate. It is significant that many geomorphologists still think in terms of evolution and have not shed the Davisian mantle. The historical approach though very streamlined like human genealogy, has little appeal to the scientists

applying empirical methods of investigation, reflected in Mackin's (1963) regrettable comments on Davis as "an old duffer with a butterfly - catcher's interest in scenery". The above statement of Mackin notwithstanding, heredity is retrospective and not prospective, and lies in history and not in the complexity of the contemporary situation. The value of a historical approach is neither absolute nor absolutely redundant.

#### **THE SYSTEMS VIEW OF GEOGRAPHY :**

The systems view, borrowed from biology, presents an approach where elements and their functional interactions give a better understanding than an extremely analytical method. The method has been adopted in Geomorphology, where a fluvial, a hydrological or a geo-ecological system is better appreciated by looking at the components in their functional relationships. Such a system, seldom in equilibrium, moves towards a steady state, though it may be disturbed by episodic events that exceed the threshold. Time is an important element in the progression of the system, and the complexities introduced by positive or negative feed back, in simple language, mean what Davis called interruptions.

Complexity, results from violent swings of some of the inputs, or the irregular variation of a number of inputs at the same time. This results in a complex situation, that cannot be explained by a simple positive or negative feedback. The situation may result from a variety of changes over a short period.

#### **THE METHODS OF GEOMORPHOLOGY :**

The approaches outlined above give us a perspective, though these don't represent the

1. Chorley, R. J. et al (1984) *Geomorphology*, p4, Methuen, New York.

methods of geomorphic research. The fundamental principle as enunciated by Wooldridge (1954) is that "the ground not the map is the primary document". Geomorphology is not a laboratory science in the sense physics and chemistry are, though, undeniably, laboratory techniques are used in the analysis of earth form or material. It is essentially a field science. The reality of landscape, a geomorphologist interprets, is in nature, in the wilderness of space, not in the confines of a map - room or laboratory. Carl Sauer's statement (1956) that "the principal training of the geographer must come, wherever possible, by doing field work" applies far more aptly to geomorphology than to the entire field of geography.

The field work of the early decades of this century has now given way to a far more sophisticated approach where qualitative observation is extended to precise measurement and field - experiments. The measurements may be related to the hill side slopes, or these may require an instrumentation of a high order, to measure the dynamic aspects like intensity of precipitation, discharge and runoff, sediment load, the composition of sediments, the rate of siltation and several such aspects. In short, present day geomorphology requires constant monitoring of landscape, if one has to understand its metabolism. Precision requires data from accurate measurement, before these could be interpreted either directly or transformed into indices and relationships. Any application of stress - strain analysis, fluid mechanics or hydrological principles rests entirely on the field-data, necessitating field work. Geomorphology cannot survive without field work, though geomorphic notions will persist. Field work, qualitative observation in an evolutionary frame, field measurements and generation and processing of data, in terms of

their physical chemical and statistical properties, their graphical presentation and mapping and finally their interpretation-all these constitute elements of research methods in geomorphology. Much more important for understanding the processes, fluvial, coastal, glacial or aeolian, are the models based on functional relationships. Often these take mathematical forms, and vary from one situation to another. In other words these models are area- specific, and a different relationship may emerge in areas under different climates, or different rock structures. Landform is unlike the physiologic unit of a living organism. There is nothing like a live and dead tissue, and any slow or violent event will change the face of the earth or a part of it. Our understanding of the relationships of the geomorphic processes enables us to understand the consequences of geomorphic changes in terms of human experience like erosion, siltation, floods, and landslides.

The case of experimental geomorphology where the actual conditions can be simulated needs no emphasis. The most common of these relate to hydrology and fluvial systems, waves, formation of spits or wind erosion in controlled conditions. Field observations and analysis of forms, material properties, movements and their relationships and prediction of trends are the present pre-occupation of geomorphologists. There is an ever increasing emphasis on what one may term 'Physical geomorphology' where matter, energy, motion and acceleration command increasing attention.

### CLIMATOLOGY :

From the days of George Forster (1778) who accompanied Captain Cook on his second voyage and who was the first to identify the pattern of temperatures on the eastern and western sides of the continents on the same

latitude, and Maury (1850) who identified the prevailing winds and presented a model of atmospheric circulation, climatology has grown into a corpus of knowledge, to be handled by specialists. Much of the work in meteorology and even climatology is done by physicists and mathematicians. Geographers have been able to identify the pattern, and do excellent statistical and trend analysis. Beyond the distribution, patterns and trends, both over space and time, geographers have little competence to contribute to climatology, as most of the advances in the subject filter down as generalizations from the researches of meteorology. "The great bulk of the postwar meteorological research has been by physicists and mathematicians whose publications, others (meaning thereby geographers)<sup>1</sup> may find difficult to understand, frequently because they lack any knowledge of basic physics, which is absolutely vital; without it, meteorology and climatology are virtually impossible. Meteorology without too much mathematics is clearly feasible; meteorology without physics is a contradiction in terms - (Chandler - 1969).

Methods of climatology are largely based on data organisation, analysis and interpretation. These may relate to the fluxes of temperature, rainfall, its intensity, variability and seasonality and its variation over a long period of time, trend analysis, occurrence of drought conditions, cyclonic storms and associated weather conditions, or even episodic conditions that represent some of the areas of study and research in climatology. Climatic classification is, no longer, an exciting theme, though palaeoclimates do engage the attention of many disciplines. During the last couple of decades, changes in the composition of atmosphere, particularly the increasing concentration of green house gases (GHG) and the prospects of global warming have shifted the attention to the

modelling of climate on the basis of the assumed rise of temperature over the next century. All this has snowballed into a major field of climatic change and its consequences.

There is no element in environment which has as immediate and direct an impact on human activity as climate, yet the limited competence of a geographer forces him to be more of a compiler and synthesiser of data than a researcher in the true sense. Experimental work on the impact of temperature, rain, soil moisture, and humidity has produced a branch of meteorology, called agricultural meteorology; and experimental work in this area relates to plant or crop ecology, relation of weather to crop yields or working out in collaboration with crop ecologists ideal conditions for the growth of specific crops. The subject may extend into hydrology on the one hand, and sedimentology on the other. The raw material of a climatologist is the weather and climatic data and his method consists largely in the organization and analysis of these data either manually or through computer processing.

### **BIO-GEOGRAPHY :**

Lately, bio-geography has emerged as an important branch of physical geography not because the bio-geographers have discovered some new facts, laws or methods of research, but because of the global outcry about protecting environment, forests, plant species, and above all the biological diversity, for which the basic material is the hierarchical arrangement of biomes, communities, populations and individual species. A knowledge of the distribution of different species, their ecology, the niche they occupy and above all the changes in the eco-systems from a strong support base to the logic of environmental preservation. Bio-geographical text book writing and

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1. *Insertion in parenthesis mine.*

bio-geographical research are at the extreme ends of the spectrum. Much of the information that goes into the production of text books is derived from bio-sciences, pedology or forestry. The contribution of geographers is only marginal, related to vegetation, floral landscape, their deterioration, and the discussion of the characteristics of different eco-systems. It is difficult to say howfar geographers will be able to participate in and contribute to the work of the biologists.

Much of what is termed bio-geography is ecology - whether it is a question of trophic web with its producers and consumers and energy transfer mechanism, or it is a discussion of geo-chemical cycles, all are included in ecology. The distribution pattern of plants and animals, and their migration have engaged the attention of botanists and zoologists for long. This is not to suggest that the bio-geographer has no role to play. In smaller areas besides determining gross productivity of the system a geographer can very successfully experiment with the influence of soil and climate on specific species, and the nature of a climax vegetation that might finally emerge. Experimentally it is quite within the reach of a geographer to determine how an eco-system works. A geographer has the advantage of being familiar with soil - forming processes as much as with the average climatic conditions, both of which largely determine the plant cover of an area.

#### **HYDROLOGY :**

This aspect of geography is shared by climatology, as much as by fluvial geomorphology. The parameters involved are so many that the subject attracts geologists, civil engineers, meteorologists, irrigation experts and geographers alike. The subject has advanced so much that the segment related to geography has been called geographical

hydrology. The river-system hydrology and ground-water hydrology, the former having much to do with precipitation, river discharge, and flood conditions, and the latter with rainfall, infiltration, aquifers and their retention capacity with the equilibrium or lack of it between annual discharge and recharge, are the usual topics of study by geographers.

The subject has reached such a stage of specialization either through hardware or mathematical modelling that given the precipitation, advanced models are available for predicting many other, if not all, characteristics of stream flow. The subject is fascinating in as much as it has also to deal with the availability of water. The hydrological work related to fluvial system is quite advanced and in areas where conditions of drought and flood prevail, the subject offers a special challenge.

#### **SOIL - GEOGRAPHY :**

No branch of physical geography has made such tremendous strides as soil-geography. Soil-science is one of the specialist study of earth's material, transformed into a complex that supports plant life. The subject has been studied from the point of view of physics, chemistry, mechanics and finally agronomy. One of the early geographers of the late XIX-th century who concentrated on the study of soils was Dokuchaiev. He is credited with the statement that soil reflects the extraordinary complex interaction of climate, slope, plants and animals with the parent material derived from the underlying geological formations". (Gerasimov - 1962). The Russian concept of soil genesis and distribution was introduced to the English speaking world by Marbut (1927), by translating the work of Glinka, another Russian who propagated the idea of Dokuchaiev. Marbut also applied the idea of soil zonation to the Great Plains (1923), before

completing the soil map of United States in 1935. The departments of agriculture in almost all countries of the world promoted the study of soils. Soil Science as a discipline in agriculture contributed much more to the physics, chemistry and fertility of soils. The contribution of soil scientists far exceeds, the contribution of geographers occupying themselves with soil in different zones of the earth as related to climate and topography. By the middle of the XX-th century, soil scientists began to feel the inadequacy of broad zonal classification of soil, and launched a programme to develop an elaborate soil - taxonomy resulting into a soil classification commonly known as 7th approximation, prepared by the U.S. department of agriculture.

Bunting's book (1965) entitled 'Geography of soils', that was an early attempt on book writing, was followed by a cascading array of literature on the geography of soils, Geographers have an unparalleled advantage in the study of soils in that they are well acquainted with the process of weathering which is the starting point of pedogenesis. In fact, a weathering profile is a pedogenic profile with different levels of maturity. Another advantage they have relates to the knowledge of climate, topography, and the vegetation in different areas. The complexity of factors giving rise to soil are well appreciated by geographers. And a geographer can interpret the pedogenesis processes much better than many other scientists. But the genesis is not all. A number of physical, chemical and biological properties develop in the soil subsequently as a result of its utilization and treatment. In fact, there is an emerging branch called pedo-geomorphology. The intraprofile processes of eluviation, illuviation, mineralization, or humification need a careful examination; and support from soil chemist is vital, yet soils can be studied by geographers as an interdisciplinary subject in

which he can make a substantial contribution.

The above is a brief review of the how physical geography and its specialized branches have developed during recent years. The emphasis in physical geography has shifted to processes, beyond the stage of identification, classification and description, may it be some specific landform, a synoptic weather condition or soil degradation. The more the processes of physical geography are understood, the better equipped will the geographers be. These processes, often lie in the fields of physics, chemistry or biology and that poses a serious problem to a geographer. Any programme for the improvement of physical geography should, therefore, aim at understanding the basic principles of cognate disciplines from which the generalizations of physical geography are derived.

#### THE INDIAN SCENE :

Physical geography in India modelled itself on the pattern of P. Lake's book on physical geography. Lake's book was a text in almost all universities at the undergraduate level. The book was adopted in regional languages without there being an explicit translation. The themes with an overtone of physical geology included such topics as rocks, weathering, work of running water and wind, mountains, lakes and deltas, glaciers and different kinds of topographies, wind systems of the world, cyclones and anticyclones; currents and tides. The treatment was descriptive. Though Lake himself was a geologist, he opened the book with atmosphere. The book was revised by Steers and his Cambridge colleagues in 1949.

As old as Lake's book was 'College physiography' written by Professor Tarr and published posthumously by Martin in 1914. The book being bulky (it ran into 837 pages) did not command much readership and was

subsequently made a prescribed text at the postgraduate level in some universities. As more knowledge accumulated and more texts on physical geography, notable among them being Finch and Trewartha (1936, 42, 49) and A. N. Strahler (1951 and subsequent editions) were available, the scope of physical geography was also enlarged. By the close of the thirties texts were available for teaching climate as a separate course, and Kendrew and Miller became the standard texts for climate.

The Graduate teaching in geography in a systematic manner started in India after the second world war, though geography courses, particularly for teachers, started as early as 1931. Some of the early professors of geography were trained in geology, who came to occupy geography chairs. The result was an emphasis on geomorphology. The availability of a text book (Wooldridge S. W. and Morgan R. S. - 1937) further helped adopting and teaching geomorphology at the post-graduate level. Though a couple of text books were available on climatology in the early forties, it was not taken up as a subject at the graduate level, primarily because of the dearth of trained teachers. In fact, climatology remained neglected in the universities for long whereas geomorphology had an unquestioned primacy. The British schools of geography were dominated by geomorphologists (Wooldridge, Steers, and Linton), and geomorphology was considered by some as the 'physical basis of geography'. Being cognate to geology or a part of it, and practised by some of the leading geographers of the fifties, geomorphology had a scientific appeal, where one had to understand the rocks, their stratigraphy, their composition and the way they have reacted to weather and tectonics to be moulded into the contemporary landscape. Denudation Chronology and evolution of drainage were very attractive exercises, as were the identification of valley

forms, terraces and meandering streams. Climatology arrived on the scene gradually, but remained for long confined to the study of weather charts, drawing of climographs and isolines, horizontal and vertical distribution of temperature on the globe, distribution and seasonality of precipitation, classification of climates, and given the data, identification of climatic types.

Both geomorphology and climatology remained for long the two representative specializations in physical geography. Hydrology was included partly in geomorphology and partly in climatology. As for the soils, this found a place in economic geography as a resource. Biogeography was hardly touched and even today, it is taught only at a few centres in India.

In the fifties and the decades that followed geography had a remarkable horizontal spread, in colleges and universities all over the country. One of the basic reasons for this expansion was the expansion of higher education itself and opening of new universities in far flung corners of the country. But the place of geography in the university rested essentially on its upgradation from schools and colleges to the universities. Being a part of social sciences like history, it had to be taught by qualified graduates, who were required to study geography as one of the subjects at the college level. And the college teachers, in turn, had to be trained at University departments of geography in some universities, and post-graduate centres, in others. Thus, geography like history has the grass-root support, and the entire network of higher teaching in geography developed following the demand of qualified teachers from lower levels. The University departments and the graduate centres were managed by people who were trained abroad, notably in U.K., or in a few instances in the United States. This first generation of professors, with a few

exceptions, trained in human or economic geography, established a tradition of research and teaching in the areas they themselves had worked. Secondly, majority of these first generation geographers, except those who were geologists turned geographers, like H.L. Chhiber and Chatterjee S.P., had graduated in liberal arts and found themselves at ease with settlements, landuse and population, areas which were largely data based and did not necessarily involve understanding of the basics of science.

The propagation and growth of a largely data - based geography, often from official sources, though in itself not very healthy, virtually eliminated physical geography from preferential areas of research. And stray efforts in some parts of the country were stifled, partly because of its faulty assessment by geography managers at the national level, but no less because a majority of them thought of geomorphology an impregnable fortress to be penetrated only by the geologists.

### **EMERGENCE OF REGIONAL PLANNING AND THE NEGLECT OF PHYSICAL GEOGRAPHY**

Another important development that took place in the sixties was the development of regional planning as an extended field of applied geography. In the era of planning and in the name of national economic development, regional planners considered themselves far more relevant to the society. Economic regionalization and a network of planning regions at different levels - repeatedly stressed as macro, meso and micro - emerged as a front runner. Planning geography exercises, their validity yet to be finally established, were the showpiece meant to secure a place for geography in the national development programme and assert the importance of the discipline in the array of other social sciences like economics,

political science and sociology. Justification for regional planning was sought in regional resource utilization and regional needs and above all the regional disparities.

India experienced a kind of echo of the radical approach in geography where the doctrine of exploitation was extended to cities, different classes and different regions. The left leaning geographers in India endeavoured to build a geographical edifice over the contrasts and differences, a geographical theme, in terms of equity - inequity, equality - inequality, parity - disparity, and extended it to regions and communities. This fitted in well with economic as well as social geography : economic as it tended to highlight the need for the development of underdeveloped regions and social because of the deprivation of certain underprivileged sections of the society. The approach with its anchorage in socialist philosophy spawned, at a less extreme level, exercises examining levels of regional development. While the radical school with its cutting edge of social justice promoted geography to highlight injustice in the system, the traditional school continued measuring the street pattern of towns, examining the landuse or looking at the demography of specific regions. In this process physical geography suffered a long neglect and was virtually dispensed with till the radicals realized the importance of the resources, largely derived from environment, which had to be assessed and preserved as natural resource. Two factors saved physical geography from total extinction. The first was the need to teach physical geography at the undergraduate level to fulfil which courses in physical geography or geomorphology, however elementary, were offered, and the second was the need for information and knowledge about environment in the emerging scenario of global concern. The concern for a revival of physical geography is not yet backed by concrete action, the subject

has not yet crossed the threshold of extinction, but with the all prevailing concern for environment, bio-geographers, hydrologists, soil geographers, and applied geomorphologists may find a place to roost without ruling the roost.

### **THE SLOW MARCH OF PHYSICAL GEOGRAPHY :**

Regardless of what the geographers in general were engaged in, some of them kept physical geography alive. Isolated from the main stream, the geomorphologists of the sixties and the seventies were the lone furrows working with their students without being noticed. Some geographers turned geomorphologists because of the professional requirement of their jobs, as at the Central Arid Zone Research Institute. Others, hailing from a geology background preferred doing geomorphology, and a few others had the benefit of some training to start or continue working in geomorphology. Thus a few nuclei, notably at Pune, Visakhapatnam, Jodhpur, Calcutta, Ranchi, Allahabad, Almora and Jammu developed where students worked on geomorphic themes. The work on most of these centres was based on field work and in a few cases even on the analysis of material. Use of aerial photographs and lately of imageries helped preparation of geomorphic maps which, in due course, became a favourite exercise. Nor were the processes neglected. Fluvial, glacial, aeolian and coastal processes received attention. In this, the study of East Coast of India by Professor Vaidyanadhan and his students at Waltair stands out as an organized contribution to Indian geomorphology. The country has, today, an association of geomorphologists in India which holds annual convention and publishes its proceedings. While a few of the University Centres continue work in geomorphology, most University departments are not attracted to it, and teach the subject

from the text book, without any exposure to field realities. A large number of colleges with post-graduate teaching, in India's heartland, teach geomorphology without even being in the field, even for a single day. Their only equipment is the text book written in Hindi. The situation in these centres as far as geomorphology is concerned, is really pathetic. Most of the teachers, recognize neither the spirit nor the purpose of teaching geomorphology, pure or applied.

### **CLIMATOLOGY :**

The situation with climatology is no better. I don't know even half a dozen teachers in India who have specialized in climatology; and even of those who managed to get a doctorate, few have done anything different from water balance' in one form or the other. The one geographical publication, appearing as a book is K. Ramamurthy's thesis on 'Rainfall Regimes in India'. There may be a couple of more theses published, like the one from Varanasi by Lalita Devi, again on 'Water Balance', but the field has remained unexplored.

The author of this note, not being a climatologist himself, cannot say much with confidence, but what is obvious is the apparent absence of a challenge from the subject, particularly to the students having no notion of physics. Climatology is thus reduced to data analysis, may it relate to dispersion, intensity and variability of rainfall, unusually high rainfall, analysis of drought and its frequency and severity, etc. The subject could be made far more interesting if applied to the analysis and prediction of floods and droughts. The climatologists, coming from geography stream, are not familiar with cloud physics or global circulation and their analysis is confined to sifting of the statistics. A full fledged department of meteorology and a Government funded

Research Institute like Indian Institute of Tropical Meteorology have hardly left any thing for geographers, but geographers can concentrate on local or regional climates and their applied aspects. There can be no climatology without meteorology which requires a knowledge of physics.

The applied aspects of climatology are more promising. Work like 'Commencement of sowing rains' is done purely on the basis of statistical analysis of rainfall amount and its periodic distribution in a specific area. Climate and forests and their mutual relation is an area which geographers could well explore. Crop-ecology is another field where geographers can make some contribution. A statistical relation of climatic parameters with the yield of various crops has often been made, though not always with reasonable results of prediction. Perhaps the best liaison climatology can establish with is hydrology. The amount and intensity of rainfall directly affect the infiltration, run off, the recharge of an aquifer and the discharge of a stream. Most aspects of hydrology have to be seen in the light of climatic conditions.

#### **HYDROLOGY AND BIOGEO-GRAPHY:**

These two branches, much to do with soil conditions, plant growth and related human activity have been completely ignored. Only lately have we started paying some attention to these themes as an extension of geomorphology. In the tropics the availability of water, either for drinking or for other economic activities like irrigation and industries, is a serious problem, not so much because of certain areas receiving very little rainfall like Rajasthan, N. Gujarat or the Central North-South dry belt of the peninsula but essentially because of a very high level of evaporation all the year round. Added to this the fact that water - conservation methods have not been fully adopted in the country. Hardly one or two universities in the

country teach hydrology as a part of geography syllabus, though hydrology is taught as a major subject in some institutions like Roorkee Engg. College.

**Bio-Geography :** Bio-geography is a very neglected subject in Indian Universities. In some universities, the subject is taught at the undergraduate level. There may be a few doctoral dissertations written by geographers in a few universities, but by and large the picture is dismal. The geographers, it is noticed, feel very neglected, in not getting a slice of the massive funds being offered for environmental research. Environment is a highly technical subject, though undeniably there are socio-economic sides of the issue. Our neglect of bio-geography, and ignorance of the work being done in the field of ecology left us stranded when the opportunity really arrived.

Bio-geography is still beyond our grasp and we continue looking at the subject in a casual way as if it is peripheral to the discipline. Stoddart (1986) makes a strong plea for putting *geography* back in *bio*, to convince biologists, of its role to provide a "Comprehensive view of the distribution of life on earth pioneered by Humboldt and established by Darwin".

#### **THE AGENDA FOR PHYSICAL GEOGRAPHY**

The community of geographers in India must realize and agree that physical geography provides the basis of the discipline, without sounding deterministic. The respectability, whatever its measure, that the subject commands, stems from the following facts :

1. Elements of Physical geography are taught in schools as a compulsory subject and there is a universal notion that geography

- deals with places and then with the natural landscape, like mountains and rivers.
2. Thus knowledge of places, in a broader sense the regions, and the knowledge of the physical world, both basic to the discipline, form the traditional core of the subject.
  3. It must be admitted that regional geography has suffered a neglect and physical geography never got the attention it deserved. Human, economic, social and political geographies are different from anthropology, economics, sociology, and political science, not so much because of a built-in element of distribution in space, as because of their contact with the earth, the environment and the resources.
  4. Shorn of its content of environment, resources and an understanding of the ecological relationships, geography becomes puerile and only an incomplete study of human behaviour. The validity of the holistic approach, so often propounded, is meaningless so long as we continue indulging in statistical legerdemain without understanding the processes, which invariably involve a complex interaction between a multiplicity of phenomena not excluding the living space, the environment and the resources.
  5. For those who are overtly concerned with environment and conservation and talk of limits to growth or sustainability in development, a knowledge of the state of environment and the natural resources is a pre-requisite before strategies could be developed and action initiated.
  6. Between man and nature, man is not a producer, he is either a user or a consumer. It is the nature that produces, stores, recycles and offers us the life support system - the

air, the water, the food and a host of other materials for our sustenance. How judiciously we are able to use these valuable resources will largely depend on an understanding of the processes of nature that determine the potential and set a limit to our exploitation. Physical geography is the vital link between man and nature and we can dispense with it only at our own peril.

7. The study of environmental processes will, of necessity, grow, as the society in general and the scientists in particular cannot afford to suffer from ignorance or misunderstanding of natural processes that all but govern their lives. Whether it will also be reflected in the growth of physical geography depends on the concern and the dedication of geographers.

#### **THE CONTEMPORARY APPROACH TO PHYSICAL GEOGRAPHY IN INDIA:**

In a very recent conference, a University Professor asserted that teaching of geography is very important, research in the subject is secondary. No doubt, the subject has grown in schools and colleges almost exclusively by teaching. This, nevertheless, should not keep us blind to the merits of research in the field. As one would like to put it - teaching and research are complementary processes. Teaching while disseminating knowledge, identifies the gaps in our knowledge and offers a challenge to fill in those gaps, the grey areas, by research.

It should be emphasized that the store of knowledge in any discipline that the society has accumulated, is only through long experience, perseverant research, and by preserving the research findings in the written texts, the simplified versions of some of which appear before us as college or university text books.

Here, I shall like to draw a distinction between the approach of a western scholar of geography and that of an Indian one relating to physical geography. In most cases, a western scholar learns geomorphology or soil geography from the field. He travels extensively, observes the field realities and thus prepares his lectures. What he reads, he confirms by field observation. He does not talk of what he has not seen, or is not sure of. Finally, after some years, he writes his lectures as a text book. In India, a large majority of teachers teach physical geography from the text books. They have no field experience, nor have they observed the landscape they are teaching, in the field. They have a mental picture of the sketches in the text books. They utterly fail to grasp either the genesis or the processes of landforms. A similar situation exists in relation to soils. Many of them have never seen soil profiles, yet are compelled to teach pedogenesis or the development of soil profiles from some text books.

The teaching of physical geography in India is wholly text book oriented, and that is a very tragic situation. This is the fallout of a facile attitude of text book recitation. Teaching aids, usually the hardware models, though helpful, do not tell the entire story and are no substitute for field acquaintance with the forms and processes. The stereo-pairs and imageries go a long way in preparing the students for what they can expect in the field. The practical work in physical geography in India is more illustrative. It involves cartographic presentation and not experimental work.

There is a lack of introspection on our part to pause, think and plan for whatever we intend doing by way of research or teaching. The purpose of the research is never clearly in sight, and the methods are not fully scrutinized and questioned. The result is

whatever little work is done in physical geography is disjointed, and not done as a part of a larger overall research programme intended to establish some facts, relations or principles.

### **A PRESCRIPTION FOR INDIAN PHYSICAL GEOGRAPHY AND PHYSICAL GEOGRAPHERS :**

Many might revolt at the sight of the word 'prescription', questioning not only the propriety of the word, but even the authority of one who offers it. Yet one must state the obvious, and be prepared for a critical scrutiny that may evolve into an acceptable norm.

In the pursuit of physical geography research and teaching, three distinct components are involved :

1. Physical geography teachers, researchers and students.
2. The areas and themes of research and teaching.
3. Equipments, tools, techniques and methods.

### **THE TEACHERS AND STUDENTS :**

Even after half a century, Indian geography has failed to take cognizance of a distinction between the culture of science and the culture of liberal arts. This has happened largely because the subject offers scope for any one to enter the field and start meddling with areas far beyond his academic reach. The holistic nature of the subject has given it a permissive streak. Physical geography requires personnel with training in science - mathematics, physics, chemistry or biology, depending on the specific branch of physical geography. Climatology requires training in physics, geomorphology will benefit greatly from physics and chemistry, and bio-geography draws heavily on bio-sciences.

The problem of non-availability of trained scientific manpower to physical geography could be remedied by strategies ranging from a very drastic step of separating physical geography from cultural geography and allow it an independent existence. This, one can imagine, will not be a welcome move and might meet with a great deal of resistance. Another step, more feasible and likely to be accepted by geographers of all shade is to make an exclusive section of physical geography. In this case, all teachers and students specializing in physical geography should be drawn from the science stream. Geomorphology, climatology, biogeography and hydrology should be the exclusive domain of science students with appropriate background. This is not to belittle the good work done by arts graduates in geomorphology, climatology or bio-geography; but, these are exceptions. One has to think in terms of a system in which, teaching and research, managed by a few scientists strike roots, make rapid strides and show positive results.

(a) Physical geography must be handled by science graduates, both teachers and students.

**The Areas and Themes :** Teaching of physical geography can be made area specific. There is no propriety in teaching and specializing in glacial landscape for a University or institution located close to the equator, nor is there a justification for a Himalayan region University to specialize in tropical processes. A University can specialize and lay emphasis on the landscape and processes to which its faculty and students are frequently exposed. Another aspect is the application of physical geography findings to relevant areas of human activity. Soil erosion, floods, droughts, pests, desertification or similar other problems need immediate attention, and can be investigated by physical geographers. Most researchers in Indian

physical geography tend to ignore this aspect. Their primary aim is the publication of a research paper in a journal, or a monograph. This attitude has more to do with the promotion prospects of individual workers and less with the immediate social relevance of research. The concern for the purposefulness of research could be a driving force in achieving excellence in researches. This could also promote experimental work, as findings of the experimental work could be of immediate use to the people in the same or similar environmental milieu.

(b) Applied and experimental work should be given priority.

**Equipments, tools, techniques and methods:** Undeniably, equipments are the basic tools of a scientist working in an applied field, may these be laboratory equipments, map-room equipments or field equipments. One is familiar with all kinds of measuring, processing and cartographic equipments. Some of the equipments in physical geography are so complicated that they assume the form of an elaborate technology, like remote sensing techniques. A geographer is greatly helped by a very quick perception of the landscape he develops by looking at the imageries produced by remote sensing techniques. While space satellites and remote sensing have produced very dependable picture of the global surface, they have, in their own right, become applied sciences.

The traditional laboratories analysing earth-material or the data are as indispensable today as they were years ago, only the instruments have become more sophisticated. Graphics no longer requires hours of slogging. The institutions doing physical geography don't have only to possess adequate laboratory equipment but even the personnel to operate

these equipments. A statistician, a computer software man, a chemist and a mathematician could be included in a good team research in physical geography.

(c) The equipment of physical geography could be elaborate and possibly equated with the equipment for the study of environment. Geography has little future without physical

geography, and the neglect and demise of the latter will herald a sure death of geography.

Physical geography is the core of geography, and for the survival of geography the core has to be nourished, preserved and strengthened. This is the most important aspect of the 'Agenda for Geography'.

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