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Only One Himalaya: Perspectives on the Himalaya as a Regional Science

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Perspectives on the Himalaya as a Regional Science

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"The first step toward devising a strategy for Planet Earth is for the nations to accept a collective responsibility for discovering much more--much more--about the natural system and how it is affected by man's activities and vice-versa. This implies cooperative monitoring, research and study on an unprecedented scale. It implies an intensive world-wide network for the systematic exchange of knowledge and experience."

Barbara Ward and Réne Dubos in *Only One Earth* (1972)

Introduction

There is only one Himalaya. Nature being so creative, each part of our planet is unique in one way or another. However, the level and significance of the uniqueness (from human viewpoint) differs from one place to another. Some places are so paramount in their character and capacity that capture our seventh sense—the sense of place. High, massive mountains are overwhelming. It is no wonder that the birth of geology (as an independent science studying the earth) in the late 18th century was contemporaneous with a radical change in Europeans' attitude towards mountains. Marjorie Nicolson in **Mountain Gloom and Mountain Glory** (1959) has documented how, after centuries of viewing mountains as "warts, wens, blisters and imposthumes" on the otherwise fair face of the earth, Europeans came to praise mountains and appreciate their natural endowments. Indeed, one of the champions of the Mountain Glory, Horace Benedict de Saussure (1740-1799), was also founding father of Alpine geology and one of the founders of geology itself. De Saussure's famous phrase, "It is above all the study of mountains which will accelerate progress in the theory of the earth," served as the epigraph of many science textbooks in the 19th century (Greene, 1982, p. 146).

The Himalaya are the world's highest, largest, and youngest mountains. Indeed recent studies of the geochemical record of strontium isotopes in marine limestone (indicative of the magnitude of continental denudation) suggest that the Himalaya-Tibetan region may be the highest and largest culmination of the earth's crust since the "Pan-African" mountains of some 500 million years ago (Edmond, 1992). If this notion is true, we humans are indeed a privileged species to have appeared and thrived at this "Himalayan" period in the long history of the earth.

Our present understanding of the unique qualities of the Himalaya would not probably surprise the ancient Indian sages and poets (were they return today), who referred to the Himalaya as "Nagadhiraj" (King of Mountains). They were simply overwhelmed by their "sense of place." The "sense of place" is usually expressed in terms of literature, arts, para-psychology, mysticism, and esoterica. However, there is also a "scientific" sense of place. Some parts of our planet are simply "hot spots" for scientific investigation, and the Himalayan region is such a "hot spot." Given the prevailing "esoteric" images of the Himalayan lands and peoples, this scientific context of Himalayan studies should be emphasized. Science is an attempt to understand how the world around us functions, how it has evolved, how nature has nurtured life (including human life), how the humanity has evolved (both biologically and socially), and how the humanity can live more intelligently, comfortably, creatively, and harmoniously with their surroundings. Scientific investigations provide a knowledge of these "how's" (whether or not our social institutions use the sciences for these purposes or how far they have been able to do so is another matter), and as such science is one of the most fundamental and useful human activities. Himalayan research (whether pertaining to nature or people) should be conceived as a crucial component of scientific knowledge and activity.

While studies of the Himalaya are increasingly abundant, relatively less attention has been paid to the field of Himalayan research itself—its overall context, significance, systematics (aims, structure, components, and function), and its philosophy as a "regional science." These issues can easily fill a volume. This article briefly discusses a conceptual framework for Himalayan research as a unified science, and outlines its significance in our age of Global Change. My emphasis here is on the natural scientific aspects of Himalayan research. However, it is hoped that the comments and conclusions made here would stimulate further discussions on the theory and organization of Himalayan research—both its sciences and humanities. If readers of this journal propose better responses to challenges facing our science and research community, and is so doing improve upon or refute my views, I will feel rewarded.

The Himalayan System as a Regional Science

In the academic classification of sciences, there is no such discipline as "Himalayan Science." However, since geosciences are field-dependent (and even place-specific), one is permitted, especially in the domains of regional geography and regional geology, to talk of Antarctic, Arctic, Andean, Alpine, or Himalayan geography or geology. These "regional sciences" are yet to be coherent, integrative disciplines of study within the academia, despite the obvious fact that the function of nature (or humans) is not divided into numerous departments or clear-cut disciplines as we have organized. A way out of this dilemma is dialogue and active collaboration between various scientists under umbrellas of "regional sciences." In this context, if we view the Himalayan region as a giant geological, biological, and anthropological mountain system (including its highland-lowland interactions), the significance of Himalayan Science becomes amplified. Such a "regional science" is multi-disciplinary and integrates numerous fields of research to understand the evolution, processes, resources, and other aspects of the Himalaya as a complex system.

A major problem with the "regional approach" to Himalayan studies is that the boundaries the Himalayan region as a subject of study are not easily defined. Partly because definition of the Himalaya has changed through time, and partly because even today there is no consensus among the ethnologist, social scientist, physical geographer, historical geographer, development/resource manager, ecologist, and the geologist as to what constitutes the Himalayan region. Perhaps the first lesson of Himalayan Science is to tackle this question itself and to present a spectrum of definitions of "Himalayas" for various purposes. The lower end of such a spectrum would be a high range of mountains, the Great Himalayan Range, separating the Tibetan Plateau from the lower hills and plains of northern India, and extending from Nanga Parbat on the west to Namche Barwa on the east corner, for about 2500 km. The upper end would be a vast highland in south-central Asia, including the Tibetan Plateau and all the big and small mountains surrounding it.

The grand scale and inherent complexity of the Himalayan system makes it difficult to structure a comprehensive, detailed scheme for components of Himalayan Science. The following scheme should be treated as a first-order approximation; it takes into account various disciplines that independently study the Himalaya. These include the following:

I. Studies of geological materials (minerals and rocks): Mineralogy, petrology, and geochemistry

II. Studies of endogenic processes and structures: Tectonics and geophysics

III. Studies of exogenic (surficial) processes and landforms: Geomorphology

IV. Studies of vegetation and flora: Botany

V. Studies of wildlife and habitat: Ecology

VI. Studies of atmospheric phenomena: Meteorology, climatology, and glaciology

VII. Studies of geological history: Geochronology, stratigraphy paleontology, and paleogeography

VIII. Studies of anthropological history: Physical anthropology, Quaternary science, archeology, mythology, history, and historical geography

IX. Studies of natural hazards and environmental problems (including earthquakes, landslides, avalanches, floods, soil erosion, deforestation, etc.)

X. Studies of natural resources (exploration of soil and freshwater resources, energy sources, economic mineral deposits, etc.)

XI. Studies of mountain development and resource management (including forestry, agriculture, landuse, construction, population, tourism, etc.)

XII. Mapping (graphic data-base in a broad sense), including geological mapping, topographic and geographic surveys, applications of Geographic Information Systems (GIS), aerial photography, space-based remote sensing and satellite imagery, and Global Positioning System.

Obviously there are other fields that should be added to the above list, such as high-altitude physiology. The aim of any such listing is to bring together various Himalayan fields currently studied separately within the realms of physical geography, geology, ecology, meteorology, some of the social sciences, etc., and to show how they are interrelated and can come under one umbrella to provide detailed, broader pictures of the Himalaya and more sophisticated solutions to problems in Himalayan Science.

Nevertheless, even the sketchy list mentioned above clearly indicates that while we may talk of "Himalayan Science", it is impossible to envision a full-scale "Himalayan Scientist". Therefore, the notion of a unified Himalayan Science should not be taken as lessening the value of highly specialized studies. Himalayan Science is rather an attempt to place numerous pieces of research in their true context; it is a balance of reductionist and holistic approaches, and encourages collaboration and interaction among Himalayan researchers.

Significance of Himalayan Science

Scientific research usually adopts one of the following three "orientations" or "approaches":

(i) Functional (mechanistic) approach deals with fundamental processes, systems, and their material products;

(ii) Historical (evolutionary) approach concerns the changes through time and their causes, patterns, and consequences; and

(iii) Utilitarian (applied) approach attempts to explore and develop material and energy sources for human use or safeguard human lives and assets from hazards.

A regional approach embodies all of these approaches on a common ground. Therefore, Himalayan Science can adopt any of the traditional orientations to research, but with an additional advantage of providing a framework for cross-fertilization between disciplines. Historically, cross-fertilization of research studies has been proved to be very fruitful. In the Himalaya, for example, integrative studies of tectonic and geomorphic processes (these two fields were unified as "dynamical geology" in the 19th century), and interactions of physical environment and human activities (to some extent "cultural ecology", but these interactions cover a much broader scope) are already yielding fascinating results.

Another benefit of a unified Himalayan Science is that it creates a sense of "professional community" for Himalayan researchers, and thus strengthens the "niche" of our research in the present competitive world of science. Practically speaking, the concept of Himalayan Science calls for creation of broad platforms and extensive networks and media among Himalayan researchers, such as team-teaching courses, collaborative workshops, more integrated and interactive conferences and seminars, multi-disciplinary research projects, a widely-circulated international research journal specifically devoted to the Himalayan region (rather than the existing mini-periodicals), an international society for Himalayan scientists, a professional newsletter and electronic network, and popularization of Himalayan Science (see my letter in *Himalayan Research Bulletin*, XV(2), 26-28).

Scientific Significance of the Himalaya

One reliable way to assess the importance of a scientific discipline is to review its history and see what contributions it has made to human knowledge or welfare. Regional sciences are no exception. Fortunately, there are numerous examples of Himalayan contributions to science (indeed some of them being very fundamental and classic) that ensure the success and fruitfulness of further studies and investments in Himalayan research. Here I briefly narrate three of these success stories.

My first example comes from geophysics. "Isostasy" is a basic geophysical principle that explains why some parts of the planet are high while others are low. This fundamental scientific discovery stemmed from the Trigonometric Survey of India during the 1838-1843. The survey work led by Sir George Everest (1790-1866) intended to measure precisely (as a base line) the distance from Kalian in south India to Kalianpur close to the Himalaya. The Himalaya rising over 7000 m above sea level should attract the plumb bob used in the survey. Knowing the dimensions of the Himalaya and the average density of rocks that it is made of, Everest calculated the amount of deflection of plumb lines. To his surprise, the plumb bob was attracted less than one-third of the expected amount. The disparity between the theoretical (expected) and observed (real) values indicated that there was mass (gravitational) deficiency within the Himalaya. This was explained in two different ways by John Pratt, Archdeacon of Calcutta, and George Airy, Astronomer Royal of England, in 1855. In a 47-page article in **Philosophical Transactions of the Royal Society of London**, Pratt suggested that different parts of the earth's crust have different densities but all float on a uniformly dense substratum. The less dense crustal blocks make highlands and mountains, while the more dense rocks constitute lowlands and basins. Alternatively, Airy argued (in an only four-page article in the same journal) that various parts of the earth's crust have almost the same density but with different thicknesses. Highlands and mountains have greater thicknesses (they have elevations projected upwards as well as "roots" extending into the denser substratum), while lowlands and depressions have simply lesser thicknesses. As we now know both of these hypothesis are valid, each explaining a certain geological setting. As far as the Himalaya and high mountains are concerned, Airy was right: Mountains have roots. The High Himalaya has a crustal thickness of some 70 km, which is nearly twice the crustal thickness of the Indian Peninsula. As far as the difference between the high continental crust and the low oceanic crust is concerned, Pratt was right: These two major rock types (granite mainly making up the continental blocks and basalt making up the oceanic floor) have different densities (granite has a density of 2.65 kilogram per cubic meter and that of basalt is 2.95 — seemingly a slight difference, but "that makes all the difference"). On a finer scale, however, a combination of both Airy-Pratt's concepts may be closer to the truth. In his textbook, *The Earth Sciences* (1971), Arthur Strahler remarks that Airy-Pratt's explanation of Everest's geodetic observations "has since been one of the most powerful influences in the development of geologic theories." The state of gravitational balance of the earth's crust (floating at rest on a denser substratum) was later designated as "isostasy" (from Greek words, *isos*, equal, and *stasis*, standing still) by the American geologist, Charles Dalton, in 1893.

The story of isostasy is an example of Himalayan contribution to physical geoscience, which seeks to understand how the solid earth functions. Now let us take an example from historical geoscience: the discovery of Tethys. This was an ocean that lay between Eurasia (to the north) and the supercontinent of Gondwanaland (encompassing South America, Africa, India, Australia, and Antarctica) during the Mesozoic Period (250-65 million years ago). As we understand today, breakup and northward drift of African and Indian tectonic plates from Gondwanaland gradually closed the Tethys Ocean, and finally the head-on collision of Africa and India with Eurasia gave rise to the Alps-Zagros-Himalayan mountain belt during the Cenozoic Period (the past 65 million years).

The concept of Tethys grew out of mapping and correlation of marine sedimentary rocks in Europe and Asia during the 19th century. Major evidence for this former ocean was supplied by studies in the Himalaya. In the first half of the 19th century, many travelers and explorers had crossed the Himalayan mountains and brought fossil collections and rock samples. For example, based on Lady Sarah Amherst's collection, Sir Roderick Murchison (1792-1871) had remarked on the identical character of Jurassic marine fossils between the Himalaya and Great Britain. A systematic work was undertaken by Captain Richard Strachey, a scientific officer in India, who visited Kumaun and portions of southern Tibet. He specifically correlated the Mesozoic formations of the Himalaya with those of Great Britain as described by Murchison in *The Silurian System* (1839). In the summer of 1862 during a visit to London, the Austrian geologist, Eduard Suess (1831-1914), was shown Strachey's fossil collections and he also was struck by the similarities between marine fossils from southern Tibet and those of Europe. A fuller account of Himalayan marine formations was given by Ferdinand Stocklizca, who visited Spiti and Ladakh during the summers of 1864-65. (Stocklizca died in a geological excursion to the Karakoram in June 1784, becoming probably the first Himalayan geologist to have lost his life for science in the filed itself.)

As geological information accumulated, in 1885 the German geologist Melchior Neumayr (Suess' son-in-law) proposed the existence of a former equatorial seaway extending from the Caribbean through the Alpine-Himalayan belt to southeast Asia. Neumayr called it "zentrales Mittlemeer" (Central Mediterranean). Meanwhile, Suess acquired more Himalayan fossils and encouraged an Austrian expedition to the Himalaya. Suess' student, Carl Griesbach, had joined the Geological Survey of India in Calcutta in 1878 (ultimately becoming its Director in 1894). The Austrian expedition was jointly conducted by the Imperial Academy of Vienna and the Geological Survey of India, and led by Carl Diener with the assistance of Carl Griesbach and Charles Middlemiss. Their 1895 report extended Stocklizka's work and correlated many Mesozoic formations and fossils between the Himalaya and the eastern Alps.

In 1893, Suess redefined Zentrales Mittlemeer as Tethys, after the sister and wife of Okeanos (God of the ocean in Greek mythology). He proposed Tethys for "the folded and crumbled deposits ... of a great ocean which once stretched across part of Eurasia ... stand forth to heaven in Thibet, Himalaya, and the Alps" (Suess, 1893). In his view, the present Mediterranean was a remnant of Tethys. The concept of Tethys has proved to be very useful to interpret many geological observations in Asia. Fortunately, in the Himalaya (for example in Kashmir, Zanskar, Spiti, and southern Tibet) the entire succession of Paleozoic and Mesozoic formations are preserved and exposed to the geologist's eye. Therefore, studies of this zone of the Himalaya (called the Tethys Himalaya) provides many keys to unraveling some secrets of the history of earth, life forms, climate, and geography of a vast tract of our planet since the appearance of the trilobites in Cambrian seas until the Great Dying of Dinosaurs.

My third example comes from bioscience. In 1848, the English botanist Joseph Dalton Hooker (1817-1911) arrived in Sikkim to study plants and wildlife. Having accompanied Sir James Ross to Antarctica (1839-43), Hooker intended to study natural history of the temperate regions and his choice lay between the Himalaya and the Andes. He decided upon the former, mainly at the suggestion of Hugh Falconer, the then Superintendent of the Botanical Gardens in Calcutta. Hooker had indeed chosen one of the best regions in the world for his purpose. Over a horizontal distance of only 200 kilometers, he could climb from an altitude of 200 meters to some 7000 meters above the sea level, and study virtually the whole spectrum of world's habitats for plants, insects, birds, and mammals. In his **Himalayan Journals**, Hooker wrote:

> "From the bed of the Ratong [a river in Sikkim], in which grows palms with screw-pine and plantain, it is only seven miles in a direct line to the perpetual snow. From the plains of India, or outer Himalaya, one may

behold snowy peaks rising in the distance behind the foreground of tropical forest; here, on the contrary, all the intermediate phases of vegetation are seen at a glance. Except in the Himalaya this is no common phenomenon, and is there owing to the very remarkable depth of the river-beds" (Hooker, 1855, vol. 1, pp. 324-325).

The elevation and location of the Himalaya are favorable for biodiversity: Lofty mountains close to the warm sea waters. "Even when an attempt is made to divide the forest types along the lines of the standard classifications of tropical, sub-tropical, temperate and alpine, they become inadequate to describe the rich diversity of the Himalayan forests" (Bandyopadhyay, 1992). Hooker's seven-volume report, **Flora of British India** (1872-97), has been an important contribution to the science of botany. Readers interested in this subject may refer to Ray Desmond's excellent book, **The European Discovery of the Indian Flora** (1992).

When Hooker's **Journals** was published in London in 1854, another British naturalist, Alfred Russell Wallace (1823-1913), departed for the Malay Archipelago to investigate the flora and fauna in the monsoon southeast Asia. His extensive studies of biodiversity led him to divide the world into six distinct "biological regions". The Himalaya is a border zone between two such biological regions - the "Palearctic" region (the temperate Eurasia) to the north and the "Oriental" region (the tropical southeast Asia). Understanding the dynamics, habitat, and evolution of floral and faunal life in the Himalayan zone is of scientific significance, and protection of this crucial geoecological region should be considered as a global task. (I am making this remark with all due to respect to the native peoples of the Himalaya. It should not imply that the Himalayan lands do not belong to the Himalayan peoples. Indeed, we need to learn a lot from indigenous knowledge as how to protect the Himalayan environment. A harmonious life with nature is the last thing that Himalayan subsistence farmers want to learn from urban intellectuals, be them from New York or New Delhi.)

These examples were taken from the Himalayan research studies during the 19th century. I deliberately focused on the 19th century to point out another aspect of Himalayan research. During the British Raj, studies in the Himalaya and south Asia were motivated largely by economic and political aspirations of the British East India Company and the British Empire. For example, the original idea behind the establishment of the Geological Survey of India in Calcutta in 1851 was to explore India's coal reserves in order to develop the Great Indian Railway system. Or the plan of establishing the Botanical Garden in Calcutta in 1787 owed its origin to the need for growing Burma Teak on the banks of the Hooghly river for ship-building purposes (Kumar, 1991). Moreover, in those days field work in the Himalaya was far more difficult than in our time. Nevertheless, studies in the Himalayan region and south Asia proved to be much more than Utilitarian and contributed significant knowledge to the sciences. Why? There are two main reasons for this. Firstly, because the Himalayan region has high potentials for unraveling the clues to the machinery and evolution of the earth and environment. Secondly, because pioneering Himalayan researchers in those days tried to derive notions and interpretations from their own observations rather than merely applying to the Himalaya the concepts originated in other regions of the world. This latter point is quite important for present-day Himalayan research (both in natural and social sciences) because Himalayan research is increasingly becoming an international enterprise, with researchers coming from various countries and theoretical backgrounds. The Himalaya possess high potentials for scientific discoveries, but only if researchers try to collect high quality data and make inferences from their observations; a mere application of concepts and models derived from other regions would simply reduce the Himalaya to a "second-rate" field of research. This statement should not be taken as a denial of comparative mountain studies (which are very useful indeed), but an emphasis on the "let the Himalaya speak for itself" approach to Himalayan research.

Concluding Remarks

This article attempted to place various fields of Himalayan research in a regional, integrative context, termed as Himalayan Science. The emphasis was on natural sciences and relevant aspects of social sciences. Some classic examples of Himalayan contributions to science were presented. Appreciation of the scientific importance of the Himalayan region has increased in our century. While Himalayan studies during the 19th century was largely motivated by what Rudyard Kipling called the "Great Game" of Britain and Russia to expand their political and economic frontiers in south Asia, the Himalayan region is now increasingly drawing researchers due to its own scientific merits and potentials (Sorkhabi, 1996). The plate tectonic theory has recognized the Himalaya as a "type example" of continent-to-continent collisional mountain. The effects of the Himalaya on the monsoon wind system and ecology of Asia is another area of active research. The pioneering work of Carl Troll and his student Ulrich Schweinfurth on the altitudinal zonation of the Himalayan mountains with regard to vegetation and climate (a field of research Troll called "geoecology") has brought to light the importance of botanic geography of the Himalaya. Recent studies show that the glaciers of high mountains in the Tibetan region are sensitive indicators of global climatic warming. The concepts of sustainable mountain development and hazard mapping in mountainous regions has highlighted the importance of the Himalaya to tackle many

important issues related to both mountain environments and mountain societies (see Ives and Messerli, 1989, for detailed discussion). We can add to this list many other instances highlighting Himalayan research. In short, the Himalaya provide unique opportunities for studying how mountains of similar type on earth form, how they affect the biotic environment, how they are affected by human activities, and so on. "This implies," to quote Barbara Ward and Réne Dubos "cooperative monitoring, research and study on an unprecedented scale. It implies an intensive world-wide network for the systematic exchange of knowledge and experience." A Himalayan Science with an organized community is only a logical conclusion.

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