

## **A Perspective on Global Change and Mountain Lowland Regions The Need for an Intergrated Approach**

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At the very outset I take the opportunity to express my sincere gratitude to the office bearers and members of the Institute of Indian Geographers for electing me president for 2005-2006 and giving me the privilege to address the 27th Annual Geography meet at Jammu in an atmosphere of unique foothills of the Himalayan Mountain beauty and grandeur of the river Tawi. I consider my election as president of the 27th IIG as a token of recognition of the modest contribution made by my colleagues and young scholars in the Department of Geography, University of Rajasthan, Jaipur during last two decades, particularly in the field of physical geography and geo-environmental studies. I am conscious of my limitations, when I recall the distinguished senior geographers like Prof. K.R. Dikshit, Prof. S.C. Gupte, Prof. C.D. Despande, Prof.N.B.K. Reddy, Prof. R.D. Dikshit, Prof. K.N. Singh, Prof. P. Nag, Prof. Bireshwar Banerji, Prof. Sawarnjeet Mehta, Prof.S.D. Sinde & Prof. H.S. Gupta who held this position before me and contributed significantly and nurtured this Association.

The Institute of Indian Geographers (IIG) has completed 27 years in the service

of geography and its life membership has increased to more than 700, covering all parts of the country. It is indeed a matter of immense satisfaction that the IIG journal "Transaction" has been rated as one of the best journals in the country. I am confident that it will attain greater heights in the years to come.

I am grateful to the Vice Chancellor, Prof. Amitabh Mattoo, Prof. M.N. Koul, Dr. V.S. Manhas, Prof. G.B. Singh, Dr. R.P. Sharma and their colleagues for hosting 27th IIG at Jammu University, Jammu and provide us an opportunity to renew our contacts and exchange views on geographical issues in general and the Himalayan region in particular.

I found myself at first in a little difficulty to decide upon a topic that would be appropriate for the occasion. It seemed most natural to speak on physical geography with which I was specially conversant. But this was perhaps too restricted a view to take for such an august gathering as the present one in which geoscientists are represented and I sought for some general questions that might interest you. Yet when I began to

venture into the realms that were not my own I felt a certain trepidation since specialization now makes it very difficult for an ordinary person to speak without danger of tripping in any subject but his own. Eventually I decided not to roam too far, untrammelled by that strictly professional knowledge which many of you here possess in your own specialization and, still within the safe bounds of my own general territory, to give you a brief sketch of a nature of global environmental change with special reference to the highland/lowland systems. It also fits in the focal theme of the Meet.

### **The Human-nature Relationship**

Man has been interacting with the environment right from the primary stage of human development and continues to do so in this stage of nuclear technology. The interactions between environmental change and human societies have a long and complex history, spanning many millennia. They vary greatly through time and from place to place. Despite these spatial and temporal differences, in recent years a global perspective has begun to emerge that forms the frameworks for a growing body of research within the environmental sciences. As the emergence of this perspective two fundamental aspects of the nature of the planet have emerged

- The first is that the Earth itself is a single system, within which the biosphere is an active, essential component.
- In terms of a sporting analogy, life is a player, not a spectator.
- Second, human activities are now so pervasive and profound in their conse-

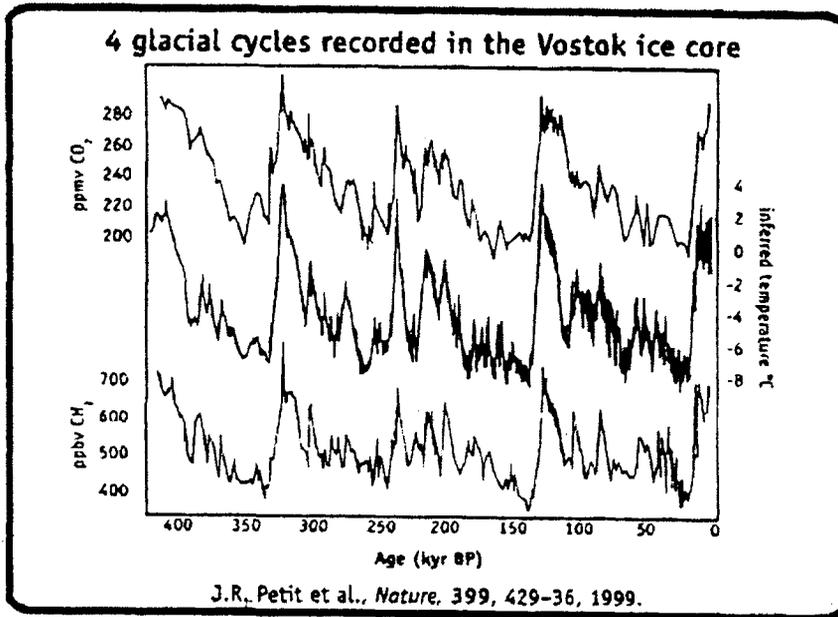
quences that they affect the Earth at a global scale in complex, interactive and accelerating ways ; humans now have the capacity to alter the Earth systems in ways that threaten the very processes and components, both biotic and abiotic, upon which humans depend.

### **The Earth as a System**

The fact that the Earth behaves as a single, interlinked, self regulating system was put into dramatic focus in 1999 with the publication of the 420,000 year record from the Vostok ice core (Petit et.al 1999). These data are arguably among the most important ones produced by the scientific community in the 20th century. These provide a powerful temporal context and dramatic visual evidence for an integrated planetary environmental system (Fig. 1).

The Vostok ice core data indicates three striking characteristics which demonstrate undoubtedly that the Earth is a system

- The temporal dynamics of global temperature and of the global carbon cycle, as represented by the atmospheric concentration of the trace gases carbon dioxide ( $\text{CO}_2$ ) and methane ( $\text{CH}_4$ ), are tightly coupled and show very similar pattern throughout the record..
- The main maxima and minima of temperature and atmospheric trace gas concentration follow a regular pattern through time, each cycle spanning approximately 100,000 years.
- The range over which temperature and trace gas concentrations varied is bounded at upper and lower limits ; the values fall recurrently within the same



**Fig. 1:** The 420,000 year Vostok ice core record, showing the regular pattern of atmosphere CO<sub>2</sub> and CH<sub>4</sub> concentrations and inferred temperature through four glacial-interglacial cycles. The upper and lower bounds of all three variables are tightly constrained. These features are typical of a self-regulating system.

envelope through four cycles of the Earth System over the last half million years.

### Global Change

Global environmental change is now one of the biggest challenges facing mankind, and has captured the attention of scientists, policy makers and the public at large. As a developing country with rapid industrial and economic growth, India is experiencing widespread environmental pressure due to escalating demands on its natural resources. Fresh water shortage desertification, soil degradation and other environmental problems are becoming increasingly common. These problems are mostly related to an-

thropogenic activities, especially industrialization and urbanization and hence are likely to strongly affect social and economic sustainability of India. Importantly, these environmental problems are not only regionally but also globally significant. In recognition of this situation several global environmental change programmes and projects have been established in India and are contributing to international global environmental change programmes of IGBP.

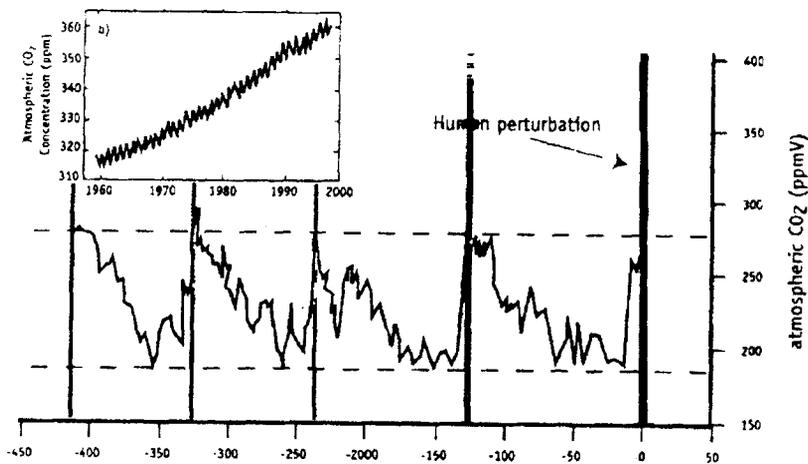
Over the past few decades, evidence has mounted that planetary-scale changes are occurring rapidly. These are, in turn, changing the patterns of forcings and feedbacks that characterise the internal dynamics of the Earth System. Key indicators, such as the concentrations of CO<sub>2</sub> in the atmo-

sphere, are changing dramatically, and in many cases the linkages of these changes to human activities are strong. It is increasingly clear that the Earth System is being subjected to an ever-increasing diversity of new planetary-scale forces that originate in human activities, ranging from the artificial fixation of nitrogen and the emission of greenhouse gases to the conversion and fragmentation of natural vegetation and the loss of biological species. It is these activities and others like them that give rise to the phenomenon of global change.

### Role of the Biosphere

Biological Processes Interact strongly with physical and chemical processes to create the environment which keeps the Earth habitable for life. The more the functioning of

the Earth System is examined in detail, the greater is the realisation of the role played by life itself in helping to control the System. For example, biological processes contribute significantly to the absorption of atmospheric  $\text{CO}_2$  in the surface layer of the ocean, thereby allowing more  $\text{CO}_2$  to dissolve from the atmosphere. About 25% of the carbon fixed by phytoplankton in the upper layers sinks to the interior, where it is stored away from contact with the atmosphere for hundreds or thousands of years. This biological pump, along with physico-chemical constraints on the solubility of  $\text{CO}_2$  control the pattern of  $\text{CO}_2$  exchange between the oceans and the atmosphere. Intriguingly, the nature of the phytoplankton species involved in the biological pump may hold a key to the rate of and potential for carbon storage.



Sources: Petit et al (1999) Nature 399, 429-436 and National Oceanic and Atmospheric Administration (NOAA), USA

**Fig.2** Atmospheric  $\text{CO}_2$  concentration from the Vostok ice core record with the recent human perturbation superimposed. The inset shows the observed contemporary increase in atmospheric  $\text{CO}_2$  concentration from the Mauna Loa (Hawaii) Observatory.

## Drivers of Change

Over the past two centuries, both the human population and the economic wealth of the world have grown rapidly. These two factors have increased resource consumption significantly, evident in agriculture and food production, industrial development, international commerce, energy, production, urbanisation and even recreational activities. These are just some of the enterprises transforming the Earth System.

Around 6.15 billion people inhabit the globe at present. All share basic human needs, such as the demand for water, food, shelter, community health and employment. The ways in which these needs are met are critical determinants of the environmental consequences at all scales (Table 1).

In the developed world affluence, and more importantly the demand for consumer goods for entertainment, for mobility, for communication and a broad range of goods and services, is placing significant demands on global resources. Between 1970 and 1997, the global consumption of energy increased by 84% and consumption of materials also increased dramatically. While the global population more than doubled in the second half of the last century, grain production tripled, energy consumption quadrupled, and economic activity quintupled. Although much of this accelerating economic activity and energy consumption occurred in developed countries, the developing world is beginning to play a larger role in the global economy and hence is having increasing impacts on resources and environment.

Over the past three centuries the amount of land used for agriculture has increased five-fold. Furthermore, large areas of land area have been lost to degradation, due to, for example, soil erosion, chemical contamination and salinisation. Although the increase in agricultural yields due to application of fertilisers, pesticides and irrigation has been of essential benefit to humankind, the negative consequences for the Earth System have been considerable. These include major alterations to ecosystem functioning, interference in the nitrogen and phosphorous cycles, changes of species diversity, loss of soil organic matter and soil erosion. Changes in marine ecosystem as a result of human activities are no less significant.

As the 21st century unfolds, population, development, affluence, and technology are set to interact in ways that will have important implications for the Earth System. Unless many of the trends of the 20th century are slowed significantly or reversed, the pressure on the planetary environment will increase even further. Strategies will have to be found to ensure the sustainability of the Earth System while accommodating economic and social development.

It is now clear that human driven changes are pushing the Earth System beyond its natural operating domain into planetary terra incognita. Management strategies for global sustainability are urgently required. Earth system science is the key for implementing any approach towards good planetary management as it can provide critical insight into the feasibility, risks, trade off and timeliness of any proposed strategy.

**Table 1. Proximate and underlying drivers of human transformation of Earth**

<b>Compartments/Cycle Transformed</b>	<b>Proximate Driver</b>	<b>Underlying Driver</b>
Land	Clearing (cutting forest, + burning), agricultural practices (e.g. tillage, fertilisation, irrigation pest control, highyielding crops etc.), abandonment.	Demand for food (+dietarl preferences), recreation, other ecosystem goods and services.
Atmosphere	Fossil fuel burning, landuse change (e.g., agricultural practices), biomass burning, industrial technology.	Demand for mobility, consumer products, food.
Water	Dams, impoundments, reticulation systems, waste disposal techniques, management practices.	Demand for water (direct human use), food (irrigation), consumer products (water susage in industrial processes).
CoastallMarine	Land-cover conversion, groundwater removal, fishing intensity & technique, coastal building patterns, sewage treatment technology, urbanisation.	Demand for recreation, lifestyle, food, employment.
Biodiversity	Clearing of forest/natural ecosystems ; introduction of alien species.	Demand for food, safety, comfort, landscape amenity.

**Table 1.** Proximate and underlying drivers of human transformation of Earth, Proximate drivers are the immediate human activities that drive a particular environmental change; underlying drivers are related to the fundamental needs and desires of individuals and groups. Proximate and underlying drivers are the end points in a linked sequence with numerous intermediate linkages markets, institution, infrastructure, policy, political systems, cultural values.

**The Nature of Global Change and Anthropogene Era**

Until very recently in the history of Earth, humans and their activities have been an insignificant force in the dynamics of the Earth System. Today, humankind has begun

to match and even exceed nature in terms of changing the biosphere and impacting other facts of Earth System functioning. The magnitude, spatial scale, and pace of human-induced change are unprecedented. Human activity now equals or surpasses

nature in several biogeochemical cycles. The spatial reach of the impacts is global, either through the flows of the Earth's cycles or the cumulative changes in its states. The speed of these changes is of the order of decades to centuries, not the centuries to millennia pace of comparable change in the natural dynamics of the Earth System.

The extent to which human activities are influencing or even dominating many aspects of Earth's environment and its functioning has led to suggestions that another geological epoch, the **Anthropocene Era** has begun

- in a few generations humankind is in the process of exhausting fossil fuel reserves that were generated over several hundred million years
- nearly 50% of the land surface has been transformed by direct human action, with significant consequences for biodiversity, nutrient cycling, soil structure and biology, and climate;
- more nitrogen is now fixed synthetically and applied as fertilizers in agriculture than is fixed naturally in all terrestrial ecosystems;
- more than a half of all accessible freshwater is used directly or indirectly by humankind, and underground water resources are being depleted rapidly in many areas;
- the concentration of several climatically important greenhouse gases, in addition to CO<sub>2</sub> and CH<sub>4</sub>, have substantially increased in the atmosphere;
- coastal and marine habitats are being dramatically altered; 50% of mangroves have been removed and wetlands have shrunk by one-half;

- about 22% of the recognized marine fisheries are overexploited or already depleted, and 44% more are at their limit of exploitation; and
- extinction rates are increasing sharply in marine and terrestrial ecosystems around the world; the Earth is now in the midst of its first great extinction event caused by the activities of a single biological species (humankind).

### **Global Change and Mountain Regions**

Mountain regions occupy about one-fourth of the Earth's surface, they are home to approximately one tenth of the world's population and provide goods and services such as water, forest products, refugia for biodiversity, storage of carbon and soil nutrients, and unspoiled recreation areas to more than half of humanity. Accordingly, they received particular attention in 'Agenda 21' (Chapter 13, Managing Fragile Eco-systems), a programme for sustainable development into the 21st century adopted by the United Nations Conference on Environment and Development (UNCED) in June 1992 in Rio de Janeiro, and more recently by the UN declaration for the year 2002 as the "International Year of Mountains". In recognition of the sensitivity of mountain environments, and the consequences that changes in these environments might have caused for humanity, the scientific community has responded in recent years with a more focussed interest in global change research in mountain regions. Regional, national, and even global research initiatives are now concentrating their attention on mountain areas and are, in many cases, initiating cooperative efforts.

## The Himalayan Mountain System

The Himalayas literally means the 'abode of Snow' have been revered as "an abode of God". The snow covered high peaks of the Himalayas are the source of the perennial rivers of Indo Gangetic Plains. The fact that the Himalayas are the life line of India and influence the monsoon in India and its agrarian economy. The Himalayas constitute as one of the most dynamic blocks of the earth's crust. They extend in the form of an arc for a length of about 2400 km from Nanga Parbat in the North-Western Kashmir to Namcha Barwa in Arunachal Pradesh. The average width of the Himalayas is 240 km., which has been divided into three longitudinal zones; from north to south Tethyan Himalayan Zone, central crystalline zone of the Higher Himalaya and Lesser Himalayan Zone (Ravindra Kumar, 2006).

It would be appropriate to mention that uplift of mountains is caused by the interplay of tectonics, climate and rates of erosion. Erosion leads to passive, isostatic uplift and the tectonic pressure results in uplift and an increased rate of erosion. Erosion rates are- also governed by the climatic conditions. In the absence of sufficient data on denudational rates and uplift chronologies in the Himalayas, it is difficult to distinguish between features related to relative significance of tectonics and climate (Ravindra Kumar 2006).

The studies indicate that in the last two decades the environmental status has changed alarmingly resulting in accelerated soil erosion, sediment transportation, siltation, landslides, drying up of lakes, dams surface water resources and lowering of water table. These regions are now approaching the category of a critical zone

from the point of view of water resources and biodiversity.

The massive and wide spread retreat of the Himalayan Glaciers, particularly (Gangotri) highlights the impact of global climate change at high elevations and the consequences for lowland agriculture, hydro electric power, mitigation of natural hazards and ecotourism. The Himalayas not so long ago were layered sequentially by different species of trees at different elevations until the snowline beyond which was eternal snow and barren (rugged) rocks. But now, look at the Himalayas, which once had dense forests and prowling tigers and other herbivorous and carnivorous now stands naked, devoid of the rich flora and fauna which clothed it.

In our greed and avarice, we have stripped naked the mighty Himalays. The devastating floods and earthquakes are warming signals. With accelerated soil erosion, agriculture has become less remunerative. The sacred rivers and their tributaries in the low land system have already become sewers carrying the effluents. So is the case with other mountains and high lands of this great country.

## Global Change and Land use/ Land cover Change - A case of Indogangetic Plains

The Indo-Gangetic Plain is a deep crustal trough filled with quaternary sediments. It is closely related with the rise of the Himalayas (Singh 1996, Agrawal *et.al* 2002). Maximum thickness of the sediments is encountered in the northern parts of the IndoGangetic Plain. It is one of the most extensive fluvial plains of the world, consists of rich fertile alluvium from the Indus and the Ganges river systems. The Indian

portion of IGPR extends over an area 1600 km by 320 km reaching from the Indus delta in the west to the Ganges delta in the east and comprising around 21% of the total area of the country. It broadly includes the states of Punjab, Haryana, U.P., Bihar and West Bengal and is home to 40% of India's population. More than 70% of the districts of the Indian IGPR are under agriculture. The dominant rice wheat cropping system in this sub region has been a major contributor to the 'Green Revolution' in India, providing close to the half of the Indian food grain production.

The study of Abrol Y. P. et al (2002) reveals that major historical land cover changes in the IGPR include conversion of fallow land and scrub to agriculture, agriculture and wastelands to settlements or urban areas, and both creation and loss of wetlands. The study further reveals that the major land use intensifications relate to cropland and include. 1) an increase in irrigated cropland, 2) an increase in the area under high yielding variety, 3) an increase in cropping intensity, 4) an increase in fertilizer application, 5) changes in cropping pattern, 6) increased mechanization and 7) crop residue / biomass use for fodder and fuel.

Many of these changes are interlinked and have been driven by a number of technological, policy, socio-economic and biophysical factors.

A very scientific study of long term historical land use changes and their impacts on the agro-ecosystem, carbon cycle in Indian IGPR states, estimated an increase of 435.6 Mt. in crop biomass for the period 1901-1991 by Dadhwal and Chhabra, (2002). The study reveals that the estimated

total 1990 CO<sub>2</sub> emission from energy, industrial, agriculture, waste and land use change and forest sectors are 585 Tg for Indian IGPR states compared to 76.1 and 39.9 Tg for Pakistan and Bangladesh respectively (Algas, 1999). A district level analysis of five major Indian IGPR states estimated the total CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emission in 1995 as 211.3, 5.8 and 84.8 Gg respectively (Garg A. et al 2001).

Large scale historical land use / land cover changes in the IGPR resulting in increased carbon flux to the atmosphere have drawn the interest of the international scientific community. It has become necessary to understand the fundamental patterns and processes of land use / land cover changes taking into account the biophysical, socio-economic and development factors that drive them in this agriculturally dominant and rapidly changing region. It is the most dominant area in which geographers can collaborate with the international scientific community.

### **Why Focus on Mountains? Scientific Rationale**

From a scientific point of view, the strong altitudinal gradients in mountain regions often provide the best and sometimes even unique opportunities to detect and analyse global change processes and phenomena, because

1. meteorological, hydrological, cryospheric and ecological conditions change strongly over relatively short distance. Accordingly, biodiversity tends to be high, and characteristic sequences of ecosystems and cryospheric systems are found along mountain slopes. The boundaries between these

systems (e.g. ecotones, snowline, glacier boundaries, etc.) are often climatically sensitive and may experience rapid shifts due to environmental change and thus can be used as indicators;

2. the higher parts of many mountain ranges are not affected by direct human activities and may serve as locations where the environmental impacts of climate change alone, including changes in atmospheric chemistry, can be studied ;and
3. mountain regions are distributed all over the globe, from the equator almost to the poles and from oceanic to highly continental climates. This global distribution provides unique opportunities to carry out comparative regional studies from widely separated parts of the globe and to analyse the regional differentiation of environmental change processes.

Related to the changing environmental conditions along mountain slopes, changes also occur in socio-economic conditions, land-use and land-management practices, resource exploitation and the appeal of mountain regions for tourism. Unsustainable management practices may lead to the deterioration of the living conditions to the point where migration processes are intensified; some mountain areas become depopulated whereas others become over populated. Such processes have a number of strong and mostly negative side effects.

### **Environmental Problems in Mountain-Regions**

Ten years ago, Chapter 13 of the, Agenda 21 document acknowledged the important

role of global change issues in mountain regions by pointing out the mountain environments as essential to the survival of the global ecosystem and many of them are experiencing degradation in terms of accelerated soil erosion, landslides, and rapid loss of habitat and genetic diversity. The seriousness and magnitude of these environmental problems in mountain regions have not abated over the last decade, and in many cases, they have been exacerbated by compounding issues. Consequently, the statements made at the 1992 United Nations Earth Summit in Rio are, unfortunately, just as valid today as they were a decade ago. The traditional perception that mountains represent pristine systems completely isolated from human impact and only marginally connected to economic, political and cultural centers of

influence is rapidly becoming outdated. For example, the massive and wide spread retreat of alpine glaciers highlights the impact of global climate change at high elevations and the consequences for lowland agriculture, hydroelectric power, mitigation of natural hazards and ecotourism. Similarly, greater physical, administrative and market integration of mountain and upland agriculture with mainstream systems has fundamentally altered local resource management strategies leading to resource use intensification and over exploitation. Threatened by the increasingly global, scale of both systemic (impact environments at global scale) and cumulative (operate at local scale but are becoming globally pervasive) human impacts, many mountain systems are moving along a trajectory that fits clearly within the rubric of critical regions. Critical regions are places where high rates of environmental change are manifest in fragile ecosys-

tems coupled with economies strongly dependent on local environmental resources and limited response capability.

### **Globalisation and Mountain Regions**

An additional source of change in mountain environments is related to the process of globalisation, i.e. the growing global integration of social, political and economic relationships.

Globalisation as it affects mountain environments is reflected in demographic changes, the incorporation of mountain economies into extra-regional economies, the increasing influence of urban processes and perspectives, increases in consumption, and changes in the location of decision-making and institutional arrangements. For the next few decades, globalisation processes are likely to be at least as important as environmental changes as factors promoting change in mountain regions. At the same time, however, the cumulative and systemic environmental changes may significantly threaten the ability of mountain regions to provide the critical goods and services, both to mountain inhabitants and to supply the extra regional demands of other communities.

### **Inter Disciplinary Research Needs in Mountain Regions**

Considering the fragility of mountain environments, the complex network of factors, both physical and socio-economic, that may impact these environments, and the substantial direct and indirect consequences that changes in mountain regions may have on humanity, it is clear that an integrated approach to addressing these issues is urgently

required. For example, human-water interactions are global change issues that will very likely become critical in coming decades. Some mountains in arid and semi-arid regions provide more than 80-90% of the water resources to the surrounding, lowlands for irrigation, drinking water, industry and domestic use. Bearing in mind that approximately 60-70% of current freshwater resources is currently used for food production, and that the complex issue of food security is very likely to become quite important in the 21 st century, effective water management strategies will need to consider a broad range of issues and consequently, will require a focus on mountain regions, and will require input from both physical and social sciences.

An integrative approach for global change research in mountain regions should consist of a series of coordinated experimental, observational, and modeling studies, with the aims of detecting and articulating the consequences of global environmental change and informing policy processes at local to global scales. A number of global change research programmes are ongoing in mountain regions and many of these are intensifying and exploring avenues for collaboration and integration. Such initiatives include the Global Mountain Biodiversity Assessment (GMBA), the Global Observation Research Initiative in Alpine Environments (GLORIA), the Mountain Module of the Terrestrial Ecosystem Monitoring System (TEMS) of the Global Terrestrial Observing System (GTOS), and the Mountain Research Initiative (MRI), a joint effort of IGBP, IHDP, and GOTS.

In order to address the consequences of global change in mountain regions an initiative on global change and mountain

regions - the Mountain Research Initiative (MRI) was developed in 2001 under the IGBP. The core objectives of the initiative are to

- 1) develop a strategy for detecting signals of global environmental change in mountain environments; and
- 2) to define the consequences of global environmental changes for mountain regions as well as low land systems dependent on mountain regions at local to regional scales.

To achieve the above objectives, the research under the MRI has been structured under four activities:

- 1) Long term monitoring and analysis of indicators of environmental change in mountain regions.
- (2) Integrated model based studies of environmental changes in different mountain regions.
- (3) Process studies along altitudinal gradients and associated head water basins.
- (4) Sustainable land use and natural resource management.

Mountain/Lowland regions provide unique and valuable settings in which to study the specific facets of environmental changes, their regional consequences, and resource management strategies to mitigate these consequences. This conclusion is not all inclusive in itself, as the value of mountain/lowland, regions as sites of scientific inquiry has long been recognised. However, the vast majority of work to date has not been able to structure or facilitate a synthetic understanding of the interactions between climate, land activities, taking into account the specific conditions in mountain/lowland

environments. At present, the relevant tools and observations often suffer from mismatches in scale and gaps in coverage. The rationale for an initiative on “Global Change and Mountain Regions” thus rests on the potentially large payoff of a strategy that links mountain regions of the world as sites for monitoring and understanding the processes of change as well as places where a predictive understanding of the consequences of change is critical for sustaining land and water resources. The proposed activities of the Mountain Research Initiative will contribute not only to the scientific understanding of the ongoing processes of change, but ultimately also lead to suggestions for actions directed at preserving the ability of mountain regions to sustainably provide the goods and services on which humanity has come to depend.

As humanity and the planet Earth enter the 21st century, it is clear that the relationship between the two must change. We are rapidly approaching important crossroads that require significant choices to be made. Business as usual is no longer an option for many of the world’s environments, and mountain/lowland regions are not an exception. As we approach these crossroads, it is clear that global change research in mountain/lowland regions will become increasingly important in the coming decades. The Amsterdam Declaration signed by more than 800 scientists at the IGBP OSC meeting in July, 2001 states that the accelerating human transformation of the Earth’s environment is not sustainable and that a new system of global environmental science is required that will integrate across disciplines, environment and development issues and the natural and social sciences. This is particularly true for global change research

in mountain/lowland regions given the sensitive and complex nature of the relationship between mountain/ lowland environments and the people who inhabit and are dependent upon them.

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