MOUNTAINS WITNESSES OF GLOBAL CHANGES
RESEARCH IN THE HIMALAYA AND KARAKORAM: SHARE-ASIA PROJECT
DEVELOPMENTS IN EARTH SURFACE PROCESSES

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MOUNTAINS WITNESSES OF GLOBAL CHANGES
RESEARCH IN THE HIMALAYA AND KARAKORAM:
SHARE-ASIA PROJECT

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Foreword

This new volume on *Mountains, Witnesses of Global Changes* in our book series, *Developments in Earth Surface Processes*, is a departure from our dominant focus on geomorphology in that we address here a predominance of atmospheric and environmental factors in some alpine environments, particularly those of the Himalaya. Inasmuch as many of these atmospheric and environmental processes directly or indirectly interact with, control, or are controlled by landforms of the high mountains, the linkages of the papers of this book with the underlying geomorphological themes of our book series are obvious. These linkages are especially exemplified by the great snow and ice resources of the Himalaya, the sources of the downstream melt-waters that are so vital to the millions of people who depend upon such waters for irrigation throughout the region. Any major disturbance to the westerly and monsoon sources of such an elemental product of atmospheric processes must be scientifically assessed with very great precision and originality in order to be better able to forecast future changes.

Anthropogenic and natural aspects of global change, including climatic warming from buildup of greenhouse gases and global dimming from aerosol emissions, are climate forcings of commonly opposite sign that complicate interpretations. Issues of effects on the hydrological cycle are paramount, especially in South and East Asia where billions of people live. Most simply, climate warming alone could lead to melting away of small glaciers, with concomitant decrease in vital melt waters downstream. But increased heating over oceans could lead similarly to greater evaporation and increased monsoonal precipitation over land, thus potentially leading to glacier growth. Similarly, certain aerosols can absorb solar radiation and increase warming, while others reflect incoming solar radiation, or increase cloud cover to cool the Earth’s surface. Increased clouds can increase precipitation, but aerosol-induced clouds have smaller droplets that reduce precipitation. Thus, strong questions of the direction of future change exist that must be addressed by robust research and new methods of data collection.

The Himalaya, the so-called ‘water towers’ of Asia, is marked by a great paucity of primary data collection points that can be used for predicting future trends. The Chinese government, however, has recently established the world’s highest climate station, at an altitude of 5200 m, on the Tibetan side of Mount Everest (Qomolangma in Chinese; Sagarmatha in Nepali). Forty more automatic and satellite-linked weather stations across Tibet will aid greatly in data collection across this roof of the world. Coupled with the new data-collecting sites described in the volume herein, much better forecasting tools will become available. But because of the state of adversity between India and Pakistan, hydrological forecasting south of the Himalayan chain is regarded as a classified strategic asset by both countries. This short-sighted treatment of what would normally be treated as the common resource heritage of humankind is
a reflection of only some of the difficulties faced by scientists in the region. As the competition for water heats up in this new century the reshaping of national economies and new geopolitical alliances will likely result. Thus, the importance of research in mountains as witness of global change could not be greater. It is the business of this book to offer some insights to facilitate such inquiries.

This book is divided into the five main sections that were the divisions of the conference in Rome sponsored by the Government of Italy in November 2005; atmospheric brown clouds (ABC), the Italian Ev–K²–CNR Committee in Project ABC, SHARE – Asia (Stations at High Altitude for Research on the Environment of Asia) scientific fields of atmospheric physics and chemistry, and global change, environmental indicators of global changes, and commitments to environmental monitoring at altitude in Asia. The 35 papers presented here are by some of the scientists who are expert in various aspects of the high-altitude environments of South Asia and elsewhere. Several of the papers are presented only as abstracts because their authors chose not to contribute longer versions of their work; we included these for a sense of completeness from the original conference.

The overall impression one is left with after reading over these works is that impressive understandings of environmental changes in the mountains of South Asia and elsewhere in the world have been acquired, but that far more needs to be done. Issues of atmospheric pollution, changes to alpine lakes, shrinking glaciers, diminishing water supplies, and other related problems are clearly presented in these papers. The future may be grim for some people in the mountains of the world unless attention is brought to bear upon some of these problematic issues and solutions sought.

Like the proverbial canary in the coal mine, the harsh environments of high alpine terrains are quite delicate enough to show changes as a kind of natural early-warning system, have we but the wit to observe and understand such changes as they happen. By dint of careful long-term monitoring, we scientists of the mountains of the world hope to alert the world’s people of imminent problems associated with such areas. As one reads through these papers, one may see how the problems are being studied at present, and perhaps one may be helped to greater awareness of possible solutions to problems that are developing. The wider this information is disseminated, the more pointed the future research can become, as people become aware of possibilities. We offer this latest volume in our book series on Developments in Earth Surface Processes as state-of-the-art surficial geoscience in South Asia and a few other mountain areas in hopes that others will be drawn to continue such studies in the magnificent, but changing, Himalaya and other mountains of the world.

John F. Shroder, Jr.
Editor-in-Chief

Developments in Earth Surface Processes
Preface

From an environmental point of view, mountains are particularly sensitive and important for monitoring the state of health of our planet. Only through distribution of meteorological climatological and atmospheric composition monitoring points in mountain regions, coupled with modeling simulations, will we be able to thoroughly analyze complex pollutant transport mechanisms and better understand imminent global changes. The Himalaya–Karakoram Range, because of its elevation and geographic location, represents one of the ideal places for studying long-range pollutant transport systems on a regional scale and for monitoring changes induced by mechanisms that act on a global scale through monsoon circulation.

The Ev–K²–CNR Committee promotes interdisciplinary remote-area research in environmental and the earth sciences. Recently, it launched the project SHARE – Asia (Stations at High Altitude for Research on the Environment in Asia) for development of an integrated system of measurements that will contribute to increasing general scientific knowledge on climatic and pollution-related processes while helping build local capacity for monitoring the relevant phenomena. SHARE – Asia currently includes the Pyramid Meteo Network (PMN), a climate monitoring network founded in 1994 by the Ev–K²–CNR Committee, comprising six stations installed in Nepal’s Sagarmatha National Park (SNP), and two stations in Pakistan on the Baltoro Glacier.

The meeting that generated the papers in this volume was held in Rome on 16–17 November 2005. It was organized by the Ev–K²–CNR Committee and promoted by the Italian National Research Council (CNR) in collaboration with the Italian National Mountain Institute (IMONT). The purpose of the meeting and this book is to highlight the uniqueness of the scientific work of Ev–K²–CNR in important international projects like Coordinated Enhanced Observing Period (CEOP), Atmospheric Brown Clouds (ABC), International Global Atmospheric Chemistry (IGAC), Global Atmospheric Watch (GAW), and Global Land Ice Measurements from Space (GLIMS).

The Ev–K²–CNR Committee thus aims to create a unique opportunity for dialogue between major environmental scientists and experts, highlighting the close relationship between diverse themes with a common thread: in-depth comprehension of the environmental phenomena that are determining the health of our planet.

Renato Baudo, Gianni Tartari and Elisa Vuillermoz
Editors
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Acknowledgments

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We thank all who attended the meetings in Rome and who contributed their technical and organizational efforts to make the meeting and this book come to fruition. Without the direct help of the legions of people who were involved in all these processes, such productive meetings and useful scientific volumes would not be possible.

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# List of Acronyms

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<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>4DDA</td>
<td>Four-dimensional data analyses</td>
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<tr>
<td>AAR</td>
<td>Accumulation area ratio</td>
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<td>ABC</td>
<td>Atmospheric Brown Clouds Project</td>
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<td>ABL</td>
<td>Atmospheric boundary layer</td>
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<td>AERONET</td>
<td>Aerosol robotic network</td>
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<tr>
<td>AGAGE</td>
<td>Advanced Global Atmospheric Gases Experiment</td>
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<td>AGU</td>
<td>American Geophysical Union</td>
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<tr>
<td>AL:PE</td>
<td>Acidification of mountain lakes: palaeolimnology and ecology</td>
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<td>ANN</td>
<td>Artificial neural networks</td>
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<td>AOC</td>
<td>Advisory and Oversight Committee</td>
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<tr>
<td>AOD</td>
<td>Aerosol optical depth</td>
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<td>AOT</td>
<td>Aerosol optical thickness</td>
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<tr>
<td>APN</td>
<td>Asia-Pacific Network for Global Change</td>
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<td>ASM</td>
<td>Asian summer monsoon</td>
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<td>ASTER</td>
<td>Advanced Spaceborne Thermal Emission and Reflection Radiometer</td>
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<tr>
<td>AWSs</td>
<td>Automatic weather stations</td>
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<td>BANG</td>
<td>Bangladesh</td>
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<td>BCR</td>
<td>Community Bureau of Reference</td>
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<td>BENG</td>
<td>West Bengal</td>
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<td>BHUT</td>
<td>Bhutan</td>
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<td>BIHA</td>
<td>Bihar and Jharkhand</td>
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<td>BMRC</td>
<td>Bureau of Meteorology Research Centre</td>
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<td>BOB</td>
<td>Bay of Bengal</td>
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<td>BR</td>
<td>Biosphere reserve</td>
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<td>BS</td>
<td>Bias score</td>
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<td>BTC</td>
<td>Bilateral Technical Committee</td>
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<tr>
<td>CACGP</td>
<td>Commission on Atmospheric Chemistry and Global Pollution</td>
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<tr>
<td>CALIPSO</td>
<td>Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation</td>
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<tr>
<td>CAMP</td>
<td>CEOP (Coordinated Enhanced Observing Period) Asian–Australia Monsoon Project</td>
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<tr>
<td>CCCM</td>
<td>Canadian Climate Centre Model</td>
</tr>
<tr>
<td>CDA</td>
<td>CEOP (Coordinated Enhanced Observing Period) Central Data Archive</td>
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<td>CEM</td>
<td>Epson Meteo Centre</td>
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