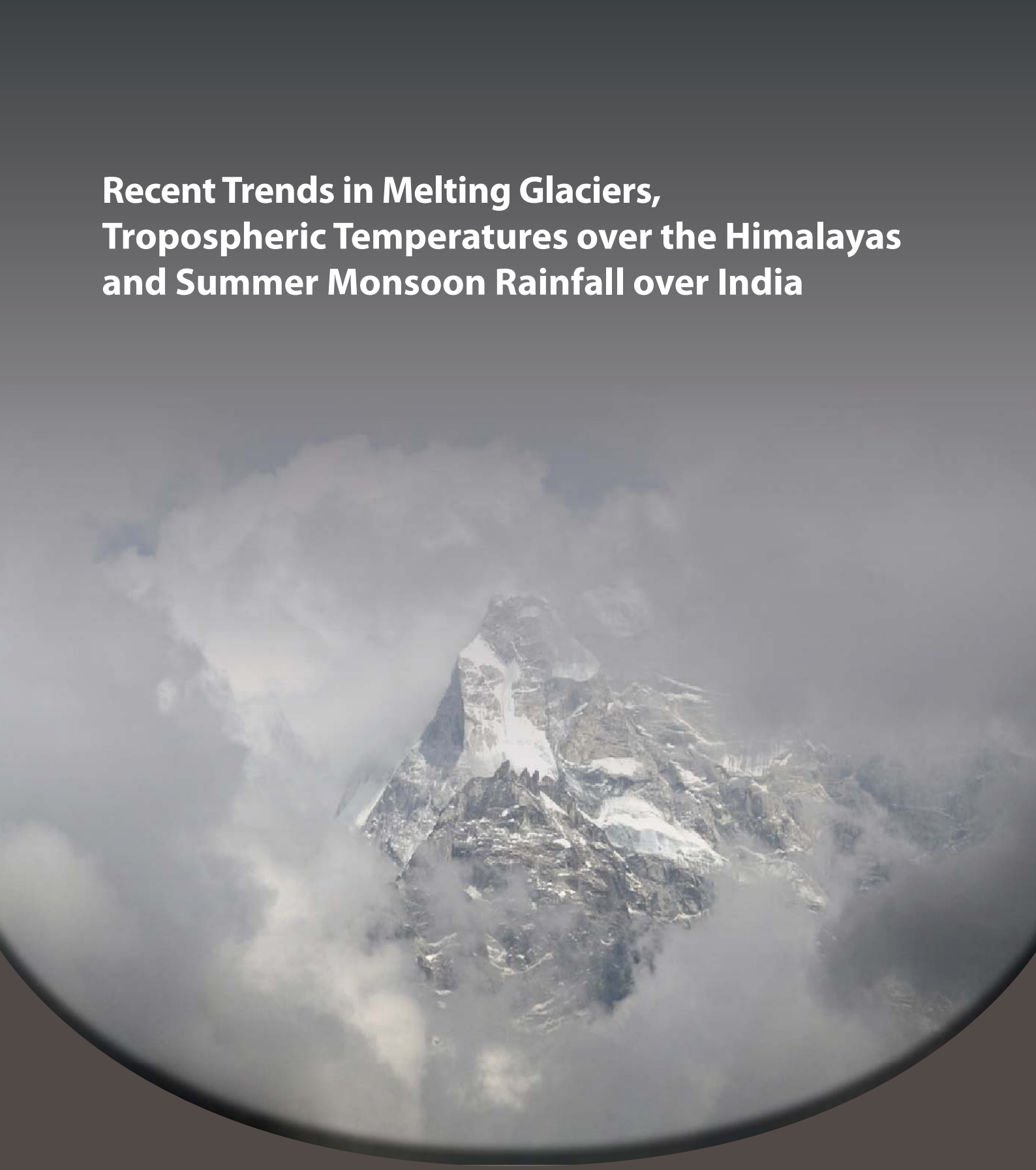
Recent Trends in Melting Glaciers, Tropospheric Temperatures over the Himalayas and Summer Monsoon Rainfall over India



UNEP

United Nations Environment Programme
PO Box 30552, Nairobi 00100, Kenya
Tel: +254 20 7621234
Fax: +254 20 7623943/44
http://www.unep.org

For bibliographic and reference purposes this publication should be referred to as:

UNEP (2009), *"Recent trends in melting glaciers, tropospheric temperatures over the Himalayas and summer monsoon rainfall over India"*
Division of Early Warning and Assessment (DEWA)
United Nations Environment Programme (UNEP)
P.O. Box 30552
Nairobi 00100, Kenya

The following organisations collaborated on this report:

- United Nations Environment Programme (UNEP)
- Institute of Green Economy, India
- The Energy Resources Institute (TERI) University, India
- Sharda University, India

Recent Trends in Melting Glaciers, Tropospheric Temperatures over the Himalayas and Summer Monsoon Rainfall over India

Bernard Goldbach/Flickr.com

Table of Content

Introduction 1

Summary of the International Expert Workshop on "Emerging Issues in Climate Change— State of Tropospheric Temperature, Pollution, Melting Glaciers and their Potential Impact on Monsoon and High Altitude Vegetation in the Himalayas-Tibetan Plateau", December 28-29, New Delhi India 2

Chapter 1: The State of Melting Glaciers of Himalayas and Climate Change 5

The Glaciers in Context 5

Impact of Climate Change 6

Recent findings on current status of the Himalayan Glaciers 10

Glacial Lakes 19

Causes of Glacial Change 20

Reasons for Differing Interpretations 22

Future Impact of Climate Change 24

References 25

Chapter 2: Recent Trends in Tropospheric Temperature over the Himalayas and Summer Monsoon Rainfall over India 28

Himalayas and Monsoons 28

Tropospheric Temperature Trends 30

All-India Monsoon Rainfall 31

References 33

Epilogue 34

Annex 1: Agenda of the International Expert Workshop on "Emerging Issues in Climate Change" 35

Annex 2: List of Participants 36

Acronyms 40

Editorial and Production Team 40

Introduction

There are growing concerns about the impact melting glaciers in the Himalayas will have on about 1.5 billion people of vulnerable densely populated communities in downstream river basins. Yet there is huge uncertainty about how snow and glacial melting in the Himalayan region will continue to respond to climate change, and how such change will affect ecosystems and human well-being. There is a notable lack of available observations in order to make robust quantitative assessments about the significance and extent of the issue. The threat associated with the potential consequences is so great that the scant knowledge must not be an excuse for failing to act. Scientific research is critical to help reduce uncertainty and to underpin sustainable mitigation and adaptation strategies. In this context following are some of the scientific and institutional issues which need to be addressed:

Scientific inquiry

- How much do we know about the changing climate in the Himalayas? Is it changing? Have potential changes been detected in atmospheric/surface temperature trends based on observations from ground and satellite data as well as from model simulations?
- What are the different sources/causes of climate warming over the Himalayas (greenhouse gases, aerosols, black carbon)? Atmosphere-surface feedback is a very important component through which energy exchange takes place. How is the atmospheric forcing altering the important feedback processes in the Himalayas?
- What are the potential and observed impacts on water resources and the regional hydrological cycle, and what are the consequences for humans and ecosystems?
- The Himalayas glaciers and snow pack are known as the 'water tower of Asia'. How are they changing in today's climate in the Himalayas?
- The Monsoon is the region's lifeline and its strength is fundamentally influenced by spring-time warming in the Himalayas-Tibetan Plateau, which acts as an elevated heat source. What is the South Asian monsoon variability response to climate change in the Himalayas and how do they act together?
- How is vegetation in the high altitude responding to the changing climate and how it will impact biodiversity in the region?

Institutional inquiry

- What data and models are available for adaptation planning? How can data sharing within countries and among countries, which is a major issue, are improved?
- How can scientific research be strengthened to promote evidence-based policies?
- What is needed to enhance cooperation among countries in the region to provide early warning information by integrating physical and social sciences?
- What kind of a focused working group could foster important strengthened collaboration among international scientific communities to address various aspects of climate change research in the Himalayas and further guide concerned policymakers?

In order to focus on some of the above issues and assess the current state of the knowledge, an extensive literature search was conducted to develop background documents and an international workshop was organized on 28-29 December, 2010 in New Delhi, India which was attended by 75 experts and 28 technical papers were presented. This report includes the summary of the workshop and a state–of–the–art review of the scientific knowledge on the topics covered.

Due to time constraints it was not possible to go through a peer review process before finalizing the report. There seems to be different figures from different sources on a number of issues which were difficult to reconcile so it was decided to refer to published sources enabling readers to draw their own conclusions.

Dr. Ritesh Gautam of NASA- Goddard Space Flight Center, Maryland USA , Professor Ramesh P. Singh Chapman University, California , Mr. Gyde Lund , Ms. Jane Barr and Dr. Promode Kant generously contributed their time and expertise towards this report. Ms Arshia Chander and Ms Kim Giese helped with editing, lay-out and design of the report at a very short notice.

UNEP SPONSORED INTERNATIONAL EXPERT WORKSHOP ON EMERGING ISSUES IN CLIMATE CHANGE

State of Tropospheric Temperature, Pollution, Melting Glaciers and their Potential Impact on Monsoon and High Altitude Vegetation in the Himalayas-Tibetan Plateau

Dec 28-29, 2009, New Delhi. India

SUMMARY REPORT

Background:

Climate change is affecting the temperatures, amount of snow and ice in the Himalayan region as well as rainfall patterns in the densely populated downstream regions of Asia which would have enormous significance for livelihood and well being of the people of the region. There is a need to prepare the people, institutions and countries of the region to anticipate the consequences of climate change and evolve suitable and cost-effective adaptation responses. However, there is inadequate availability of information on these processes of change making it both difficult to plan appropriate responses and create public opinion in favour of drastic actions that are needed to address the issues.

An extensive literature review was undertaken and an international expert consultation workshop was organised to begin a multi-stakeholder consultation process and assess the current state of scientific knowledge on climate change over the Himalayas, atmospheric and surface temperature trends and the effect of warming on the glaciers and the monsoons, role of aerosols in both moderating and accentuating warming under differing circumstances and the response of high altitude vegetation to climate change. Additionally, the workshop was also expected to recommend steps to encourage more national and international research initiatives in this direction and broaden access to databases, strengthen national capacities in research, monitoring and data sharing for sustainable development in the region and also to create sufficient awareness among public for wider policy and financial support for necessary action.

The workshop was attended by a total of 75 scientists, subject matter experts, academics from universities and specialised institutions from a number of countries, senior government functionaries and representatives of international organizations. The workshop was inaugurated by Dr P J Dilip Kumar, Special Secretary in the Ministry of Environment and Forest, Government of India. A total of 28 presentations were made by the participants on the trends in changes in temperature and precipitation over the Himalayas, contribution of aerosols to these trends, glacier melt and observed and simulated changes in monsoonal patterns. Towards the end of the workshop group discussions were held on four central issues and this summary report is based on the consensus developed during the workshop as reflected in the outcome of the Group discussions as well as discussions during the technical sessions.

The state of melting glaciers

There was no consensus on the changes in nature of ice cover in the Himalayas (including the Tibetan plateau). The main glacial parameters are length, area, volume, mass and thickness and ***the glacier length alone can not be taken as the only parameter that signifies mass balance changes***. In general, the majority of Himalayan glaciers are shrinking in area and thickness and the extent and nature of shrinkage has not changed significantly over the last 100 years. The nature of changes in glaciers are varied and complex with some glaciers exhibiting changes in length in an observational relationship to area and mass while some have changed in length with little change in mass and yet others show changes in thickness but not length. Glacier behaviour varies across the region with higher retreat rates recorded in the east.

Prof. Murari Lal, one of the authors of the Intergovernmental Panel on Climate Change (IPCC) report, said that the IPCC statement that the Himalayan glaciers are likely to melt by 2035 had been made on the basis of a report of the World Wide Fund for the Nature (WWF) 2005 that had quoted Prof Syed Hasnain. He noted that it was wrong to assume, as has been done in sections of media that the year 2035 had crept in the report by mistake. But Prof. Syed Hasnain, who was also present on the occasion, stated that he had never mentioned any such date in his scientific papers purportedly quoted in the WWF report. The workshop participants are of the opinion that the IPCC conclusion that the Himalayan glaciers could melt by 2035 may have to be revised as our understanding of the phenomena has matured since the period of data collection and synthesis for the Fourth Assessment Report of IPCC. The participants, however, wanted to emphasize that this does not, in any way, reduce the need for mitigation of, and adaptation to, climate change that has been initiated by the international community.

Impact of Dust, Black Carbon and Chemical Pollution on Himalayan Glaciers

Causes for climate change over the Himalayas include aerosols with black carbon and dust, deforestation, forest fires, human-induced pollution and many other anthropogenic activities besides the emission of greenhouse gases. The black carbon deposition in Tibetan Himalayas is higher than other places in the northern hemisphere and has been a cause of significant albedo reduction in central Tibetan plateau. Studies in USA indicate that dust-induced albedo decrease could cause early snow melts by as much as 30 days and increased evapotranspiration due to early melt-out may decrease basin runoff by 5 per cent. Similar effects are possible in Himalayas too but there is severe lack of data that precludes drawing of any conclusions on dust and black carbon induced melting of snows. There is little scientific work done yet on the source identification of atmospheric chemical pollutants, their composition and deposition in the Himalayas-Tibetan Plateau. Also, the role of aerosol deposition was realized to be a complex one as its impact on the albedo varies greatly with the type of glaciers. In order to systematically prepare realistic models of all the above sources causing the environmental degradation, there is a need of equipping some of the observatories with devices for collecting related ground and atmospheric observations.

Temperature trends

Ground observations of air temperature measurements show strong spatial and seasonal gradients across the Himalayas-Tibetan Plateau. For example, the atmosphere over the western Himalayas, which contain major glaciers and make headwater to major rivers including the Indus and the Ganges, were found to be associated with enhanced warming trends in the past three decades from the longest record of microwave satellite observations. The two crucial seasons, i.e. the

Potential impact on Monsoon

One of the major issue for deliberation before the Workshop was the likely effect of the changing climate on the monsoons as it would have enormous socio-economic consequences for the Himalayan region and the downstream plains. Clearly more research on the monsoon variability in the changing climate over the South Asian region is needed both over the downstream Plains as well as over the slopes and valley regions of the Himalayas. The all India average monsoon rainfall in the past half century was associated with a neutral-weak negative trend while the early summer monsoon rainfall was showed to be on the rise in the recent past decades. One of the research areas discussed was the impact of aerosols and the phenomenon of the Elevated Heat Pump on monsoon as well.

Data Inadequacy and Access

Lack of sufficient meteorological data from Himalayas has been a major handicap in drawing conclusions on the impact of climate change on the glaciers and snow cover. Multi-sensor satellite coverage of entire Himalayas is essential for a detailed examination of the glacier dynamics and associated phenomena like Glacial Lake Outburst Floods (GLOFs) and this data has to be validated by means of statistically valid field measurements to ensure a complete understanding. Participants felt that it was necessary to have an adequate network of Automatic Weather Stations (AWS) for collecting meteorological data and stated that the costs of setting up and maintaining these AWSs would be manageable if the data generated are made accessible to its many users on a differentiated price basis. The workshop recommended detailed studies on a few representative benchmark glaciers in the four 'glacier zones' of the Himalaya: Afghanistan and Pakistan, NW Himalaya and Karakorum; Central Himalaya including SW Tibet; and Eastern Himalaya including SE Tibet, Nepal, Bhutan and NE India, over a