Report of the 2nd

Third Pole Environment (TPE) Workshop

2010

Kathmandu, Nepal

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TPE Program Office
No. 18 Shuangqing Rd.,
Haidian District, Beijing 100085, P. R. China
www.tpe.ac.cn
Email: tpe@itpcas.ac.cn
Phone: +86-10-62849531

Science Editors: Tandong Yao
Lonnie G. Thompson
Volker Mosbrugger

Managing Editors：Fan Zhang
Xiaoxin Yang

Technical Editors: Daniel Joswiak
Meri Joswiak
Weicai Wang

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Third Pole Environment (TPE) workshop
Kathmandu, Nepal
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PREFACE

A continuation of the 1st Third Pole Environment (TPE) Workshop held in Beijing in August, 2009, the 2nd TPE Workshop witnessed a 3-day exchange of academic presentations and discussions aimed at strengthening knowledge of Third Pole environment related science activities during the past year, while planning for continued and intensified collaboration amongst scientists and scientific projects.

The hosting of the 2nd TPE workshop at Kathmandu was proposed and agreed upon during the 1st workshop at Beijing, 2009. It gained considerable support from academic institutions, and attracted sustained attention from international organizations and/or programs interested in studying TPE. Upon circulation in late July of the first circular pertaining to the 2nd TPE Workshop, we were pleased to see an overwhelmingly positive response from colleagues worldwide. Overall feedback addressed similar issues relating to the key science questions proposed at the 1st TPE Workshop, which have been the basis for coordinated activities in TPE studies throughout the past year. In order to answer these key questions, it is necessary for TPE to take a multi-disciplinary and multi-national approach, thus deciding on the topics of the 2nd TPE Workshop.

On behalf of the TPE science committee, we thank the workshop participants' attendance at the 2nd TPE Workshop held in Kathmandu. We would also like to express our deep appreciation to all the scientists who are supporting and contributing both to the TPE program and to Third Pole-related scientific research.

Tandong Yao
Lonnie G. Thompson
Volker Mosbrugger
TPE Science Committee Co-chairs
November 15, 2010

1. Introduction

1.1. TPE Overview

1.1.1. Mission

The Third Pole Environment intends to attract international research institutions and academic talents to focus on a theme of "water–ice–air–ecosystem-human" interactions in the Third Pole region, to reveal environmental change processes and mechanisms on the Third Pole and their influences on and regional responses to global changes, and thus to serve for enhancement of human adaptation to the changing environment and realization of human-nature harmony.

The mission of the TPE program is to develop the science and technology for sustainable development of the Third Pole region under global climate change and growing human impact.

1.1.2. Program History

Like Antarctica and the Arctic, the Third Pole region is drawing increased international attention. The Third Pole region is home to thousands of glaciers in the tropical/sub-tropical region that exert a direct influence on social and economic development in the surrounding countries including China, India, Nepal, Tajikistan, Pakistan, Afghanistan, Bhutan, Bangladesh, and Myanmar. It is subjected to influences from multiple climatic systems, complicated geomorphologies and various internal and external geological impacts. The result is a region witnessing unique interactions among the atmosphere, cryosphere, hydrosphere, biosphere, and lithosphere. These processes acting at high elevation compose the fundamental basis for the unique geographical unit of the Third Pole region.

In order to observe and monitor the changing environment in the Third Pole region, many programs focused on the region have already been

widely implemented. Some of these programs include the Ice Core Program (ICP), the Himalayas Inter-disciplinary Paleoclimatic Projects (HIPPS), GEWEX Asia Monsoon Experiment on the Tibetan Plateau (GAME/Tibet), Coordinated Enhanced Observing Period (CEOP), Asian-Australian Monsoon Project on the Tibetan Plateau (CAMP/Tibet), the Pyramid Laboratory, Monsoon Asia Integrated Regional Study (MAIRS), Tibetan Plateau: Formation - Climate - Ecosystems (TiP), and the Climate and Cryospere Programme (CliC). In addition to these, more research programs continue to be introduced by scientists from various nations with the objective of observing and monitoring regional environment and climate in the Third Pole region, both on long and short-term bases.

It was recognized that in order to gain a comprehensive understanding of the mechanisms of environmental change and their impacts on the region, current observational resources need to be integrated, and research goals and approaches need to be updated and identified. Considering both this need for integration and collaboration and the importance of the Third Pole region in global environmental scenarios, a preliminary workshop was held in Beijing in August 2009. The workshop was sponsored by the Chinese Academy of Sciences, the National Natural Science Foundation of China, the Ministry of Science and Technology, China, and was hosted by the Institute of Tibetan Plateau Research (ITP), CAS. The aim of the first workshop was to establish initial interest and ideas for a long-term research program, entitled Third Pole Environment (TPE). A full report on the first workshop is available through the TPE office, or on the TPE website at: http://www.tpe.ac.cn.

1.1.3. On-going Science Activities and Collaboration

Based in those countries in the Third Pole region, TPE cooperates with interested scientists worldwide. Collaboration with international institutions and organizations has been continually sought in the past year to facilitate TPE implementation with multi-national efforts.

There were some multinational joint activities worth highlighting, including the initiation of a pilot research on Geo-surface Processes and Adaptation to Climate Change in Himalayas (Geo-PACC), the establishment of Comparative Monitoring Networks on the North and South Slopes (COMNENS) of the Qomolangma and the Xixabangma, the Sino-German joint expeditions by seven groups of scientists to the Tibetan Plateau funded by the TiP project, and the establishment of Comparative Monitoring Networks on the West and East Slopes of the Pamir Plateau (COMNEWE). Other important scientific activities included several trans-border field expeditions for joint sampling and several pairs of monitoring stations bordering the Plateau, and activities relating to the Tibetan Plateau Environmental Changes and Human Adaptations (TECA), Cryospheric Program, EU Seventh Framework Program, among others.

1.1.4. Management and Structure

The basic program structure for TPE was outlined during the 1st TPE workshop in August 2009. The outline details a 3-pronged approach involving program management, data management, and monitoring networks and stations. The program is establishing the science committee, which functions to propose scientific questions, clarify research objectives, evaluate research approaches, and coordinate tasks. Co-chairs of the program are Profs. Tandong Yao, Lonnie G. Thompson, and Volker Mosbrugger. The TPE office handles matters delegated down by the Co-chairs, particularly on issues relating to organization of workshops, special sessions at international conferences and training programs, publishing TPE workshop reports and newsletters, maintenance of ritual correspondence, and updating the TPE website.

1.2. Workshop Mission and Overview

The mission of the 2nd TPE Workshop was to provide a platform for invited scientists and program coordinators to present their major scientific activities during the past year, to explore scientific challenges and new scientific frontiers, and to propose new ideas or plans for implementation of

the TPE program.

The first two days of the workshop were dedicated to scientific presentations, with an open forum to share both recent scientific activities and related experiences in the operations, management, and structure of other international scientific research programs. Workshop participants presented results related to studies of the atmosphere, cryosphere, hydrosphere, ecosystems, human aspects and tectonics, program management and related projects.

The final day of the workshop was dedicated to collaborative group discussions, and to the workshop plenary discussions. During the collaborative group discussions, participants were divided into six groups, each focusing on one of the six key science questions related to 1) past climate, 2) water and atmosphere, 3) cryosphere, 4) ecosystems, 5) human impacts, and 6) adaptation. Workshop participants could choose a group according to their own interest, and were free to move between groups during the discussions. Following the collaborative group discussions were the plenary workshop discussions, when participants were presented with three topics based on the group discussions, and free to participate in any discussion at their own will. The three topics: flagship stations and observatories, data and modeling, products and integration, highlighted TPE's commitment to multi-national cooperation.

The 2nd TPE Workshop thus provided an ideal forum for interested scientists and organizations to discuss the ongoing development and direction-of-effort to further implement the TPE program.

2. Science Background

2.1. Regional Importance

The Third Pole region is centered on the Tibetan Plateau, stretching from the Pamir Plateau and Hindu-Kush on the west to the Hengduan Mountains on the east, and from the Kunlun and Qilian Mts on the north

to the Himalayas on the south. The Third Pole covers over 5,000,000 km^2 in total and with an average elevation surpassing 4000 m.

The Third Pole region borders more than 10 countries and impacts more than 1.5 billion people in and around the region. At present, environmental changes in the Third Pole region are characterized by unique changes in the cryosphere, atmosphere, hydrosphere, and biosphere. These changes seriously impact social and economic development in the region, and influence the global environment. The Third Pole is both affected by and affects regional, hemispherical and global climate change. Changes in the atmosphere, cryosphere, hydrosphere and biosphere work together to shape the current and future outlook of the global climate and environment.

The interactions between and among cryosphere, hydrosphere and atmosphere are key to understanding the Third Pole environment. Given the close ties of glacier-lake interactions to regional water cycle variability, fluctuation in glacial mass balance has a far-reaching effect not only on the behavior of glaciers and lakes in the Third Pole region, but also on water resources of the populace and social stability in the region. In addition, glacial-terminus lake outburst floods (GLOF) intensify with glacial retreat, which can pose geological and diplomatic difficulties as well as serious dangers to people and habitats. Glacial retreat also induces glacial-water-fed lake expansion floods (GLEF) which looms large on pastures and livestock in the catchment. Global warming induces large scale degradation of permafrost on the Third Pole, introducing significant quantities of CH_4 and CO_2 to the atmosphere, thus likely accelerating the Greenhouse effect. Global warming also causes abrupt changes to the Asian monsoon, which seriously impact the Third Pole environment.

In addition to increasing CH_4 and CO_2 under melt, the cryospheric processes of the Third Pole directly influence the hydrological processes of the regions. Glacial melting and lake level rise show a sensitive response

to climate change; with the glacial mass projected to show a dramatic decrease in upcoming years and taking on a severely modifying role in the existing hydrological processes.

Biosphere changes in the Third Pole region are characterized by ecosystem degradation and land cover changes. Although ecosystems in some regions of the Third Pole are improving with increased precipitation, the overall condition is degrading under the combined influence of global warming and increased human activities. Under extreme climate conditions, influencing factors of alpine ecosystems typically exist at threshold conditions, and are confronted by the possibility of breakdown due to slight fluctuations in the surrounding environments.

Human activities in and around the region have complicated the variation of the Third Pole Environment. The environment over the Third Pole region is more and more influenced by anthropogenic output and land degradation. The increasing industrial and transportation emissions into the atmosphere combined with different atmospheric circulation systems, such as the general westerlies and monsoon circulation have a significant impact on the Third Pole region. Recently, more and more studies concentrate on the impact of black carbon on glacial melt, as well as distribution and possible sources of POPs on regional climate. An essential issue is predicting the extent to which rapid economic development and increased anthropogenic activities will have on environmental conditions in the Third Pole.

Current studies of environmental changes in the Third Pole region involve two main foci: observation of existing processes and paleo-environmental archiving. In order to observe existing processes, the monitoring of cryosphere, biosphere, and hydrosphere components is crucial. For a comprehensive reconstruction of paleo-environments, analysis of proxies such as ice cores, lake cores, and tree ring records are invaluable.

2.2. Key Science Topics and Questions

Workshop participants from the 1st and 2nd TPE Workshops have identified the following main science topics to be addressed by TPE:

Glaciers

- Inventory of glaciers in the Third Pole region
- Response of cryosphere to climate change: impact on environment, ecology and water resources
- Interactions between glaciers and lakes
- Impact of climate change on the hydrology of debris covered glaciers
- Comparison between Antarctic, Arctic and TPE ice cores
- Black carbon measurements in glacierized valleys
- Glacial change in terms of forcing parameters: anthropogenic versus natural
- Benchmark glacier monitoring for World Glacier Monitoring Service
- Development of techniques to investigate small and large glaciers
- Regional ELA modeling

Water

- Inventory of lakes
- Water source of lakes and rivers: its sensitivity to climate change
- Water cycle at a basin scale (different sizes): quantification and prediction
- Measurement of high-elevation precipitation
- Limnology and paleolimnology: functioning and dynamics of lake ecosystems
- Preparation of a hydroclimatic atlas for the TPE region
- Water storage assessment and regional adaptation
- Stable isotopes in water bodies

Climate

- Natural climate variability, especially inter-annual and decadal changes
- Change of monsoon and mid-latitude circulation in the last century
- Interaction between general circulation and TPE
- Extreme events

- Long-term monitoring of climate
- Radiation and energy budget
- Flux of Greenhouse gases and other gases such as SOx
- Atmospheric transport of pollutants to TPE
- Aerosol dynamics in the atmosphere and atmospheric deposition
- Ground-truthing for models and transfer functions
- Regionally differentiated prediction of future climate

Ecosystems

- Thermo- and hydrodynamics of permafrost
- Characteristics of the carbon cycle and vegetation on the TPE and their impact/feedback on the monsoon
- Biodiversity and carbon asset
- Past and present patterns and processes of changes in the TPE biosphere
- Origin and evolution of alpine meadows in the TPE
- Extent and nature of human induced changes on TPE vegetation
- Human dimensions
- Consequences of climate, cryosphere and ecosystem changes on human societies
- Direct anthropogenic impact on TPE and climate feedbacks
- Indigenous environmental knowledge on both change and hazards, integration in management concepts
- Payment for ecosystem services from downstream to upstream
- Geohazards and natural hazards: monitoring and early warning systems
- Mining economy and geological prospecting as a factor of pollution and landscape damage in mountain regions

Multi-component interactions

- Water, climate, ecosystem and human interactions
- Validation of remote sensing products for land processes, water and energy budget studies (see also under Climate)
- Land and atmospheric interactions and its impact on Asian monsoon and climate change

- Integrative data and modeling approaches

Working from the above Key Science Topics, TPE workshop participants and the Science Committee have identified the following six scientific questions as being the focus of TPE. These key science questions form the basis for coordinated studies and answering these key questions necessitates a multi-disciplinary and multi-national approach taken by the TPE program:

Question 1: What environmental and ecological changes have occurred on different time scales in the past, and how are these changes driven?

Question 2: What are the characteristics of water and energy cycles, what are their main components, and what is their relationship to the Indian monsoon and westerlies?

Question 3: How will ecosystems change under global warming, especially at high elevations?

Question 4: What is the status of glaciers on the Third Pole, and how will glacial retreat and mass balance changes affect the water and energy cycle and its components? What are their environmental impacts?

Question 5: What is the impact of anthropogenic output?

Question 6: What is the most appropriate way to adapt to current environmental changes in the Third Pole region?

3. Update on Relevant Science Activities

The 2nd TPE Workshop witnessed two days of academic presentations and one day of discussions, evolving around the key science topics aforementioned and targeted at a joint effort and intensified understanding of the environment of the Third Pole region. In the first two days, nearly 40 presentations were given, addressing some cross-cutting interdisciplinary subjects, reporting on multi-national efforts in understanding the regional

environment, and sharing the essence and experience in interdisciplinary research and program management.

The following summarized categories include a list of presentations according to the main topics of the 2nd TPE Workshop presentations. However, most presentations may fit into more than one of the listed categories. The summary below therefore is only listed for general reference and future workshop planning.

Cryosphere

Arora, B. “Roadmap to quantify climate forcing factors on Himalayan glaciers”

Bjornsson, H. “Glaciers of Iceland: present state and future outlook”

Lamsal, K. “Estimation of snow and ice melt contribution in discharge of glacierized Langtang Khola Basin, central Nepal”

Liu, S. (1) “The new glacier inventory of the Tibetan Plateau”

Liu, S. (2) “Project of cryosphere and environment in Tianshan”

Nakawo, M. “Glacier shrinkage in the Himalayas under the monsoon climate with the abundance of debris and dirt”

Nasir, J. “Current status of glacier studies and initiatives for future research in Pakistan”

Shresth, T. “Local variations in melting response of Indian-Himalayan Glaciers”

Tian, L. “Monitoring the glacier ice volume change in the Himalayas region”

Xu, B. “Black soot and the survival of Tibetan glaciers”

Mool, P. “Glaciers, glacier lakes and glacier lake outburst floods in the Himalayas”

Hydrosphere

Menenti, M. “Land surface hydrology in the Plateau and HKH regions”

Tartari, G. “Lakes as indicator of climate change impact on quantity, quality and biology of the TPE’s water resources”

Gleixner, G. “Reconstruction of climate and water cycle from Tibetan Plateau lake sediment cores”

Atmosphere

Ma, Y. (1) "The progress on the study of atmosphere-land interaction over heterogeneous landscape of the Third Pole area"

Marinoni, A. "The SHARE multidisciplinary project and the atmospheric climate observations at the Nepal Climate Observatory– Pyramid, GAW Global Station"

Ueno, K. "Great Himalayas as a gate of water and energy cycles into the Tibetan Plateau"

Tartari, G. and Lentini, G. "Importance of long term monitoring of climate data in the Khumbu Valley (Himalaya) and in Gilgit Baltistan (Karakorum) as a contribution to the TPE's activities"

Yang, K. "Promoting satellite applications in the TPE water and energy cycle studies: chance and challenge"

Ecosystems

Bhuju, D. "Species response to climate change in high altitudes: initiative of a national organization in the Himalayan discourse"

Li, M. "Physioecological mechanism of the alpine treeline dynamics under global warming"

Mosbrugger, V. (2) "The role of vegetation in mountain dynamics: some facts and speculations"

Thorhallsdottir, T.E. "Proglacial ecosystem development in Iceland"

Zomer, R. "Environmental monitoring and long-term ecological research for biodiversity conservation and sustainable development in the Kailash sacred landscape"

Tectonics

Ding, L. "Preliminary study on the provenance of Tajik Basin: uplift and exhumation record of Pamir and Tianshan orogens"

Pan, B. "Study on relationship between erosion and tectonic uplift in Northern QilianShan Mountains"

Human Aspects

Kollmair, M. "ICIMOD's work on sustainable livelihoods and poverty reduction"

Kilroy, G. “Developing an evidence base in the transboundary Koshi river basin to address impacts from climatic and socio-economic drivers”

Yan, X. “Influences of transportation activities on the Third Pole Environment (TPE)”

Program Management and Related Projects

Yao, T. “TPE progress since the 1st workshop”

Ma, Y. (2) “Study on the change of Tibetan Plateau climate system and the mechanism of its impact on East Asia (TPCS-IEA)”

Liu, L. “Progress of the Geo-pack”

Greenwood, G. “How can the TPE project implement interdisciplinary Earth System Science?”

Karki, M. “ICIMOD's Regional Programme Framework and Collaboration Potentials (e.g. Abu Dhabi Knowledge Forum)”

Mosbrugger, V. (1) “DFG Priority Programme 1372 TiP–Tibetan Plateau: Formation-Climate-Ecosystems”

Ouyang, H. “Transboundary observation programme on water and hazards to the Third Pole Environment”

Van Oevelen, P.J. “The future of GEWEX and its new imperatives

Winiger, M. “Indus River Basin Initiative-a new approach to a better understanding of the climatic-hydrologic system of HKH”

Yang, D. “TPE and North Pole Environment (NPE): similarity and connection”

Most workshop participants generously made their presentations available for download through the TPE website at: www.tpe.ac.cn/wkshp2/presentations. A complete list of presentations by author’s last name can be found in Appendix 3.

4. Collaborative Topic-Based Discussions

On the third day of the workshop, participants gathered into six groups to discuss some of the main science topics relevant to TPE. The six discussion groups were related to the six key science questions of TPE, and included: past

climate, water and atmosphere, cryosphere, ecosystems, human impacts, and adaptation. The task of each group was to identify the most important scientific questions and problems, to identify the links to related international programs, and to identify key geographic regions of interest. Following the group discussions, one person from each group presented a summary of results, as outlined in the following sections.

4.1. History

The history group was led by G. Gleixner and B. Pan, with G. Gleixner presenting the group discussion results. First to be presented was the most important scientific questions and problems relate to past climate and environment of the Third Pole.

1. What are the interactions between geo-factors (uplift/erosion/parent material) and climate evolution and ecosystem development? Are tectonic events (uplift) driving the development of the climate system and the ecosystems? What are the system feedbacks?
2. How are monsoon systems and westerlies interlinked in time and space? What are the system feedbacks?
3. Can we link the existing paleo-records (ice, lake, and dendro cores, caves? basin sediments, ocean sediments) to make a spatially valid and consistent time series?
4. What is the interaction of humans and climates on ecosystems and what are their feedbacks?
5. Can we link/develop models to the experimental records/reconstructions?

The history group next identified possible links to related international programs, including:

- HKT community
- ICDP/IODP
- PAGES
- Paleoclimate modeling community
- IGBP
- ILP
- FOCUS

Finally, the history group addressed the identification of key areas within the Third Pole region. The group primarily stressed the need to develop and collect data sources for appropriate site selection, including data related to climate, vegetation, tectonics, soils, and lakes. The group also offered several suggestions for key locations to study, including: the Tajik Basin (record of the westerlies), the Tarim basin (northern air masses), Pamir, Tianshan, Ferghana, Siwalik basin, Qilianshan, Hexi Corridor, and inland-foreland comparisons.

Following the history group discussion was a couple of participant comments. In particular, the linking of existing paleo-records was stressed, as was the importance of model validations and establishing links to the paleo-modeling community.

4.2. Water and Atmosphere

The water and atmosphere group was led by K. Ueno and F. Zhang, with K. Ueno presenting the group results. The main scientific questions identified by the group discussion included the following list:

1. Transport of water vapor under land-atmosphere interaction; where does water vapor comes from, how does it climb the mountains, and where does it precipitate? Regional water budget needs to be addressed and closed.
2. Monsoon variability and mechanism: relationships between aerosols, monsoon onset, and precipitation amount; aerosol forcing in the water and atmosphere circulations.
3. Models validation and scaling: how to provide proper model input? How does global model relate to regional model? How to integrate information on various water bodies obtained by different researchers and accurately define each interaction?
4. Glacier microclimates: how does it relate to glacier change? What's the trend of temperature and precipitation change with elevation and time? How can meteorological science contribute to glacial study?
5. Teleconnections: how do process in a region like the Third Pole relate to other regions as the Arctic?

Some of the concept, methodology, and policy needed to examine these

science questions were subsequently discussed by the group as follows

1. A grand vision to clearly identify the goals and with which to attach key hypotheses: this type of vision will be important for international groups to examine and identify possible collaborations to where they can link up.
2. A TPE data base: including data storage, management and data sharing policy. Promoting a TPE journal or publication with the goal of having authors agree to an established data sharing policy.
3. Transect study with systematic mapping from the low, to middle, and to high elevations: this approach allows the comparison of different gradients across the Third Pole region; incorporate basin-studies, since some transects may be closely related to existing basin studies.
4. Satellite and in situ data: combine point measurements with remote sensing data, with a modeling approach. Data management over high elevation is needed.
5. More instrumentations and improved techniques for measurement of precipitation, discharge, moisture, snow fall, and snow cover:

The group discussion and comments further identified several key collaborative areas:

1. To implement TPE related field measurements using existing stations (including Khumbu, Namco, Xixabangma, and Koshi) and ICIMOD transboundary transects (such as the Kailash transect) with a more complete geographic coverage of station networks and not overlooking the less-populated northern regions of the Third Pole.
2. To establish large transects that cover the whole Third Pole region in addition to the current two from north to south and one from west to east.
3. To identify and bring key products needed by the water and atmosphere studies in the Third Pole region. The products may also be needed by all other related groups.

4.3. Cryosphere

The cryosphere discussion group was led by D. Yang and B. Arora, with D. Yang presenting the group's results. The cryosphere group identified three major components of interest: snow cover/snowfall, ice (including glacier, lake and river ice), and permafrost. Six main science questions were outlined:

1. What is the difference between the TPE cryosphere and the northern regions cryosphere?
2. How have temperature and precipitation changed in the Third Pole region, and how do lapse rates vary in space and time?
3. What are the main forcing factors (natural and anthropogenic) of climate change in the Third Pole region at global, regional, and local scales?
4. What is the state of the cryosphere in the Third Pole: what do we know and what changes?
5. What is the most appropriate way to incorporate modeling in the TPE program?
6. How should TPE basins and glaciers be selected?

The cryosphere group then offered several suggestions for links to key groups:

- CliC
- IGBP
- IACS
- GLIMS/NSIDC
- HignNoon (EU FP7 project)
- Globeglacier/ESA.

In addition to offering possible collaborations with other groups, the cryosphere group stressed the importance of discussing the nature of links to other organizations and what it means for TPE to link to an organization. Due to time constraints, the cryosphere group was not able to fully discuss key locations and areas for cryosphere research, but focused instead on discussing the criteria for selecting sites. The group suggested the main criteria examined for cryospheric studies should include: climate regime, size/dimensions, IASC bench mark glaciers, coordinate with CEOP/CliC reference sites, variety of glacier changes (from small to large changes), sites with existing long-term observations, and locations with available high resolution remote sensing data. As a final point, the cryosphere group stressed the need to work with other groups including members from the hydrologic and atmospheric communities, as well as modelers.

In response to the cryosphere group's presentation, workshop participants had several comments and suggestions. One comment was regarding the need to clarify the links to other organizations in terms of funding organizations versus

collaborative projects, and that the links to other communities (such as the hydrology community) require an active effort that will not happen on its own. Another participant commented about the importance of lakes, which can record glacier and permafrost changes from river discharge. Other comments included the need to prioritize what to do first, and the need for ground-truthing and validation of modeling results.

4.4. Ecosystems

M. Li and T.E. Thorhallsdottir were responsible for leading the ecosystems group, and T.E. Thorhalldottir presented the group discussion results to the workshop participants. With regards to the main science questions, the ecosystems group identified three key questions:

1. What are the gaps in knowledge of ecosystem studies in the Third Pole region?
2. How will global change impact ecosystems at different levels of biological organisms?
3. How can the consequences and impacts be monitored?

Each of the three questions was further discussed, beginning with the knowledge gaps. First, the group identified the need to determine the adequacy of the present knowledge of ecosystems in the Third Pole region, including the relationships of species distribution with environmental factors. Next, the group questioned the current knowledge of priority areas (most diverse) and most fragile ecosystems within the Third Pole. Another knowledge gap identified was related to the spatially discontinuous knowledge of ecosystems in the Third Pole; some areas are well- known and others are much less known. The ability to distinguish between physical limits of tolerance and biological limits was also identified as a major knowledge gap. The group also emphasized the need for a systematic sampling system and standardized approaches to allow for comparisons of different regions. Finally, the group identified a knowledge gap in the form of capacity building at a regional level in terms of expertise and infrastructure.

The second question of how to identify the impact of global change at different levels was also further discussed by the ecosystems group. The group expressed the need to consider both terrestrial and aquatic ecosystems,

first at the species level, with the identification of endemic species and the use of endangered species as a measure of biodiversity. The most relevant changes for ecosystems identified by the group were changes in temperature, precipitation, and pollution levels. These changes need to be considered at the species level, and should include the impact on communities and ecosystems at different elevations. The ecosystems group further discussed the importance of elevation to ecosystems in the Third Pole region by asking if species will move upwards in elevation, and if so, at what rate? The group also questioned the limits of upwards movement and the barriers for different species. They also questioned if fragmentation and environmental heterogeneity will influence and limit responses of species in the Third Pole. A final question related to the impact of global change on ecosystems was: What will be the fate of clear lakes?

The third question of how to best monitor consequences and impacts of global change was discussed next. First, the group stressed the importance of a common methodology for examining altitudinal transects in both the north and south regions of the Third Pole. Another way to monitor impacts suggested by the ecosystems group was to use reference catchments for freshwater ecosystems, as well as using permanent plots for vegetation and ecosystems studies. The group suggested using studies designed with different levels of intensity, including both highly intensive studies with high input and long-term integrated studies as well as broader-level studies aimed at a more rapid assessment requiring less expertise and input. Finally, the group intimated the need for comparative study sites in other parts of the globe, for example in the European Alps or in Iceland.

The ecosystems group next identified possible links with other international programs, which are included in the following list:

- SHARE
- LTER
- GLORIA
- ITEX
- GMBA
- IGBP

The group stressed the importance of adopting a common methodology related to established international groups.

As with some of the other discussion groups, the ecosystems group spent more time discussing criteria by which to rank priority areas, rather than choosing specific geographic regions of interest. The main criteria for ranking included: fragility, most stressed, greatest value (in terms of both biodiversity and monetary value, e.g. medicinal plants), characteristic or representative ecosystems types, largest remaining pristine or minimal anthropogenic impact areas, areas with invasive species to study the process of invasion, and areas with ongoing ecosystem studies and their accessibility. This comprehensive list of criteria presents an ideal foundation and basis for ecosystem site selections in the Third Pole region.

Subsequent to the ecosystem group presentation summary, a couple of comments were put forth by participants. First, it was suggested the list of groups include MIREN, as well as MRI. It was also suggested to look at ecosystem services. Another participant found the group was not focused on climate change, and would thus need products from other groups.

4.5. Human Impacts

The human impacts group was led by M. Menenti and B. Xu, with a summary of group results provided by B. Xu and presented by M. Menenti. The group first identified three main issues relevant to human impacts in the Third Pole:

1. Transboundary water management.
2. Transboundary air pollution (black soot and other pollutants, POPs, heavy metals).
3. Land cover and land use changes.

Several gaps in scientific knowledge were then identified by the group, including a detailed knowledge of catchment hydrology, the impact of black soot on energy and mass balance and the Third Pole cryosphere, the attribution of observed pollution, and a standardized land use classification protocol.

The human impacts group provided an outline of the main variables

necessary for observation to help fill in the outlined gaps in scientific knowledge. The variables include water, air, surface properties, accumulation of pollutants, and changing land use and land cover. Each variable was further clarified; with regard to water, the group identified the need to quantify transboundary water transfer, meltwater from glaciers and permafrost, precipitation, and groundwater storage. With regard to air, the group identified black carbon, POPs, heavy metals and aerosols as the main factors related to human impacts. Spectral reflectance and composition of glaciers were identified as the main surface properties of interest. The group proposed black carbon, POPs, and heavy metals as the main pollutants to monitor; especially in relation to their accumulation in high elevation ecosystems. With regard to changing land cover and land use, the group identified the need for long-term mapping with standardized legend and mapping protocols.

Links to international programs related to human impacts in the Third Pole included the following list:

- WCRP/GEWEX/GHP, CliC
- IGBP-IHDP/GLP
- GEO
- UNEP ABC
- FAO GLCN
- UNEP Malé Declaration (with five Third Pole countries)

Related to linking with other international programs, the human impacts group stressed the importance of involving governments, and not limiting TPE to only academic institutions and individuals. The groups also suggested TPE prepare a monograph on transboundary water management, as well as a monograph on transboundary air pollution. To help achieve a more comprehensive monitoring and to identify sources and inventories of environmental pollutants, the group suggested each country develop a monitoring program to study changes fluxes of black carbon and POPs.

In addition to the aforementioned suggestions by the human impacts group, a road map and prioritization of five tasks was put forth.

Task 1. : Network establishment

Task 2. : Capacity building to monitor

Task 3. : Conduct of monitoring including field measurements, remotely sensed data with the incorporation of modeling and land cover/land use mapping.

Task 4. : Reporting and data sharing with TPE countries and other stakeholders.

Task 5. : Identification of measures to reduce emissions, and advisory on better water management.

After the human impacts group presentation, there were several comments and suggestions by workshop participants. The first suggestion was to use trace elements instead of heavy metals. There were also several comments related to human socio-economic factors. It was suggested to examine how much water is available, and how society is supported by water. In addition, one comment stressed the importance to clarify how much pollution is present, and examining the main source areas of pollution in conjunction with the impacts on people in the region. Another comment suggested a larger role for modeling, including parallel models run at global, regional, and local levels. A final participant comment stressed the major impact of TPE is in the realm of science, not in politics, although the TPE science program would provide scientific results relevant to political actions.

4.6. Adaptation

The adaptation discussion group, led by G. Greenwood, focused on the question of “What is the best route or way to cope with environmental changes in the Third Pole region?” The group approached this question from a geographic and social science perspective. Three main science questions related to adaptation were identified:

1. What are the different livelihood groups, and what is nature of these groups (farmers, households, etc.)? Also included here is the question of how and where the different groups co-exist, and the need to identify and incorporate indigenous knowledge and developmental trajectories. In addition, macro-drivers of the various livelihoods need to be identified.

2. What are the vulnerability pathways, i.e., how does a given environmental change affect the livelihood of different groups?
3. What are the options for addressing vulnerability? The group presented this question as it relates to research, not development.

The adaptation group stressed the importance of understanding trade-offs associated with options, and the importance of talking to the people most affected in order to understand what options exist. The group suggested a social mapping approach, using trade-off analysis (including financial, social and legal aspects), and participatory action research (consulting with stakeholders) to achieve the desired outcome. The outcome of this approach is to have some options in a place for specific livelihood groups to give them information on trade-offs. A possible product would be a set of guidelines for developmental policies to promote coping capacity in the Third Pole region.

As a pre-requisite for this approach, the group identified the need for a list or, ideally, quality maps of probable environmental changes. Maps products would portray the location, nature and probability of different environmental changes that could potentially affect some livelihood group such as lake level rise, incidence of debris flows, shift in melt timing, shifting phenology and range compositions, etc. These maps would serve as targets for biophysical researchers: can they translate their research results into projected future environmental conditions?

The adaptation group also identified some related international groups, and generated the following list:

- GLP
- IHDP/Human Security
- ESSP/MAIRS
- ICIMOD
- Key researchers & groups: e.g. Missouri Botanical Garden
- CGIAR
- CIFOR

Since the question of adaptation is, at some level, related to the entire Third

Pole region, the group had difficulty selecting key areas in this respect. However, they stressed the importance of incorporating places with existing data and mandated projects, such as Sanjiangyuan (the source of the Yellow, Yangtze and Lancang Rivers), the Kailash region and the Koshi basin.

After the presentations, several participants had comments and suggestions. One participant from Pakistan suggested developing a pilot project in Pakistan, since many of the outlined problems exist there. Participants from ICIMOD pointed out their ongoing projects in Pakistan related to range management and water management, but the adaptation group questioned who in Pakistan can take the initiative to make these ideas a reality and stressed the need to find people who will be there on a long-term basis to see it through. The participant from Pakistan suggested exploring ties to the Geology University in Pakistan for collaboration with TPE, as well as exploring governmental support. Another participant commented on the technical difficulties associated with a GIS platform, with the main foreseeable difficulty in linking the different coordinate systems for the whole Third Pole region. A final comment was related to the lessons learned from other projects, such as AMMA in Africa.

5. Plans for Implementation

The following sections outline the results of the Plenary Discussions on the third day of the workshop (Sections 5.1-5.3), and present further plans for implementation in the form of the science plan brochure, as discussed at the workshop. The final section summarizes two upcoming TPE events that will further shape and develop the TPE program. Plenary discussions included one group to discuss flagship stations and observatories, one to discuss data and modeling, and one to discuss products and integration.

5.1. Flagship Stations and Observatories

This Plenary Discussion group was tasked with determining the most suitable existing and new sites to establish a TPE monitoring network of field observations. Discussion was led by T. Yao and B. Arora, with T. Yao presenting a summary of the group discussion. The group first outlined several

possible ways to select flagship locations, including: geographically, climatically, social relevance, existing stations, and new stations. Time constraints prevented a full discussion of the outlined criteria, and the group proceeded with listing the most relevant stations existing in each country, and also proposed some new locations as well. Stations were grouped according to the following categories:

- TPE Flagship Glacier and Permafrost Stations
- TPE Flagship River Basin Stations
- TPE Flagship Lake Basin Stations
- TPE Flagship Ecosystem Stations
- TPE Flagship High Elevation Stations
- TPE Flagship Pollution and Aerosol Stations

Specific stations and observatories within each of the above categories were then outlined, and are summarized in the following section.

- TPE Flagship Glacier and Permafrost Stations

Dokriani Bamak Uttarakh (Central Himalaya, monsoon)

Kolahoi glacier (Indus river system, west Himalaya, westerlies)

East Rathong glacier (Brahmaputra river system, Eastern Himalaya, Sikkim, monsoon)

Yala glacier (central Himalaya, monsoon)

Rikha Sambha (central Himalaya, monsoon)

Qiyi Glacier (northern Tibetan Plateau, westerlies)

Xiao Dongkemadi Glacier (central Tibetan Plateau, westerlies and monsoon)

Rongbuk Glacier (central Himalaya, monsoon)

Glacier No. 94 (eastern Himalaya, monsoon)

Kangwure (central Himalaya, monsoon)

Naimonanyi (western Himalaya, westerlies and monsoon)

Muztag Ata (Pamir, westerlies)

Baltoro (Karakorum, westerlies)

Fedchenko (Pamir, westerlies)

Mera Glacier (Inkhu Valley, Central Himalaya, monsoon)

New station suggested in Karakorum

Permafrost station: Golmud

New permafrost station suggested: Khumbu

- TPE Flagship River Basin Stations

Due to the complexity of river stations, it was suggested to incorporate glacier stations representative for use as river basin station by adding hydrological measurements and monitoring (i.e. river discharge).

Indus-Baltoro (Karakorum)
Koshi-Yala (central Himalaya)
Bramhaputra-Nyingchi (eastern Himalaya)
Damu Darya-Fedchenko (Pamir)
Yangtze River-Dongkemadi (central Tibetan Plateau)
Tarim River (western Tibetan Plateau)

- TPE Flagship Lake Basin Stations

Nam Co (central Tibetan Plateau)
Ranwu (eastern Tibetan Plateau)
Laddakh station (western Himalaya)
Bangong (western Tibetan Plateau)
Rara (central Himalaya)
Karakury Lake (Pamir)

- TPE Flagship Pro-Glacial Lakes

Imja (Khumbu region)
Tsho Rolpa (Tamakoshi Basin)
Chorabari (Gahwal Himalaya, Ganga Basin)
Longbasaba (to the east of Mt. Qomolangma)
Pumqu (central Himalaya)
Poiqu (central Himalaya)
Dongguala Co (eastern Himalaya)
New station suggested: Gilgit station (Karakorum)

- TPE Flagship Ecosystem Stations

Nyingchi (Forest)
Gonggashan (Forest)

Lhasa (Agriculture)

Nagqu (Grassland)

Nagri (Mountain dessert)

Haibei (Meadow)

Dzongri valley (eastern Himalaya)

Palampur station (central Himalaya)

Langtang National Park (central Himalaya)

Sagarmatha National Park (Khumbu)

Jomsom-Mustang (central Himalaya)

- TPE Flagship High Elevation Stations

Several potential sites are suggested: Qomolangma (southern and northern slopes), K^2, Xixabangma, Muztag Ata, Langtang Valley, Nyingchi, Baltoro, Fedchenko, Passu (Hunza Valley-Gilgit)

- TPE Flagship Pollution and Aerosol Stations

Nyingchi station (southeastern Tibetan Plateau)

Nam Co station (central Tibetan Plateau)

Muztagh Ata station (Pamir)

Qomolangma Station (southern slope)

New stations suggested: Qomolangma (northern slope), Gilgit (Karakorum)

In addition to the station lists, two key transect types were noted: Catchment Transects, and Mass Balance Transects. One additional comment after the group's presentation was a suggestion emphasizing both local and regional scales, in addition to using stations on both north and south facing stations for energy balance considerations. The need for a quality Third Pole base map product was also stressed, in order to better understand the spatial distribution of existing and proposed stations and to examine where additional measurements and monitoring may be needed.

5.2. Data and Modeling

The data and modeling Plenary Discussion Group was led by V. Mosbrugger and S. Kang, with discussion results presented to workshop participants by V. Mosbrugger. First, the group outlined the four most relevant data types

pertaining to the TPE program, including:

1. In-situ data
2. Remotely sensed data
3. Re-analysis data
4. Modeling data

The group also discussed ways to integrate these data types, with an expressed need for a data information center, a data sharing policy, and an explicit data structure. With regards to the data information center, the group identified the need to determine where the data center will be located, and what types of data will be made available. Concerning the data sharing policy, the need to develop such a policy within the TPE program was indicated. With regards to an explicit data structure, the group expressed the need for a structure that allows multi-national and cross-disciplinary evaluation, and also allows model validation. The issue of data quality control was also discussed by the group, and the need to develop a standard protocol and methodology for various measurements was stressed. To achieve this, the group suggested development of intercomparison projects. It was also recognized that it may not be possible to standardize all data measurement, and therefore "conversion factors" between different methodologies may be developed.
Next, the group presented four hierarchical levels, or steps, of data and modeling. These included meta-databases, data quality standards, data sharing standards, and a unique TPE database or world data center. The TPE database would be an ideal starting point for model validations.

The data and modeling group finished with a summary of the most relevant points for modeling. The importance of modeling was first stressed, since it plays a pivotal role in all six research topics previously discussed (Section 4). The need to always link data and modeling was stressed, in order to achieve mutual validation, improved processes understanding, process-based up- and down-scaling, and to examine teleconnections between regional and global scales. The group also expressed the need to distinguish between empirical/statistical models and dynamic models. The group proposed several model types to be incorporated, including integrated/complex coupled dynamic models that link various components, regional models, and data assimilation.

Following the group discussion, several comments were put forth by workshop participants. The first suggestion was for a data report to be produced at the initial stage. Since a data report will also relate to the various products previously discussed, it will be beneficial to have a report generated from different institutions or groups. Another participant urged the group to look at what has already been done, since much of the data management and structure discussed has been previously established by other organizations (e.g. by NOAA.). The group fully agreed, and explained that the goal is not to invent new structures, but rather to compile existing data using established international standards. Final comments were related to the foreseeable difficulties in keeping a large database running, with significant commitment in time and money necessary for compiling, updating, and maintaining the database. In response, the group suggested linking it to institutions or an existing world data center.

5.3. Products and Integration Processes

The products and integration processes group was led and presented by G. Greenwood. The main topics of discussion for the group were a GIS platform, interdisciplinary groups, key products, and program management. The group presentation began with some notes about TPE program management and the relation to integrative processes. It was stressed that if integration is desired by the TPE program, it must be planned for at the start. Integration will not emerge from the process on its own but rather requires planning. In addition, it was emphasized that having specific overarching products, such as maps of projected environmental changes, provides a means to bring people together.

Regarding program management, the group offered several key suggestions. The first was related to how criticism is managed, with an expressed interest in a clear forum to manage criticism. It was suggested the TPE website may be an appropriate forum to manage criticism, and it was also articulated that TPE should establish some standard operating procedures for information dissemination. The group also suggested TPE have some means for peer review, which will be a concern with a truly integrative TPE mission. Related to

this issue, it was suggested to establish a program cycle for periodic reviews and revisions. This cycle could be a 5 year review, which provides an opportunity to re-evaluate where TPE is heading and to also re- evaluate the science questions proposed by TPE. For example, a re-evaluation of the science questions can ask what questions have been answered and what questions need to be re-stated. It was also suggested by the group that involving a program anthropologist to study the progress and interactions of this inter-national and inter- disciplinary group of scientists may be beneficial.

Another point regarding program management was related to the vision, mission, goals, and objectives of TPE. The group discussed the need for a standard and strategic language with logical clarity to express these issues. It was also asked how “water-tight” these goals should be, and to examine how clear they currently are. The products and integration group also felt it necessary to establish a science steering committee as soon as possible, with people who embody the program and are invested in carrying it forward. It was clear from the group’s discussion that these program management issues should continue to evolve for TPE.

Next, the group discussed key products most relevant to the TPE program, with the following list of 10 items generated:

1. Precipitation, including when, where, how much, in what form, and the trends.
2. Land use/land cover classification to incorporate existing data.
3. Vegetation- floristic and life forms.
4. Population and Urbanization.
5. Livelihood groups including social, economic, livestock, resources, etc.
6. Endemism centers, vascular species richness.
7. Runoff and discharge.
8. Options for adaptation.
9. Scenario analysis.
10. Shared data products, including a data policy, platform (shell), and accessibility.

The products and integration group further discussed the idea of integrative knowledge products, and it was emphasized that these products need to be

policy-relevant. Also, the group stressed that although long-term monitoring is an ideal goal, what is actually being monitored will determine how integrative the research program is. Ultimately, the following questions will need to be addressed: what is monitored, what disciplines are included, what funding is available, what is the rationale, how is “long-term” defined, and how can a common protocol be applied?

5.4. Science Plan

A major topic of discussion at the 2nd TPE Workshop was the development and finalization of a TPE Science Plan. The TPE Science Plan will partly relate to establishing a framework for multi-national programs. It was suggested the Science Plan should not be aimed only at promoting TPE research, but should mainly serve as a framework, something similar to IGBP or other established large multi-national science programs, and should be designed to allow other established structures to fit in.

This type of TPE Science Plan may help national funding agencies to provide money for research and provide other support. The need to achieve some common funding to do this was expressed. The plan, as discussed at the workshop, is to create TPE Science Plan that is very broad, but very attractive, and allows other international programs to fit in. The working timeframe identified for implementation of the Science Plan was suggested to apply for at least 10 years. Discussions from this 2nd TPE Workshop will help define the aims and content of the TPE Science Plan, with additional discussions between TPE Co-chairs beginning to take place in mid-December.

5.5. Upcoming TPE Events

The upcoming American Geophysical Union (AGU) meeting will be important for further discussions and development of the TPE program. The Third Pole Environment (TPE) will be the focus of four sessions at the AGU Fall Meeting in San Francisco, CA. The meeting will be held from December 13-17, 2010, and is expected to gather more than 16,000 geophysicists from around the world to present and review the latest issues affecting the Earth. This year,

TPE will be highlighted in a session titled “The Third Pole Environment (TPE) Under Global Changes”, taking place on the afternoon of Wednesday, December 15 and all day Thursday, December 16. The session is sponsored by the Global Environmental Change focus group of AGU, and co-sponsored by the Atmospheric Sciences, Biogeosciences, Cryosphere and Hydrology focus groups of AGU and by the TPE program. Conveners will be Tandong Yao, Lonnie Thompson, and Volker Mosbrugger (three Co-chairs of TPE program), together with Yongwei Sheng. Session information can be found on the AGU Fall Meeting website at: http://www.agu.org/meetings/fm10/.

The Third Pole Environment (TPE) will also be the focus in a session at the next European Geosciences Union (EGU) General Assembly. The meeting will be held in Vienna, Austria from April 3-8, 2011. The session will be part of the Hydrological Sciences Programme Group (HS6.1), titled “The Third Pole Environment-Observation and modeling of hydrometeorological processes in high elevation areas”. Yaoming Ma will be the Convener of the session, and the Co-conveners are Peter J.van Oevelen, Bob Su, and Fan Zhang. Session information and description can be found on the EGU meeting website at: http://meetingorganizer.copernicus.org/EGU2011/session/6582/.

6. Conclusions

6.1. Workshop Conclusions

The 2nd Third Pole Environment (TPE) Workshop concluded on October 28, 2010 in Kathmandu, Nepal. The workshop focused on the regional challenges posed by the changing environment of the Third Pole region. Roughly 90 scientists, field professionals, researchers, and program managers from 16 countries contributed to the workshop mission, including those from the Hindu Kush-Himalayan region and beyond. Those who attended the 2nd TPE Workshop were pleased with the organization and content of the workshop, and have many valuable suggestions for future progress. Participants’ comments were gathered with feedback forms at the workshop, and are summarized in Appendix 5.

The topics discussed during the workshop followed the road-map laid out during the 1st TPE Workshop, which address six key science questions defined by scientists and program coordinators. Participants of the 2nd TPE Workshop agreed to continue international collaboration and efforts in establishing flagship monitoring stations, an accessible platform for sharing data, and in launching transboundary scientific expeditions. All of this will be carried out with the objective of increasing current environmental understanding of the Third Pole.

Several key points make the TPE program crucial and unique. Firstly are the global circumstances of the Third Pole region: glacial retreat and its impacts, climate and global change, resource shortages, growing population and the need for holistic/earth system science and sustainability research. Secondly is the recognition that the Third Pole region is a sensor area for environmental systems, including climate/monsoon, cryosphere, and ecosystems. Thirdly are the regional and geopolitical implications concerning major geo-resources and bio-resources of the Third Pole region.

In order to move forward, group discussions pointed out the need for several key products including tools to aid site selection; good base maps and background information for the most appropriate site selection, as well as a set of standardized protocol and methodologies, especially for measurements. In addition to this, participants of the 2nd TPE Workshop have slated for completion, before the next TPE workshop, some key tasks including: the collection of information about future plans/ ideas/suggestions, the organization of national/multinational projects and funding, the planning and holding of small meetings to promote integration of stations and standardization of data/data quality as well as training programs and capacity building events, and the promotion of UNESCO and other international programs from the TPE platform.

6.2. The 3rd TPE Workshop 2011

During closing comments at the 2nd TPE Workshop, participants received an offer from Helgi Bjornsson on behalf of the President of Iceland. It was an offer

to host the 3rd TPE Workshop in Iceland in September of 2011. Though not located in the Third Pole region, Iceland is in one of the Polar Regions on earth and bears similarity with Third Pole region in confronting global climate changes. Thus holding the next TPE workshop in Iceland was agreed to be a very beneficial step forward for the TPE program, as it will open the door for collaboration with more scientists and related programs and fulfill TPE's commitment to linking itself with other two poles for a holistic understanding of global climate and environment changes. Two locations were initially proposed as possible venue locations; the large city of Reykjavik in the southwest, with a fieldtrip to the glaciers in the Skaftafell National Park (~5hr. drive away), or a location directly at the Skaftafell National Park.

Exact workshop location and dates are subject to further discussion and will be announced in early 2011. TPE science plan is expected to undergo the final discussion during the 3rd TPE Workshop before being approved to guide further development of the TPE program.

Appendix 1. Workshop Agenda

The 2nd Third Pole Environment (TPE) Workshop		
October 25-28,2010, Kathmandu, Nepal		
Monday, October 25, 2010		
9.00 am – 6.00 pm	Pre-registration at the hotel	
6.00 – 8.00 pm	---Dinner---	
Day 1, October 26, 2010		
Time	**Speaker**	**Topic**
8.00 – 9.15 am	Registration	
	Introduction and Welcome Session	
	Chair: Prof. YAO Tandong	
9.15 – 9.20 am	DEVKOTA, Lochan	Welcome by Local Organizing Committee
9.20 – 9.30 am	KARKI, Madhav	ICIMOD organization and relevance to the Third Pole Environment
9.30 – 9.35 am	QIU, Huasheng	Comment on the TPE program
9.35 – 9.40 am	OUYANG, Hua	Brief remarks
9.40 – 9.55 am	YAO, Tandong	TPE progress since the 1st workshop
9.55 – 10.20 am	---Group Photo and Tea Break---	
Session 1	*Chair: Prof. Lochan P. Devkota*	*Academic Presentations 1*
10.20 – 10.40 am	UENO, Kenichi	Great Himalayas as a gate of water and energy cycles into the Tibetan Plateau
10.40 – 11.00 am	BJÖRSSON, Helgi	Glaciers of Iceland: present state and future outlook
11.00 – 11.20 am	YANG, Daqing	TPE and North Pole Environment (NPE): similarity and connection
11.20 – 11.40 am	WINIGER, Matthias	Indus River Basin Initiative - a new approach to a better understanding of the climatic-hydrologic system of HKH
Session 2	*Chair: Prof. YANG Daqing*	*Academic Presentations 2*
11.40 am – 12.00 pm	TIAN, Lide	Monitoring the glacier ice volume change in the Himalayas region
12.00 – 12.20 pm	NAKAWO, Masayoshi	Glacier shrinkage in the Himalayas under the monsoon climate with the abundance of debris and dirt
12.20 – 12.40 pm	LIU, Shiyin	The new glacier inventory of the Tibetan Plateau
12.40 – 1.00 pm	NASIR,Jawad	Current status of glacier studies and initiatives for future research in Pakistan
1.00 – 2.00 pm	---Lunch---	
Session 3	*Chair: Prof. Masayoshi Nakawo*	*Academic Presentations 3*
2.00 – 2.20 pm	MENENTI, Massimo	Land surface hydrology in the Plateau and HKH regions
2.20 – 2.40 pm	XU, Baiqing	Black soot and the survival of Tibetan glaciers
2.40 – 3.00 pm	LAMSAL, Krishna	Estimation of snow and ice melt contribution in discharge of glacierized Langtang Khola Basin, central Nepal

3.00 – 3.20 pm	YAN, Xuedong	Influences of transportation activities on the Third Pole Environment (TPE)
3.20 – 3.40 pm	TAYAL, Shresth	Local variations in melting response of Indian-Himalayan Glaciers
3.40 – 4.00 pm	---Tea Break---	
Session 4	*Chair: Prof. Suresh R. Chalise*	*Academic Presentations 4*
4.00 – 4.20 pm	MA, Yaoming	The progress on the study of atmosphere-land interaction over heterogeneous landscape of the Third Pole area
4.20 – 4.40 pm	YANG, Kun	Promoting satellite applications in the TPE water and energy cycle studies: chance and challenge
4.40 – 5.00 pm	TARTARI, Gianni	Lakes as indicator of climate change impact on quantity, quality and biology of the TPE's water resources
5.00 – 5.20 pm	ZOMER, Robert	Environmental monitoring and long-term ecological research for biodiversity conservation and sustainable development in the Kailash sacred landscape
5.20 – 5.40 pm	MOOL, Pradeep	Glaciers, glacier lakes and glacier lake outburst floods in the Himalayas
6:30 – 8:30 pm	---Reception Dinner hosted by ICIMOD---	
Day 2, October 27, 2010		
Time	**Speaker**	**Topic**
Session 5	*Chair:Prof. Volker Mosbrugger*	*Academic Presentations 5*
9.20 – 9.40 am	LI, Maihe	Physioecological mechanism of the alpine treeline dynamics under global warming
9.40 – 10.00 am	PAN, Baotian	Study on relationship between erosion and tectonic uplift in Northern QilianShan Mountains
10.00 – 10.20 am	GLEIXNER, Gerd	Reconstruction of climate and water cycle from Tibetan Plateau lake sediment cores
	ARORA, Baldev	Roadmap to quantify climate forcing factors on Himalayan glaciers
10.40 – 11.00 am	MOSBRUGGER, Volker	DFG Priority Programme 1372 TiP – Tibetan Plateau: Formation-Climate-Ecosystems
11.00 – 11.20 am	---Tea Break---	
Session 6	*Chair:Prof. Madan L. Shrestha*	*Academic Presentations 6*
11.20 – 11.40 am	DING, Lin	Preliminary study on the provenance of Tajik Basin: uplift and exhumation record of Pamir and Tianshan orogens
11.40 am – 12.00 pm	BHUJU, Dinesh	Species response to climate change in high altitudes: initiative of a national organization in the Himalayan discourse
12.00 - 12.20 pm	THORHALLSDOTTIR, Thora Ellen	Proglacial ecosystem development in Iceland
12.20 – 12.40 pm	GREENWOOD, Gregory	How can the TPE project implement interdisciplinary Earth System Science?
12.40 – 1.00 pm	KARKI, Madhav	ICIMOD's Regional Programme Framework and Collaboration Potentials (e.g. Abu Dhabi Knowledge Forum)
1.00 – 2.00 pm	---Lunch---	
Session 7	*Chaired by: Prof. YAO Tandong*	*Special session*

2.00 – 2.15 pm	KILROY, Garrett	Developing an evidence base in the transboundary Koshi river basin to address impacts from climatic and socio-economic drivers
2.15 – 2.30 pm	KOLLMAIR, Michael	ICIMOD's work on sustainable livelihoods and poverty reduction
2.30 – 2.45 pm	OUYANG, Hua	Transboundary observation programme on water and hazards to the Third Pole Environment
2.45 – 3.00 pm	MOSBRUGGER, Volker	The role of vegetation in mountain dynamics: some facts and speculations
3.00 – 3.15 pm	MARINONI, Angela	The SHARE multidisciplinary project and the atmospheric climate observations at the Nepal Climate Observatory – Pyramid, GAW Global Station
3.15 – 3.30 pm	TARTARI, Gianni and LENTINI, Gianluca	Importance of long term monitoring of climate data in the Khumbu Valley (Himalaya) and in Gilgit Baltistan (Karakorum) as a contribution to the TPE's activities
3.30 – 3.50 pm	---Tea Break---	
Session 8	*Chaired by: Dr. Pradeep Mool*	*Special session*
3.50 – 4.05 pm	MA, Yaoming	Study on the change of Tibetan Plateau climate system and the mechanism of its impact on East Asia (TPCS-IEA)
4.05 – 4.20 pm	LIU, Shiyin	Project of cryosphere and environment in Tianshan
4.20 – 4.35 pm	van OEVELEN, Peter J.	The future of GEWEX and its new imperatives
4.35 – 4.50 pm	LIU, Linshan	Progress of the Geo-pack
4.50 – 5.30 pm	Proposition of new ideas and thoughts	
6.30 – 8.30 pm	---Dinner Banquet hosted by TPE---	
Day 3, October 28, 2010		
Time	**Speaker**	**Topic**
Session 9	*Session leaders*	*Group Discussions*
9.20 am – 1.00 pm (including tea break)	Group 1. History (led by G. Gleixner and B. Pan) Group 2. Water/atmosphere (led by K. Ueno and F. Zhang) Group 3. Cryosphere (led by D. Yang and B. Arora) Group 4. Ecosystems (led by T.E. Thorhallstdottir and M. Li) Group 5. Human impacts (led by B. Xu and M. Menenti) Group 6. Adaptation (led by G. Greenwood and P. Mool)	
1.00 – 2.00 pm	---Lunch---	
Session 10	*Session leaders*	*Plenary Discussions*
2.00 – 4.30 pm (including tea break)	Group 1. Flagship stations and observatories (led by T. Yao and B. Arora) Group 2. Data and modeling (led by V. Mosbrugger and S. Kang) Group 3. Products and integration (led by G. Greenwood and P. Mool)	
4.30 – 5.00 pm	Concluding remarks by Prof. YAO Tandong Concluding speech by Dr. Andreas Schild (director-general of ICIMOD,,one of the supporting institutes) Proposition by Helgi Bjorsson to hold the 3rd TPE Workshop in Iceland	
Finale		

Appendix 2. List of Participants

Name	Country	Affiliation	Email Address
Adhikari, Tirtha Raj	Nepal	CDHM, TU	tirtha43@yahoo.com
Arora, Baldev Raj	India	Wadia Institute of Himalayan Geology	arorabr47@gmail.com
Aryal, Deepak	Nepal	CDHM, TU	daryal1@hotmail.com
Bajracharya, Om Ratna	Nepal	DHM, Government of Nepal	omratna@hotmail.com om@dhm.gov.np
Bajracharya, Samjwal	Nepal	MENRIS, ICIMOD	sabajracharya@icimod.org
Bhuju, Dinesh Raj	Nepal	NAST	dineshbhuju@gmail.com
Bjornsson, Helgi	Iceland	Institute of Earth Sciences, Univ. of Iceland	hb@raunvis.hi.is
Boom, Daan	Nepal	IKM, ICIMOD	dboom@icimod.org
Chalise, Suresh Raj	Nepal	Tribhuvan Uni.	srchalise2002@yahoo.com
Chettri, Nakul	Nepal	ECES, ICIMOD	nchettri@icimod.org
Choudhury, Dhrupad	Nepal	SLPR, ICIMOD	dchoudhury@icimod.org
Devkota, Lochan Prasad	Nepal	CDHM, TU	devkotalp@hotmail.com
Ding, Lin	China	ITPCAS	dinglin@itpcas.ac.cn
Doosti, Abdul Aziz	Afghanistan	ICIMOD	adoosti@icimod.org
Fayziev, Radjabovich Abjulkhak	Tajikistan	Institute of Geology, Tajikistan	faiziev38@mail.ru
Gleixner, Gerd	Germany	Max-Planck Institute for Biogeochemistry	ggleix@bgc-jena.mpg.de
Greenwood, Gregory	Switzerland	MRI, Univ. of Bern	green@giub.unibe.ch
Gurung, Binod Das	Nepal	IWHM, ICIMOD	bgurung@icimod.org
Gurung, Deo Raj	Nepal	MENRIS, ICIMOD	drgurung@icimod.org
Gurung, Jay	Nepal	Himalayan HIMCCA	
Ouyang, Hua	Nepal	IWHM, ICIMOD	houyang@icimod.org
Joswiak, Daniel	China	ITPCAS	daniel@itpcas.ac.cn
Joswiak, Meri E.G.	China	ITPCAS	meri@itpcas.ac.cn
Kang, Shichang	China	ITPCAS	shichang.kang@itpcas.ac.cn
Karki, Madhav Bahadur	Nepal	ICIMOD	mkarki@icimod.org
Karky, Bhaskar Singh	Nepal	EAD, ICIMOD	bkarky@icimod.org
Kattel, Dambaru B.	China	ITPCAS	katteldb@itpcas.ac.cn
Kayastha, Rijan Bhakta	Nepal	HiCCDR, KU	rijan@ku.edu.np
Khanal, Narendra Raj	Nepal	CDG, TU	nrkhanal@enet.com.np
Kilroy, Garrett	Nepal	IWHM, ICIMOD	gkilroy@icimod.org
Kollmair Michael	Nepal	SLPR, ICIMOD	mkollmair@icimod.org
Lamsal, Krishna	Nepal		naturekrish@gmail.com
Lentini, Gialuca	Italy	ISAC-CNR	g.lentini@isac.cnr.it
Liu, Linshan	China	IGSNRR	liuls@igsnrr.ac.cn

Name	Country	Affiliation	Email Address
Liu, Shiyin	China	CAREERI, CAS	liusy@lzb.ac.cn
Li, Maihe	Switzerland	Swiss Federal Institute for Forest, Snow and Landscape Research (WSL)	maihe.li@wsl.ch
Ma, Yaoming	China	ITPCAS	ymma@itpcas.ac.cn
Macchi Mirjam	Nepal	SLPR, ICIMOD	mmacchi@icimod.org
Malakhov, Firuz	Tajikistan	Institute of Geology, Tajikistan	v_minaev@mail.ru
Marinoni, Angela	Italy	ISAC – CNR	a.marinoni@isac.cnr.it
Menenti, Massimo	Netherlands	Delft Univ. of Technology	M.Menenti@tudelft.nl
Mool, Pradeep	Nepal	IWHM, ICIMOD	pmool@icimod.org
Mosbrugger, Volker	Germany	Senckenberg Research Center for Nature Study, Frankfurt	volker.mosbrugger@senckenberg.de
Nakawo, Masayoshi	Japan	National Institutes for the Humanities	nakawo@chikyu.ac.jp
Nasab, Nusrat	Pakistan	FOCUS Humanitarian Assistance Pakistan	nusrat.nasab@focushumanitarian.org
Nasir, Jawad	Pakistan	SUPARCO	jwd786@yahoo.com
Nayava, Janak Lal	Nepal	SOHAM	chiefeditor.jhm@gmail.com soham@soham.org.np, soham_npl@yahoo.com
Oli, Krishna Prasad	Nepal	ECES, ICIMOD	koli@icimod.org
Pan, Baotian	China	Lanzhou Univ.	panbt@lzu.edu.cn
Penjar, Kinley	Bhutan	UNDP	kinley.penjar@undp.org
Pokharel, Adarsha Prasad	Nepal	SOHAM	saibaba@wlink.com.np
Pradhananga, Dhiraj	Nepal	SOHAM	soham@soham.org.np, soham_npl@yahoo.com
Qiu, Huasheng	China	Bureau of International Co-operation, CAS	hs-qiu@cashq.ac.cn
Qiu, Jane	China	Nature	jane@janeqiu.com
Rajbhandari, Rupak	Nepal	Trichandra Campus, TU	rupak.rajbhandari@gmail.com
Rajkarnikar Gautam	Nepal	Koshi River Basing Management Programme, WECS, Government of Nepal	pinku_gautam@hotmail.com
Sah, Madho P.	India	Wadia Institute of Himalayan Geology	madho_sah@rediffmail.com
Sah, Pradip Kumar	Nepal	WECS, Government of Nepal	pradip_sah@yahoo.com

Name	Country	Affiliation	Email Address
Schild, Andreas	Nepal	ICIMOD	aschild@icimod.org
Shakya, Naina	Nepal	ICIMOD	nshakya@icimod.org
Sharma, Aseem	Nepal	IWHM, ICIMOD	asharma@icimod.org
Shrestha, Arun Bhakta	Nepal	IWHM, ICIMOD	abshrestha@icimod.org
Shrestha, Basanta	Nepal	MENRIS, ICIMOD	bshrestha@icimod.org
Shrestha, Madan Lall	Nepal	NAST	madanls@hotmail.com
Shrestha, Ritu Meher	Nepal	IWHM, ICIMOD	rmshrestha@icimod.org
Sveinbjornsson, Dagfinnur	Iceland	Climate Research Fund	dagfinnur@gmail.com
Tartari, Gianni	Italy	Water Research Institute of the Italian National Research Council (CNR-IRSA)	tartari@irsa.cnr.it
Tayal, Shresth	India	The Energy and Resources Institute	t.shresth@gmail.com
Thakuri, Sudeep	Nepal	Water Research Institute of the Italian National Research Council (IRSA-CNR)	4262411 (O), 4241403 (R)
Thorhallsdottir, Thora Ellen	Iceland	Univ. of Iceland	theth@hi.is
Tian, Lide	China	ITPCAS	ldt@itpcas.ac.cn
Tuladhar, Milan Raj	Nepal	ICIMOD	mtuladhar@icimod.org
Ueno, Kenichi	Japan	Graduate School of Life and Environmental Sciences, Univ. of Tsukuba	kenueno@sakura.cc.tsukuba.ac.jp
van Oevelen, Peter J.	USA	International GEWEX Project Office (IGPO)	peter.vanoevelen@gewex.org
Wang, Weicai	China	ITPCAS	weicaiwang@itpcas.ac.cn
Wang, Zhenyu	China	Bureau of International Co-operation, CAS	zywang@cashq.ac.cn
Winiger, Mathias	Germany	Univ. of Bonn	winiger@uni-bonn.de
Xu, Baiqing	China	ITPCAS	baiqing@itpcas.ac.cn
Yan, Xuedong	China	Beijing Jiaotong Univ.	yanxuedong@jtys.bjtu.edu.cn
Yang, Kun	China	ITPCAS	yangk@itpcas.ac.cn
Yang, Xiaoxin	China	ITPCAS	xxy@itpcas.ac.cn
Yang, Daqing	Norway	CliC, Norwegian Polar Institute	daqing.yang@npolar.no
Yao, Tandong	China	ITPCAS	tdyao@itpcas.ac.cn
Zhang, Fan	China	ITPCAS	zhangfan@itpcas.ac.cn
Zomer, Robert	Nepal	ECES, ICIMOD	rzomer@icimod.org

Appendix 3. 2010-2011 TPE Working Timeline

Towards the end of the 2nd TPE Workshop, a working timeline for upcoming tasks was outlined by TPE Co-chairs T. Yao and V. Mosbrugger. The following timeline includes the topics and schedule proposed:

2010, October 26-28: 2nd TPE Workshop
- Ideas about the science plan
- Ideas concerning flagship stations, infrastructure, data handling

2010, Mid-November: Report of the 2nd TPE Workshop (homepage + mail)

2010, December 13-16: AGU San Francisco
- Presenting TPE-results/progress
- Meeting to further develop the science plan (information on homepage)

2011, March: Collect and present information about existing stations, and information about running TPE-projects. Make information available on the TPE homepage.

2011, April 3-8: EGU Vienna: Presenting TPE-results/progress

2011, April: draft science plan with pictures on the homepage
- E-Mail discussion and improvement until the next workshop
- Presentation of results at EGU, Vienna

2011, August 30-September 2: TPE Workshop in Iceland: final discussion and approval of the TPE Science Plan.

2011, December 5-9: AGU San Francisco: presenting TPE Science Plan (brochure) to the public.

Appendix 4. List of Acronyms

AGU	American Geophysical Union
AMMA	African Monsoon Multidisciplinary Analysis
CAMP/Tibet	Asian-Australian Monsoon Project on the Tibetan Plateau
CAREERI	Cold and Arid Regions Environmental and Engineering Research Institute (CAS)
CAS	Chinese Academy of Sciences
CDG	Central Department of Geography (TU)
CDHM	Central Department of Hydrology and Meteorology (TU)
CEOP	Coordinated Enhanced Observing Period
CGIAR	Consultative Group on International Agricultural Research
CIFOR	Center for International Forestry Research
CliC	Climate and Cryosphere Project
CNR	Italian National Research Council
DHM	Department of Hydrology and Meteorology (Government of Nepal)
EAD	Economic Analysis Division (ICIMOD)
ECES	Environmental Change and Ecosystem Services (ICIMOD)
EGU	European Geosciences Union
ESA	European Space Agency
ESSP	Earth System Science Partnership
FAO GLCN	Food and Agriculture Organization of the United Nations Global Land Cover Network
FOCUS	Focus Humanitarian Assistance
GAME/Tibet	GEWEX Asia Monsoon Experiment on the Tibetan Plateau
GEO	Group on Earth Observations
GEWEX	Global Energy and Water Cycle Experiment
GHP	GEWEX Hydrometeorology Panel
GLIMS	Global Land Ice Measurements from Space
GLORIA	Global Observation Research Initiative in Alpine Environments
GLP	Global Land Project
GMBA	Global Mountain Biodiversity Assessment
HiCCDRC	Himalayan Cryosphere, Climate and Disaster Research Centre
HIMCCA	Himalayan Alliance for Climate Change
HIPPS	Himalayas Inter-disciplinary Paleoclimatic Projects
HKT	Himalaya-Karakorum-Tibet

IACS	International Association of Cryospheric Sciences
ICDP	International Continental Scientific Drilling Program
ICIMOD	International Centre for Integrated Mountain Development
ICP	Ice Core Program
IGBP	International Geosphere Biosphere Programme
IGBP-IHDP	International Human Dimensions Programme on Global Environmental Change
IGSNRR	Institute of Geographic Sciences and Natural Resources Research
IGPO	International GEWEX Project Office
IKM	Integrated Knowledge Management (ICIMOD)
ILP	International Lithosphere Program
IODP	Integrated Ocean Drilling Program
IRSA-CNR	Water Research Institute (CNR)
ISAC-CNR	Institute of Atmospheric Sciences and Climate (CNR)
ITEX	International Tundra Experiment
ITP	Institute of Tibetan Plateau Research (CAS)
IWHM	Integrated Water and Hazards Management (ICIMOD)
KU	Kathmandu University
LTER	Long-Term Ecosystem Research
MAIRS	Monsoon Asia Integrated Regional Study
MENRIS	Mountain Environment and Natural Resources' Information System (ICIMOD)
MIREN	Mountain Invasion Research Network
MRI	Mountain Research Initiative
NASA	National Aeronautic and Space Administration
NAST	Nepal Academy of Science and Technology
NSIDC	National Snow and Ice Data Center
PAGES	Past Global Changes
SHARE	Stations for High Altitude for Research on the Environment
SLPR	Sustainable Livelihoods and Poverty Reduction (ICIMOD)
SOHAM	Society of Hydrologists & Meteorologists, Nepal
TiP	Tibetan Plateau: Formation - Climate - Ecosystems
TPE	Third Pole Environment
TU	Tribhuvan University
UNEP	United Nations Environment Programme
UNEP-ABC	UNEP – Atmospheric Brown Clouds
WCRP	World Climate Research Programme
WECS	Water and Energy Commission Secretariat, Government of Nepal