Report of the 3rd

Third Pole Environment

(TPE) Workshop

2011

Reykjavik, Iceland

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Reykjavik, Iceland

August 29-September 1, 2011

Contents

PREFACE

Thus far, 2011 has been a very productive year for TPE. Firstly, we are excited to announce the entrance of TPE into the UNESCO-SCOPE-UNEP Policy Brief Series – an important step in establishing TPE as a vital international scientific program. Since the last TPE workshop in Kathmandu, Nepal, Co-chairs, affiliated scientists and institutions have made considerable headway in laying out the roadmap for TPE's continued growth and success, as evidenced by the considerable progress made on the TPE Science Plan draft.

TPE researchers and program staff have shown commitment to expanding field investigations, creating training and networking activities and increasing TPE publications. We are pleased with the overall progress and excited about the future of TPE.

We would like to express our sincere gratitude to the local organizing committee, supporting organizations, and all participants of the 3rd TPE Workshop in Reykjavik. We would also like to thank all those who have been involved in the program since its inception in 2009. It is only through our collaborative efforts that we can expect to obtain our ambitious program goals.

With Kind Regards,

Tandong Yao, Lonnie Thompson, Volker Mosbrugger
TPE Co-Chairs

1. Introduction

1.1. Brief TPE introduction

The Third Pole Environment (TPE) program was initiated at the 1st TPE Workshop in Beijing in 2009. The goal of TPE is to study the regional Earth system sustainability in the Third Pole, particularly focusing on a theme of "water–ice–air–ecosystem-human" interactions. TPE is designed as a collaboration amongst countries in and around the Third Pole region, as well as any other country that wishes to contribute to its mission. It focuses on the development of international, interdisciplinary and integrated studies involving natural and social scientists, as well as experts and practitioners with long-term experience, institutional mandates and functions to assess past, ongoing and future environmental change processes and mechanisms at local, regional and global scales. More information about the Third Pole Environment (TPE) program can be found on the web at: http://www.tpe.ac.cn/.

1.2. Workshop goals

The first and second TPE workshops have assessed the significance of TPE and identified key scientific questions. The 3rd TPE Workshop in Iceland continued to build on the progress and success of the first two TPE workshops. The workshop agenda consisted of four main parts, including:

a) Review and present scientific progress related to TPE research
b) Small-group theme discussions to deepen scientific questions
c) Review and discuss the TPE Science Plan draft
d) Discuss the planning and configuring of TPE flagship research stations

During the first two workshop days of Aug 30th and 31st, academic presentations were followed by group discussions within the following five themes:

- Climate
- Glaciers
- Lakes and rivers
- Ecosystems

- Natural dynamics of the Third Pole environment-Lessons from the Past

The TPE Science Plan draft was discussed at the end of the second day, and the discussions were continued in the morning of the third day. A technical meeting on TPE flagship stations was held on the third and final workshop day, Sept. 1st, which included presentations followed by a round-table discussion. The flagship station discussions centered on the five main topics of:

- Standardized equipment for stations
- Suggestions for additional flagship stations
- Coordinated management and financing
- Data availability and data sharing policy
- Conclusions and action points

The complete 3rd TPE Workshop agenda can be found in Appendix 1 and the list of participants can be found in Appendix 2.

2. Opening Ceremony

During the opening session, TPE was pleased to welcome highly esteemed colleagues including: the President of Iceland, Olafur Ragnar Grimsson; the Rector of the University of Iceland, Kristín Ingólfsdóttir; TPE Co-chairs, Tandong Yao, Lonnie Thompson and Volker Mosbrugger; Chinese Academy of Sciences Representative, Honglie Sun; ICSU Executive Director, Deliang Chen; UNESCO representative, Sarah Gaines; and Secretariat of the International Glaciological Society, Magnus M. Magnusson. The opening session speeches highlighted the relevance of TPE Earth Systems Science initiative and praised TPE for its efforts in creating an international, interdisciplinary and integrative research program to study the Third Pole Environment. Opening speeches can be found in Appendix 3.

3. Workshop Presentations

Significant recent progress is being presented in scientific research within the Third Pole region. Presentations of recent results were organized according to the following themes: Climate, Glaciers, Lakes and Rivers, Ecosystems, and Natural Dynamics of TPE-Lessons from the Past. Authors have generously

made their presentations publicly available, and can be downloaded from the TPE website at: http://www.tpe.ac.cn/wkshp3/presentations. Presentations according to each theme are listed below, and can be found in Appendix 4 listed alphabetically by author last name.

Climate

Masson-Delmotte, V. “A bipolar perspective on climate change during the last climatic cycles”

Su, B. “Quantifying Climate Change Impacts in data-scarce Environment,”

Ueno, K. “Variability of precipitation phase in High elevations”

Yang, K. “A synthetic report of recent climatic changes and their impacts on energy and water budgets over the Tibetan Plateau”

Glaciers

Aizen, V. “Central Asia Cryosphere as a Part of the 3rd Pole Environment”

Bolch, T. “Assessing glacier mass changes in high Asia based on space imagery”

Jarosch, A. “The Relevance of Regional Glacier Models for Understanding the Third Pole”

Kulkarni, A. “Observed changes in Himalaya cryosphere”

Lakes and Rivers

Armstrong, R. “A preliminary assessment of the contribution of seasonal snow cover to runoff in the Upper Indus Basin”

Bookhagen, B. “Hydrologic Gradients, Climatic Extremes, and Surface Erosion in the Himalaya”

Winiger, M. “Assessing spatial gradients of water balance in the Hindukush-Karakorum-Himalaya – data need and uncertainties”

Ecosystems

Gislason, G.M. “Glacial river ecosystems and the effect of global warming”

Kirchner, J. “Exploring mountain landscapes and ecosystems by studying their streams”

Mosbrugger, V. “Third Pole Ecosystems - their relevance for ecosystem services and geoengineering”

Piao, S. “Change in vegetation growth and carbon balance of Qinghai-Tibetan grasslands over the past five decades”

Natural Dynamics of TPE – Lessons from the Past

Chen, D. “Visioning: Towards a new initiative on Earth system research for global sustainability”

Nakawo, M. “Research Integration for Environmental Issues between human/social studies and natural science”

Thompson, L. “Third Pole Glaciers, Recorders and Indicators of Climate Change”

Yao, T. “Recent Environment Change in Third Pole Region”

4. Group Discussions – Six Themes

For the group discussion sessions, workshop participants were free to choose a group according to their own interest, and were free to move between groups at any time. The five themes for discussion were: climate, glaciers, lakes and rivers, ecosystems, natural dynamics of the Third Pole environment-lessons from the past and anthropogenic impacts. The format was an open discussion regarding any aspects of the theme as related to TPE. After the group discussions, one representative from each of the six themes presented a summary for all workshop participants. This summary is presented below according to each of the themes.

4.1. Climate

The climate group was coordinated by V. Mason-Delmotte and B. Su, and B. Su presented the group discussion results. The climate group began by discussing the issue of data quality. The group noted that field data, for

example, was not usually intercompared, and stressed the need for field measurements to be measured and processed with the same protocol to obtain more meaningful data comparisons. The group also discussed climate data availability and the need for meta-databases, and mentioned that issues associated with providing data should be further discussed at another time.

Another main issue discussed by the group was related to climate modeling. They stressed the need for modelers working from a TPE perspective, and also suggested a call to space agencies to generate TPE data sets, similar to those produces for the International Polar Year (IPY). The group noted that gridded data and reanalysis data are now available at coarse resolution, and improved downscaling methods are needed to use this type of data in the Third Pole region. Further related to the reanalysis issue, the group discussed data assimilation and raised the question of what measurements and data from TPE can be integrated into assimilated reanalysis data. They suggested TPE check the different reanalysis data sets and contact the reanalysis centers, like NWS and NCAR, to see what is really in the model products. The need to evaluate the quality of reanalysis products was also stressed, and the group suggested defining a set of indicators to evaluate different variables. Additionally related to modeling, the climate group proposed a project on validation of CMIP5 to check the consistency of model products by evaluation of hydroclimate variables. The group outlined some basic needs of climate modelers, including data availability by timescales to examine short-, middle- and long-term coupling. The group also had some suggestions for additional measurements that would be useful to modelers, namely the monitoring of pollen at flagship stations. The group also emphasized the importance of elevation, and suggested greater attention to measurements at different elevations since condensation will be quite different.

One of the main science questions pointed out by the climate group was related to feedbacks between vegetation and climate. The group pointed out the fact that it is currently not clear what climate feedbacks will occur with vegetation changes. They noted that current efforts are underway to detect

and attribute vegetation changes, but the underlying causes of change have not been thoroughly addresses. Another main science question discussed by the group was related to natural climate forcings, such as volcanic, and their climate impacts. The climate group suggested TPE focus on hydroclimate aspects, in general.

As a final comment, the climate group suggested TPE somehow be involved in the IPCC AR5 report. The group was surprised not many glaciologists studying the Third Pole were involved in the last report, and noted the importance not only in scientific contribution TPE can make but also as a way to improve the visibility of TPE.

After the climate group's discussion summary, there were a few questions from participants. Some of the discussion centered on the IPCC report, including some questions and clarification of timelines and further discussion of how TPE could be involved. One participant suggested TPE write to IPCC directly and request to be an additional group with input for the report. Another participant noted the importance of submitting relevant publications, as there is a deadline by which papers must be submitted in order to be cited in the report.

Other questions and comments by participants were related to data availability, modeling aspects, and mechanisms of climate change. A participant noted that data availability is certainly a complex issue, as it requires people to agree on data sharing policies and procedures. It was suggested that someone should begin working on a document related to data sharing, as this will be necessary to move the issue forward. Another workshop participant suggested that weather forecast models should be included in the discussion of climate modeling, as these models can predict many variables. Finally, the importance of an improved understanding of the mechanism of recent climate change was stressed by a participant, who mentioned that there are a number of papers about climate change in the Third Pole region, but very few papers suggest a mechanism for the increased regional warming. The climate group agreed that these are additional points for consideration.

4.2. Glaciers

Coordinators of the glaciers group included R. Armstrong and T. Bolch, with T. Bolch presenting the summary of the group discussion. The group first outlined some key points discussed by the group. First, the glacier group indicated the need for a complete and recent glacier inventory for the Third Pole region, as many currently used inventories use old GLIMS data or topographic maps with high uncertainties. They agreed this should be released to the public, and recommended using the declassified imagery such as Corona or KH-9. The glacier group commented that there are many studies of glacier area changes, but even more important is volume changes.

Another main suggestion coming from the glacier group discussion was to use the term “reference glacier” instead of representative or benchmark glacier. Related to reference glaciers, the group suggested about 20 glaciers would be a realistic starting point, and noted that there are already many existing ones. The group further discussed reference glaciers, and agreed that they should have some clearly defined characteristics or categories, such as those representing different climates, different elevations, sizes, etc. The glacier group suggested methods for studying reference glaciers including direct in situ measurements, lidar measurements for generation of detailed surface models, and GPR to measure glacier bed topographies. Results from those measurements can be used to enhance current models and also get new theoretical methods which can be applied to larger areas.

Related to glacier modeling, the group discussed the problem of debris cover. In the Himalaya, many glaciers are covered by debris, and the group advised some type of classification according to debris cover, such as thin, thick or no debris cover. This is important for integration into models as different types of debris cover will greatly affect the melting regime. The glacier group suggested further coordination and communication with modelers, by asking them what information they need most in order to run models more precisely. They also indicated a need for closer collaboration between glaciologists and hydrologists, for example to know the contributions of glacier melt vs. snow melt.

The group stressed the need to make data available and suggested TPE promote data archiving at no cost. They also suggested existing databases be adopted without developing new ones, to prevent the creation of a large number of databases. The glacier group also indicated a basic need for an inventory of existing projects, as the number of projects in the Third Pole region continues to grow. In this way, projects may be developed to complement research with minimal overlap.

After the glacier group's discussion summary, there were several participant comments. One participant suggested the radiation balance be measured if the goal is to address the causes of glacier changes, and recommended some remote sensing platforms be used for such tasks as distinguishing old snow from new snow. The group members agreed that this should be included. Another participant suggested HALO be looked at for the Third Pole region, as this can produce gravity and other measurements. It was also suggested NASA be approached, as they are planning a spaceborn lidar that will run for several years and can get volume changes. They noted there is a call from NASA, not for single scientists but research groups may apply. The glacier group thought it would be great to address this with NASA at the planning stage, however another participant who worked on this NASA panel in the past indicated this may not be practical under time constraints, since this process will likely take a very long time. This participant thought lidar is ideal, but noted that any flying platform will suffice since altitude is not a big problem if extremely high resolution is not needed. In contrast to satellite data, another scientist suggested maps should not be completely rejected as many high quality photos are still available from the 1920s and 1930s. The glacier group agreed that terrestrial photos or oblique photos should be used if they exist, as well old maps from the 1930s, if used with caution. A final comment was related to the inclusion of IPY data, and contact with the ICSU group for data guiding was suggested.

4.3. Lakes and rivers

The lakes and rivers group discussion was coordinated by M. Winiger and F. Zhang, and M. Winiger presented the discussion summary. The group began by noting there were some group points from last year's discussion already in the 2nd TPE Workshop Report (2010), and these points were not included again. The group acknowledged lakes and rivers as a central component of ecosystem services, and have many important scientific aspects as well. It was suggested that wetlands be included in discussions of lakes and rivers, as these areas make up a large portion of highland areas.

Next, the lakes and rivers group stressed the importance of investigating the role of dams or artificial lakes, especially in highland regions of the Third Pole with many outlet rivers. The group discussed these big river systems, and noted that more dams are being planned for the future. These may be studied in terms of impacts and associated risks, but the group acknowledged this as a difficult political issue as well. The Third Pole region also has large areas of plains, and the group discussed the large flood regions where rivers show different behavior compared to steep terrain, especially in the southern regions. Throughout the Third Pole, groundwater and permafrost are a huge storage and reservoir, and the group suggested somehow the influence of this storage on the thermal properties of landscapes. They noted the difficulties associated with this, as there is little knowledge about how these water flows function in the whole system.

The lakes and rivers group next brought to attention some of the hazards associated with extreme events. Many rivers are associated with steep terrain, and carry large sediment loads. Although these increased sediment loads in lakes and ponds present good possibilities for dating, they can also present big problems, for example in terms of power plants. Additionally, the group pointed out that too much sediment coming to large agricultural areas, as seen after the flooding in Pakistan, can destroy whole systems. The group suggested paying special attention to the general characteristics of runoff and to extreme events that occur every few decades. These extreme events have

a high influence on the whole highland regions and adjacent areas. An important question is how to manage and deal with these extreme events.

The lakes and rivers group also discussed TPE data and meta-databases. They stressed the need to collect information about what has been done by whom, including some measure of data quality. The group discussed the need to clearly define flagship stations, including which parameters are measured, site locations, and available data services. It was suggested the stations be mapped to better understand the current coverage of stations. They noted that some new stations were proposed at the 2nd TPE Workshop, but an up-to-date inventory and database of current observations (locations, duration, contact information, etc.) is still needed. The group also indicated the need for a general inventory and classification of the different types of lakes and rivers, and a TPE hydroclimate atlas would be an ideal product for collaboration. This type of atlas could also include susceptibility maps, land use and runoff information.

At the end of the lakes and rivers presentation, it was suggested that TPE use some similar approaches as ICIMOD, such as the river basin approach, transect approach, or wetland initiatives. The group also suggested relating to the 'hot spots' already identified by ICIMOD, as some of the regions already have a number of investigations underway or completed. It will be important to define products and outcomes of these initiatives for stakeholders and planners.

After the lakes and rivers discussion summary, there were several comments and suggestions. The first related to the importance of reservoirs, and linking human activity. A participant commented on the need to remove or upgrade old infrastructure, and also suggested reconstructing downstream discharge and asking modelers to integrate these aspects. Another participant commented on the need to define the stakeholders, and the lakes and rivers group acknowledged that they did not go into those details. Another participant noted that people working with hydroplants in the region are really looking for some discharge information, and they would be one of the stakeholders. The

lakes and rivers group indicated the importance of highland-lowland exchange, as the needs are mainly defined from lowlands while the resources are mainly in the highlands. The group acknowledged the importance of TPE in this regard, as a cross-cutting platform between the highlands and lowlands, for example to what extent the needs of the lowlands affect those in the highlands.

4.4. Ecosystems

Coordinators of the ecosystems group included S. Piao and G. Greenwood, with G. Greenwood presenting the summary of the discussions. The ecosystems group began by reiterating the main theme, that TPE is not an implementing agency but an overarching framework. They stressed the need to define products and identify the types of activities TPE will be involved in. The group discussed some of the products needed, and noted that some were already discussed at the last TPE workshop. One of the suggested products is an ecosystem map over the whole region. The group discussed integrating many of the products already available in TPE countries, such as vegetation maps. If these maps are available, for example, in China, India, and Nepal, the group stressed the need for TPE to bring these together somehow and look at integrating different classification schemes. The ecosystems group clearly defined a need for an ecosystems map for the Third Pole, but acknowledged their difficulty in characterizing aquatic habitats in the Third Pole region. They suggested bringing in some ecohydrologists to get a better characterization in this area.

Regarding ecosystem services, the group suggested TPE move beyond stating that ecosystems provide services to over 2 billion people, by becoming specific about what services are provided and where. The group stressed the need to quantify ecosystem services, for example by putting some number with the four categories outlined by V. Mosbruggers, which include regulating, provisioning, supporting, and cultural services.

In addition to ecosystem classifications, the group also discussed the need to define those who are consuming resources in the Third Pole region. This

concept was also discussed at the 2nd TPE Workshop in terms of human livelihoods, for example how different livelihoods will be affected and what is the vulnerability of different groups. The ecosystem group suggested that a livelihood study would be valuable for comparison with flagship station locations to find the most relevant stations within different ecosystems, or to assist with identification of new station locations. Also related to flagship stations, the ecosystem group stressed the need for a comprehensive station list to characterize the ecosystems currently being monitored. With coverage of the existing system, one could overlay it on the eocsystem product in order to define those ecosystems that are poorly monitored by the existing system and therefore those where new stations should be installed. The group also suggested these stations be both monitoring and experimental sites, comparable to those established as LTER stations, or CERN, perhaps not as an ideal model but as a resource for methodologies and approaches. This type of long-term ecological monitoring at specific sites could then be up-scaled, via the ecosystem product mentioned above, to get a bigger picture of ecosystem changes.

The ecosystem group next outlined some of the key questions from their perspective; one of these is the current function of ecosystems in the Third Pole. For example, is the Third Pole a carbon source or sink? The group suggested this could be answered using flux towers in different ecosystems, and would allow different researchers to work in different regions using an accepted methodology. Another main topic put forth, complementary to the carbon cycle, was related to the water cycle and how to close the water cycle. Additions questions put forth included how to prove high elevation ecosystems are sensitive, how will ecosystems change under different management regimes, how will protected ecosystems respond, how will ecosystems change with warming, will changes in terrestrial ecosystems affect aquatic ecosystems, and what are the feedbacks of vegetation on climate. The group discussed these questions but acknowledged there is not yet a complete list of science questions related to ecosystem studies and suggested a working group to develop a full list of questions, including species-related questions. The

ecosystems group pointed out that megafauna has successfully motivated conservation efforts in the past, and suggested TPE include this in the planning stages. Lastly, it was noted that many of the science questions discussed by the ecosystems group deal with people, and will require close collaboration with local communities and with local governments. After the summary of the ecosystem group discussion, there was one comment from a participant emphasizing adaptation and the need to understand how local people may adapt to future changes.

4.5. Natural dynamics of the Third Pole environment - Lessons from the Past

This group, also called the past environments group, was coordinated by V. Aizen and J. Kirchner, with V. Aizen presenting the discussion summary. This group mainly discussed the major tools used to study past environmental change. One of main tools discussed was ice core records, including both shallow and deep cores as sources of information about past environments. The group discussed ideal ice core sites at different elevations, noting there are possible drill sites over 6000 m in the Third Pole region. The past environments group also highlighted the possibility for ice cores to calibrated ice thickness measurements, for example those from radiosonde or satellite data. Other points regarding ice core studies were the additional calibration needed for isotope and other proxy records to improve dating, and the need to determine the relative causes of surface ice mass loss, including contributions from snow redistribution, melt, or sublimation.

In addition to ice core records, the past environments groups discussed other proxies such as lake and dendro cores. They suggested increased attention on comparison studies between the proxies, although regions ideal for dendro coring are mainly limited to southeastern regions of the Third Pole. To accomplish comparisons between ice and lake cores, the group indicated the need to identify and work with groups who can do deep lake drilling. It was noted that further study of paleo-sediments may also help answer questions about past changes in climate and moisture flow, especially with sediments

from the flat areas of the Third Pole. In general, the past environments group emphasized the need to collect existing data from ice cores and other proxies, in order to avoid duplicating what has already been done.

The main scientific questions discussed by the past environments group related to the following: reconstruct climate history for the past hundreds to thousands of years including changes in atmospheric circulation processes, reconstruct past changes in glacier water-resources to aid in future simulations and predictions, determine glacier covered area distribution during the Pleistocene and Holocene over the Third Pole region, model past and possible future climate incorporating available proxies.

Several questions were raised after the past environments group summary. One question was for clarification of the term 'past environments' which mainly means past climate in this context. It was also noted by the group that changes in past climate and atmospheric circulation also effect changes in vegetation. Another question was raised regarding statistical models, and the group clarified some of the suggested approaches, that of using data for model validation and initial data for simulations of future changes. A final question was raised about the number of cores needed for atmospheric circulation reconstruction. The group suggested using what is available now, and selecting more sites in different areas as well.

4.6. Anthropogenic Impacts

The anthropogenic impacts group was coordinated by P. Mool and M. Nakawo, with the discussion summary presented by P. Mool. The group began by outlining the main topics related to anthropogenic impacts which were discussed at the 2nd TPE Workshop in Nepal. Three main topics were outlined in those discussions, including: air pollution (esp. black carbon and trace elements), trans-boundary water management, and land cover and land use changes. At this year's workshop, the group further discussed data needs, including both socio-economic and socio-cultural data.

The anthropogenic impacts group listed some of the necessary demographic information needed within the Third Pole region; including data related to population, use of natural resources, migration, urbanization, movement of village due to water demand, influence of globalization and changes in society. In addition, the group discussed a need to identify the main drivers related to demographics, such as market demands, water, and governmental policies.

Next the group discussed the need for land cover and land use data, with the suggestion to use NDVI classifications. The group identified the need to identify the changes in LCLU, the main driving factors of these changes, and to understand the linkages of LCLU with policies in the region. The anthropogenic impacts group stressed the important differences between northern and southern slopes of the Himalayas, for example in terms of snow and ice cover, water availability, and water resource management.

The anthropogenic impacts group also discussed ecosystem services in terms of the linkages between highland and lowland areas, and questioned how to encourage research on these issues and on related policy issues. An example given by the group was man-made dams, which have concerns related to sediment transport, water availability, as well as changes in ecosystems and in the atmosphere. Another discussed topic was rangeland and farming, and the group stressed the need to better understand how management policies are impacting natural systems in the Third Pole region.

The final point made by the anthropogenic group was the importance of interfacing with other research groups. To move this forward, the group suggested first identifying who is already doing research on these topics, and then determining how to build in TPE research within existing systems. A couple of examples of existing systems presented by the group were ICIMOD, and MAB (a national committee program). One difficult question that will need to be addressed is how to fund and coordinate these collaborative research topics.

After the group discussion summary, one participant suggested adding the impact of sediment flux within studies of anthropogenic impacts. For example, by studying the impact of activities such as road construction and development to determine if these have a significant impact on river sediment loads. The anthropogenic impacts group agreed that this should also be addressed.

5. Plenary Session – Discussion of TPE Science Plan Draft

The TPE Science Plan draft was discussed by the workshop participants in a large-group setting. TPE Co-chairs lead the discussion but welcomed general or specific comments from all participants. The discussion began with comments about the general structure of the science plan. The initial comment was about the boundaries of the Third Pole, and the discussion turned to the question of whether or not the Tien Shan should be included. From a geologist's perspective, it was not included in the Third Pole, while from a glaciologist's perspective the Third Pole includes the entire mountain systems and massifs of central Asia; it includes Pamir and Tien Shan which both influence climate and environment. To help answer this question, Co-chair Mosbrugger pointed out that the idea is to have a flexible program without the need to have very specific boundaries. For example, to study the Asian monsoon one might want to drill in the Bay of Bengal, and in this way the science may direct the locations of interest without the need to constrain the boundaries. Another participant spoke in support of this type of flexibility, pointing out another example - if you want to study ecosystem services you have to extend to the lowlands.

After discussing the Third Pole region, participants discussed the purpose of the science plan. A participant started the discussion by asking, who is the science plan for? Co-chairs Yao and Mosbrugger began by answering that the science plan is to help with funding by clearly expressing a plan for comprehensive, integrating, and collaborative studies in the Third Pole. They further explained that the idea of the plan is to have something that the science community, those interested in studying the Third Pole, can take to

various funding agencies. The science plan should demonstrate to funding agencies, scientists, and policy makers that TPE has a strategic concept for the next 10 years. The idea of flexibility was again stressed, with the science plan outlining an open research program that is able to raise funds. One participant indicated that people don't just want to be involved with TPE for funding, but because they want to answer some research questions of interest.

The structure of the science plan was further discussed, beginning with two main options for the structure. One idea is to have a more general and concise plan that can be expanded, another idea is to have a more strict structure outlining specific tasks to be accomplished. It was noted that the science plan currently has elements of both, some parts are more general and other parts are very detailed. In general, participants mainly voiced approval for a more general, concise high-level science plan. One of the participants presented the idea to move the implementation section to a separate document as an implementation plan, and thought it too long in its current form. Several participants suggested incorporating these ideas by creating two documents, one a more general and concise document (ranges of 2-8 pages were suggested by several participants) to clearly outline the goals and purpose of TPE, and the other to contain more specific details about how the science plan will be implemented. It was also suggested that the short version have a summary at the very beginning with the most essential and compelling elements.

Further related to the content goals of the science plan, a participant commented that a key point should be outlining the added value of such a large-scale approach. Instead of a long list of different data that will be collected, they envisioned a more general and shorter document that clearly demonstrates the added value of the interdisciplinary approach. Another participant agreed with this and suggested the goals be more clearly defined in the science plan, for example is the main goal related to climate, to the monsoon system or to something else? Co-chair Thompson indicated the main goal and importance of TPE is integration. Another participant stressed the importance of establishing clear goals, and suggested having TPE

centered on humans, including impacts and adaptation, which will make it more attractive to funding agencies. An example they put forth was the issue of flooding, our activities affect flooding and in turn flooding impacts humans. It was also suggested TPE prioritize some of the research plans and goals, and separate some of the goals according to short- and long-term perspectives. For example, this is a long-term program but what are the priorities for the next 5 years? Another comment about the structure of the science plan and the structure of TPE in general, was the lack of working groups to do the research on specific projects. This participant suggested adding to the structure of TPE office, Co-chairs, and science committee some form of working groups, and indicated the need to identify some people who can be involved

One specific comment about the science plan content was the lack of a clear definition of TPE, is it a framework, a program, or a project? It was noted that in some parts of the plan TPE program is used, and in some parts TPE project is used. The consensus among TPE Co-chairs and participants was to be consistent with the wording, that TPE is a program.

Returning to the question of whom the science plan is for, Co-chair Thompson put forth the notion that it would be ideal to have a block of funds allocated for the Third Pole community, comparable to NSF funds specifically allocated for Arctic or Antarctic research. The floor was then opened for other suggestions about what participants would like to see the science plan accomplish. One participant from Austria noted that proposals there are short, with only 10-15 pages total, and it would be helpful to have a 2 page summary of the relevance to include with proposals. One participant indicated they would like to see the science plan clearly convey the global importance and that it is not just a regional project, as some misunderstand it to be only about Tibet. However, another participant commented that there is indeed a specific area. For example, TPE will not study high elevation areas around the world but only those within the region of the Third Pole.

To discuss the scope of the science plan, a participant commented on the importance of also including governments and local authorities, and not just funding agencies, in order to ensure the success and sustainability of the program in the future. Another suggestion to increase the sustainability was to have TPE serve as more of a framework to channel Third Pole research. This type of framework would allow TPE to easily adjust to research needs, as it is difficult to foresee research directions in the next 10 years. Co-chair Mosbrugger emphasized that TPE is clearly a science program, and the goal is to establish a long-term program lasting for 20 or more years. He also pointed out that the mission recognized at the last TPE workshop in Nepal outlined three main goals: to focus the scientific community, to attract funding, and to establish the major infrastructure. Another participant suggested these goals be clearly conveyed not only to funding agencies, but also to those in attendance at this workshop and to other members of the scientific community. In this way TPE can invite others who share this common vision to be involved. Related to this vision was the suggestion that the 'water-ice-air-ecosystem-human' framework currently used in the science plan be more clearly defined so others can more easily see how they could fit in with TPE. It was also noted by a participant that social scientists are currently under-represented in TPE, although the science plan should be prepared in a way such that they can fit in and realize their own projects.

Another specific comment about the content and scope of the science plan was about the six science questions. It was noted that the first four questions are of a more focused scope relating to paleoclimate, future climate and the water cycle, while the last two questions are at a different level of generality relating to adaptation and anthropogenic impacts. It was questioned how serious TPE is about handling the last two questions, as the current level of generality may prove difficult to answer. In order to think about what should be included in the science plan, it was suggested to also think about what is not part of TPE. This may be a useful exercise to help clarify the scientific basis, some things are included and some things are not within the scope.

Co-chair Thompson next directed the discussion towards placing TPE in a global perspective, and commented that it will be useful to make links to the greater Earth system for promoting TPE internationally. To help achieve this, it was suggested to have some general science questions without strict boundaries, and to have a summary of the importance of TPE that can come across in one page. Several participants had suggestions of topics that may help achieve these goals. One participant thought concentrating on water resources is important. It was also suggested to concentrate on the human component, which is very basic to the study of climate, ecosystems, and the water cycle. Another participant emphasized the possible collapse of ecological systems, which could cause a humanitarian crisis in the Third Pole region. Co-chair Mosbrugger commented that the science questions should be open, and stressed the need to have milestones. For example, what would TPE like to accomplish in the next five years? Answering this question will require defining the priorities, such as documenting vanishing archives. In this way, TPE may remain an open program while still defining priorities of where funds will be invested, as a way to show funding agencies what will be accomplished and when. The immediate challenge now for TPE will be getting the discussed ideas together and writing both a 1-5 page science plan summary as well as a more detailed implementation plan. Further suggestions about the TPE Science Plan draft are welcomed; participants are encouraged to email comments at any time to tpe@itpcas.ac.cn.

6. Technical Meeting on TPE Flagship Stations

6.1. Presentations

During the technical meeting on TPE flagship stations during the final workshop day, there were both academic presentations and round-table discussions of issues associated with establishment and maintenance of the stations.

Tayal, S. “TERI’s Glacier Monitoring Observatories: an integrated approach to research”

Devkota, L. “Comparative hydrometeorological and cryospheric stations on the northern and southern slopes of Qomolangma”

Ma, Y. “Tibetan Observation and Research Platform (TORP): a new base for the study of ‘water–ice–air–ecosystem-human’ interactions on the Tibetan Plateau”

Ding, L. “Collaborative flagship station: uplift of Pamir-Tianshan and its tectonic and climatic implications (UPTEC)”

Van Oevelen, P.J. (via conference call) “GEWEX: its measurement programs and approaches”

Ouyang, H. “A Regional Framework for Transboundary Monitoring on Major River Basins in the Himalayan Region”

Mool, P. “Monitoring and assessment of changes in Glaciers, Snow, and Glacio-hydrology in the Hindu Kush–Himalaya”

Yang, D. “Development of TPE regional precipitation datasets and products: need and progress”

6.2. Round-table discussion

The round-table discussion of TPE flagship stations was coordinated by Co-chairs L. Thompson and V. Mosbrugger. Opening comments by V. Mosbrugger outlined the strengths of the workshop participants in their ability to present a large amount of data, and stressed the need for synergy. The discussion was informal, and the goal was not to make concrete decisions but rather to gather ideas from the participants about the development and coordination of flagship stations. It was also pointed out that the discussions were not limited to this session; participants may email additional comments to TPE at any time. The main points discussed were the standardization of equipment and stations, suggestions for additional flagship stations, coordinated management and financing, data availability and data sharing policy, and action points including the development of flagship station working groups.

The discussion began with comments about the standardization of equipment. As an initial comment, Co-chair Mosbrugger emphasized the immediate need for a database and map (GIS) to access metadata in order to understand what data is currently collected and where. Related to the standardization of equipment, it was noted that some of the WMO recommendations aren’t feasible at high elevations, for example having stations installed on flat ground.

Another participant acknowledged that it is probably not feasible to have standard equipment at all stations, as many stations are already established. Therefore, it was recommended to make some intercomparison projects of data obtained from different instrumentation to make data interconvertable between locations. There are many technical considerations for standardizing high-elevation stations, as an example one participant noted that even the length of wires should be standardized, for considerations of voltage loss in longer wires.

Regarding what types of measurements are recorded at stations, it was suggested to begin by measuring what is inexpensive, easy, and reliable as well as some more in-depth measurements. As an example, an entire species inventory is difficult to obtain, but monitoring when a species flowers is easy to do. One participant commented that they would like to see more measurements of stream and soil temperatures, as these data can provide good integrating measurements. A participant pointed out that high-elevation stations present many technical difficulties and are difficult to maintain, therefore they may also be more difficult to fund. Related to this point, another participant emphasized the need for technicians to maintain some stations, especially in developing countries, to ensure the proper functioning and recording of equipment. The power of remote sensing data should also be considered, and one participant commented on the usefulness of flagship stations to calibrate remotely sensed data which may then be used in other locations in the Third Pole region.

Also discussed was the possibility of contacting other groups that have been successful at establishing high-elevation stations. As an example, one participant noted the recent workshop in the Netherlands which gathered about 40 scientists, many from Canada, to discuss observations made on glaciers. This would be an ideal group to contact and discuss what has and has not worked or been reliable for them. Similarly, when standardization and data calibrations have been established by TPE, these should be made available to other groups who may be planning to set up their own stations.

The round-table discussion next turned to suggestions for additional flagship stations. As there is already an extensive list generated from the 2nd TPE Workshop in Nepal, only a few additional station suggestions were put forth. Additional recommended stations included Ketchikal glacier and Zadang glacier, as these are heavily monitored. It was suggested to concentrate on areas that have been heavily monitored and also areas where such monitoring may have been discontinued, such as the Batura glacier. One participant questioned the inclusion of a Tarim River station, since this river mainly originates outside the Third Pole region.

Another participant commented on the lack of human aspects in the flagship stations. It was suggested that flagship stations also collect information about people living around the stations. For example, where are the main livestock areas and how are they supported, what is the income of people in the region, how do people make a living there? It was also pointed out that clarifying the socio-ecological research questions will help identify what information should be collected. From an ecology standpoint, it is necessary to determine if the proposed stations cover all the relevant ecological environments. It was suggested to look at LTER and CERN stations for more ideas and guidance related to ecological stations. In addition LTSER's have already established socio-ecological sites. Isotope stations were also proposed as another category of flagship stations, as there are already more than 20 stations measuring oxygen and hydrogen isotopes.

After the comments about additional flagship stations, coordinated management and financing were discussed. As an initial comment, the need for a taskforce or working groups was stressed. One idea is to have some flagship stations run by several nations, as international cooperation will help ensure continued funding and data sharing. It was suggested to have some workshops in the near future for these working groups. Some workshop participants volunteered to assist with specific working groups and planning of related workshops. Co-chair Yao volunteered to assist with a mass balance working group, while Co-chair Mosbrugger and Greenwood volunteered to

assist with an ecology working group. Bolch indicated the current development of a remote sensing workshop in Pakistan and volunteered to assist with a working group on the remote sensing of glaciers. D. Yang volunteered to assist with a working group on measuring precipitation in mountainous regions. B. Su together with Y. Ma proposed a working group and meeting related to land-atmosphere interactions, indicating a target of November 2011. Winiger volunteered to assist with a working group on flagship stations and although not present, G. Tartari was recommended for the working group as well. One of the initial tasks for these working groups is to discuss how to organize and classify currently available station data. Therefore, these groups will need active involvement from those who are already running some of the stations in order to discuss instrumentation and development. The representative from UNESCO expressed interest in having UNESCO involved in these workshops, as they have already had a mass balance workshop, and suggested more involvement from young scientists. Related to this issue, a participant from ICIMOD noted the upcoming mass balance field training and also expressed interest in a data sharing workshop. Information dissemination was highlighted in this planning process in order to keep the growing Third Pole community connected and updated on issues such as newly established stations, and upcoming workshops.

Workshop participants also had several comments about flagship stations in relation to capacity building. One comment was that capacity building must be coordinated with several institutes and groups involved in training students, and this could be an ideal link between physical and human systems. By training students in climate services, mitigation and adaptation, TPE can help create a new generation of scientists with this type of experience. It was noted that capacity building is also an important component for funding considerations. The difficulty is developing capacity building without a funding project, and in this way TPE may be a crystallization point for capacity building projects and information dissemination. One participant emphasized the need to have a position for these students in their home countries. Another participant highlighted the recently established Mountain Societies Research

Centre at the University of Central Asia which is devoted to capacity building in mountain regions. It was noted that UCA is also part of the Himalayan University Consortium, which is a member network devoted to research and education for sustainable mountain development. Considering there are some universities within Third Pole countries where capacity development has already started, this would be an ideal link for TPE and can assist with establishing the infrastructure.

The next topic for discussion was data availability and data sharing policy. It was suggested to leave this topic to a separate taskforce or working group, as this was previously discussed at the 2nd TPE Workshop in Nepal and development of the policies was beyond the scope of current discussions. Preliminary tasks for the working group will be to review the existing data sets, and contact data contributors to discuss more specifics about the availability and sharing policies. Developing a questionnaire for researchers was suggested as means to see what data is available. This type of questionnaire is also relevant for the flagship stations themselves in order to have a clear understanding of what data is being collected and what instruments are being used.

Concluding remarks mainly related to upcoming timelines and review of the timelines discussed at the 2nd TPE Workshop. Completing the full science plan by December may need to be revised. Although it should be possible to complete the short summary version this December, it will require feedback by the workshop participants and by those who have volunteered for the working groups. All participants were provided with a copy of the TPE Science Plan draft and were urged to email any comments as soon as possible. The revised structure will aim to make it more readable to executives, funding agencies, and policy makers by stripping the details and outlining a clear vision and highlighting the importance. It was also suggested to have a science journalist edit the science plan summary to make it more attractive and ensure the readability.

7. Workshop Conclusions

Participants from 15 countries from around the world participated in the 3rd TPE Workshop in Reykjavik, Iceland. Academic presentations highlighted some of the current research in and around the Third Pole, and also imparted information about project visioning and infrastructure from those with experience managing other large science programs. During the group discussions, participants in six groups shared their views on such issues as data needs, program products, integration, and relevant science questions.

The TPE Science Plan draft was constructively discussed during two of the workshop days. The discussions mainly revolved around the purpose, structure and scope of the science plan. A revised structure was recommended to include two versions; a more general high-level plan taking the form of a short 1-5 page summary highlighting the vision and importance, with more details related to the implementation to be added in a second longer version. A target of December was put forth for the more general high-level plan, and a draft of this version will be discussed further at the upcoming AGU Fall Meeting.

During the technical meeting on TPE flagship stations, presentations conveyed suggestions for developing a station network, and introduced some of the current monitoring platforms and regional frameworks. A round-table discussion offered participant the opportunity to comment on the major issues concerning the development of TPE flagship stations. Discussions centered around the issues of standardization of equipment and stations, suggestions for additional flagship stations, and coordinated management and financing. In addition, some workshop participants volunteered to oversee working groups on mass balance, ecology, remote sensing of glaciers, measuring precipitation in mountainous regions, land-atmosphere interactions, and flagship stations.

At the conclusion of the 3rd TPE Workshop, S. Tayal offered an invitation to hold the next TPE Workshop (2012) in India. Dates and location of the 4th TPE Workshop will be announced early next year.

Appendix 1. Agenda

The 3rd Third Pole Environment (TPE) Workshop		
August 29-September 1, 2011, Reykjavik, Iceland		
Monday, August 29, 2011		
6.00-8.00 pm	--- Registration and Reception ---	
Day 1, August 30, 2011		
Opening ceremony		
Time	**Speaker**	**Topic**
9.00-10.15 am	Local welcome *Chair: Helgi Bjornsson*	Speeches given by Local Organizing Committee, Rector of the University of Iceland, and the President of Iceland
	TPE welcome *Chairs: Tandong Yao, Lonnie Thompson &Volker Mosbrugger*	Speeches by TPE Co-chairs, CAS, ICSU, UNESCO, and IGS representatives
10.15-10.35 am	---GroupPhotoandTea Break---	
Participants proceed to Radisson Blu Saga Hotel where following sessions will take place.		
Session 1: Climate Chairs: L. Thompson & H. Sun		
10.35-11.05 am	Su, Bob	Quantifying Climate Change Impacts in data-scarce Environment
11.05-11.25 am	MASSON-DELMOTTE, Valerie	A bipolar perspective on climate change during the last climatic cycles
11.25-11.45 am	YANG, Kun	A synthetic report of recent climatic changes and their impacts on energy and water budgets over the Tibetan Plateau
11.45am-12.05pm	UENO,Kenichi	Variability of precipitation phase in High elevations
12.05-1.00pm	---Lunch---	
Session 2: Glaciers Chairs:T. Yao &HelgiBjornsson		
1.00-1.30 pm	AIZEN, Vladimir	Central Asia Cryosphere as a Part of the 3rd Pole Environment

1.30-1.50 pm	JAROSCH, Alexander	The Relevance of Regional Glacier Models for Understanding the Third Pole
1.50-2.10 pm	BOLCH, Tobias	Assessing glacier mass changes in high Asia based on space imagery
2.10-2.30 pm	KULKARNI, Anil V.	Observed changes in Himalaya cryosphere
2.30-2.45 pm	---Coffee break---	
Session 3: Lakes and Rivers Chairs: V. Masson-Delmotte& J. Kirchner		
2.45-3.15 pm	BOOKHAGAN, Bodo	Hydrologic Gradients, Climatic Extremes, and Surface Erosion in the Himalaya
3.15-3.35 pm	WINIGER, Mathias	Assessing spatial gradients of water balance in the Hindukush-Karakorum-Himalaya–data need and uncertainties
3.35-3.55 pm	ARMSTRONG, Richard	A preliminary assessment of the contribution of seasonal snow cover to runoff in the Upper Indus Basin
Session 4: Parallel group discussions-Coordinators		
3.55-6.00 pm	a) Climate/Atmosphere V. Masson-Delmotte & Bob Su b) Glaciers R. Armstrong & T. Bolch c) Lakes and Rivers M. Winiger & F. Zhang	
	---Reception dinner by the President of Iceland Olafur Ragnar Grimsson--- Bus leaves at 6.40 pm	
Day 2, August 31, 2011		
Time	**Speaker**	**Topic**
Session 5: Ecosystems Chair: H. Ouyang&Gísli Mar Gíslason		
9.00-9.30 am	PIAO, Shilong	Change in vegetation growth and carbon balance of Qinghai-Tibetan grasslands over the past five decades
9.30-9.50 am	KIRCHNER, James	Exploring mountain landscapes and ecosystems by studying their streams
9.50-10.10 am	MOSBRUGGER, Volker	Third Pole Ecosystems - their relevance for ecosystem services and geoengineering
10.10-10.30 am	Gísli Mâr Gíslason	Glacial river ecosystems and the effects of global warming
10.30-10.45 am	---Coffee break---	
Session 6: Natural dynamics of TPE-Lessons from the Past ***Chairs: V.Mosbrugger & Y. Ma***		
10.45-11.15 am	THOMPSON, Lonnie	Third Pole Glaciers and Ice Cores Records of Past, Present and Future Climate

11.15-11.35 am	YAO, Tandong	Recent environment change in Third Pole region
11.35-11.55 am	NAKAWO, Masayoshi	Research Integration for Environmental Issues between human/social studies and natural sciences
11.55am-12.15pm	CHEN, Deliang	Visioning: Towards a new initiative on Earth system research for global sustainability
12.15-1.15 pm	---Lunch---	
Session 7: Parallel group discussions-Coordinators		
1.00-2.30 pm	d) Ecosystems S. Piao & G. Greenwood e) Past environments V. Aizen & J. Kirchner f) Anthropogenic impacts P. Mool & M. Nakawo	
2.30-2.45 pm	---Coffee break---	
Session 8: Plenary Discussions Chairs: T. Yao, L. Thompson & V.Mosbrugger		
2.45-4.00 pm	Presentation of group discussion results by group coordinators	
Session 9: Discussion of TPE Science Plan		
4.10-5.30 pm	Group discussions of TPE Science Plan chaired jointly by three TPE co-chairs	
5.30-6.00 pm	Plenary discussion	
7.00 pm-	----Dinner at the Radisson Blu Saga Hotel---	
Day 3, September 1, 2011		
Technical workshop on TPE flagship stations		
Time	**Speaker**	**Topic**
9.00-9.30 am	YAO, Tandong	Introduction of the concept of Flagship stations
9.30-9.50 am	TAYAL, Shreth	TERI's Glacier Monitoring Observatories: an integrated approach to research
9.50-10.10 am	DEVKOTA, Lochan	Comparative hydrometeorological and cryospheric stations on the northern and southern slopes of Qomolangma
10.10-10.30 am	MA, Yaoming	Tibetan Observation and Research Platform (TORP): a new base for the study of "water–ice–air–ecosystem-
10.30-10.45 am	---Coffee break---	
10.45-11.05 am	OEVELEN, Peter J.van (presentation via Skype)	GEWEX: its measurement programs and approaches
11.05-11.25 am	FAYZIEV,Abdulkhak&DING,Lin	Collaborative flagship station: uplift of Pamir-Tianshan and its tectonic and climatic implications (UPTEC)

11.25-11.45 am	OUYANG, Hua	A Regional Framework for Transboundary Monitoring on Major River Basins in the Himalayan Region
11.45am-12.05pm	MOOL, Pradeep	Monitoring and assessment of changes in Glaciers, Snow, and Glacio-hydrology in the Hindu Kush–Himalaya
12.05-12.25 pm	YANG, Daqing	Development of TPE regional precipitation datasets and products: need and progress
12.25-1.30 pm	---Lunch---	
1.30-5.00 pm	Round table discussions	Proposed topics: 1) Standardized Equipment of Stations 2) Suggestions for Additional Flagship Stations 3)Coordinated Management and Financing 4)Data Availability and Data Sharing Policy 5)Conclusions and Action Points
7.00pm-	---Joint reception by Chinese and Indian Embassies---	
Finale		

Appendix 2. List of Participants

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Appendix 3. Opening Ceremony Speeches

Member of the Local Organizing Committee and Professor, University of Iceland, Helgi Bjornsson

President of Iceland, Olafur Ragnar Grimsson, Rector of the Univ. Of Iceland, Kristín Ingólfsdóttir, colleagues from 15 countries. On behalf of the local organization committee, Dagfinnur Sveinbjornsson, Thorstein Thorsteinsson, Thora Ellen Thorhallsdottir and Gisli Mar Gislason, I wish you welcome to this three days Third Pole Environment Workshop here in Iceland and the following field trip in southern Iceland. We look forward to 30 lectures, 5 parallell group discussions, followed up by plenary discussions, and roundtable discussions on specific topics. y talks by Icelandic scientists. The topics dealt with range from the atmosphere, climate, cryosphere, and biosphere: water, lakes, rivers, ice, glaciers, precipitation, draughts, floods in rivers, ecosystems, lessons of the past and present, flagship stations, vegetation, and impacts. This sounds exciting.

This is an international gathering of scientist, mulit-diciplinary, albeit all participants are discussing environmental issues, processes of nature and product in the highest mountain range on the Earth, the Tibetan Plateau, often called “the roof of the Earth” with an average elevation above 4000 m above sea level, in regions sparesly populated indeed but which impact affects lives of over 1 billion people in this part of the world, downrivers to sea level at the mouths of the Yellow River, Yangtze River, Bramaputhran, Ganges, Indus. This region affects the general atmospheric circulation over the East Asia but the environmental changes over this third pole have potentially global effects as they do in the Arctic and Antarctica. Snow cover in the TP seems to be retated to the North Atlantic Oscillation, also to the variations in winter and summer monsoons, drought and floods in the middle and lower reaches of the Yangtze River. These mountains and rivers are now far away from us during this meeting. But, the processes are the same in Tibet, at 5000 m above sea level as they are in Iceland, at 1000 m elevation. By gathering here this time for the TPE-meeting almost north by the Arctic Circle the participants can close to sea level find glaciers, landscape, vegatation, erosion phenomena which they would need a climbing expedition to experience closer to the latitude of Cancer. In details, the processes and their products are to some extent different in various parts of the world but the processes are the same and for scientists it is important to expand their understanding, thereby their imagination, their

sense of scales. Iceland, has in common with the third-pole regions that it is sparesly populated (3 people per km^2 or 8/$mile^2$) but in Tibet 2/km^2. As the Third Pole, Iceland is an important benchmark against which to judge anthropogenetic impacts.

The initiative to invite to this meeting here in Iceland came from President Olafur Ragnar Grimsson who for many years has actively worked for promotion of international research on global environmental problems. This effort has been enthusiasticly supported by the rector of the university which kindly took time to ivite us to these premises.

President of Iceland, Olafur Ragnar Grimsson

Distinguished Rector of the University, scientists and scholars,

You travelled from afar to be with us this morning and in the coming days when we host here in Iceland this remarkable scientific collaboration, the most interesting and significant scientific cooperation of our times. I know it is a strong statement, but looking at the Himalaya region, looking at the situation of the countries, looking at the need to study the melting of the ice, the river systems, the glaciers, we are hard put to find another research or cooperation which would be of as much significance for as many people as what you are engaged in. I think it is about four years since I was privileged to talk with Lonnie Thompson in Ohio about the research of the glaciers, the cooperation with China, India and other countries in the Himalayan region and the urgent need to bring together a significant effort in this area.

I have for a long time been familiar with India, I arrived first in 1983. Having also been to China more than a decade before we discussed this in Ohio. Although I came from Iceland, I somehow felt responsible that maybe I should try to help to bring together such a cooperation centered on what's now called the Third Pole region. And then the meeting with Prof. Tandong Yao in China last year, being invited to his remarkable institute, and having the benefit of discussion with scientists and scholars, I became absolutely convinced that in a small way, the scientific community of my country and Iceland as a republic, and we as a nation, could perhaps help in some way of furthering this cooperation. Especially since time is short. The pace of change in this region, not only in Iceland which I have just described, but also in this region is such that the need for knowledge and the mapping out in scientific

strengths of the contents of change is indeed urgent. Then when Tandong Yao came forward with this idea to host the 3rd meeting of the workshop in Iceland, I welcome it. I thought it was brilliant. It demonstrated his originality, and willingness to travel. As everybody knows, Iceland is not in the Himalayas, so to take your 3rd workshop to our country was indeed a manifestation of uniqueness of this cooperation. Two of them I've already mentioned, and Volker Mosbrugger are indeed willing to lead fellow scientists and others into unchartered territories.

And here we are today. The presidency is very honored to have been part of organizing and hosting this workshop together with the University. I know for the University of Iceland which celebrates its 100th anniversary today, to host your meeting is perhaps one of the most important events of this anniversary year because it signifies not only how far we have travelled since 40 students came together in 1911 in our parliament building to found the University, because there was no building to host it in the city of Reykjavik, and the University had to be housed in our parliament building for the following decades, because it didn't really have a home. To host this scientific cooperation on the Third Pole Region, as I said, is a remarkable manifestation of how far our scientific community has travelled and how we have succeeded, despite being a small nation, in creating a university which can make important and significant contributions to scientific discoveries on some of the most urgent topics of our time.

Iceland is, as you know, and as has been already mentioned, rich in volcanoes and glaciers. The Rector mentioned that this building is named after one of our most significant volcanoes. Iceland is probably the only country in the world, where buildings are named after volcanoes, where airplanes of the national airline are named after volcanoes and glaciers. Maybe some of you came on Reykvjovik plane to Iceland, despite the difficulty of pronouncing the name the airline decided to name one of its aircraft, and others also take the name from volcanoes and glaciers. Iceland is also probably the only country where women take their names from volcanoes and glaciers. That shows something about their nature. Like my four-year-old grand-daughter, who is called Katla. You might be familiar that Heckla and Katla, until Eyjafjallajökul erupted, where the most famous volcanic mountains in Iceland, and of course Heckla is a very common female name in our country. I think it indicates that our culture and society has been intertwined with nature, with the

volcanoes, with the glaciers, and with the struggle of surviving in a country which provides such hazards for nature.

When we witnessed the eruptions last year and this year, and last fall, I think our generation suddenly realized what the descriptions in the previous annals of the 15th, 16th, and 17th centuries really meant. When we had read in our younger days in the annals that it was a darkness as midnight, and people couldn't see their hands, or even the sheep, or the cows, and there were disasters and hunger, and people died. It didn't really have a meaning for us until we could witness last year and this year and these extraordinary forces of nature on display in our country.

Iceland is not only, as you know, the largest volcanic country in Europe, it also has the largest desert in Europe. We have been battling that desert for now systematically with scientific knowledge for a century. That experience has now led us to establish educational cooperation in desertification and soil preservation with countries in Africa, Asia and other parts of the world. And we are of course, as all of you know, the home of the largest glaciers in Europe. As you've heard mentioned, they are fast disappearing, and I say "fast", you mention 200 years. The former President of China, Jiang Zemin said to me when he came to Iceland 8 years ago, for us in China, 50 years is not a long time. So for the glaciers to disappear in four times that period, which Jiang Zeming didn't think is a long period, indicates how rapidly this is really happening. Due to the importance of both the volcanoes and the glaciers, through the work systems, through the formation of clean energy, through the volcanic geological nature of our country, our scientific community has worked for almost half a century systematically on these aspects of our region.

I think it is a fact worth reflecting on, how such a small nation which in the beginning of the 20th century when the university was founded with only about 100,000 people could make such significant contributions in so many diverse fields, not only in glaciology, volcanology and soil science, but also in medical science, engineering, and of course, cultural studies of many nations. When we look at the Himalaya region, we know that not only are there large nations, the two largest, most populous countries on earth, but there are also small countries and small communities, which like Iceland, could by themselves make significant contributions to the development of science and research in their region. The history of the University of Iceland and our international scientific cooperation during especially the

second half of the 20th century is a strong evidence of how small nations and communities can be equal partners in the advancement of science.

I see your workshop in Iceland in the coming days as another evidence of the contribution of our country can make, not just because of the excellence of our scientific community and the significant research we have done in Iceland, but also because Iceland is a kind of a nice neutral ground to meet, and discuss and examine issues that might be sensitive if the meeting took place somewhere else. To illustrate my point, I could name some capitals in Europe, some cities across the Atlantic where the sensitivity of having this meeting might be a little bit different from meeting here in the small and neutral and rather relaxed aspect of Iceland. That is important indeed because as we all know, the Third Pole region, the Himalayan countries is not just an area of the globe where the ice is significant, but it also really has some of the most sensitive boundaries, and some of the most critical landmass with respect to harmonious cooperation and global peace.

Looking around here in the north, we also have a familiar experience of social development. During the Cold War the Arctic was perhaps one of the most militarized areas in the world. The military bases in Iceland, Greenland, and other parts of the Arctic regions, in Canada, Alaska and Murmansk and other places, the nuclear submarines and other evidence of the arms buildup in the north and the Artic regions was a crucial part of the Arctics. When the cold war ended, and that process, by the way, also began here in Iceland at the summit between Regan and Gorbachov which took place here in Reykjavik in 1986, the nations and communities in the north and the Arctic gradually started to cooperate. It was difficult, I can tell you, because I was quite familiar with this transformation. But it was spearheaded by scientists and researchers and scholars, who came together to study the environment of the Arctic, which gradually lead to intensified scientific cooperation between scholars and universities and research institutions in those eight arctic countries that never had cooperated before. Consequently it was found necessary to create a framework around this cooperation, so the Arctic Council was formed at the middle of the 1990s; primarily and as a rather low-key cooperation for scientific and environmental studies. When Iceland held the presidency in the Arctic council about eight years ago, the Arctic Climate Assessment Report and the Arctic Human Development Report became crucial documents for the future policy making and scientific cooperation in this area.

When I was honored with the Nehru Award in India a year and half ago, and visited China last September, I ventured to launch the notion that maybe this model of how the Arctic cooperation developed, from scientific dialogue and some research projects into a more systematic and comprehensive state of cooperation involving both the smaller countries in the Arctic and the larger ones, could be something which the Himalayan region could also look at. To bring together what we could perhaps call a Himalayan council modeled on this rather soft, low-key scientific research oriented approach of the Arctic council. Especially since a key in the Arctic cooperation has been the involvement of the indigenous people. The involvement of the people who have lived in the Arctic for thousands of years, long before the republic of Iceland, the federal state of Russia, or the United States came into being. People who had this as their home long before we started to report our mission. And similarly the Himalayas have communities and people who have lived there for thousands of years, long before the states that now are present in the region were formally established.

One of the crucial tasks for us, both in the Arctic and the Himalayas, is not just to do the research and organize the scientific projects and present the conclusions and the evidence, but also to relate this to the life and challenges of the people who live in the region and how they can, in an open way and respectful way, be incorporated into this process. I believe we have succeeded in the Arctic and the north in doing this by formally inviting representatives of indigenous people and the communities to be equal partners, to gather with the scientists, researchers and policy makers in this region. I decided to mention this early this morning because what you are doing, what you have been doing in these meetings in China, Nepal, and what you will be doing in Iceland in the coming days is to map out a necessary, crucial cooperation in an area of importance not just to the two billion people who live in the Himalaya region and depend on the water reservoirs of the Himalayas, but of fundamental consequence for the entire world. That is fundamentally what this is all about. We need to do in such a way, that people who have had these regions as their home for thousands of years are also respectfully included in the process.

So I wish you great success in your deliberation. I want to thank my friends, Dagfinnur and Helgi, Thorstein and Thora Ellen for their contributions in bringing this about. I want to thank the University of Iceland for having embraced our cooperation with the Presidency in organizing this. I can’t resist in pointing out this part in diplomatic terms, this is also a first. I don’t think ever before the president of a country has been so openly, and in a relaxed way,

involved in bringing together scientific cooperation with respect to a very far away part of the world. I don't mention that to indicate my own involvement. I mention it to indicate that what we are doing here, and what you are doing here, needs new approaches and new methods in order to be successful. In the same way as when Yao Tandong came to me and said, "Let's host the next meeting in Iceland, what do you think about that? The projects you are engaged in also map out a new way of cooperating." That's how these initiatives, this new way for doing scientific cooperation can help us all to be better prepared for the fundamental changes which the melting of the ice, and the changes in the glaciers and the water systems, not only in the Third Pole region, but also in our neighborhood here in the north will bring to the entire world.

I wish you a great success. I welcome you to Iceland and I'm looking forward to giving you some food tonight when you come to the President's residence. Thank you.

Rector of the University of Iceland, Kristín Ingólfsdóttir

Good morning everyone, President Grimsson, ladies and gentlemen,

It is such a pleasure to welcome you on behalf of the University of Iceland this morning and it is a distinct honor for the university that the Third Pole Environment Workshop should be held here, in our building for the natural sciences. The name of this building is Askja, named in honor of one of Iceland's largest volcanoes, and one of the most active volcanoes, situated in the center of the country. By naming this building Askja, the univeristy is underlining the importance of geological sciences, and also paying tribute to the beauty of the volcano.

Allow me tell you a little bit about the university, if I may. It is a comprehensive univeristy, the Univeristy of Iceland. The student population is 14,000 and you may be interested in knowing that of 14,000, around 1,100 are foreign students. They come as exchange students at undergraduate level, they come for masters courses, and increasingly they are coming for doctoral studies in many different areas. For example, in areas related to your topics today, glaciology and other disciplines related to geosciences, natural resource management, sustainable development, energy research, climate change. Students come from all over the world. The largest number come from Germany, Denmark and the United

States. We also, as you may be interested, have a large body of Chinese students. We just had some Chinese students leave who were here for one year. They learned Icelandic in Beijing for two years and came here for their third year and they have now left speaking fluent Icelandic. In the same way, our students learn Chinese here for two years and go to China for the third year. It is an interesting sign of the changing globe. We also have Chinese students in other disciplines. We are very pleased with the development that the number of foreign students is increasing.

The University of Iceland is celebrating its 100-year anniversary this year and in celebrating such a milestone we are looking over our shoulder and reminding ourselves of the courage and the vision of those that fought to establish a university here in 1911 in a tiny society and a very poor society of fisherman and farmers. We of course at the same time are looking forward, and looking to the future. Our main focus is on how best to prepare, in terms of education, research and innovation. At the same time, we prepare to meet the known grand challenges in collaboration with others. We must also focus on other fields that may be fundamental for solving tomorrow's unknown challenges. Certainly, in the recent months we have been reminded of how difficult it is to predict the future and the future needs of education and research. For example, by witnessing social and political upheaval in many countries, financial crisis, natural disasters, nuclear leakage, and looking close to home, volcano eruptions here in Iceland last year and this year caused a disruption worldwide and calling for new knowledge in the geosciences, aviation technology and international flight control. All of these events have called, with short notice, for new knowledge in multidisciplinary subjects. I can tell you that we here at the university take the role of the university very seriously in the current economic recovery period and we are convinced that our role is best played in through excellence in research and teaching. We are determined to carry the torch forward and ensure that education and research play a vital role in the future development of this country. Ladies and gentlemen, let me not keep you further from your excellent meeting ahead, which I'm sure will give us stimulus and inspiration to deal with the global tasks that await. Thank you very much.

TPE Co-chair, Tandong Yao

Dear President Grimsson, ladies and gentlemen,

It is our great honor to hold the 3rd workshop of the Third Pole Environment in Iceland, at a beautiful university, and also at an exciting moment when you are celebrating the 100-year anniversary. As scientists we really appreciate your focus on environment, particularly on the Third Pole environment. I think you are still organizing another meeting after the Third Pole Environment Workshop. It is Northern Research Forum. I think it's another indicator that maybe we are experiencing another very promising future of the research collaboration between the Third Pole environment and the North Pole environment. We all appreciate the wonderful work done by the local organizing committee, particularly by Dagfinnur and Helgi and also the Rector of the University of Iceland. We really appreciate all the work you have done.

It is your great contribution that made it possible that we will have the Third Pole Environment Workshop here. Here today we have around 40 scientists outside Iceland and 20 or so scientists from Iceland. Some of our colleagues have been continuously participated in the previous two workshops and the workshop today. I think in the previous two workshops we mainly discussed about the necessity and the scientific questions related to the Third Pole environment. The 1st workshop was in Beijing, the 2nd was in Kathmandu. During those two workshops, people discussed about the significance of the Third Pole environment, and also discussed about what are the key questions, scientific questions, to be discussed if we are studying the Third Pole environment. Actually, during the 2nd workshop in Kathmandu people began to focus on what we should do if we have scientific questions, because through the last two workshops, scientists gradually focused on six scientific questions. Then from the last workshop, we started focusing on the science plan, and how to cope with the six scientific questions. So maybe that is another major task for the participants of this workshop. And also, during the last workshop, scientists started to discuss the necessity of monitoring observatories. The idea was proposed by an Indian scientist, who was a former director of the Wadia Geological Institute, Professor Aurora. Because of visa problems, they do not have time to issue a visa. So he has no ticket to come this time, but I am suggesting him to come to Beijing to discuss about the observatories. We've proposed the concept of flagship stations, that will be another issue that will be discussed in the workshop. Basically for the workshop we have three days, and we will have a lot of heavy duties to make the workshop a success. Finally, I wish you a

pleasant and productive stay here in Iceland at an exciting moment when the University of Iceland is celebrating its 100-year anniversary. Thank you very much.

TPE Co-chair, Lonnie Thompson

President Grimsson, esteemed colleagues,

I have the pleasure to welcome you to the Third Pole Environment workshop. I must say this is the first of these, even though I have been on the group of conveners since 2009, that I have actually made and if you had asked me two days ago, I would not have thought I would show up at this one. But it is good to be here and I want to thank my fellow conveners Professor Yao Tandong and Volker Mosbrugger from Germany.

I like to tell a little story with Yao Tandong, he is a friend and colleague. We first met when he was a graduate student in 1984 in the Tianshan Mountains in western China. And President Grimsson was talking about the change that has taken place, and when I look back where we first met and the changes that have taken place in the world, there is no way we could possibly have seen that.

I also want to thank the workshop organizing committee, particularly the local organizing committee, because they do the heavy lifting that makes a conference like this possible. I am looking forward with great interest to the discussions and deliberations over the next three days and I look forward to interacting with all of you. Welcome and thank you very much.

TPE Co-chair, Volker Mosbrugger

Dear President, Rector, friends and colleagues,

My name is Volker Mosbrugger. I am the last of the conveners. It is my pleasure, of course, to welcome you to this workshop in Iceland. This is the third workshop that I am having here together with you. What I really enjoy is that the group is constantly growing and this is really what TPE is about.

We have heard from the previous speakers that the Third Pole Environment program is really unique in many respects. It focuses on a key area of the earth system, it is addressing the most important scientific questions, but it is not only about science, it is about the people, and as we learned just a few minutes ago, it is also about politics. And I really think that this is something unique about this program, that we are trying to go from fundamental science to applied science and application in politics. This is what makes TPE so fascinating. In addition, what we like of course is a multinational and multidisciplinary program, we have all kinds of disciplines included and we should actually include more and more disciplines, because when we talk about complex systems, like the Third Pole environment, this is not just a geoscience problem, or an economy problem or a meteorological problem or political problem. It is a complex system problem, so we really need a lot of disciplines and we need a lot of nations included. I think this workshop here may also be a stimulus to attract more people, more nations, and we are very gald that Iceland decided to be part of this endeavor.

Like Lonnie Thompson I would like to give you an example that relates to my own experience with TPE, and this has to do with Germany of course. Germany decided in about 2004 and 2005 to be involved in this research concerning the Tibetan Plateau and its surroundings. It took us about three to fours years and then we started, together with Chinese friends a program that is called TiP – Tibetan Plateau Research. This program is funded with two million Euros per year and this is a research program that is focusing entirely on fundamental research. Later, we realized this is not enough. We need to include applied research and development programs. Now we have an additional program that is called Central Asia Monsoon Dynamics and Geoecosystems. This is funded with four million Euros a year, and this is focusing on research and development. So this means that the German community actually is involved in this program with a sum total of about four million Euros a year, and I would really love if more countries would consider this program so important and invest research money. I really think it is worth it, because of the science, but also because of the people living and depending on this system.

So I look forward to this workshop. I am sure it will be a great success since our colleagues in Iceland have done a wonderful job to organize it. It was a pleasure to see how well it was organized and no problems so far, and I'm sure you can organize that the volcanoes all

stop working for a couple of weeks or so until we are done. Thank you very much for welcoming us here, receiving us here, and I wish us all a great success. Thank you.

Chinese Academy of Sciences Representative, Honglie Sun

Your excellency President, ladies and gentlemen,

Good morning. We're gathering together at Reykjavik, Iceland, today to witness the 3rd Third Pole Environment workshop, to further develop the TPE program, and thus to promote understanding of the environmental issues in this region.

Long dedicated to the Tibetan Plateau research, I've been working in the region since the 1960s. I was honored to lead the first comprehensive field expedition to the Tibetan Plateau in the 1970s. I was also happy to see so many young scientists engage their intelligence and effort to the Tibetan Plateau study, generations after generations. On knowing the birth of the TPE program, I'm pleased to see that scientific community interested in the region are committed to a joint coordinated effort to understand environmental changes in the region together.

I was informed that apart from participants from the previous two workshops, there are more new faces who are studying in the polar regions. This is a demonstration of the rising attention among international scholars about the public and therefore security influenced by global climate change.

As global warming is a task to be addressed by world efforts, the Third Pole environment study is not a mission that can be accomplished by one particular nation. Instead, it calls for international platform and cooperation. I'm glad to see the active involvement of experienced scientists and program managers from around the world. I'm convinced that with your participation and suggestions, a more timely adaptation measures will be proposed to address climate and environmental changes in the region.

On behalf of the Tibetan Plateau research community in China, I would like to thank you for your attention to the Third Pole region, and expect more and stronger devotion of the TPE scientific program to the adaptation strategies in the region.

I would also extend our gratitude to our Icelandic colleagues, who have helped prepare the workshop and logistics. I believe the 3rd TPE workshop will be another success as a result of close regional cooperation and international attention. I would like to wish the workshop participants a pleasant and fruitful stay at Reykjavik, thank you.

ICSU Executive Director, Deliang Chen

Mr. President of Iceland, Madam Rector of the University of Iceland, Dear colleagues, ladies and gentlemen,

It is my pleasure to be here on behalf of ICSU, the International Council for Science, which most of you are familiar with because ICSU is such a huge global network of scientists in many disciplines and we also have many active programmes, bodies, and activities with which you have been interacting. In listening to the previous speeches, I was really inspired by many of the activities, concepts, ideas that have been mentioned. Many of these ideas and concepts are at the heart of ICSU activities.

For those of you who are not familiar with ICSU. ICSU is a membership based organization with a global vision and coverage. We have three categories of membership. Number one is national members. We have 141 member countries involved, and most of them are the National Academies of Sciences, like the US Academy. From my own country, Sweden, the Royal Swedish Academy of Sciences is a national member of ICSU. We also have scientific union members. Once upon a time, ICSU was called the International Council for Scientific Unions. Although we are now called the International Council for Science, we still keep the acronym ICSU because all the international scientific unions in ICSU represent a unique wide base in terms of disciplinary expertise which covers subjects ranging from mathematics to chemistry, from biology to geosciences, and form geography to psychology. Currently we have 30 union members. The third category is something called “scientific associates” which are institutions, regional initiatives and regional and international associations. A good example is IIASA, the *International Institute for Applied Systems Analysis,* which is located in Vienna.

Looking at ICSU’s activities in the past, I am glad to say that many features of the community represented here resonate really well with those of ICSU. ICSU is active in three

areas. These include scientific collaboration, universality of science, and science for policy. By universality we mean there should be freedom of movement, freedom to conduct science, and freedom of sharing of scientific information and data. Furthermore, we all have responsibility too - responsibility to our society - because the promotion of international science is really for the benefit of society. The President mentioned the role of science diplomacy in arctic research. We also believe that science should be a neutral place where people from different nations, religions, and political systems can work together. I was also glad to hear the Rector's statement about policy-making, about the short notice we usually face to deliver that scientific knowledge that policy-makers need to address society issues. Personally I'm happy to see that some of the discussions in this community are moving towards that direction.

We are living in an era when not only excellence in science is important, but also the active role that science plays in the sustainable development of society. As professor Yao has mentioned, ICSU has been playing a very active role in developing international global change programmes such as the World Climate Research Programme, and the International Geosphere-Biosphere Programme. All together we have 19 such international programmes. I know that many of you are involved in some of the programmes or projects under these programmes.

From our experience in the past decades we have realized, especially through involvement in the World Summit for Sustainable Development in 2002, that there is a great potential for the scientific community to play an active role in science for policy and in the interface between science and policy. After that time we realized more and more that global programmes and activities are important, but regional activities are more useful, at least in terms of policy-making.

As you know, the successful International Polar Year (IPY) during 2007-2008, co-organized by ICSU and the World Meteorological Organization, focused on two regions, namely the Arctic and Antarctic regions. Your third polar initiative is not only important to the Himalaya region, but also has the potential to have a positive impact on cryosphere studies in general. The result of this research agenda has implications for policy-making, for people, and for regional development; sustainability is the key word here. Thus I am excited to be here with you.

In my presentation later on, I would like to present a new sustainability initiative which is being developed by ICSU and its partners at the global level. Among other characteristics of the initiative, this time we will focus more on regional activities. We are still developing the concept, and I am keen to listen to your views and ideas on how the initiative should be framed. I am here to learn about your research works. Finally, I would like to thank the organizers for the kind invitation to me, and for the fantastic preparation for the workshop. Thank you.

UNESCO representative, Sarah Gaines

Honourable President, Rector, Distinguished scientists, Ladies and gentlemen, good morning.

I am delighted to represent UNESCO – United Nations Educational, Scientific and Cultural Organization – here at the third workshop of the Third Pole Environment, University of Iceland in Reykjavik.

Perhaps best known around the world for its protection of world heritage, such as the Surtsey World Heritage Site in Iceland, UNESCO is also host to a number of major scientific programmes known to this community, such as the International Hydrological Programme, the Man and the Biosphere Programme, and the International Geoscience Programme, where I am based. Our overall mandate, to do interdisciplinary, international research of societal relevance with the ultimate goal of building peace through common interests, fits nicely with the goals of your Programme.

UNESCO is enthusiastic to become more involved in the Third Pole Environment Programme.

The Third Pole is characterized by complex atmospheric, cryospheric, hydrological and ecosystem processes that bear special significance for the Earth's climate and water cycles and are critical for the well-being of the numerous human populations living on the plateau and in the surrounding regions of Afghanistan, Bangladesh, Bhutan, China, India, Kazakhstan, Krgyzstan, Myanmar, Nepal, Pakistan, Tajikistan, and Uzbekistan.

In June, we published the newest policy brief in the UNESCO-SCOPE-UNEP series on the Third Pole Environment, thanks to the co-authorship of a number of the organizers and

speakers in this workshop. This series aims to describe emerging science issues in a digestible and appealing format for policy makers, with a focus on communicating the issues which require a policy response. The Third Pole Environment policy brief will be distributed to our Member States as well as our networks of parliamentarians.

Besides our work on science policy, UNESCO has a number of relevant activities and networks which relate closely to the themes of this workshop. Firstly, within the Climate Theme, UNESCO builds upon the strengths of our scientific programmes with the larger activities of the house through an interdisciplinary platform which focuses on improving our cooperation with the UN system while reinforcing the connections within the climate change discourse between societal issues, specifically local and indigenous knowledge systems, education for sustainable development for all, preservation of tangible and intangible heritages and the ethical issues associated with climate change. Furthermore, UNESCO participates in the Group on Earth Observations, a strong advocate for sustained and coordinated climate observing systems. It is supporting an ambitious and multidisciplinary effort to strengthen the ability of governments to minimize and adapt to the societal and environmental impacts of climate variability and change. The Glacier Terrestrial Network is providing new glacier inventories to the World Glacier Monitoring Service database.

Related to your Glaciers Theme, UNESCO has recently established a Central Asian Regional Glaciological Center in Almaty, Khazakstan, as what is known as a Category II Centre of UNESCO to monitor ice melt and encourage scientific collaboration. The International Hydrological Programme has published multiple relevant technical notes, such as the Glossary of Glacier Mass Balance with the International Association of Cryospheric Scientists, which was published this year. UNESCO continues to develop its interdisciplinary work on glacier studies, with an interdisciplinary meeting on Andean Glaciers planned to take place in Chile, next week. We also work with space agencies to monitor change using remote sensing at World Heritage Sites including a number of glaciers.

Thirdly, the Ecosystems Theme, is closely linked to the work of the Man and the Biosphere Programme, whose World Network of Biosphere Reserves, now numbering 580 sites in 114 countries, was constructed to serve as living laboratories for sustainable development chartering new ways for human communities to interact with the conservation areas.

Established 40 years ago, many Biosphere Reserves have long research records taking place in their core protected zone. In the Third Pole Region biosphere reserves include Changbaishan in China, Nanda Devi in India, and Issyk-kul in Kyrgystan. The GLOCHAMORE project of the MAB Programme – Global Change in Mountain Regions – works in biosphere reserves in mountain regions around the world with the emphasis that global change processes can best be understood through inter-disciplinary and integrated studies involving natural and social scientists as well as input from protected area managers who often have long-term experience, institutional mandates and functions.

Finally, the theme on Natural Dynamics is an area of critical importance for further focus. Earth System Science is increasingly the focus of the International Geoscience Programme. International research teams have conducted recent IGCP projects in the region include: Evolution of Asian River Systems, Cretaceous Paleoclimates in Asia. UNESCO's work to bring together natural and social science in an interdisciplinary manner has focused recently on natural disasters. From August 2010, we launched an interdisciplinary science response to the flooding in Pakistan, which has strived to show the importance of integrated science for flood prediction, emergency response, and management including associated phenomena such as glacial melt and landslides while working to improve interagency cooperation within the Pakistan government.

Based on the multiform areas of interest, I look forward, during the course of this workshop, to develop more concrete plans for UNESCO's involvement, reinforcement and collaboration in the Third Pole Environment. Initially, I see important opportunities to develop further international cooperation, correlate your proposed research stations with UNESCO sites, and expand upon the research in social sciences.

The interplay of earth system processes in the Third Pole Environment is not only a fascinating area of research but a topic of crucial importance to the lives and livelihoods as well as to the economic and social development of 1/5th of the world's population who live in the affected river basins.

I thank you for your work, for the efforts of this workshop's organizers and I look forward to the next few days of workshop and the future of this Programme. Thank you very much.

Secretariat of the International Glaciological Society, Magnus M. Magnusson

Mr President, ladies and gentlemen, dear colleagues.

On behalf of the International Glaciological Society, its President and its Council, I would like to express our gratitude at being invited to participate in this Third Pole Environment workshop. I would like to thank our Chinese colleagues for their initiative in setting up this series of workshops. I would also like to thank all the international scientists that have travelled far to attend. And it is very nice to see some old friends

I would like to thank our hosts, the Icelandic authorities and the Icelandic Scientists. The fact this workshop is being held here in Iceland reflects upon the respect Icelandic glaciologists have gained worldwide. It makes me proud.

The International Glaciological Society, or the IGS as it commonly known, has been in existence since 1936 and has been publishing glaciological research papers since 1947. The Society's publications have played a major role in the dissemination of the scientific findings from the Polar Regions. For the first few decades those papers concentrated on glaciology in the first two poles namely the Arctic and the Antarctic and of course the playground of Europe, the Alps. But thanks to our Chinese colleagues and their international collaborators we have seen a surge in scientific papers addressing the problems of the Third Pole Environment. A good example of how the IGS is starting to support some of the interest in the Third Pole is a publication in progress, an issue of the Society's Annals of Glaciology published in conjunction with an IGS sponsored symposium held in Columbus Ohio last year.

A little over two weeks ago China celebrated the 50th anniversary of the Tianshan Glacier Research Station, a research program established by the esteemed Professor Shi Yafeng in 1958. Professor Shi can truly be called the father of Chinese glaciology. He was a long standing member of the IGS and was made an honorary member of the Society in 1994. Sadly Professor Shi passed away in February this year at the ripe old age of 93. In preparing for the Tianshan celebration I investigated the contribution of our Chinese colleagues to the IGS literature. The increase in the number of scientific papers is very noticeable and very encouraging.

But let me return to the Third Pole Environment:

Third Pole Environment workshop opening today is the third such workshop, after workshops in Beijing (2009) and Kathmandu (2010). An area of approximately 5 million km^2 with an average altitude of 4000 m, the region has obviously a close association with the cryosphere. The region has three of the four main components of the cryosphere, excluding only sea-ice. In winter the region is almost entirely under the seasonal snow cover. The region has about 3 million km^2 of permafrost, which is equivalent to 13% of the global permafrost area. Further, the Third Pole Region is heavily glaciated. The estimated 107,153 km^2 of glaciated area in the Third Pole region accounts for about 20% of the total glaciation in the world, outside of Greenland and Antarctica. The estimated ice volume of this region is about 9,000 km^3, accounting for 10% of the total glacier ice volume outside of Greenland and Antarctica. These characteristics truly qualify this region to be called the Third Pole Region.

The significance of the Third Pole Region is, however, more than these numerical comparisons suggest, because the region is inhabited by more than 1.5 billion people, much more than the other two Polar Regions. The human activity of the region heavily depends on the availability of water. This problem is already reaching a serious level, but will be even more so in the future. The glaciers in this region play an important role as a water source, but these same glaciers are diminishing fast, as will be discussed at this workshop.

The long-term continuous observation of the mass balance of the glaciers in the region does not exist at present. The only glacier monitored for more than 30 years was the Abramov. The Abramov series which was terminated at the end of the 1998 field season and the station was subsequently destroyed. Although this observation series misses the most dramatic loss of mass of the last ten years, the average annual balance of -410 mm (w.e.)/a is far greater than the global average (-270 mm/a). Further, the negative balance is accelerating at -14 mm/a^2, at a much faster rate than the global mean (-10 mm/a^2). Unfortunately we do not know objectively, how representative this single glacier is, but this is all what we have in this vast region.

The equilibrium line altitudes (ELA) of the region of the Himalayas can be compared with the other 16 glaciated regions of the world, although the observational period is short in comparison with those other regions. Such a comparison shows for example that the

Himalayas and the Andes have strong similarities. The ascending rate of the ELA in the Himalayas is 12 m/a, three times faster than the global mean ELA ascending rate of 4 m/a.

Supporting these features of the highest plateau on the planet, is the tendency that the temperature rise at high altitudes in general, and in this area in particular is clearly above the global mean warming rate of the land surface areas. This trend is one of the main reasons many pro-glacier lakes have appeared, posing a threat to the population in this area. This important subject is one of the major foci at the workshop on high altitude climate held in Austria in this week parallel to this workshop, and will be discussed in detail in a future IGS symposium.

Despite the importance of the TPE science, the region has a grave problem. We do not have observation series that are long enough to be climatically relevant. The lack of long-term monitoring activities in this region is one of the most serious problems hampering the formulation of a long-term strategy to cope with the fast changing environment. We sincerely hope that projects under preparation and subsequent execution, discussed here at this workshop, will incorporate the importance of the long-term monitoring of the Third Pole Environment, and thus build a valuable foundation for future activities. It will be a great challenge to fully understand the "Third Pole", and the IGS hopes to continue to play an important role in the dissemination of learning in this new challenging area. We are indeed hopeful to be able to sponsor a symposium, in the not too distant future, on the Tibetan Plateau Environment in collaboration with our Chinese colleagues. To close I wish you a very productive and beneficial workshop and I look forward to participate. Thank you

Appendix 4. List of Presentations

Aizen, V. “Central Asia Cryosphere as a Part of the 3rd Pole Environment”

Armstrong, R. “A preliminary assessment of the contribution of seasonal snow cover to runoff in the Upper Indus Basin”

Bolch, T. “Assessing glacier mass changes in high Asia based on space imagery”

Bookhagen, B. “Hydrologic Gradients, Climatic Extremes, and Surface Erosion in the Himalaya”

Chen, D. “Visioning: Towards a new initiative on Earth system research for global sustainability”

Devkota, L. “Comparative hydrometeorological and cryospheric stations on the northern and southern slopes of Qomolangma”

Ding, L. “Collaborative flagship station: uplift of Pamir-Tianshan and its tectonic and climatic implications (UPTEC)”

Gislason, G.M. “Glacial river ecosystems and the effect of global warming”

Jarosch, A. “The Relevance of Regional Glacier Models for Understanding the Third Pole”

Kirchner, J. “Exploring mountain landscapes and ecosystems by studying their streams”

Kulkarni, A. “Observed changes in Himalaya cryosphere”

Ma, Y. “Tibetan Observation and Research Platform (TORP): a new base for the study of ‘water–ice–air–ecosystem-human’ interactions on the Tibetan Plateau”

Masson-Delmotte, V. “A bipolar perspective on climate change during the last climatic cycles”

Mosbrugger, V. “Third Pole Ecosystems - their relevance for ecosystem services and geoengineering”

Mool, P. “Monitoring and assessment of changes in Glaciers, Snow, and Glacio-hydrology in the Hindu Kush–Himalaya”

Nakawo, M. “Research Integration for Environmental Issues between human/social studies and natural science”

Ouyang, H. “A Regional Framework for Transboundary Monitoring on Major River Basins in the Himalayan Region”

Piao, S. “Change in vegetation growth and carbon balance of Qinghai-Tibetan grasslands over the past five decades”

Su, B. “Quantifying Climate Change Impacts in data-scarce Environment,”

Tayal, S. “TERI’s Glacier Monitoring Observatories: an integrated approach to research”

Thompson, L. “Third Pole Glaciers, Recorders and Indicators of Climate Change”

Ueno, K. “Variability of precipitation phase in High elevations”

Van Oevelen, P.J. (via conference call) “GEWEX: its measurement programs and approaches”

Winiger, M. “Assessing spatial gradients of water balance in the Hindukush-Karakorum-Himalaya – data need and uncertainties”

Yang, D. “Development of TPE regional precipitation datasets and products: need and progress”

Yang, K. “A synthetic report of recent climatic changes and their impacts on energy and water budgets over the Tibetan Plateau”

Yao, T. “Recent Environment Change in Third Pole Region”

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