REPORT No. 5

WORLD METEOROLOGICAL ORGANIZATION
GLOBAL CRYOSPHERE WATCH

FINAL REPORT OF THE CRYONET ASIA WORKSHOP

FIRST SESSION

Beijing, China
3-5 December 2013

World Meteorological Organization
Weather · Climate · Water

GCW
Global Cryosphere Watch

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WORLD METEOROLOGICAL ORGANIZATION

GLOBAL CRYSOPHERE WATCH

CRYONET ASIA FIRST WORKSHOP

BEIJING, CHINA

3 – 5 DECEMBER 2013

Final Report

Observing Systems Division
WMO Integrated Global Observing System Branch
Observing and Information Systems Department

WORLD METEOROLOGICAL ORGANIZATION

May 2014
GCW CryoNet Asia Report-1

EXECUTIVE SUMMARY

One of the priorities of the World Meteorological Organization (WMO) Global Cryosphere Watch (GCW) is the initiation of its surface-based observational network, called “CryoNet”. The goal of CryoNet is to cover all components of the cryosphere (glaciers, ice shelves, ice sheets, snow, permafrost, sea-ice, river/lake ice) through an extensive network of in-situ observations. While some of these cryospheric components are already measured through existing component networks, other components are not measured by established networks or are only partly covered by existing networks. In several cases these networks are performing measurements on the same cryospheric quantity using different guidelines or procedures. Consequently, an improved and integrating global cryospheric network of surface observations is of utmost importance for assessing the state of the cryosphere.

The First CryoNet Workshop (November 2012, Vienna) initiated the process of defining types of surface sites such as integrated sites, reference sites, and/or tiered sites. Formal procedures for establishing the GCW network were discussed but not finalized. Requirements for site inclusion in CryoNet were drafted, existing measurement standards were inventoried, and the current state of data availability and exchange was examined.

WMO held its First Asia CryoNet meeting in Beijing, China, 2-5 December 2013, hosted by the Chinese Academy of Sciences (CAS) and China Meteorological Administration (CMA). The purpose of the Asia CryoNet Workshop was to continue efforts in implementing CryoNet, but with an emphasis on the measurement sites, observations, and issues in Asia. This includes, but is not limited to, the “Third Pole” region. The focus of this meeting was snow and ice measurements in the "Third Pole" (Himalaya and surrounding) region. Participants were from China, Pakistan, India, Japan, Russia, Kyrgyzstan, Kazakhstan, Tajikistan, Uzbekistan, USA, Canada, Austria, Italy, and Switzerland.

Major outcomes of the workshop can be summarized as follow:

- Reviewed existing observation sites/observatories over the “Third Pole” region. Achievements and gaps of observations were identified.
- Defined the boundary of Asia CryoNet will not limited to “Third Pole” only, but whole Asia except Arctic. Asia CryoNet will be in coinciding spatially with WMO Region II.
- Set up guidelines for future directions how Asia CryoNet being organized.
- For some stations/sites, focal points (station leaders) were listed
- Funding resources were detected and deeply discussed.
- Highlights the importance of GCW to the responsible bodies in China, like CAS and CMA. Pursue continuous support and upgrade observations in Third Pole region towards GCW standard.

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1. ORGANIZATION OF THE SESSION

1.1. Welcome and Opening of the session

The First Global Cryosphere Watch (GCW) CryoNet Asia was hosted by the Chinese Academy of Sciences (CAS) at the China Meteorology Administration (CMA) in Beijing, China, 3-5 December 2013. The meeting was organized by the CryoNet Team of the GCW Observing Systems Working Group and co-led by Cunde Xiao, Jeff Key and Wolfgang Schöner.

Dr. Cunde Xiao welcomed the participants on behalf of the Chinese Academy of Science at the China Meteorological Administration. On behalf of the Local Organizing Committee, he provided attendees with relevant information regarding local arrangement.

Dr. Wenjian Zhang, Director of the World Meteorological Organization (WMO) Observing Systems Department, welcomed participants on behalf of WMO. He emphasized that this meeting was a major step in the development and implementation of CryoNet within GCW. He noted that the establishment of a cryospheric network in Asia would be a crucial step in the implementation of CryoNet and could potentially serve as an example for other regions in the world.

1.2. Adoption of the Agenda

The programme for the workshop was adopted with minor amendments. The final programme is attached as ANNEX 2. The final List of Participants is attached as ANNEX 3.

All documents and presentations prepared for, or given at, the workshop are available online at http://www.wmo.int/pages/prog/www/OSY/Meetings/GCW-CN-Asia/CryoNet_Asia_Documentation_Plan.html

1.3. Participant introductions

Participants briefly introduced themselves and identified their interests and background relevant to the themes of the workshop (see also ANNEX 2).

2. CRYONET BACKGROUND

This session set the context for the development and implementation of the GCW CryoNet. All participants were asked to review the Final Report of the First GCW Implementation Meeting (GCW-Report-1) and the GCW Implementation Plan (GCW IP) as these documents provided the framework for discussions at this meeting. All presentations and written documents of GCW-IM-1 are hyperlinked as part of the Documentation Plan http://www.wmo.int/pages/prog/www/OSY/Meetings/GCW-IM1/DocPlan.html.

2.1. GCW Implementation Plan

The GCW Implementation Plan (presentation 2.1) is accessible on the GCW website (http://globalcryospherewatch.org). It includes activities and timelines that will be updated regularly. The need to develop metrics of success is recognized as an important element in developing GCW and CryoNet. GCW is being developed to build on what exists currently by engaging other communities and is not taking on the mandate of others. It should be noted that

cryosphere is now seen as a major source of information for assessing climate variability and change and hence there is a need for standardization to have confidence in the observations and their use. It must be remembered that the GCW is global and not just polar or alpine.

2.2. **CryoNet Asian Sites Questionnaire**

To stimulate initial thinking about the GCW CryoNet Asia prior to the workshop and to share participants' thoughts on the purpose and benefits, structure and scope of the network, participants were asked to answer the following questions:

1. *How could GCW-CryoNet help meet your national, regional or global interests?*
2. *What could you or your organization contribute to the implementation of GCW-CryoNet?*
3. *What do you see as the benefits of CryoNet: (e.g. for operational and research network operators, scientific and decision/policy making community, environmental monitoring and modelling, scientists, satellite data providers, etc.)?*
4. *What do you see as existing gaps in cryospheric observations (e.g. thematic, spatial, temporal, availability, exchange, data policy, etc.) and how might CryoNet address these?*
5. *Please prioritize CryoNet activities according your personal view (select High/Medium/Low):*

    Establishment of CryoNet tier#1-tier#4 network
    Establishment of supersite network
    Harmonisation of cryospheric network
    Standards, guidelines and training for observations
    Inter-comparison experiments (e.g. sensors, methods)
    Cooperation with existing networks
    Data policy on archiving, accessibility and exchange
    Support national needs

6. *Please share any other thoughts for participant to consider at the meeting.*

2.3. **CryoNet Asian sites Questionnaire Responses**

Participants' responses are given in ANNEX 4, as submitted, and summarized in Table 1. Participants were from different organizations, agencies and institutions from several countries that operate stations or networks which could contribute to CryoNet, particularly as reference or integrated sites.

3. CRYONET ASIA: OBJECTIVES AND BENEFITS

One of the priorities of the GCW is the initiation of CryoNet, the surface-based observational network. The goal of CryoNet is to cover all components of the cryosphere (glaciers, ice shelves, ice sheets, snow, permafrost, sea-ice, river/lake ice) through an extensive network of in-situ observations. While some of these cryospheric components are already measured through existing component networks (such as GTN-P for permafrost or GTN-G for glaciers), other components are not measured by established networks (e.g. sea ice) or are only partly covered by existing networks (e.g. snow). In several cases these networks are performing measurements on the same cryospheric quantity using different guidelines or procedures. Consequently, an improved and integrating global cryospheric network of surface observations is of utmost

relevance for assessing the state of the cryosphere. The following gaps have been identified by the community of researchers and practitioners with respect to cryospheric observations and monitoring:

- Lack of harmonization in cryospheric observations
- Lack of network-hosts for several cryospheric observations (e.g. glacier flow measurements, automatic weather stations on glaciers)
- Lack of guidelines for the measurement of some cryospheric properties
- Need for improved training, especially at the international level
- Access to cryospheric observational data.

The First CryoNet Workshop (November 2012, Vienna) initiated the process of defining types of surface sites such as integrated sites, reference sites, and/or tiered sites. Formal procedures for establishing the GCW network were discussed but not finalized. Requirements for site inclusion in CryoNet were drafted, existing measurement standards were inventoried, and the current state of data availability and exchange was examined. **The purpose of the Asia CryoNet Workshop is to continue these efforts in implementing CryoNet, but with an emphasis on the measurement sites, observations, and issues in Asia. This includes, but is not limited to, the "Third Pole Project" region of the Himalayas.**

Meeting participants will help refine the CryoNet network strategy, levels of observation, requirements for site inclusion in the network, and measurement practices. The following topics will be discussed:

- Aims and need for CryoNet
- Classification of the CryoNet station network
- Selection procedure of CryoNet stations
- Measurement standards
- Data policy within CryoNet in general and integrated sites in particular
- Suggest showcase projects for CryoNet
- Sustainability; reactivation of closed sites

3.1. **Global Cryosphere Watch (GCW) under WMO EC-PORS**

The idea for GCW grew from of a number of national and international programs, but perhaps the most important was the Integrated Global Observing Strategy (IGOS) Cryosphere Theme. The IGOS Cryosphere Theme examined the capabilities and requirements for cryospheric observations. The report was published in 2007. That same year, the WMO Congress welcomed the proposal of Canada to create a Global Cryosphere Watch and requested that the WMO Intercommission Task Group on IPY establish a group to prepare recommendations for GCW development. In 2011, Congress approved GCW as a WMO initiative.

GCW now is under the "umbrella" of the WMO Executive Council expert panel on Polar Observations, Research, and Service (EC-PORS). There are GCW focal points from approximately 30 WMO members (countries).

Since 2011, a framework for GCW operation has been developed that includes an advisory group and task teams. There are currently six task teams: CryoNet Team, Infrastructure and Practices Team, Requirements and Capabilities Team, Products Team, Portal Team, and Outreach Team.

The GCW Implementation Plan (IP) describes the framework and the responsibilities of each team.

Much progress has been made over the last 18 months, notably:

- An information website has been developed with both static and dynamic content (http://globalcryospherewatch.org)
- The GCW data portal continues to be developed by the Norwegian Meteorological Institute
- A Snow Watch project was initiated and a workshop was held. Snow "trackers" have been developed
- The CryoNet Team was formed at the first CryoNet workshop, and robust information on potential sites has been collected
- Existing compilations of measurement practices have been collected
- A comprehensive glossary of snow and ice terms from a variety of sources has been developed.

3.1.1 CryoNet under GCW

One of the main initial priorities of the GCW is the initiation of CryoNet, the surface-based observational network. Engagement of participants in advance of the meeting was essential in order to share background information before the meeting. The first implementation workshop for CryoNet aimed to initiate the process to define the types of surface sites, e.g., tiered network of integrated sites, reference sites, and baseline sites in cold climate regions, on land or sea, operating a sustained, standardized programme for observing and monitoring as many cryospheric variables as possible. This would also involve initiation of the development of formal procedures for establishing the GCW network, evaluation of potential integrated sites, discussion of the measurement standards and determination of data availability and exchange.

CryoNet, through long-term, sustainable observing and monitoring, will contribute to:

- Quantifying changes in the cryosphere over a range of time and space scales
- Quantifying and understanding of the effects of climate change on cryosphere and vice-versa covering changes and their underlying processes as well as feedbacks
- Assessment of the impacts (interaction with) of the cryosphere on other earth spheres, in particular the hydrosphere, the biosphere and the lithosphere
- Verification of satellite data with in-situ measurements to improve modelling approaches for interpretation of satellite data and to extend the point information from CryoNet stations into the space domain
- Standardized cryosphere observations for NWP and hydrologic model development and verification
- Training in cryospheric measurements
- Harmonization of cryospheric information for the public

As identified at the first GCW Implementation Meeting, a GCW *CryoNet Team* will help to guide the development of the network. This workshop initiates the tasks identified at that meeting, including:

- definition of the types of surface sites, e.g., integrated sites, reference sites and baseline sites in cold climate regions, on land or sea, operating a sustained, standardized programme for observing and monitoring as many cryospheric variables as possible;
- initiation of the process to develop site and observing standards, guidelines and protocols;
- determination of data availability and exchange;
- evaluation/identification of potential integrated sites; and,
- initiation of the development of formal procedures for establishing the GCW network.

3.1.2 Summary of Questionnaire

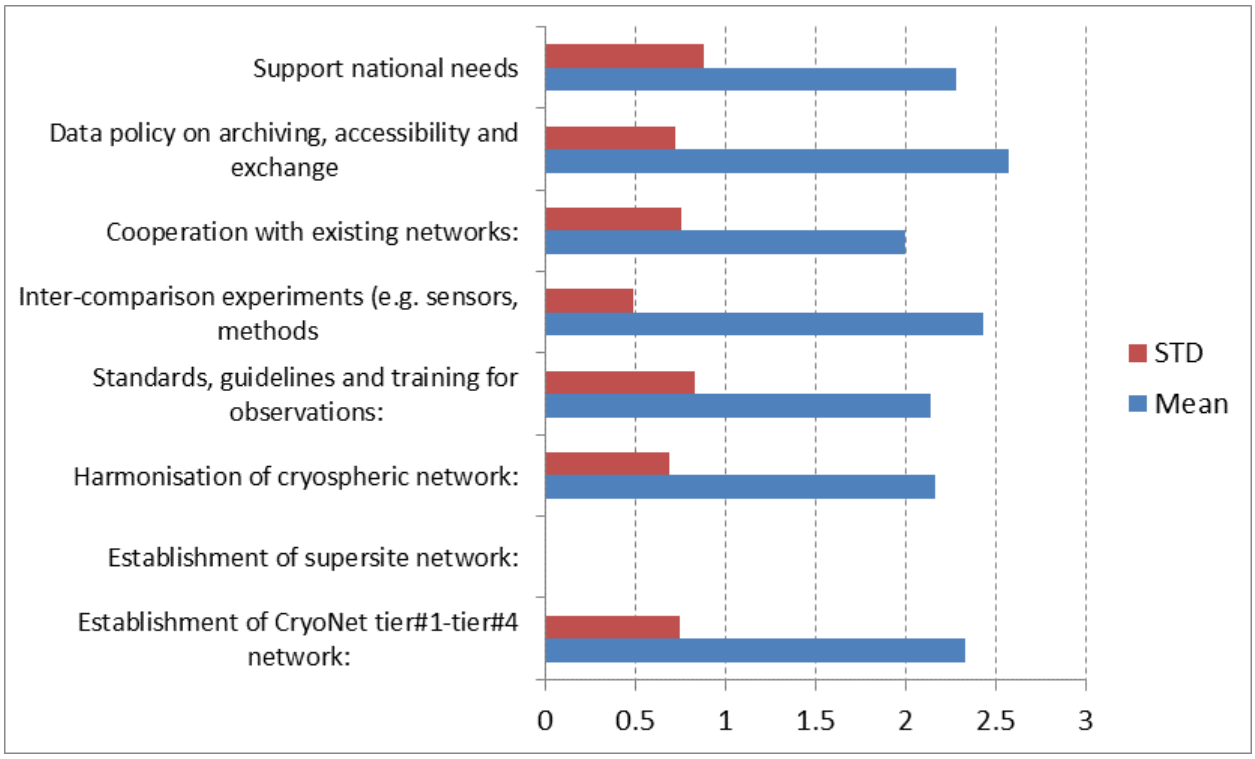

Table 1: Summary of participant questionnaire responses (1=low priority, 2=medium priority, 3=high priority)

Key messages from the questionnaires (from both the Vienna and Peking meeting) could be summarized as follows:

- Establishment of a tiered CryoNet network was ranked at the highest priority
- There is high need for harmonization as well as standards and guidelines in cryospheric observations
- Existing cryospheric networks are highly interested in cooperation with GCW
- CryoNet should fill gaps in existing networks
- Data policy and data accessibility is of highest priority for cryospheric community

These issues re-emphasized the initial recommendations derived from discussions at the First GCW Implementation meeting. Furthermore, W. Schöner noted that people from the 1st CryoNet Meeting in Vienna, who answered the questionnaire, seemed to be the more familiar with the

general aims of GCW. This fact and need of basic information on GCW has to be considered in case of other regional CryoNet meetings to be organised in the future.

4. INTRODUCTION SESSION

The list of presentations of the session related to the introduction is given in the table below followed by comments, questions or suggestions raised by the participants on some of the presentations. Note that all presentations listed in tables below can be downloaded here.

N°	Title	Name
1	WMO Integrated Global Observing System (WIGOS)	W. Zhang
2	Global Cryospheric Watch (GCW) under WMO EC-PORS, including GCW website	J. Key
3	CryoNet under GCW and Summary of the questionnaire	W. Schöner
4	Cryosphere Monitoring Programme in the Hindu Kush Himalayas and Cryosphere Knowledge Hub	P. Mool
5	Third Pole Environment: An international initiative	T. Yao
6	Gaps in regional network	C. Xiao

- *WMO Integrated Global Observing System (WIGOS) (W. Zhang):*

W. Zhang reminded that we should also focus on CAL/VAL. T. Ohata agreed and added that we should strengthen the collaboration between observers and modellers to create an integrated network. V. Aizen stressed on the fact that we need to establish representative measurement sites to deliver scientifically reliable data to climatic and hydrologic simulations.

- *CryoNet under GCW and Summary of the questionnaire (W. Schöner):*

W. Schöner also reminded that CryoNet is not designed to include all kind of cryospheric stations. However, AWS could also be considered to be included. J.Key pointed that we do not need as many sites as possible, but the representative ones in either data quality or spatial distribution point of view. Furthermore, AWS do not always meet the WMO requirements. Thus further discussion is needed on this issue. He also asked if another category in the CryoNet tired structure is required.

- *Cryosphere Monitoring Programme in the Hindu Kush Himalayas and Cryosphere Knowledge Hub (P. Mool):*

P. Mool gave an overview of the Cryosphere Monitoring Programme in the Hindu Kush Himalayas and the Regional Cryosphere Knowledge Hub (RCKH) with an emphasis on the Data Sharing Policy developed within the programme. He also asked how to link their already establish network to GCW CryoNet and reaffirm the willingness of ICIMOD to collaborate with WMO in order to strengthen international collaboration. P. Mool likewise reports some coordination and communication problems mentioning as example several Indian published works on the same glacier. He deplored that they do not talk to each other. On AWS, P. Mool noted that sustaining an AWS is really challenging in high mountain area. Every time they go on site they find problems. The main concern is to “safely bring people home”. Then, training on glacier strongly focuses on fieldwork rescue techniques.

5. POTENTIAL GCW STATIONS

The list of presentations of the session related to the potential GCW stations is given in the table below followed by comments, questions or suggestions raised by the participants on some of these presentations.

N°	Title	Name
7	GEO contribution to GCW CryoNet	A. Massacand
8	Cryospheric and related observations over Southeast Tibet	L. Zhu Y. He
9	Observations of snow cover in Xinjiang	W. Wei
10	Cryospheric and related observations in Chinese Tianshan and Altay mountains	Z. Li S. Liu
11	Observations of frozen ground in China	L. Zhao
12	Cryospheric and related observations over Eastern Pamir (Chinese part of the Pamir) and Western Tibet	B. Xu, L. Tian
13	Cryospheric and related observations at Nam Co, Mt. Everest and Mt. Tanggula	S. Kang, C. Xiao X. He, G. Wu
14	Cryospheric and related observations in Qilian Mountains	X. Qin, N. Wang R. Chen, Z. Li
15	Cryospheric observations at CMA stations	D. Zhang, J. Wang, L. Ma
16	Cryospheric observations at Siberian Altai, Tien Shan and Pamir	,I. Severskiy, V. Aizen

- *GEO Cold Regions initiative (A. Massacand):*

Through a remote presentation A. Massacand gave a summary of the GEO Cold Regions initiatives which is an emerging activity featured with the efforts on information services for cold regions (Arctic and Antarctic, the Third pole and mountain cold regions).

In addition to this presentation Y. Qiu pointed some information: "It was indicated that GEOSS, with the intrinsic characteristic of information service for society, plays the complementary roles to the GCW CryoNet through the observations of the environmental sets (Ecosystem, Biodiversity, and other), and it also provides CryoNet more visibility to the whole communities of GEO Society Benefit Areas (SBAs) and decision makers. GCW CryoNet was suggested to enhance the involvement in the GEO Cold Regions initiative (an information service for cold regions), in the GEO Work Plan".

Conclusions of this session were mainly made through an open discussion driven by V. Aizen who addressed different questions:

- What is the goal of GCW?
- What are the methodologies?
- Duplication and gaps: what is missing?
- How will data be made available?

W. Schöner briefly responded by mentioning that GCW CryoNet has several goals to fit different types of stations.
B. Goodison noted that we were thinking here regionally but we should think globally. We should also use the same observation methods in order to make data globally compatible. Also, getting data in high elevation is crucial for Asia and data sharing is vital in this regards especially for

snow cover, on what V. Aizen agreed saying that we do not share enough data on snow cover, glaciers and permafrost measurements. For each region, in our case for Asia, there should be created a coordinating body where all data will be transmitted for quality control and sharing based on an agreement signed between the participating countries.

T. Ohata stressed that it is impossible to expand stations for ever. How many stations do we need? We need also to model environment/weather/climate…

V. Aizen replied that to determine the number of stations involved in data collection it would be necessary to complete the preliminary methodological research on the representativeness of each data collection point, then it will be clear how much stations would be included in GCW network.

6. POTENTIAL GCW STATIONS (In High Elevation Central Asia)

The list of presentations of the session related to the potential GCW stations in High Elevation Central Asia is given in the table below followed by comments, questions or suggestions raised by the participants on some of these presentations.

N°	Title	Name
17	Cryospheric Measurements and Observations in Central Himalaya, India	B. P. Thakur
18	SHARE RIVERS - A long term monitoring of quantity and quality of rivers and running waters in Sagarmatha National Park (Nepal)	F. Salerno
19	Asia Eurasian cryospheric data archive by CrDAP (Cryosphere Data Archive Partnership) in JAMSTEC	H. Yabuki
20	CAIAG actions on high elevation observations in Kyrgyzstan	B. Moldobekov
21	Cryosphere Monitoring Activities in Pakistan	G. Rasul
22	Field bases in the Russian Arctic	V. Smolyanitsky
23	Cryosphere monitoring system in Tajikistan	A. Kodirov

- *SHARE RIVERS - A long term monitoring of quantity and quality of rivers and running waters in Sagarmatha National Park (Nepal) (F. Salerno):*

F. Salerno showed a real-time data sharing example through the SHARE RIVERS initiative. Referring to a question related to AWS, he also mentioned that very often AWS experience some data void due to failure or technical problems on instruments (e.g. power supply).
B. Goodison noted that in addition to data void, accuracy of measurements is in some cases questionable.

- *Asia Eurasian cryospheric data archive by CrDAP (Cryosphere Data Archive Partnership) in JAMSTEC (H. Yabuki):*

H. Yabuki presented an observation network data over eastern part of Russia with a potential contribution to GCW. This network represents a large database but compatibilities with GCW need to be checked.

7. POTENTIAL GCW STATIONS (Over High Latitudes of Asia)

The list of presentations of the session related to the potential GCW stations Over High Latitudes of Asia is given in the table below followed by comments, questions or suggestions raised by the participants on some of these presentations.

N°	Title	Name
24	Glacial ecosystems in Asian high mountains	N. Takeuchi
25	AsiaCryoWeb, the web designed data base with Central Asian data on long-term meteorological observations, seasonal snow cover dynamics, glaciers area changes and ice-cores isotope-chemistry	V. Aizen
26	Asia cryospheric data archived by NSIDC USA	T. Zhang

- *Asia cryospheric data archived by NSIDC USA (T. Zhang):*

Commenting the presentation given by T. Zhang on Asian cryospheric data researches from the NSIDC, J. Key noted that NISDC is a great data provider and that an exchange procedure already exists with GCW catalogue.

- *Field observations in Central Asia (V. Aizen):*

V. Aizen, in his presentation showed the data available through the AsiaCryoWeb Internet site created at the University of Idaho in US: long-term climatic data (i.e. precipitation, temperature), seasonal snow cover dynamics for the last 30 years with one day resolution computed using remote sensing data, glacier covered area for three period of time within the last 40-50 years based on remote sensing and aerial photography data, and the Central Asian ice-cores isotope-chemistry data, but he regretted that similar data is difficult to obtain from China to extend this data base.

8. BREAK-OUT SESSION ON POTENTIAL GCW STATIONS

Below are the summaries of the breakout discussions addressing several topics related to the development and implementation of the CryoNet in Asia.

- Should we focus on the “Third Pole Project” or we should concider the whole Asia?
  CryoNet Asia should include Himalaya, Karakorum, Hindukush, Pamir, Tien Shan, and Altai, the major mountain cryosphere in high elevated Asia. That is the scope of the GCW CryoNet in accordance with the WMO regional subdivisions.

- Where to put the Asia boundary to be considered in CryoNet?
  We should stick to the WMO region subdivisions.

- If whole Asia is considered, do we need to define the boundary of it with pan-Arctic?
  CryoNet should expand including pan Arctic.

- Should all stations that measure snow be part of CryoNet?
  By definition there are already included within WIGOS.

- Other kind of issues that should be addressed:
  (1) Structure of CryoNet (Objectives)
  Water resources
  Weather/climate
  Ecology
  Geo-hazards

(2) Define levels, how should be designed?

Regional organisations, 2nd level (i.e. ICIMOD, EV2K, Central Asian Cryosphere Centre in Almaty, Kazakhstan).

(3) Climatic zones

Climate zone and users (applications)
Existing stations/sites
Required new stations/sites (gaps)
Add new variables at existing stations
Snow measurement sites (a lot) are CryoNet sites?
WIGOS and GCW CryoNet
GAP stations (i.e., especially at high elevations)
Arctic Ocean stations

(4) Tiered sites and requirements

CryoNet aims to allow users to find data of any cryospheric variables from stations that measure those following WMO standards and best practices.

(5) Sponsors

Co-sponsors are usually defined at higher level but actually everyone who provides resources, money, stations, coordination (WMO, World Bank, Goverments, users, stakeholders etc…) will automatically be co-sponsors

Following the discussion several Chinese stations were proposed to be part into CryoNet Asia. These stations are listed in the table below along with some parameters and characteristics. Note that the current cryospheric monitoring is very variable between sites and cryospheric components.

Station	Tiered Category	Cryospheric variables	Operated since	Coordinates			Focal point	Organization
				Long	Lat	altitude (m)		
Tianshan	Integrated Sites	Glacier mass balance, glacier tongue and area changes, ice thickness, glacier dynamic, glacier temperature.	1958	86°44'E	43°07'N	2130	Li Zhongqin	CAS
Golmud	Integrated Sites	Permafrost temperature, active layer temperature, upper limit of permafrost, permafrost thickness. Ground temperature, thickness of snow	1987	94°54'E	36°24'N	2829	Zhao Lin	CAS
Qilian	Integrated Sites		2008	99°53'E	38°16'N	3011	Qin Xiang	CAS
Nam Co	Integrated Sites						Wu Guangjian	CAS
Tanggula	Integrated Sites	Glacier mass balance, snow depth, IR snow temperature, ice surface eddy correlation, glacier temperature, glacier mouvement, tongue tip change, glacier form, ice volume (GPR), glacier area. Permfrost: soil temperature & moisture profiles, soil thermalconductivity, permafrost active layer thickness variation. Changes in snow cover, snow depth, snow density, snow water equivalent, snow water content.	2005	92°00'E	33°04'N	5100	He Xiaobo	CAS
Yulong	Integrated Sites	Glacier mass balance, glacier front change, equilibrium line altitude change, ice depth. Ice temperature, energy balance, glacier area, glacier thickness, glacier surface velocity	2002	100°13'E	27°10'N	2400	He YUanqing	CAS
Mustag	Integrated Sites						Xu Baiqing	CAS
Gongga	Integrated Sites						Wang Genxu	CAS
Linzhi	Integrated Sites		1999	100°07'E	39°20'N	1384	Zhu Liping	CAS
CMA stations	Integrated Sites						Wang Jiankai	CMA
Maxianshan	Integrated Sites						Zhang Tingjun	Lanzhou University/ CAS
Heihe Upper	Integrated Sites	Glacier mass balance, glacier energy balance, albedo, ice temperature, lake water level, water temperature, ice photography. Surface temperature, frozen soil depth, multilayer soil temperature & moisture, geothermal flux. DFIR double grille snow contrast field, snow depth, density, snow water equivalent, snow spatial distribution, sublimation. other hydrological and biological variables					Chen Rensheng	CAS
Tomur	Reference Sites	Ground temperature (ice) at different altitudes, snow fall (gauges), glacier length, glacier mass balance, snow pit, glacier surface velocity.	2003	80°10'E	41°42'N	3020	Han Haidong	CAS
Qomolangma (Everest)	Reference Sites						Xiao Cunde	CAS
13 Meteology stations over Tibet	Reference Sites						Wang Jiankai	CMA

Table 1: Observing stations in China. Information in this table have been extracted from the CNC-Clic/IACS Annual Report 2013 from the China National Committee of CliC/IACS (note that complementary information will be updated later on by requesting the appropriate responsible).

In the same way, table 2 summarizes stations in others countries in Asia.

Station	Category	Cryospheric variables	Operated since	Coordinates		Focal point	Orgnization
				Long	Lat		
Mertcbacher Lake	Integrated Sites						Kyrgyzstan
Golubina Glacier	Integrated Sites						Kyrgyzstan
Abramova Glacier	Integrated Sites						Kyrgyzstan
Tyuksu Glacier	Integrated Sites						Kazakhstan
Spasskayapad	Integrated Sites						Russia/Japan
Pyramid	Reference Sites						Nepal/Italy
Kyanging	Reference Sites						Nepal
Tien Shan	Reference Sites						Kyrgyzstan
Baitik	Reference Sites						Kyrgyzstan
Teplokluchenka	Reference Sites						Kyrgyzstan
Nalaika	Reference Sites						Mongol/Japan
Tyua Ashu South	Reference Sites						Kyrgyzstan
Susamir	Reference Sites						Kyrgyzstan
Murgab	Reference Sites						Tajikistan
Khorog	Reference Sites						Tajikistan
Arctic stations	Reference Sites						Russia
Baltoro	Baseline Sites						Pakistan/Italy/China
Batura	Baseline Sites						Pakistan/China

Table 2: Observing stations in other Asian countries (note that complementary information will be updated later on by requesting the appropriate responsible).

9. OBSERVATIONS / MEASUREMENTS / DATA

The list of presentations of the session related to OBSERVATIONS / MEASUREMENTS / DATA is given in the table below followed by comments, questions or suggestions raised by the participants on some of these presentations.

N°	Title	Name
27	Cryospheric measurement in China	J. Ren
28	Chinese Cryospheric data base	X. Li
29	Observation Network over Cold Regions initiated by Chinese Academy of Sciences	L. Zhu
30	Fengyun missions on Cryopsphere observations	P. Zhang
31	In-situ and satellite observations of snow cover and data assimilation in Asia domain	T. Che, L. Ma
32	Polar Space Task Group of EC-PORS	J. Key
33	The 2nd Glacier Inventory in China	S. liu
34	Climate regime of Asian glaciers revealed by a new GAMDAM glacier inventory	K.Fujita
35	Lessons from other regional networks	B. Goodison, V. Aizen, A. Snorrason

- *Chinese Cryospheric data base (X. Li):*

Through the Chinese Cryospheric data base X.LI showed that users can get most of the data for free of charge by filling a requisition form online. He also agreed to work jointly to create a link with GCW and Cold and Arid Dataset.

- *Observation Network over Cold Regions initiated by Chinese Academy of Sciences (L. Zhu):*

Referring to the Observation network from CAS presented by L.ZHU, B. Goodison raised that this is an excellent example of what we have to do with GCW CryoNet (standards, practices, coordination, structure etc.)".

- *Fengyun missions on Cryopsphere observations (P. Zhang):*

B. Goodison commented on the presentation of P. Zhang that satellite observation is a really interesting observation component that will soon be introduced to GCW especially for snow cover products. However, maintaining satellite observation can also be a real challenge due to potential sensor failures.

10. BREAK-OUT SESSION ON OBSERVATIONS / MEASUREMENTS / DATA

The break-out session was modified to a plenary discussion.

Expected outcome of discussion:
Identify needs for GCW-CryoNet activities and, based on this, building initiatives (working groups, cooperation with network partners (WGMS, IACS, etc.)

The following questions were discussed:

- What cryosphere observing programs already have well-defined measurement standards, guidelines, and best practices (used in Asia High Elevation)?

Glaciers: Guidelines are available from e.g. WGMS, IACS for glacier mass balance (however there are no guidelines/standards for AWS measurements , albedo, glacier hydrology, glacier movement, etc.). Permafrost: A standard is available from GTN-P, IPA… (recommendations for active layer thickness and borehole temperature measurements).

It was mentioned that WGMS mainly provides standards for clean ice glaciers mass balance measurements. ICIMOD has guidelines for measuring debris-cover glaciers.

It was proposed to provide also a guidance and training for GPS measurements at glaciers .

Former UDSSR followed well defined procedure for snow and glacier observations. These guidelines could serve as a useful starting point for establishing GCW/CryoNet standards. China is also well advanced in standardization of glacier observations. ICIMOD is also an example.

In order to properly define measurement standards, guidelines, and best practices it is important to have access to all national guidelines in order to synthesize and include them in GCW. In this regards a working group should be created to collect, standardize and maintain those guidelines. Participants state that it should be under the responsibilities of CryoNet to organize a workshop or meeting to develop international best practices for all cryospheric variables while others believed that development should remain at national responsibility while WMO provides an umbrella to distribute this information internationally. Currently, WMO guidelines exist for snow cover (snow depth, SWE, solid precipitation, snow density).

It was also strongly recommended that those who have already such guidelines/standards should provide them to the international community.

- Data policy (should CryoNet provide data or metadata only and what is the role of CryoNet in the context of existing world data centers?): It was clearly decided by the participants that data have to be freely available if a site is CryoNet site. However, there were concerns from participants from universities submitting their data to CryoNet because of missing recognition of their work. It was also discussed if specifications have to be made. Should there be a time-span that data holder could first publish their data? Is GCW-CryoNet able to provide Digital Object Identifier (doi) for data? The following statements capture the feedback from participants:

Clear citation must be mentioned when including data to GCW (who is provider funder, publication reference…).

K. Fujita showed an interesting example of data sharing through his last publication with freely accessible data he used for his study.

GCW system should implement the DOI process.

It was recognized that it is very important to show the users the benefit of sharing data and the added value of being part of CryoNet. It indeed permits CAL-VAL, inter-comparisons, partnership and collaboration.

To the question "what are the main concerns on sharing data internationally?" participants responded: "I want my paper be published first. It will require time (money) to share my data. What is the added value? We already have a national platform (i.e. Cold and Arid database). Other comments stipulated that data should be shared after one year of the related project expires. Some data should be released immediately and some after a certain time but all data should be released eventually. Who will check for data quality ingested in GCW?

In fact, it is also important to know why one does not want to share his/her data. That could help us to solve the problem.

11. SUMMARY & WAY FORWARD FOR CRYONET ASIA

11.1. **Summary of break-out sessions**

- *Agreements and Conclusions of breakout sessions:*

- Set-up a team (Expert group) to agree and to work on best practices (BP) issues.
- Develop plan & priorities (Should be coordinated by GCW working structure).
- Pursue common standards and BP to be tailored by a specific GCW group.
- Data policy: free exchange with conditions specified.
- Create a Regional Working Group (WG) for Asia.
- GCW-IP needs to be updated (e.g. GCW implementation period (2015-2019), operation onward, definition phase 2007-2015).
- Formal procedure for nominating GCW Asia experts.
- A letter to countries' Permanent Representative for WMO to reaffirm the GCW focal point and to seek support for GCW and CryoNet would be very valuable.
- The term "supersite" should not be used anymore to avoid any ranking for sites. We use the term "Integrated Site" instead.
- Further meeting: next meeting – host to be agreed offline.

11.2. **Discussion on:**

- Further building of CryoNet Asia

It was agreed that the first step was to draft the site classification system and then try to assign sites submitted by participants to test its applicability. The need for a support person to help this move forward was identified by the participants.

Additional tasks were suggested:

- Development of a data exchange,
- compilation of appropriate best practices, guidelines, and standards,
- identification and pursuit of funding opportunities. As CryoNet sites would be operated by national entities, it would be important to start the dialogue with national ministries to seek commitments to operating such sites.

- Further input and questions was received after the meeting addressing the structure of CryoNet:

Though the questionnaires tell us what sites are available, at least for now we need to agree on what we really want from a surface network. Which characteristics of those sites are important for a surface network? Are there capabilities or characteristics that are missing? We should consider not just characteristics of individual sites, but also characteristics of the entire network. Are we sampling all of the cryosphere elements (snow, sea ice, glaciers, etc.) both geographically and in different climate regimes? How many "integrated" sites with multi-sphere (cryosphere, atmosphere) do we need to support satellite validation activities? What about operational vs. research sites? Those questions need to be considered in forming CryoNet. Some of these "principles" will be discussed in the next meeting in Reykjavik, particularly the tiered site structure, measurement standards, and the requirements for including sites in CryoNet.

- Data policy & data sharing

A resolution is under discussion for a global framework in WMO. CryoNet can still provide some recommendation to this resolution. Once this resolution will be signed (next congress 2015) GCW will have to follow it.

- *General comments:*

B. Goodison mentioned that ECV stands for Essential *Cryospheric* Variables and not for Essential *Climate* Variables as defined by IGOS. Thus, we need to be careful and use appropriate acronyms.

ICIMOD would like to develop a program to monitor permafrost in southern slopes of Himalaya. This assessment is very important for water supply estimation in order to mitigate poverty related issues. Water quality should also be monitored in integrated sites.

A link to the main research publications on the GCW website was suggested by G. Rasul.

ANNEX 1: OTHER THOUGHTS AND QUESTIONS

(From Koji FUJITA's presentation)

Issues to be considered

- List of stations
- Knowing who do observation where
- List of meta-data
- Knowing who has what kind of data
- GCW Network?
- What for?
- Sharing data?
- Is it really possible?

No Sharing?

- No necessary to be discussed
- Data has to be shared
- Otherwise those activity is waste of resources (time, human and money)

On the Other Hand

- Is the effort of observers really respected?
- It is not enough, may be
- World Glacier Monitoring Service (WGMS)
- WGMS said "citation to WGMS is acknowledged to all contributors"
- But some contributors have complaint as "WGMS takes everything"

How Can We Share Data?

- Project term forces researcher to open the data within xx years
- xx depends on each field
- Journals force researcher to open the data when paper is published
- This accelerates citation, about which researchers concern
- Providing opportunities for publishing data

Role of GCW?

- Any idea?
- Knowing
- Why one is NOT willing to share his/her data?
- How one will satisfy after sharing the data?
- GCW should recommend appropriate alternative(s) to the fund providers, higher level of CAS, for instance?

ANNEX 2: PROGRAMME

December 2, 2013

Resgistration and accommodation in Beijing

December 3, 2013

First session: **Introduction**

Chair: **Wolfgang Schöner**

Start	End	Time	Title	Presenter
09:00	09:10	00:10	Introduction and information on Local Arrangements	C. Xiao
09:10	09:40	00:30	Introduction of participants	
09:40	09:55	00:15	WMO Integrated Global Observing System (WIGOS)	W. Zhang
09:55	10:20	00:25	Global Cryospheric Watch (GCW) under WMO EC-PORS, including GCW website	J. Key
10:20	10:45	00:25	CryoNet under GCW and Summary of the questionaire	W. Schöner
Total		**01:45**		
10:45	11:15	00:30	Coffee break	

Start	End	Time	Title	Presenter
11:15	11:40	00:25	Cryosphere Monitoring Programme in the Hindu Kush Himalayas and Cryosphere Knowledge Hub	P. Mool
11:40	11:55	00:15	Third Pole Environment: An international initiative	T. Yao
11:55	12:10	00:15	Gaps in regional network	C. Xiao
Total		**00:55**		
12:10	13:30	01:20	Lunch break	

Welcome session

Chair: **Qin Dahe**

Start	End	Time	Title	Presenter
13:30	13:40	00:10	Welcome remarks by CAS	CAS
13:40	13:50	00:10	Welcome remarks by CMA	CMA
13:50	14:00	00:10	Welcome remarks by WMO	W. Zhang

Total		**00:30**		
14:00	14:30	00:30	Group photo	

Second session: **Potential GCW Stations**

Chair: **Ninglian Wang and Vladimir Aizen**

Start	End	Time	Title	Presenter
14:30	14:45	00:15	GEO contribution to GCW CryoNet	A. Massacand
14:45	15:00	00:15	Cryospheric and related observations over Southeast Tibet	L. Zhu, Y. He
15:00	15:15	00:15	Observations of snow cover in Xinjiang	W. Wei
15:15	15:30	00:15	Cryospheric and related observations in Chinese Tianshan and Altay mountains	Z. Li, S. Liu
15:30	15:45	00:15	Observations of frozen ground in China	L. Zhao
Total		**01:15**		
15:45	16:15	00:30	Coffee break	

Start	End	Time	Title	Presenter
16:15	16:30	00:15	Cryospheric and related observations over Pamir and west Tibet	B. Xu, L. Tian
16:30	16:45	00:15	Cryospheric and related observations at Nam Co, Mt. Everest and Mt. Tanggula	S. Kang, C. Xiao, X. He, G. Wu
16:45	17:00	00:15	Cryospheric and related observations in Qilian Mountains	X. Qin, N. Wang, R. Chen, Z. Li
17:00	17:15	00:15	Cryospheric observations at CMA stations	D. Zhang, J. Wang, L. Ma
Total		**01:00**		
18:00			Welcome diner	

December 4, 2013

Second session: **Potential GCW Stations (In High Elevation Central Asia)**

Chair: **Ren Jiawen and Liu Shiyin**

Start	End	Time	Title	Presenter
09:00	09:15	00:15		P. Namgyel
09:15	09:30	00:15	Cryospheric Measurements and Observations in Central Himalaya, India	B. P. Thakur

09:30	09:45	00:15	SHARE RIVERS - A long term monitoring of quantity and quality of rivers and running waters in Sagarmatha National Park (Nepal)	F. Salerno
09:45	10:00	00:15	Asia Eurasian cryospheric data archive by CrDAP (Cryosphere Data Archive Partnership) in JAMSTEC	H. Yabuki
10:00	10:15	00:15		I. Severskiy
Total		**01:15**		

10:15	10:45	00:30	Coffee break	

Start	End	Time	Title	Presenter
10:45	11:00	00:15	CAIAG actions on high elevation observations in Kyrgyzstan	B. Moldobekov
11:00	11:15	00:15	Cryosphere Monitoring Activities in Pakistan	G. Rasul
11:15	11:30	00:15	Field bases in the Russian Arctic	V. Smolyanitsky
11:30	11:45	00:15	Cryosphere monitoring system in Tajikistan	A. Kodirov
11:45	12:00	00:15		G. Glazirin
Total		**01:15**		

12:00	13:30	01:30	Lunch break	

Second session: **Potential GCW Stations (Over High Latitudes of Asia)**

Chair: **Tetsuo Ohata and Ding Yongjian**

Start	End	Time	Title	Presenter
13:30	13:45	00:15	Glacial ecosystems in Asian high mountains	N. Takeuchi
13:45	14:00	00:15		O. Batkhishig
14:00	14:15	00:15		V. Smolyanitsky
14:15	14:30	00:15	Asia cryospheric data archived by NSIDC USA	T. Zhang
Total		**01:00**		

14:30	15:00	00:30	Coffee break	

Second session: **Potential GCW Stations (Break-out session)**

Chair: **Xiao Cunde**

Co-Chair:

Start	End	Time	Title	
15:00	17:00	02:00	Potential GCW Stations break-out session	
Total		**02:00**		

End of the day

December 5, 2013

Third session: **Observations / Measurements / Data (Part I)**
Chair: **Barry Goodison**

Start	End	Time	Title	Presenter
08:30	08:45	00:15	Cryospheric measurement in China	J. Ren
08:45	09:00	00:15	Chinese Cryospheric data base	X. Li
09:00	09:15	00:15	Observation Network over Cold Regions initiated by Chinese Academy of Sciences (CAS)	L. Zhu
09:15	09:30	00:15	Fengyun missions on Cryopsphere observations	P. Zhang
09:30	09:45	00:15	In-situ and satellite observations of snow cover and data assimilation in Asia domain	T. Che and L. Ma
09:45	10:00	00:15	Polar Space Task Group of EC-PORS	J. Key
Total		**01:30**		
10:00	10:25	00:25	Coffee break	

Third session: **Observations / Measurements / Data (Part II)**
Chair: **Jeff Key**

Start	End	Time	Title	Presenter
10:25	10:40	00:15	The 2nd Glacier Inventory in China	S. liu
10:40	10:55	00:15	Climate regime of Asian glaciers revealed by a new GAMDAM glacier inventory	K.Fujita
10:55	11:10	00:15	Lessons from other regional networks	B. Goodison, V. Aizen, A. Snorrason
Total		**00:45**		
11:10	11:35	00:25	Coffee break	

Third session: **Observations / Measurements / Data (Break-out session)**
Chair: **Wolgang Schöner**
Co-Chair:

Start	End	Time	Title	
11:35	13:00	01:25	Observations / Measurements / Data break-out session	
Total		**01:25**		

13:00 14:30 01:30 Lunch break

Fourth session: **Summary & way forward for CryoNet Asia**
Chair: **Jeff Key and Wolgang Schöner**

Start	End	Time	Title	Presenter
14:30	15:30	01:00	Summary of break-out sessions	C. Xiao, W. Schöner
15:30	16:30	01:00	Discussion on: Further building of CryoNet Asia Management of CryoNet Asia Data policy & data sharing	
Total		**02:00**		

End of the workshop

ANNEX 3: LIST OF PARTICIPANTS, ASIA CRYONET FIRST WORKSHOP

List of Experts from the Chinese Academy of Sciences (CAS)

No.	Name	Institution/Affiliation	Email
1	Official from CAS (TBD)	Chinese Academy of Sciences	TBD
2	Representative of CAREERI (TBD)	Cold and Arid Regions Environmental and Engineering Research Institute, CAS	TBD
3	Representative of ITPCAS (TBD)	Institute of Tibetan Plateau Research, CAS	TBD
4	Prof. Qin Dahe	China Meteorology Administration	qdh@cma.gov.cn
5	Prof. Yao Tandong	Institute of Tibetan Plateau Research, CAS	tdyao@itpcas.ac.cn
6	Prof. Wang Ninglian	Cold and Arid Regions Environmental and Engineering Research Institute, CAS	nlwang@lzb.ac.cn
7	Prof. Ding Yongjian	Cold and Arid Regions Environmental and Engineering Research Institute, CAS	dyj@lzb.ac.cn
8	Prof. Ren Jiawen	State Key Lab of Cryospheric Sciences, CAREERI, CAS	jwren@lzb.ac.cn
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		CAS	
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21	Dr Tian Lide	Institute of Tibetan Plateau Research, CAS	ldt@itpcas.ac.cn
22	Dr Zhang Tingjun	Lanzhou University	zhang0728@gmail.com
23	Dr Che Tao	Cold and Arid Regions Environmental and Engineering Research Institute, CAS	chetao@lzb.ac.cn

List of Experts from the China Meteorological Administration (CMA)

No.	Name	Institution/Affiliation	Email
1	Official from CMA (TBD)	China Meteorology Administration	TBD
2	Prof. Qin Dahe	China Meteorology Administration	qdh@cma.gov.cn
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4	Dr. Zhou Zijiang	China Meteorology Information Center, CMA	zhouzj@cma.gov.cn
5	Dr. Wei Wenshou	Meteorological Bureau of Xinjiang, CMA	weiws@cma.gov.cn
6	Mr. Wang Pengxiang	Meteorological Bureau of Xizang (Tibet), CMA	xzqx@163.com
7	Dr. Zhang Peng	China Satellite Meteorology Center, CMA	zhangpeng@cma.gov.cn

List of International Experts

No.	Name	Institution/Affiliation	Email
1	Dr Wolfgang SCHONER	Central Institute for Meteorology and Geodynamics	wolfgang.schoener@zamg.ac.at
2	Mr Barry GOODISON	CryoNet Team, EC-PORS-GCW, Expert	barrygo@rogers.com
3	Dr Bhanu Pratap THAKUR	Centre for Glaciology, Wadia Institute of Himalayan Geology.	bhanuglacio@gmail.com; bhanuthakur@wihg.res.in; dpdobhal@wihg.res.in

4	Dr Franco SALERNO	Water Research Institute, IRSA-CNR National Research Council	
5	Dr Nozumu TAKEUCHI	Graduate School of Sciences, Chiba University	ntakeuch@faculty.chiba-u.jp
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7	Dr Tetsuo OHATA	Japan Agency for Marine-Earth Science and Technology	ohatat@jamstec.go; fwnd8487@nifty.com
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10	Dr Ghulam RASUL	Pakistan Meteorologiacal Department	rasulpmd@gmail.com
11	Dr Vasily SMOLYANITSKY	Artic and Antarctic Research Institute of Saint Petersburg	vms@aari.aq
12	Prof. Vladimir AIZEN	Department of Geography, Glacier-Climatic Group, University of Idaho	aizen@uidaho.edu
13	Dr Jeff KEY	Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison	jkey@ssec.wisc.edu

ANNEX 4: PARTICIPANT RESPONSES TO CRYONET QUESTIONS

(Alphabetical by Country or Organisation)

To start the GCW Asia CryoNet discussion prior to the meeting and to share participant's thoughts on the purpose, benefits, structure and scope of the network, participants were asked to answer the following questions.

1. How could CryoNet help meet your national, regional or global interests?

2. What could you or your organization contribute to the implementation of CryoNet?

3. What do you see as the benefits of CryoNet: (e.g. for operational and research network operators, scientific and decision/policy making community, environmental monitoring and modelling, scientists, satellite data providers, etc.)?

4. What do you see as existing gaps in cryospheric observations (e.g. thematic, spatial, temporal, availability, exchange, data policy, etc.) and how might CryoNet address these?

5. Please prioritize CryoNet activities according your personal view (indicate HIGH/MEDIUM/LOW for each):

6. Please share any other thoughts for participant to consider at the meeting.

The responses of participants are given below as submitted. They were also asked to respond to a site questionnaire and those responses are given in Annex 4.

CHINA:

1. How could CryoNet help meet your national, regional or global interests?
Standardized observation on cryosphere can improve research level which meets all kinds of interests.

2. What could you or your organization contribute to the implementation of CryoNet?
Accept all kinds of standards produced by CryoNet.

3. What do you see as the benefits of CryoNet: (e.g. for operational and research network operators, scientific and decision/policy making community, environmental monitoring and modelling, scientists, satellite data providers, etc.)?
CryoNet can benefit scientific communities and national interests.

4. What do you see as existing gaps in cryospheric observations (e.g. thematic, spatial, temporal, availability, exchange, data policy, etc.) and how might CryoNet address these?
A big gap exists in remote and mountain regions where logistics are very difficult and application of remote sensing techniques are limited.

5. Please prioritize CryoNet activities according your personal view (indicate HIGH/MEDIUM/LOW for each):

Establishment of CryoNet network	Medium
Harmonisation/coordination of cryospheric network	Medium

Standards, guidelines and training for observations	High
Inter-comparison experiments (e.g. sensors, methods)	High
Cooperation with other networks	Medium
Data policy on archiving, accessibility and exchange	Medium
Support national needs	High

6. Please share any other thoughts for participant to consider at the meeting.

GEO: Response from Yubao QIU, GEO Secretariat, Office 6J54,7 bis, avenue de la Paix, Case Postale 2300,CH-1211 Geneva 2, Switzerland.

1. How could CryoNet help meet your national, regional or global interests?
Building on GEOSS, GEO Cold Regions initiatives is an emerging activity featured with the efforts on information services for cold regions, which are Arctic and Antarctic, the third pole and mountain cold regions. The surface-based observational network from the CryoNet are essential Cryospheric part of information (data) globally, especially through the WMO WIS interoperability operation, and outreach to the whole GEO communities of users and decision makers.

2. What could you or your organization contribute to the implementation of CryoNet?
GEO is an intergovernmental organization, focusing on implementation to the Global Earth Observation system of Systems (GEOSS), which is a brokering information system link with the existing earth observation databases (or meta data). GEO Cold Regions' main task is to provide the information to society and make the delivery of information products easily accessible, which can provide the CryoNet with the wider user communities, like those who work with the in-situ, remote sensing and even the assimilation dataset (meta data), supports the users engagement and resource mobilization from different levels and fields, outreachs to the decision maker and society, and could play the complementation role to CryoNet.

3. What do you see as the benefits of CryoNet: (e.g. for operational and research network operators, scientific and decision/policy making community, environmental monitoring and modelling, scientists, satellite data providers, etc.)?
The CryoNet could provide the **comprehensive coordination** for Cryosphere observation data from the in-situ measurement of research stations, operational meteorological stations, and Cryosphere is plauing the CORE role for the Cold Region areas.

4. What do you see as existing gaps in cryospheric observations (e.g. thematic, spatial, temporal, availability, exchange, data policy, etc.) and how might CryoNet address these?
(Here, might say): existing gaps: 1) soil precipitation observation, and glacier and snow observations over rugged mountain and developing regions; 2) data policy is the main force to open the data fundamentally, while it is not clear because of short of a strong working group on this specific Cryosphere data policy. 3) Another issues is what and who could get benefit from the utilities of the Cryosphere data, researchers, civil people, or decision maker (like: weather forecast).4) one suggestion is to foster the international cooperation on data (information) among the different programs and projects, at least on the information (data) level, GEOSS could be the platform to facilitate a Community of Practice to have this happen.

5. Please prioritize CryoNet activities according your personal view (indicate HIGH/MEDIUM/LOW for each):

Establishment of CryoNet network	MEDIUM
Harmonisation/coordination of cryospheric network	HIGH
Standards, guidelines and training for observations	MEDIUM
Inter-comparison experiments (e.g. sensors, methods)	MEDIUM
Cooperation with other networks	HIGH
Data policy on archiving, accessibility and exchange	HIGH
Support national needs	MEDIUM

6. Please share any other thoughts for participant to consider at the meeting.

ITALY: Response from Franco Salerno, Water Research Institute (IRSA-CNR, National Research Council, Via Del Mulino 19, 20861 Brugherio, MB), Italy.

1. How could CryoNet help meet your national, regional or global interests?
Through the exchange of data, experiences. Emphasizing the observational site we propose so that it could become a reference site for cryoshere studies in central southern Himalaya.
Supporting the fund raising.

2. What could you or your organization contribute to the implementation of CryoNet?
Mainly providing a surface-based observational site covering an elevation gradient from 2850 to 8000 m a.s.l. in central southern Himalaya (Nepal), the Sagarmatha National Park. The long term monitoring started in 1993. We measure meteorological variables, atmosphere composition, physical parameters for glaciers, lakes permafrost and rivers, chemical and biological parameters for lakes and rivers.

3. What do you see as the benefits of CryoNet: (e.g. for operational and research network operators, scientific and decision/policy making community, environmental monitoring and modelling, scientists, satellite data providers, etc.)?
a) Operational and research network operators for developing countries; b) scientific and decision/policy making community c) environmental monitoring and modelling; d) scientific interactions etc…and scientific making community

4. What do you see as existing gaps in cryospheric observations (e.g. thematic, spatial, temporal, availability, exchange, data policy, etc.) and how might CryoNet address these?
The main gaps are related to the role of high elevation areas in cryoshere observations.

An international policy

5. Please prioritize CryoNet activities according your personal view (indicate HIGH/MEDIUM/LOW for each):

Establishment of CryoNet network	HIGH
Harmonisation/coordination of cryospheric network	MEDIUM
Standards, guidelines and training for observations	HIGH

Inter-comparison experiments (e.g. sensors, methods)	HIGH
Cooperation with other networks	LOW
Data policy on archiving, accessibility and exchange	HIGH
Support national needs	LOW

6. Please share any other thoughts for participant to consider at the meeting.
Interdispinary approach to link cryosphere with biosphere (water cycle, limnology, pollutant circulation, biodiversity, etc…).

JAPAN: Response from Koji Fujita, Cryosphere Research Laboratory, Graduate School of Environmental Studies, Nagoya University, F3-1(200), Chikusa-ku, Nagoya 464-8601, Japan.

1. How could CryoNet help meet your national, regional or global interests?
Because present activities which I and my colleagues are conducting in the Himalayan countries are based on voluntary basis and personal interests, no sustainable and long-term observation is guaranteed. If CryoNet encourages and authorizes funding agencies and/or responsible relevant agencies to support cryosphere-related activities, it will be great help.

2. What could you or your organization contribute to the implementation of CryoNet?
My contribution will be:
1) Showing scientific importance based on the previous studies
2) Pointing out appropriate and feasible sites for the long-term observation

3. What do you see as the benefits of CryoNet: (e.g. for operational and research network operators, scientific and decision/policy making community, environmental monitoring and modelling, scientists, satellite data providers, etc.)?
As replied in Q1, supporting sustainable funding is the most important role which this kind of framework plays.

4. What do you see as existing gaps in cryospheric observations (e.g. thematic, spatial, temporal, availability, exchange, data policy, etc.) and how might CryoNet address these?
Temporally sufficient data is a matter of future sustainable observation, while the spatial diversity is getting better in the recent decade mainly by the activity of Third Pole Environment and remote sensing researches. Data sharing is not well proceeded, but it is solvable by CryoNet framework.

5. Please prioritize CryoNet activities according your personal view (indicate HIGH/MEDIUM/LOW for each):

Establishment of CryoNet network	Low	CryoNet itself cannot establish the network. CryoNet can only support those activity.
Harmonisation/coordination of cryospheric network	Med	CryoNet can provide opportunity to coordinate the network among various institutions.
Standards, guidelines and training for observations	Low	It is difficult to standardize glacier observation, which should be conducted by various methods under the different situations.

Inter-comparison experiments (e.g. sensors, methods)	Med	Although the standardization is difficult as mentioned above, inter-comparison of different methods is important.
Cooperation with other networks	High	I understand "other networks" as "other scientific community". Because the cryospheric phenomena are highly related with atmosphere and/or ocean, communication with other communities is important. CryoNet can coordinate and help this kind opportunity.
Data policy on archiving, accessibility and exchange	Extremely High	In my guess, recent active researches in this field have not really contributed to science and public because of the unreleased data. CryoNet should encourage and push it.
Support national needs	High	But those national needs will not be accumulated if participants from those countries do not attend the workshop.

6. Please share any other thoughts for participant to consider at the meeting.

JAPAN: Response from Nozumu Takeuchi, Department of Earth Sciences, Graduate School of Science, Chiba University, 1-33, Yayoicho, Inageku, Chiba-city, Chiba, 263-8522 Japan.

1. How could CryoNet help meet your national, regional or global interests?
CryoNet would definitely be a big support to community of environmental scientists as well as glaciologists in Japan. Japan should have a strong interest to study cryosphere because of the geographical location. We have a large amount of snow fall in every winter, which affect our society very much and climate in Japan also have a great influence from Arctic. We have a glaciologist community in Japan, but do not have any strong organization to manage continuous observations to study or monitor Asian or global cryosphere (except Antarctica). It would particular help when we explain such our research activities in Asia to government or general public, and off course, help for funding proposals for glaciology.

2. What could you or your organization contribute to the implementation of CryoNet?
As a research scientist of Japanese glaciological community, I may contribute to introduce research activities and available data of Japanese glaciological community to the CryoNet. On the other hand, I am working on biogeochemistry on glaciers rather than physical glaciology. If CryoNet involve such biochemical data set, I would contribute to provide or to manage the data.

3. What do you see as the benefits of CryoNet: (e.g. for operational and research network operators, scientific and decision/policy making community, environmental monitoring and modelling, scientists, satellite data providers, etc.)?
Providing data of periodical monitoring of Asian cryosphere would definitely be beneficial to research communities in glaciology and climatology.

4. What do you see as existing gaps in cryospheric observations (e.g. thematic, spatial, temporal, availability, exchange, data policy, etc.) and how might CryoNet address these?

The continuous observational sites of glaciers are not enough in Asian mountains although Asian glaciers are the largest ice mass other than polar glaciers. We have to watch the geographical variations in the glacier change in Asian mountains.
We also have to pay attention to biogeochemistry on Asian glaciers. Chemical properties of glaciers are reflective from surrounding environments including natural and anthropogenic status. Also, we shouldn't forget that special organisms are living on snow and ice on glaciers, which are also affected by surrounding environmental conditions and do affect glacial melting by their albedo effect. I would suggest that we have to see how such biogeochemical conditions change in recent climate change.

5. Please prioritize CryoNet activities according your personal view (indicate HIGH/MEDIUM/LOW for each):

Establishment of CryoNet network	High
Harmonisation/coordination of cryospheric network	
Standards, guidelines and training for observations	Med
Inter-comparison experiments (e.g. sensors, methods)	Med
Cooperation with other networks	Med
Data policy on archiving, accessibility and exchange	HIgh
Support national needs	High

6. Please share any other thoughts for participant to consider at the meeting.

NEPAL: Response from Pradeep K Mool, IMOD Programme Coordinator, Cryosphere initiative, International Centre for Integrated Mountain Development, GPO Box 3226, Kathmandu, Nepal.

1. How could CryoNet help meet your national, regional or global interests?
The International Centre for Integrated Mountain Development (ICIMOD) is regional intergovernmental knowledge and enabling centre in the Hindu Kush Himalaya region. ICIMOD can benefit by developing and strengthening the partnership with national, regional and global networks through GCW CryoNet.

2. What could you or your organization contribute to the implementation of CryoNet?
One of the regional programme at ICIMOD is the Regional Programme on Cryosphere and Atmosphere that focuses on monitoring of glaciers, snow, and glacial lakes; glacio-hydrology with an emphasis on modelling; and remote sensing and in situ measurements including mass balance measurements. The programme aims to build a regional cryosphere knowledge hub to collate and share knowledge of partners working in the region. The programme also aims to build capacity to study the cryosphere and is working with institutions that focus on glaciology which countries throughout the region have been establishing. ICIMOD can contribute to the CryoNet by regional knowledge sharing and networking on cryosphere activities in the Hindu Kush Himalayas.

3. What do you see as the benefits of CryoNet: (e.g. for operational and research network operators, scientific and decision/policy making community, environmental monitoring and modelling, scientists, satellite data providers, etc.)?
The benefits of CryoNet is mainly for operational and research network operators, scientific and decision/policy making community.

4. What do you see as existing gaps in cryospheric observations (e.g. thematic, spatial, temporal, availability, exchange, data policy, etc.) and how might CryoNet address these?
Ground based long term monitoring and thus data availability, as well as knowledge and data sharing.

5. Please prioritize CryoNet activities according your personal view (indicate HIGH/MEDIUM/LOW for each):

Establishment of CryoNet network	1
Harmonisation/coordination of cryospheric network	2
Standards, guidelines and training for observations	5
Inter-comparison experiments (e.g. sensors, methods)	6
Cooperation with other networks	7
Data policy on archiving, accessibility and exchange	3
Support national needs	4

6. Please share any other thoughts for participant to consider at the meeting.
Regularize the CryNet activities

PAKISTAN: Response from Ghulam Rasul, Pakistan Meteorological Department, Headquarter Office Sector H-8/2, Islamabad, Pakistan.

1. How could CryoNet help meet your national, regional or global interests?
The density of Surface observation network in cryosphere is poor to make any conclusive and reliable estimate on its dynamics in the context of climate change. CryoNet is the initiative which will provide a data integration and application platform for reliable estimation of the processes taking place at national, regional and global scale. Cryosphere is not only a frozen water reserve but also an engine driving the weather patterns on various scales.

2. What could you or your organization contribute to the implementation of CryoNet?
Pakistan Meteorological Department (PMD) have been managing 20 meteorological observatories (manned) at an elevation (1000-3000m) and 7 high elevation AWS at 3000-5000m. PMD would like to share the data collected from these stations at a common platform CryoNet if other regional members agreed to do so. In addition to its own stations, PMD has a maintenance and operational control of 4 stations of international collaborators. Their data can also be shared with the permission of the collaborators.

3. What do you see as the benefits of CryoNet: (e.g. for operational and research network operators, scientific and decision/policy making community, environmental monitoring and modelling, scientists, satellite data providers, etc.)?
CryoNet may be highly beneficial in the national interest to all the countries sharing its resources. Presently lack of data and large data gaps are the major limitations to large scale research studies to understand the dynamics of cryosphere in the wholesome manner. These limitations will be overcome through this networking coupled with satellite produced data at one portal. Scientific communities, researchers, planners and policy makers will be equally served with substantial sets of data.

4. What do you see as existing gaps in cryospheric observations (e.g. thematic, spatial, temporal, availability, exchange, data policy, etc.) and how might CryoNet address these?
The available information and research results are generally based upon pilot studies spanned over a limited time and space. Therefore, generalization of these results over larger context of cryosphere posed numerous questions e.g. Karakoram Anomaly. Lack of data generation points, data uniformity and data sharing policies are the major problems which can be resolved/agreed at CryoNet-a common data platform.

5. Please prioritize CryoNet activities according your personal view (indicate HIGH/MEDIUM/LOW for each):

Establishment of CryoNet network	High
Harmonisation/coordination of cryospheric network	High
Standards, guidelines and training for observations	High
Inter-comparison experiments (e.g. sensors, methods)	High
Cooperation with other networks	Medium
Data policy on archiving, accessibility and exchange	High
Support national needs	High

6. Please share any other thoughts for participant to consider at the meeting.
Density of network for monitoring cryosphere is extremely low, the donors should be persuaded to play their role in filling the data gaps. The capable institutions in the region should impart training to build the capacity of those partners which lack in technical capacity.

USA: Response from Vladimir Aizen, Department of Geography, Glacier-Climatic Group, Mines Bld Room #314, College of Science, University of Idaho, Moscow, ID 83844, U.S.A.

1. How could CryoNet help meet your national, regional or global interests?
CryoNet could help develop and coordinate a program of meteorological and glaciological monitoring in alpine and Polar Regions; the program that would be synchronized with the global meteorological monitoring system. However, this program would not be a reality without financial support from the countries participating in the project, or support from an international financial institution. The mountain countries in Caucasus and Central Asia, for example, will not be able to implement such a program without an external financial support. CryoNet should lobby the vital necessity of the program through the governments of those countries that will participate in this program at WMO or UNESCO level. The question is: does the WMO committee or CryoNet such levers? The idea of creating such a program is not new, but all attempts to organize such a program were left hanging in the air because of the difficulty in financing the program. A recent example: CEOP-HE project which is being implemented only in the Alps and in the Everest area in Himalayas.

2. What could you or your organization contribute to the implementation of CryoNet?
The answer to this question is directly related with the previous question. I would say - yes! At the level of research projects are carried out by our group in Central Asia, we can create and maintain meteorological monitoring network established at elevation over 5,000 meters, but we have to have the targeted funding for 5-10 years at least, which would include the meteorological stations acquisition, annual cost of their services, as well as the payment for satellite data transmission.

3. What do you see as the benefits of CryoNet: (e.g. for operational and research network operators, scientific and decision/policy making community, environmental monitoring and modelling, scientists, satellite data providers, etc.)?
The collection of meteorological data from polar and alpine regions of the world certainly will enrich the data for a better understanding of the physical processes, especially in high-mountain snow/ice/permafrost accumulation zones. This data will significantly promote regional climate modelling and runoff and improve weather forecasting in mountainous areas of the world, to improve the global climate model. The results of this work will benefit to develop regional and global economy and, help people to manage water related issues as well as develop new remote sensing technology to monitor meteorological conditions and river water runoff variability in real time, calibrate some satellite sensors to study complex mountain terrain.

4. What do you see as existing gaps in cryospheric observations (e.g. thematic, spatial, temporal, availability, exchange, data policy, etc.) and how might CryoNet address these?
The largest gap in cryospheric research is the lack of long-term meteorological and glaciological data from high mountains.

5. Please prioritize CryoNet activities according your personal view (indicate HIGH/MEDIUM/LOW for each):

Establishment of CryoNet network	low
Harmonisation/coordination of cryospheric network	low
Standards, guidelines and training for observations	low
Inter-comparison experiments (e.g. sensors, methods)	medium
Cooperation with other networks	low
Data policy on archiving, accessibility and exchange	low
Support national needs	very low

6. Please share any other thoughts for participant to consider at the meeting.
Mainly the questions highlighted in paragraph # 1.

ANNEX 5 : GCW-CRYONET SITE QUESTIONNAIRE AND RESPONSES

One of the top priorities of the GCW is the initiation of CryoNet, the surface-based observational network. Engagement of participants in advance of the meeting was essential so that background information could be shared before the meeting itself. This first implementation workshop for CryoNet Asia was to define the types of surface sites, such as integrated, reference sites, and/or tiered sites in cold climate regions, on land or sea, operating a sustained, standardized programme for observing and monitoring as many cryospheric variables as possible. GCW would also initiate the development of formal procedures for establishing the GCW network, evaluate potential integrated sites, discuss measurement standards, and explore data availability and exchange. CryoNet aims to build on existing sites first.

To start the GCW-CryoNet Asia discussion prior to the meeting and to share participants' thoughts on the purpose and benefits, structure and scope of the network, participants were asked to describe sites that they operate by completing a site questionnaire or providing the information in some other form.

Additional Information:

Participants are referred to the outcomes of the First GCW implementation meeting and the current Implementation Plan (INF. 2 and 5 in the documentation plan, http://www.wmo.int/pages/prog/www/OSY/Meetings/GCW-CN1/DocPlan.html) for discussion to date on CryoNet. Annex 8 of the Final Report of the first GCW meeting provided some examples of what countries suggested that a supersite and a reference site might include.

Discussion at the meeting focussed on refining the CryoNet network strategy and the levels of observation. Incorporation into CryoNet, i.e., becoming a GCW site, is not a matter of self-definition of the proposer, but rather a well-defined appointment from GCW according to certain criteria. CryoNet, through its observational network of sites, should collectively contribute to the global status of the cryosphere through regular GCW-reports and/or annual statements on the national, regional or global state of the cryosphere. "Integrated sites", for example, would have a common frame of observational aims, yet the special focus of each one should be according to the regional environment. Thus, the program of a mountain integrated site could, and one would expect would be different from that of a polar integrated site.

CryoNet aims initially to build on existing and planned cryosphere observing programmes at observatories and in other operational and research observing networks. The responses to the questionnaire provided an initial inventory of the types of sites and networks which might be a basis for developing CryoNet sites.

GCW-CRYONET SITE QUESTIONNAIRE

The questionnaire is listed below. Participants/contributors were asked to complete the tables below, to the extent reasonable, if they operated one or more sites. If they already had a site description in another format, they could submit that instead.

Site specific metadata:	
Name of site:	
Latitude/Longitude/Altitude:	
Landscape type (e.g. arctic coastal, tundra, alpine…):	
Onsite technical staff:	
All-year round observations y/n:	Year established:
Link to website if available:	
Station manager (Email):	
Organisation in charge of station:	
Other information	

Monitoring of the atmosphere:	
Solid precipitation:	Snowfall:
Trace gases:	
Aerosols	
UV, stratospheric ozone	
Radiation (longwave, shortwave)	
Others:	

Snow cover
Physical parameters:
Chemical parameters:
Others:

Glaciers and ice caps

Mass balance (measured parameters):

Ice flow (measured parameters):

Basal water pressure (measured parameters):

Others:

Sea ice

Mass balance (measured parameters):

Meteorology: radiation, air temperature, humidity, wind speed and direction, air pressure (measured parameters):

Snow on ice (measured parameters):

Ice chemistry (measured parameters):

Others:

Permafrost

Borehole measurements (measured parameters):

Meteorology: radiation, air temperature, humidity, wind speed and direction, air pressure (measured parameters):

Snow on ground (measured parameters):

Active layer thickness (measured parameters):

GST:

Others:

Ice sheet

Mass balance (measured parameters):

Meteorology: radiation, air temperature, humidity, wind speed and direction, air pressure (measured parameters):

Snow on ice (measured parameters):

Ice chemistry (measured parameters):

Others:

Other measurements (hydrological, ecological, oceanographic, etc)
Hydrology (measured parameters): Ecology (measured parameters) Oceanography (measured parameters): Other thematic linkages:

Linkages to satellite data (describe validation programs, applications of satellite data, etc.)

Participation in international monitoring programmes such as GAW, GTN-G, GTN-P, ….
Networks and start of contribution:

RESPONSES TO GCW-CRYONET SITE QUESTIONNAIRE

The individual responses of participants and contributors to the site questionnaire may be accessed by clicking on the link in the table below. Sites are listed by country. The complete set of responses can be downloaded as a zip file form the CryoNet documentation plan (http://www.wmo.int/pages/prog/www/OSY/Meetings/GCW-CN-Asia/CryoNet_Asia_Documentation_Plan.html).

NO.	COUNTRY / SITE NAME
BHUTAN	
1.	Gangju La Glacier
2.	Rikha Samba, Yala and AX010 Glaciers
CHINA	
3.	Nam Co
4.	Urumuqi Glacier N°1, Tienshan (By Japan)
NEPAL	
5.	Sagarmatha (Everest) National Park (By Italy)
6.	Yala glacier, Rikha Samba glacier
PAKISTAN	
7.	Baltoro Glacier N°1
8.	Baltoro Glacier N°2
9.	Baltoro Glacier N°3
10.	Dammay Chirah
11.	Hinarchi Glacier
12.	Passu Glacier
13.	Patundas Glacier
TAJIKISTAN	
14.	Fedchenko Glacier Meteorological Observatory (Central Pamir) (By Tajikistan)
15.	Golubina Glaciological Station (Northern Tien Shan) (By Kyrgyzstan)
16.	Abramova Glaciological Satation (Pamir-Alai) (By Kyrgyzstan)
KAZAKHSTAN	
17.	Tuyksu Glaciological Station (Northern Tien Shan) (By Kazakhstan)
RUSSIA	
18.	Aktru Glaciological Station (Siberian Altai) (By Russia)

In addition to this first list, others stations for Asia were proposed to be part of CryoNet. More information on stations listed below will be provided in a future update version of this report.

ANNEX 6: BEST PRACTICES, GUIDELINES AND STANDARDS FOR CRYOSPHERE MEASUREMENTS AND OBSERVATIONS *(EXTRACT FROM GCW-REPORT-1)*

7.1.1 A critical component in the development of CryoNet is the effort to establish **best practices, guidelines and standards** for cryospheric measurements. This would include consideration of data homogeneity, interoperability, and compatibility of observations from all GCW constituent observing and monitoring systems and derived cryospheric products. Miroslav Ondráš presented essential background on these issues as a basis for discussion in the breakout (http://www.wmo.int/pages/prog/www/OSY/Meetings/GCW-IM1/Doc7.1_BestPractices.pdf). WMO regulatory material (guides, manuals, technical regulations), much of which is now online, was summarized. Manuals provide the standard practices, while guides provide recommended practices.

7.1.2 Of particular note are the Manual on the Global Observing System and the Guide to Meteorological Instruments and Methods of Observation (CIMO Guide). The breakout session was asked to consider the need for a **review of existing GCW practices and whether there should be a "GCW Manual".** There is also the consideration for CryoNet and other GCW Networks being included in the new Manual on WIGOS. As a first step, it was suggested that **GCW review existing instrument & observing methods and practices for cryosphere in the CIMO Guide** and consider whether the CIMO Guide should be expanded to include instruments for the cryosphere. In this context, the importance of **instrument intercomparisons** was noted. Formal intercomparisons are conducted to determine and intercompare performance characteristics of instruments under field or laboratory conditions and to link readings of different instruments – data compatibility & homogeneity. The current **WMO Solid Precipitation Intercomparison** (SPICE), including snowfall & snow depth, is of direct relevance to GCW, and is considered as a contribution to GCW. Potential GCW reference sites might be suitable sites for inclusion in this intercomparison. **Are there other intercomparisons of cryospheric measurements, such as this, which should be conducted?**

7.1.3 The breakout was also asked to discuss **standardized terminology for the cryosphere**. WMO has compiled an International Meteorological Vocabulary aimed at standardizing the terminology used in this field and facilitating communication between specialists speaking different languages. METEOTERM is online and has 34662 terms in six languages, including International Meteorological Vocabulary, the International Glossary of Hydrology, and terms from related sciences that appear in WMO documents. There would be a benefit in having a **collated cryospheric vocabulary**.

7.1.4 The following recommendations were presented for consideration in the breakout session for GCW action and inclusion in its Implementation Plan:

1. Standardization of Practices (networks, observations, instruments, data exchange & policy, products):
    - Review **existing** GCW practices and develop an **inventory**; identify differences and inconsistencies
    - Identify a need for **new** standard/best practices, identify priorities and develop new standard/best practices
    - Develop Cryospheric **Vocabulary**
    - Identify standard/practices that may be promoted to **ISO** standards?
    - Develop "**GCW Manual**"; provide input to WIGOS Manual, CIMO Guide

2. Register user requirements in WMO Rolling Review of Requirements (RRR) data base:

- Propose a new application area – Cryosphere
- Identify **focal points** for Cryo different application areas and observing system capabilities
- **Verify existing** variables and add **new (key)** cryospheric variables in RRR database

3. Establish Centres of Excellence from among GCW Reference sites:
    - e.g., **Instrument Centres** and **Testbeds** responsible for maintaining a set of standard instruments, calibration, intercomparison, traceability, compatibility, integration of RS and *in-situ* observations

4. Instrument Intercomparisons:
    - Identify needs
    - Participation in WMO Solid Precipitation Intercomparison (**SPICE**)

ANNEX 7: REQUIREMENTS FOR SITE INCLUSION IN CRYONET

In order for a surface measurement site or station to be included in CryoNet, it must meet certain criteria. The draft requirements are listed below. They will be revised in early 2014.

Site Requirements:

1. The site location is chosen such that, for the variables measured, it is regionally representative.

2. There are adequate power, communication, and building facilities to sustain long-term observations with greater than 90% data capture (i.e. less than 10% missing data).

3. Technical support personnel are trained in the operation of the equipment.

4. For reference and integrated sites, there is a commitment by the responsible agency to long-term observations of at least one of the GCW variables.

5. The relevant GCW observations are of known accuracy and precision. The measurements are made according to GCW standards. Quality monitoring and quality control are routinely performed.

6. Associated standard meteorological in situ observations, when necessary for the accurate determination and interpretation of the GCW variables, are made with known accuracy and precision.

7. The data and metadata are submitted to an international cryospheric data center recognized by GCW no later than one year after the observation is made. Changes in metadata including instrumentation, traceability, observation procedures, are reported to the responsible data center in a timely manner. Metadata are also provided to the WMO Operational Information Resource (WIR) and maintained regularly.

8. The station characteristics and observational programme are updated in the GCW station information database on a regular basis.

9. A station logbook for observations and activities that may affect observations is maintained and used in the data validation process.