**Input to Congress: on WMO’s role and engagements regarding emerging challenges in High Mountain regions, with a focus on weather, water, and climate**

**proposed outline**

Background;

Resolution 27 (EC-70) approved the revised ToRs for EC PHORS panel, including: “*To develop a strategy on WMO high mountain regions focused activities, including by considering an initiative similar to YOPP for the next financial period to be submitted to Congress at its eighteenth Session for its consideration*;

At the video conference on November 14, 2018, with PR members of the Steering Committee of the High Mountain Summit, it was agreed to:

* postpone the Summit until after Congress
* prepare a submission to Congress, recommending a role for WMO, in international fora, given its role as the UN authoritative voice on weather, water, and climate and key priority directions within the framework of the WMO Strategic Goals, for addressing emerging challenges linked to changes in the high mountain environments.

Audience:

* direct audience: Members and partners attending Congress and contributing to the decisions regarding Strategic directions and engagements.
* Post congress, Broader audience: partners, potential stakeholders., affected Members, via engagements within the scope of the High Mountain Summit

**Topics to focus on, of interest to the high level participants:**

* Monitor and report impact (linked to 2030 Agenda and Sendai framework)
  + Engagement of development partners at global and regional level to support feasible monitoring mechanisms
* identify consequences of most plausible scenarios of changes in the cryosphere
  + categories of consequences, e.g. economic, food security, water security
* develop partnership framework for developing and implementing of adaptation strategies.
  + Use of convening power of WMO to elevate the engagement at international level and the reflection of high priority issues in the UN framework.

**Proposed structure (draft zero)**

* **Section 1: Introduction:**
  + International context and issues

The UN General Assembly Resolution A/RES/71/234 (Dec 2016) on Sustainable Mountain Development has r*ecognized* “*that mountains provide sensitive indications of climate change through phenomena such as modifications to biological diversity, the retreat of mountain glaciers, flash floods and changes in seasonal runoff, which are having an impact on major sources of freshwater in the world, and stresses the need to undertake actions to minimize the negative effects of these phenomena, promote adaptation measures and prevent the loss of biological diversity*.” As a result, the Resolution “*Encourages all relevant entities of the United Nations system, within their respective mandates, to further enhance their constructive efforts to strengthen inter-agency collaboration to promote sustainable mountain development*.”

The momentum created by major international initiatives. These include the [Sendai Framework](https://www.unisdr.org/we/coordinate/sendai-framework) for Disaster Risk Reduction 2015-2030, the [Paris Agreement](https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement) on climate change, and the [2030 Agenda](https://sustainabledevelopment.un.org/post2015/transformingourworld) embracing the Sustainable Development Goals (SDGs), as well as an associated [Framework for Action for implementing the 2030 Agenda for Mountains](http://www.fao.org/fileadmin/user_upload/mountain_partnership/docs/2030%20Agenda%20on%20mountains%20-%20Framework%20for%20Action.pdf)” approved in December 2017 by the Mountain Partnership which comprises 330 members including 72 governments, the publication of the 2019 Special Report on the Ocean and Cryosphere in a Changing Climate ([SROCC](https://www.ipcc.ch/report/srocc/)) of the International Panel on Climate Change (IPCC), which includes a dedicated chapter on High Mountain areas, as well as a cross-chapter paper on ‘Mountains’ to feature in the IPCC’s sixth assessment report (AR6) Working Group II report on Impacts, Adaptation and Vulnerability, scheduled for publication in 2021.

* + WMO role within the UN framework: strategic context and overview

As weather, climate and the water cycle know no national boundaries, international cooperation at a global scale is essential for the development of meteorology, climatology and operational hydrology as well as to reap the benefits from their application. WMO provides the framework for such international cooperation.

* **Section 2: Objective: succinct description of objectives, desired outcomes (the role of this paper), and the longer term impact of it.**

*(EC-70) This document will provide recommendations on key elements for translating the WMO strategy on priority activity areas responding/addressing changes in high mountain regions, [including by considering an initiative similar to YOPP for the next financial period to be submitted to Congress at its eighteenth Session for its consideration]*

* **Section 3: Problem statement** 
  + Policy needs of changing mountain environments.
  + Key affected sectors;
  + Challenges of a changing mountain climate;
  + Current status, at regional level

The **provision and regulation of water** are, perhaps, the most critical ecosystem services provided by mountains to more densely populated adjacent lowlands (Egan and Price, 2017). Mountain regions cover a quarter of the Earth’s land surface, and are present on all continents, are centres of biological and cultural diversity, and of traditional knowledge, and a quarter of the world’s population lives in or in the proximity of mountain regions, including some of the world’s poorest populations.

There is increasing societal recognition of the **importance of the mountain cryosphere** (glaciers, snow, permafrost) and other critical systems at high altitudes (such as páramo systems in the tropics), of their cascading influence on downstream water supplies, of their climate impacts, as well as of the related natural hazards threatening directly and indirectly populations, economic activities, infrastructure and ecosystems downstream and in lowland areas.

**Mountains serve as water towers** for at least a half of the world’s population, as it depends on water originating from mountain headwaters. Glaciers and snow act as buffers in regulating the variability of water resources during dry seasons. Water stored as snow and ice in the mountains replenishes groundwater and drive river runoff in spring, filling reservoirs for use later in summer. (Egan and Price, 2017). Over 40% of global goods and services, including food, hydropower, biodiversity, minerals, recreation, flood protection, are generated in, or linked to mountain regions.

The quality and quantity of water from mountain areas has a profound effect on lowland areas, underpin agricultural irrigation, supporting ecosystems, and feeding hydroelectric power stations.

**Large mountain ranges act as climatic barriers**, and climatically induced changes in regions with snow, glaciers, and permafrost and other critical high altitude systems could trigger significant feedback processes, such as accelerated warming trends, receding of glaciers, thawing of permafrost, and changes in the precipitation and freshwater regulation regimes, all, at large scale. Changes in the mountain climate have potential to further affect the global climate, e.g. the thawing of permafrost can accelerate the release of greenhouse gases into the atmosphere, further contributing to the global climate change .

Large mountain ranges, such as the Himalayas, the Tibetan plateau, the Andes, the Ethiopian highland, the Rockies and the highest free standing mountain such as Kilimanjaro play a key role in the evolution of large scale weather systems (e.g. altering the monsoonal circulations).

Alterations and loss of critical mountain ecosystems, permafrost decay, glacier recession, and the rising of the snow line, are **increasing the risk of uncertainty in water resources, of disasters** caused by landslides, floods, glacier outburst floods, avalanches, and other snow-related hazards. These risks are likely to increase in frequency and intensity and could be exacerbated by climate change-induced feedback processes, further threatening people, the infrastructure, societies, in mountain regions, and in lowlands. These feedback mechanisms and their impacts are, as yet, to be fully understood, quantified, and accounted for.

* **Section 4 Principles guiding the proposed response**
  + International framework: SDGs, Sendai
* Section 5: **What is missing**

While mountain regions represent a key to the overall climate system, accounting for mountain regions’ complex climatic processes in the information value chain, has remained a challenge, in many regions of the globe and have multiple dimensions including (i) coordination and governance, (ii) the availability and dissemination of observations, data, and information, (iii) the sustainability of investments, (iv) the availability and maturity of coordinated scientific knowledge to address emerging threats, and (v) the sustainability of operational services.

1. Coordination and governance:

Experience has shown that at national and local levels, the responsibility for hydro-meteorological information and services for mountain regions rests with multiple agencies, organizations, and stakeholders, frequently, have unclear or competing responsibilities. Stakeholders from affected economic sectors are, often, not adequately engaged. This limits, significantly, the ability to develop and disseminate hydro-meteorological, disaster and risk management, and climate adaptation information and services relevant to needs.

Internationally, while more than two thirds of freshwater resources are stored in snow and ice, the importance and impact of cryosphere to water resources, sustainable mountain development, and as a hazard, including for mountain regions is not well articulated in the major policy frameworks within the 2030 Agenda, Sendai framework, and the Paris agreement. While water security is becoming one of the greatest challenges of the world’s population, the absence of such references, makes the task of developing and implementing policies to address these issues, much more difficult.

1. the availability and dissemination of observations, data, and information,

Many mountain regions remain insufficiently monitored: the monitoring of snow, glaciers, permafrost and of critical tropical highland ecosystems is sparse and, mostly, uncoordinated, despite the increasing number of international programs focusing on it. Even where available, the access to data is limited, and many countries are lacking the expertise and capacities for extracting the full value from the information available, and for embedding it in a broader societal context.

1. Sustainability of investments,

Important investments have been made, internationally, for addressing the pressing need for improved services on water, weather, and climate in high mountain regions, through multiple financing mechanisms (World Bank, Green Climate Fund, Climate Adaptation Fund, National Development agencies, etc); however, most campaigns have had limited coordination and time horizon, with limited consideration for long-term continuity and sustainability of observations, data infrastructure, or services, leading to limited tangible benefits.

1. Availability and maturity of coordinated scientific knowledge

The current level of knowledge about changes in cryosphere and other critical high mountain systems and their impacts, and the available related services are not fully compatible with the socio-economic needs of the affected regions. In the ‘value chain’, critical elements are still missing, or are under-developed.

The scientific understanding of the socio-ecological systems in high mountains needs to be substantially strengthened, along with the understanding of the ecosystem services and goods provided by the cryosphere and other critical systems in mountain regions and their human uses under rapid environmental and socio-economic development.

The ability to predict …..

1. Sustainability of operational services

The provision of weather, water and climate services is inherently challenging in the mountain where observational data is sparse, and topography plays an essential role, and this work is further complicated by climate change.

**Sect 6: Policy and action recommendations**

Enhanced, comprehensive, end-to-end, long-term, service capabilities will equip countries with tools needed for meeting targets established under the UN 2030 Agenda and the Sustainable Development Goals, e.g. Goal 13, Climate Action , the goals regarding sustainable water resource management, as well as, the four priorities of the Sendai Framework for Disaster Risk Reduction 2015-2030.

1. Coordination and governance:

there is a need for effective coordination across different government ministries, agencies, academia, economic actors including the private sector, and the public, along the information value chain, so as to integrate the contribution of specific agencies and jurisdictions. This will provide a framework for complementary engagements, as, the responsibilities for high mountain regions are often shared across many agencies and actors.

1. the availability and dissemination of observations, data, and information,

There is a need to enhance and optimize the Earth system observations (space and in-situ) in mountain regions, and in particular the climate, cryosphere and other critical high elevation systems, by strengthening and complementing existing monitoring, operated by various national and research agencies. This calls for long-term observations, and sustained monitoring of high mountain water sources, including the mountain cryosphere, and for an understanding of the processes that affect them.

Significant progress has been made in recent years on observing the cryosphere from space, and this provides a significant opportunity for enhancing the service value chain for high mountain regions.

1. Sustainability of investments
2. Availability and maturity of coordinated scientific knowledge

Improving the understanding of the accelerated impact of climate change on the mountain cryosphere is critical to sustainable climate observations-based services. This requires advancing the scientific knowledge of the mountain water cycle, its variability and its extremes, improving the understanding of teleconnections between high and mid latitudes, and further developing environmental prediction capabilities of the integrated water cycle relevant to high mountain environments. These will improve the understanding of the water-atmosphere-cryosphere interaction, and its influence on weather and climate systems, at multiple scales.

1. Sustainability of operational services

The sustainability of effective water and disaster risk reductions services: is underpinned by the availability of an optimized, integrated monitoring system. At the same time, it requires the long term strengthening of local mandates, capacities, and access to reliable investments and to local expertize for monitoring, data generation, research, analysis, prediction, and information dissemination, and this is, in particular, the case of developing countries.

**Section 7. Moving forward**

As changes in high mountains have far reaching impacts, geographically, and involve engagements from international to local level, at policy, investment, scientific, and governance level, a focused and structured approach is needed, taking the wealth of engagement, information, and knowledge already available, and the numerous efforts underway, to the next level.

For many adaptation efforts, the difficulty in ensuring connectivity between providers and users is reminiscent of what is known in telecommunications as the “last mile”—the final leg in the infrastructure network that channels communications from a provider to individual customers. Success in strengthening the “last mile” in the provision of adaptation services, must consider the willingness and capacity of end users to utilize the information provided, and that the delivery of information and services that are understandable, timely and actionable for the users.

The efforts proposed under this plan can be seen as the “last mile” in enabling change.

**The actions forward are proposed under four grand challenges:**

**i. An accelerated impact of climate change on the mountain cryosphere (draft concept)**

Climate change strongly affects the mountain Earth system, leading to rapid changes of the mountain cryosphere. At the same time, a number of feedbacks that significantly contribute to the global climate sensitivity are due to the cryosphere .

There is increasing evidence of unprecedented pace of glacier retreat, increased variability in the contribution of snow and ice to streamflow and water availability, the upward shift of seasonal snowlines, thawing of permafrost, and the increased frequency and intensity of extreme hydro-meteorological events.

**ii. Water security impact on downstream communities, economies, energy, and food production (draft concept)**

Changes in the mountain cryosphere and in critical high mountain ecosystems cause changes in mountain water resources, with profound effects on livelihoods, food production, and economies, including far-reaching downstream effects on major economic sectors, and exacerbating the potential for conflicts over water.

**iii. Socio-economic, socio-cultural, and ecological impacts of high mountain hazards, threatening people, ecosystems, and infrastructure (draft concept)**

The existence of people, ecosystems, infrastructure, and development investments, in mountain regions, downstream, and downwind are increasingly threatened by climate extremes, extreme weather, and by hydrological changes and events in mountain regions, e.g. avalanches, floods, erosion, slope instability, thawing permafrost, glacier lake outburst floods, long term risk of drought, etc.

**iv. policy relevance**

[ I’m including the reference from Christian Huggel: <http://www.cambridgeblog.org/2016/01/un-climate-talks-and-the-impact-on-the-high-mountain-cryosphere/>

Section 8: Opportunities:

* + international cooperation/ funding and adaptation initiatives;
  + current scientific developments with potential for sustainable deployments,
  + existing operational programs and services,

**Section 9: Engagements:**

Recommended role for WMO, in coordination with Members, governments, social partners, scientific community, funding agencies

1. Convene relevant international players, to develop a coordinated message to promote the water and climate adaptation policies addressing the impact of cryosphere.
2. Mobilize public and private sector leaders to leverage funding in support of relevant initiatives;
3. Promote collaboration for new and ongoing initiatives, strengthening the provision of hydro-meteorological, climate, and prediction services for mountain regions, optimizing and enhancing cryosphere and high mountain observations, and advancing the scientific research agenda to address emerging gaps;
4. Leverage the knowledge and influence of relevant stakeholders in order to coordinate and upscale end-to-end services and increase interagency engagement, including identifying barriers and proposing enabling actions;
5. Ensure that existing funding mechanisms such as The World Bank, Green Climate Fund, Global Environmental facility, the Adaptation Fund, and others, identify high mountains as priority areas for investments and projects.

**Section 9: Institutional framework for coordination**

1. Identify key specifications and research areas for user-relevant design and implementation of climate services in mountain regions, responding to investment knowledge needs, for instance by national institutions and development partners, with a focus on developing countries;
2. Foster a high-level dialogue, leading to addressing high mountains in the WMO strategic objectives for the 2020-2023 financial period, for consideration at the 18th World Meteorological Congress, as well as in the programs of all co-host organizations;
3. Leveraging governance, providing input to policy development, and promoting internationally funded initiatives, to support the goals of the 2030 Agenda, and of sustainable mountain development;
4. Promoting closer links between science and policy.

* Sect 10: Inputs and resource mobilization

From John’s presentation:

INARCH’s global mountain observatories are providing a unique set of published, archived, high quality, surface, model and remote sensing datasets

• INARCH encourages process validation and description to inform large scale and operational model advances, acknowledging the need to demonstrate improved predictions of the water security impacts of global change in mountain regions.

• INARCH is implementing hybrid downscaling with moderate (km) scale dynamical downscaling from atmospheric models followed by fine (<100s m) scale downscaling (dynamical, empirical) to snowdrift resolvingscales for improved snow and ice hydrology prediction in support of mountain climate change policy runs.

• INARCH will use these model runs to predict the response of mountain snow, ice and hydrology to climate change, taking into account transient vegetation cover, basin geometry and hydrological and cryospheric storage.