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The International Cryosphere Climate Initiative (ICCI) appreciates the opportunity to make this Submission to the Global Stocktake (GST) and its Technical Dialogue (TD), in concert with the broader Cryosphere scientific community. The GST should affirm the role of science in development of international climate policy. Given the implications of Cryospheric changes for both timing of emissions reductions, and their scale; explication of these dynamics for Parties must become a higher and new priority under the UNFCCC and its Paris Agreement. The Cryosphere scientific community stands ready to assist the Secretariat, Parties and Observers in so doing at the June 2022 Bonn session.

We are pleased to submit our views on the first meeting of the Joint Contact Group on the Global Stocktake, including its Technical Dialogue; to take place at the next inter-sessional meetings in June 2022.

Climate change has brought about significant negative changes in the global Cryosphere, be it snow, ice or permafrost; in both mountain and polar regions. These changes are evident at the local, regional and global levels; including decrease in snow cover; loss of mass from ice sheets, land glaciers and sea ice; permafrost thaw and degradation; and changes in both polar oceans, including acidification, freshening, and disturbances in ocean currents.[1]

Such changes in the Cryosphere however have their greatest human and ecosystem impacts outside of mountain and polar regions; not least because of permafrost carbon emissions, and sea-level rise (SLR) from melting of mountain glaciers and polar ice sheets. Extensive, multiple global feedbacks also arise from loss of Arctic summer sea ice: including potential extreme weather events, accelerated ice loss from Greenland, and increased thaw of permafrost (and therefore, greater CO2 and methane emissions).[2]

Loss of mountain glaciers and snow, especially in mid-latitude and tropical regions impact more than three billion people, reliant to some degree on this ecosystem resource already today. Changes are especially acute in the northern Andes, western U.S., Scandinavia, and the Alps; where economic activities such as agriculture, power generation and tourism depend on a rapidly shrinking mountain Cryosphere. Changes in the Hindu Kush Himalaya have had negative direct and indirect impacts on over two billion people; ranging from changes in water availability, to flooding and landslides from a deadly combination of extreme rainfall and heightened meltwater, especially in the spring and summer months.[1] All these impacts are projected to become far more damaging as global mean temperatures approach the 1.5°C Paris limit, with greater impacts should this be exceeded.[3]

Because high latitude and polar waters absorb CO_2 more rapidly, the important fisheries in and near the polar regions, for example the North Sea, Barents Sea and Southern Ocean, already are seeing seasonal impacts of ocean acidification.[4] A combination of freshening waters from melt of glaciers and the Greenland Ice Sheet, warmer waters, and the invasion of more mid-latitude species threaten polar marine ecosystems and local/regional fishing industries.[2] These threats will grow should CO2 emissions and atmospheric concentrations of

greenhouse gases continue to rise. We note that at current rate of increase (≈2.5ppm/year), 450ppm will be exceeded in the 2030's – a level that marine scientists identified already in 2009 as a limit that should not be exceeded, due especially to damaging acidification impacts in polar regions.[5]

Most importantly, nearly all of these damaging global impacts from the Cryosphere are essentially irreversible and permanent on human timescales: they will remain for decades, centuries and even millennia. This is especially true with emissions scenarios that contain an overshoot of the maximum global temperature rise set in the Paris Agreement (well below 2°C/1.5°C, with regard to pre-industrial levels).

Indeed, limiting temperature rise to 1.5°C will significantly reduce the risks and negative impacts due to changes in the Cryosphere, with a substantial difference between a 1.5°C and a 2°C temperature peak. These include more frequent, intense and longer extreme weather events; the potential at 1.5°C to slow multi-meter sea-level rise from Greenland and Antarctica; and preservation at 1.5°C of remnants of mid-latitude glaciers/snowpack that will largely disappear at 2°C, and of two-thirds the ice in the Himalayan region, supporting 2.5 billion people with water resources. Permafrost thaw and carbon emissions that require offset for more than a century will be on a smaller scale at 1.5°C. Preservation of Arctic summer sea ice would occur most years at 1.5°C, versus ice-free conditions for several months each summer by 2°C, with related global climate feedbacks.[6,7]

In sum, higher levels of warming and CO2 emissions will substantially increase the risk of crossing global Cryosphere tipping points. Lower levels of warming and emissions will in turn substantially decrease this risk. These considerations are both complex, and inter-related. Although contained in several recent IPCC reports as well as more recent research publications, **the implications for the GST, and future NDCs require more time to be adequately presented to Parties and other stakeholders than has occurred in technical dialogues to-date.**

It is crucial that we limit global warming through global efforts. The Global Stocktake must inform Parties if their efforts are in line with the Paris Agreement temperature goals and successfully limit negative impacts from the Cryosphere. **ICCI and its associated Cryosphere scientist network are of the strong opinion that these dynamics require greater attention to inform the outcome of the GST, as well as the Second Periodic Review (PR2).**

- ICCI therefore requests that the Global Stocktake, and its first Technical Dialogue improve our collective understanding of the emissions scenarios that will help achieve a substantial decrease in the risk of crossing global Cryosphere thresholds.

- ICCI further requests that a dedicated Cryosphere workshop take place to better inform both processes, GST and its TD1, PR2 and its SED3, prior to the next inter-sessional meetings in June 2022. ICCI and its associated Cryosphere scientist network stand ready to actively assist the Secretariat in this effort.

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