SUPPLEMENTAL MATERIALS

ASCE *Natural Hazards Review*

Global Snow- and Ice-Related Disaster Risk: A Review

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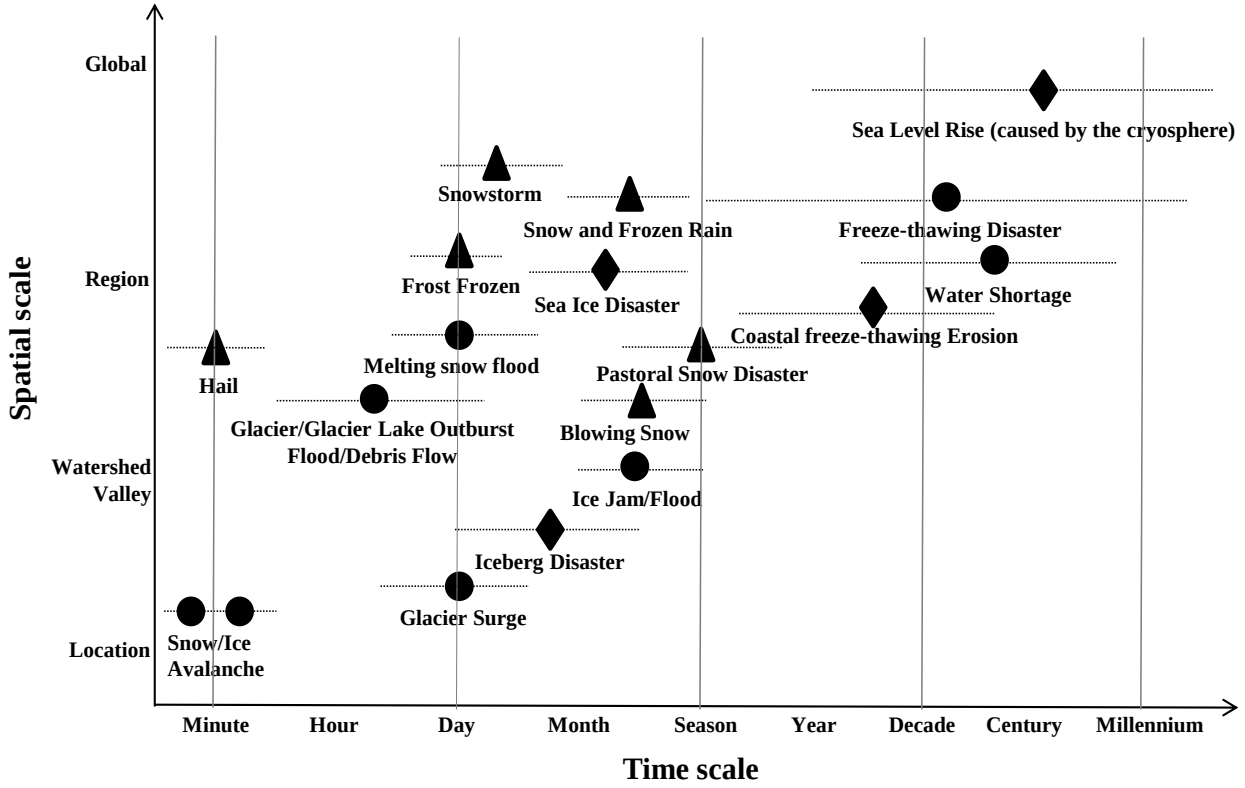
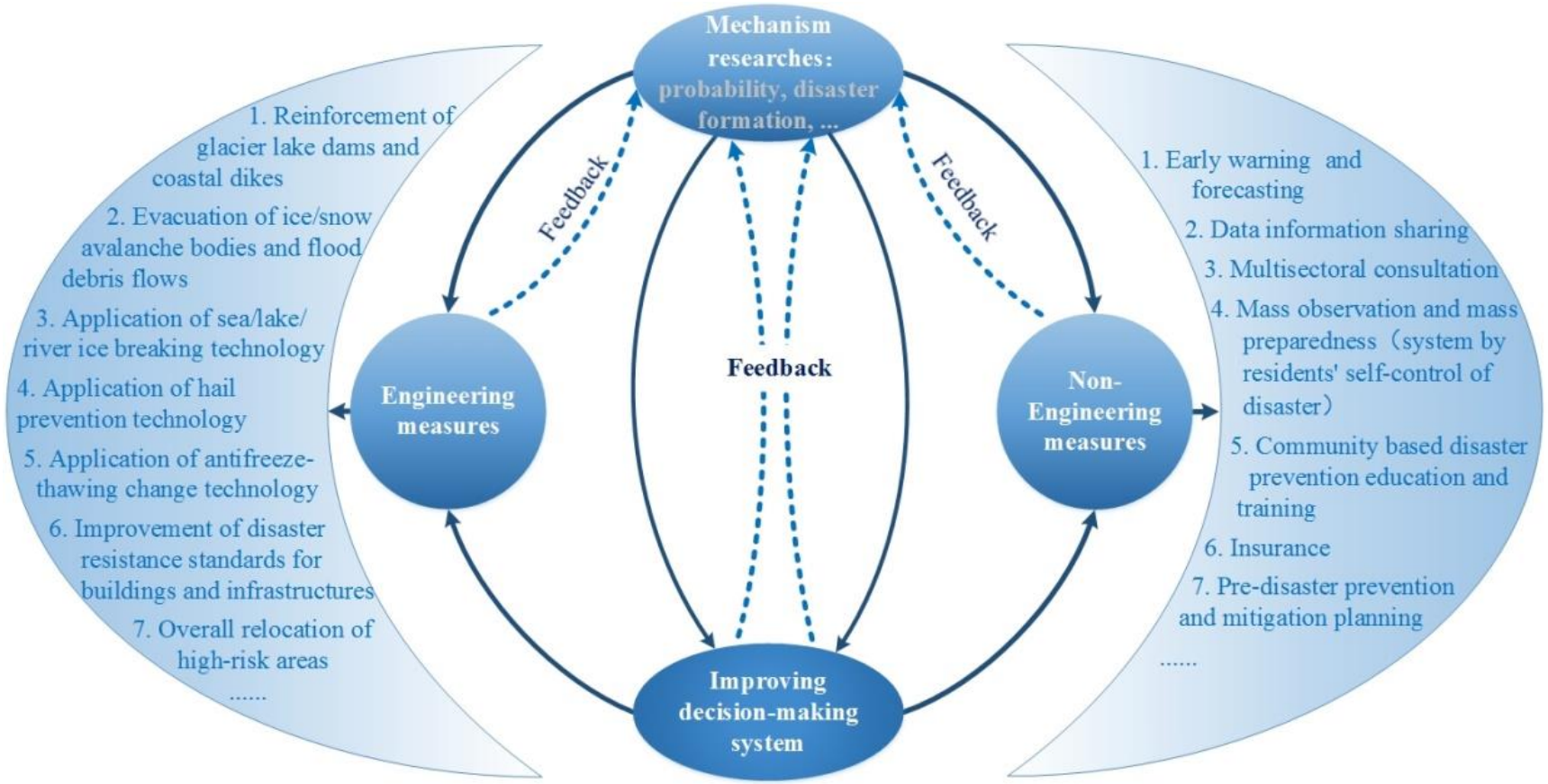
Supplemental Material Figure S1 Temporal and spatial scale of snow and ice-related disasters



(Black dots, triangles and diamonds represent three types of disasters on land, on the ocean and in sky, respectively; Dotted line represents the duration of the disaster)

Supplemental Material Figure S2 Framework of snow and ice-related disasters prevention and response strategies



Supplemental Material Table S1 Snow and ice-related disasters on land and their triggering factors and main disaster-bearing bodies

Sub- disaster	Triggering factors	Main disaster-bearing bodies	Examples	Sources
Snowstorm disaster	Short-term extreme snowfall event	Transportation Transportation Housing	Heavy Snowstorm Hits US, Prompts Mass Flight Cancellations in Chicago, Kansas in 2018	Zarzycki, 2018.
Freezing rain and snow disaster (including ice storm)	Icing on the disaster-bearing body during snow and freezing rain process	Building construction Transportation Electric lines Fruit industry	Starting on January, 2008, tens of thousands of passengers were stranded on Beijing-Zhuhai Expressway due to freezing rain and snow weather.	Chen et al., 2011 Liu et al., 2013
Hail disaster	Rapid and dense landing of small and medium ice particles (ice embryos) after encountering cold water droplets	Crops Fruit industry Vegetable industry Agricultural products	On April 25, 2019, Colorado holds the title of most costly state for hail damage in the U.S	Wang et al., 2016 Gunturi and Tippett, 2017 Allen et al., 2019
Frost disaster	When the temperature drops sharply in the autumn and winter, water vapor directly condenses on the object	Crops Fruit and fruit industry Vegetable industry Agricultural products	A frost event in Kenya in January 2012 caused a loss of about 9.6 million United States dollars	Wang et al., 2016 Faustand Herbold, 2018 Cohen and Gninghaye, 2018 Kotikot et al., 2020
Ice avalanche	Large-scale ice masses sliding or landing or ice breaking off from the hanging glacier	Residents Infrastructure	Deposits of the ice avalanche from Allalin glacier, which killed 88 workers at the construction site for the Mattmark dam (hydropower reservoir), Saas Valley, Southern Swiss Alps on August 30, 1965	Schweizer et al., 2015 Shugar et al., 2021
Avalanche	Large-scale snow (block) sliding or landing	Alpine tourists Infrastructure	Avalanche at Walenstadt (Schattenbach), Switzerland	Haeberli et al., 2015, 2021 Ballesteros-Cánovas et al., 2018
Glacier surge	Rapid movement of glaciers caused by the interaction	Residents,	Variegated Glacier, Alaska.	Harrison et al., 2015;

	between rapid deformation of ground moraine hydrological processes under the ice	Pastures Infrastructure		Rashida et al., 2018
Pastoral snow disaster	Deaths caused by snow cover and insufficient livestock feed	Livestock Residents	From December 2018 to March 2019, 57,900 livestock has died because of the snow disaster, which leads to the direct economic losses of 0.192 billion CNY.	Wang et al., 2019a
Drifting or Blowing snow	Weather events caused by strong winds in the snow area	Road Transportation	Blowing snow off the road in the Mayetas area, Tacheng administration of the Xinjiang Uygur Autonomous Region, China (January 2013)	Nishimura et al., 2014
GLOF	Dam Break Flood caused by ice collapse, continuous precipitation, pipe surge, etc.	Residents Roads, Bridges Infrastructure Downstream residents	Lake Palcacocha, Peru, with two security dams in the foreground (dam on the left clearly damaged by 2003 lake overflow)	Wang et al., 2015, 2020 Kougkoulos et al., 2018 Veh et al., 2020
Glacier flood/debris flow	Melting/debris flow formed by melting glaciers, or accompanied by heavy rainfall, volcanic eruptions	Roads Bridges Power stations Infrastructure	*The downstream area of Chorabari Glacier experienced flood/debris flow in Central Himalaya, India*	Shen et al., 2009 Petley, 2013
Melting snow flood	Spring flood formed by melting snow	Cultivated land Downstream residents	*Snowmelt floods in Kazakhstan, April 2015.*	Duan et al., 2018 Niedzielski et al., 2019
Ice jam/flood	Ice blocks the river and raises the upstream water level; when thawing, the downstream water level rises and forms the flood	Water conservancy Hydropower Shipping	Ice-jam flooding, Ounasjoki River, Finland	White et al., 2007 Lindenschmidt et al., 2018 Rokaya et al., 2018
Freeze-thawing disaster	Strong freezing and thawing effect	Road network Pipe network Wire network Other infrastructure	Potential risk of above-ground pipe network in the frozen soil area of Ice-rich coasts of North Yakutfu, Russia	Streletskiy et al., 2015 Hjort et al., 2018 Farquharson et al., 2019

Note: Some low-frequency and derivative cryosphere disasters such as volcano-glacier/snow mudslides (Cáceres, 2016; Hemmings et al. 2016; Reinthaler et al., 2019), earthquake-ice collapse disasters, freeze-thaw-rockfall

disasters, ice and snow debris flows-salting lakes (blocking the river), avalanche-landslides-blocking rivers, are omitted.

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Supplemental Material Table S2 Snow and ice-related disasters on the ocean and their triggering factors and main disaster-bearing bodies

Sub- disaster	Triggering factors	Main disaster-bearing bodies	Examples	Sources
Iceberg disaster	Iceberg moving with heavy fog	Drilling platforms Offshore residents Facilities	The village of Ilulissat in western Greenland is surrounded by icebergs that have calved from the Jakobshavn Glacier	Haeberli et al., 2015, 2021
Sea ice disaster	Sea ice formation and disappearing, ice flotation, Ice shelf collapse, etc.	Ports Harbor facilities Drilling platforms Navigation safety Coastal aquaculture	CCG icebreaker freeing vessels beset in pressured ice, East Coast of Newfoundland in April 2007.	Haeberli et al., 2015, 2021
Coastal freeze-thaw erosion	Coastal collapse caused by freezing and thawing in permafrost regions	Land Coastal landscape Buildings Infrastructure	The erosion and collapse of the Arctic permafrost coastal zone	AWI, 2013 Haeberli et al., 2015, 2021; Fritz et al., 2017 Wright et al., 2019
Sea level rise disaster	Sea level rise caused by melting of glaciers	Homeland security Infrastructure Land area	Male, Maldives	Muis et al., 2016 Wahl et al., 2017

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