

Changing Cryosphere in High Mountains

高山地域の雪氷圏の変化

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LA of Chapter 2 and SPM of SROCC
LA of Chapter 4 (Water) of AR6 WGII

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Typhoon Hagibis (台風19号)

- ◆ 181 rivers flooded (including 37 destructions of levees), 58 death, 15 missing (at 9:00 on 15th October).
(台風19号で37河川での堤防決壊を含む181河川が氾濫、58名死亡、15名行方不明(10/15 9時時点))
- ◆ This kind of events are projected to increase in warmer climate.
(日本ではこのような洪水災害は温暖化で増加する見通し)



11th April 2019

2019年4月11日



2019年10月13日

13th October 2019

Arakawa,
Tokyo

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Why Cryosphere?

- Impact of climate change is significant and clearly observed
雪氷圏には地球温暖化の影響が顕著に現れる

High Mountains

- ◆ Almost 10% (671 million people) of the global population lived (100km from glaciers or permafrost) in high mountain regions in 2010. It is projected to be 736-844 million by 2050.
2010年に世界人口の10%、2050年には7-8億人
- ◆ Target region include all mountain regions where glaciers, snow or permafrost are prominent features of the landscape.
氷河、雪、凍土が顕著な景観的特徴を持つ地域を対象

Elevation Dependent Warming

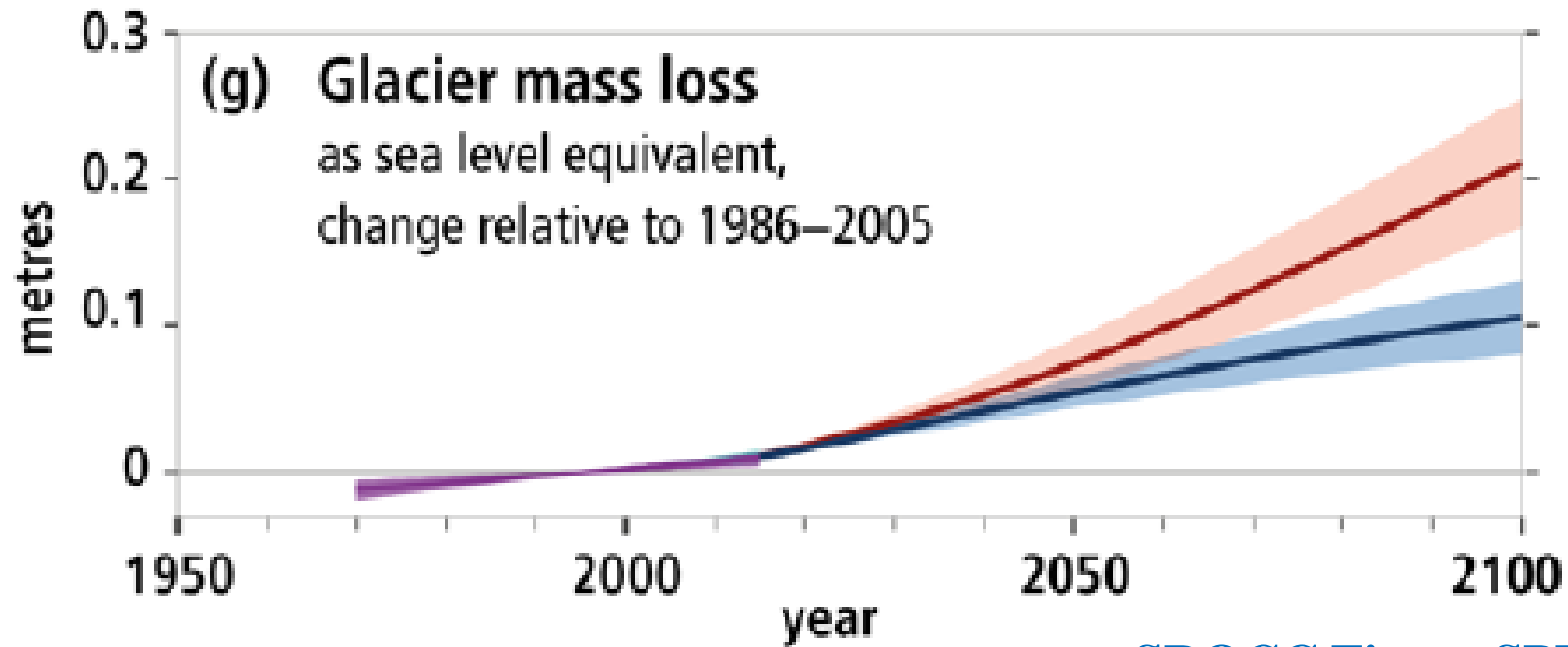
- ◆ Over recent decades as well as future projection, $0.3 \pm 0.2^\circ\text{C}$ per decade in mean of Western North America, European Alps, High Mountain Asia (global average $0.2 \pm 0.1^\circ\text{C}/\text{dec}$).
標高が高い場所では、全球平均よりも昇温が大きい。
過去の観測も将来予測も同様。

Fuji mountain in Japan 富士山 $+0.35^\circ\text{C}/10\text{年}$
(3775m, 1 station, 1985-2005)

Changes in cryosphere in high mountains

- ◆ Over the last decades, global warming has led to widespread shrinking of the cryosphere, with mass loss from ice sheets and glaciers (*very high confidence*), reductions in snow cover (*high confidence*) and Arctic sea ice extent and thickness (*very high confidence*), and increased permafrost temperature (*very high confidence*).
過去数十年に雪氷圏の減少、氷床と氷河の質量の減少、雪被覆の減少、凍土の温度上昇などが広域で観測されている
- ◆ The change are projected to continue in the near-term (2031–2050) due to surface air increases (*high confidence*), with unavoidable consequences for river runoff and local hazards (*high confidence*).
それらの変化は今後も続き、河川流出やローカルな災害へ影響する
- ◆ The rates and magnitudes of these cryospheric changes are projected to increase further in the second half of the 21st century in a high greenhouse gas emissions scenario (*high confidence*). 21世紀後半の温室効果ガスの排出が多いシナリオでは、それらの変化の度合いはさらに大きくなる。

Glacier mass loss



SROCC Figure SPM.1

- ◆ Projected glacier mass reductions between 2015 and 2100 (excluding the ice sheets) range from $18 \pm 7\%$ for RCP2.6 to $36 \pm 11\%$ for RCP8.5, corresponding to a sea-level contribution of 94 ± 25 mm sea-level equivalent for RCP2.6, and 200 ± 44 mm for RCP8.5 (*medium confidence*).

全球平均では、氷河の将来の減少は18%～36%

Impact of cryosphere change

- ◆ River runoff (河川流出): Changes in snow and glaciers have changed the amount and seasonality of runoff in snow-dominated and glacier-fed river basins (*very high confidence*) with impacts on agriculture (*medium confidence*).
量と季節変化の変化、農業への影響
- ◆ Ecosystem (生態系): Species composition and abundance have markedly changed in high-mountain ecosystems in recent decades (*very high confidence*), partly due to changes in the cryosphere (*high confidence*). 多様性や量の変化
- ◆ Tourism and recreation (ツーリズム): Skiing, glacier tourism and mountaineering have been negatively impacted by declining snow cover, glaciers and permafrost (*medium confidence*).
- ◆ Cultural assets (文化的価値): Negatively affected by future cryospheric change in many regions (*high confidence*).

Ecosystem

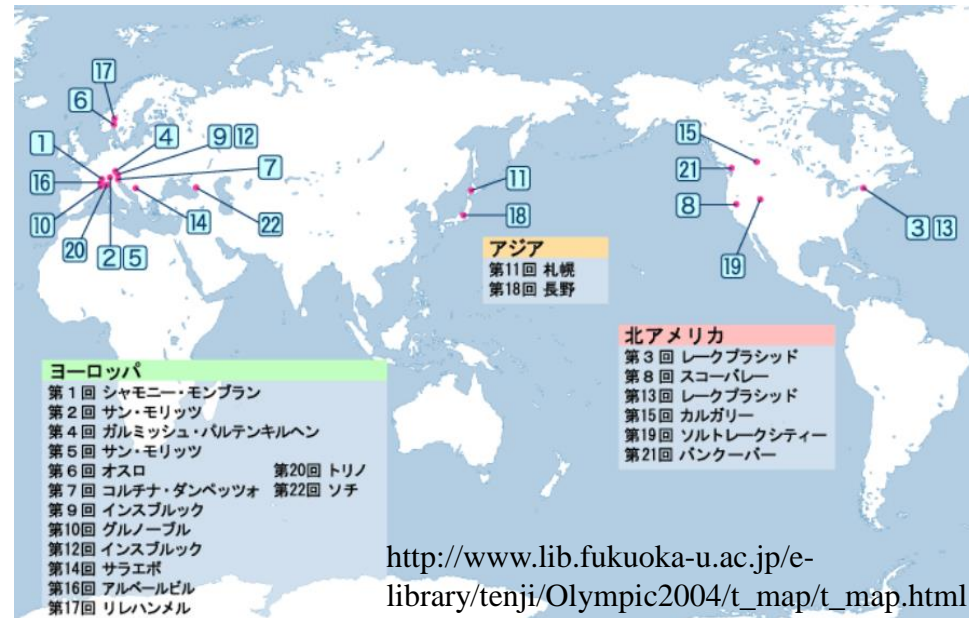


Ptermigan (ライチョウ)

<https://www.env.go.jp/nature/kisho/hogozoushoku/raicho.html>

- Decreasing snow-cover duration, glacier retreat and permafrost thaw allow plant species, including some endemic species, to increase their abundance and extend their range in many mountain ranges.
雪被覆の減少や氷河の後退で、植物など生息域を拡大することもある
- Under all climate scenarios, the duration of camouflage mismatch will increase, enhancing predation rates thereby decreasing populations of coatcolor changing species. 冬に色が変わる動物の捕食率の増加

Tourism



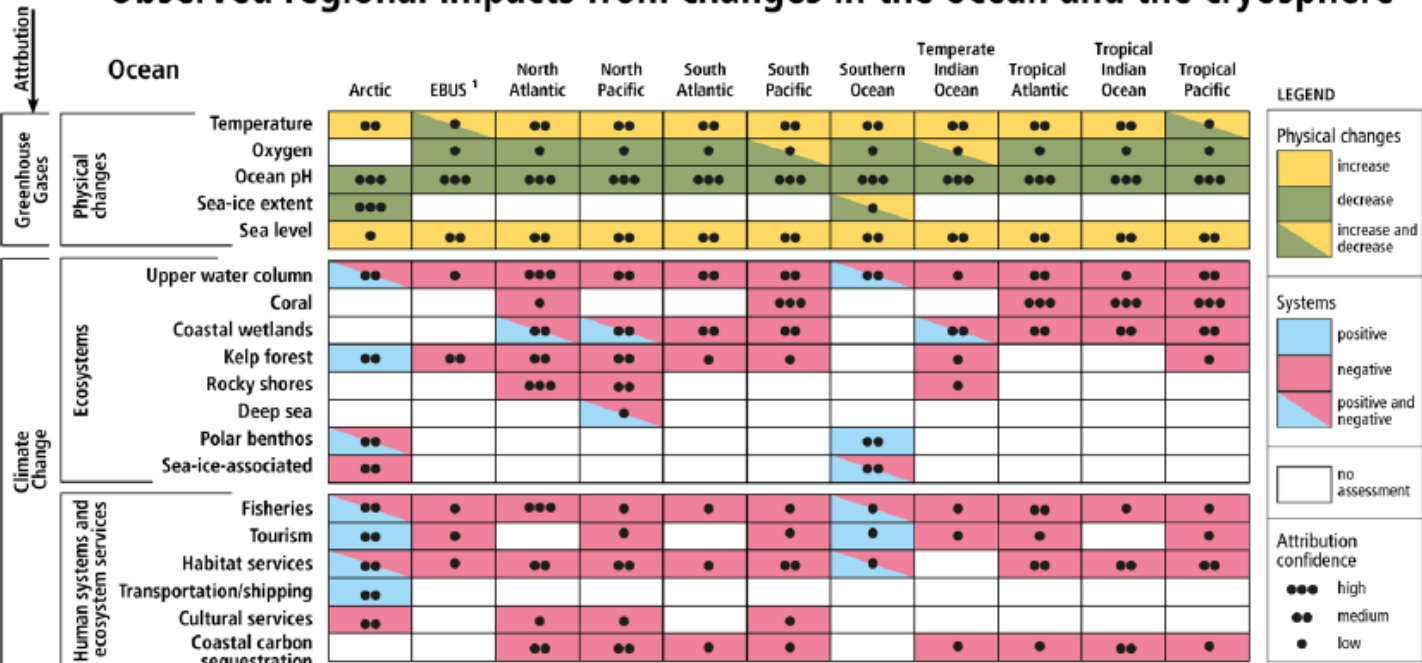
Ski and glacier tourism will be negatively impacted.

スキーや氷河などのツーリズム分野にはネガティブな影響

Olympic Winter Games locations are projected to exhibit adequate snow.

過去の冬季オリンピックの開催地の適地も減少する。

Observed regional impacts from changes in the ocean and the cryosphere

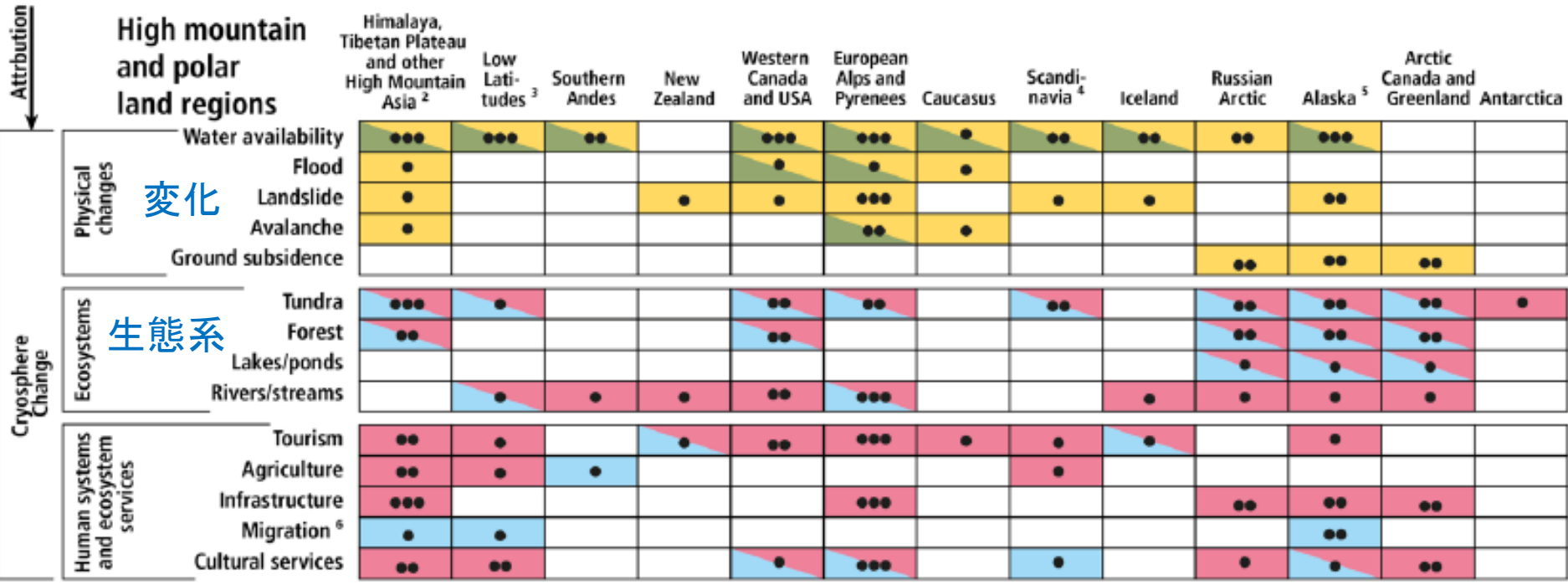


¹ Eastern Boundary Upwelling Systems (Benguela Current, Canary Current, California Current, and Humboldt Current); (Box 5.3)

² including Hindu Kush, Karakoram, Hengduan Shan, and Tien Shan; ³ tropical Andes, Mexico, eastern Africa, and Indonesia; ⁴ includes Finland, Norway, and Sweden; ⁵ includes adjacent areas in Yukon Territory and British Columbia, Canada; ⁶ Migration refers to an increase or decrease in net migration, not to beneficial/adverse value.

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Figure SPM.2

Impact of cryosphere change



人間への影響

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Physical changes

- increase
- decrease
- increase and decrease

Systems

- positive
- negative
- positive and negative

Attribution confidence

- high
- medium
- low

no assessment

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Figure SPM.2

Summary

- ◆ Changes in cryosphere are observed and projected in high mountains. 高山域の雪氷圏では気候変動による変化が観測され、また予測されている
- ◆ Impacts of these physical change on ecosystems and human activities are more widely covered in the report. 今回の特別報告書では、それらの生態系や人間への変化についてより詳しくまとめられている
- ◆ Glacier melt models have been developing, from simple degree-day factor model to more computationally costing method. 氷河モデルの開発・発展は続けられており、より計算コストが必要で複雑な手法も可能となってきた