Climate change increases the risk of facing difficult winters in reindeer herding

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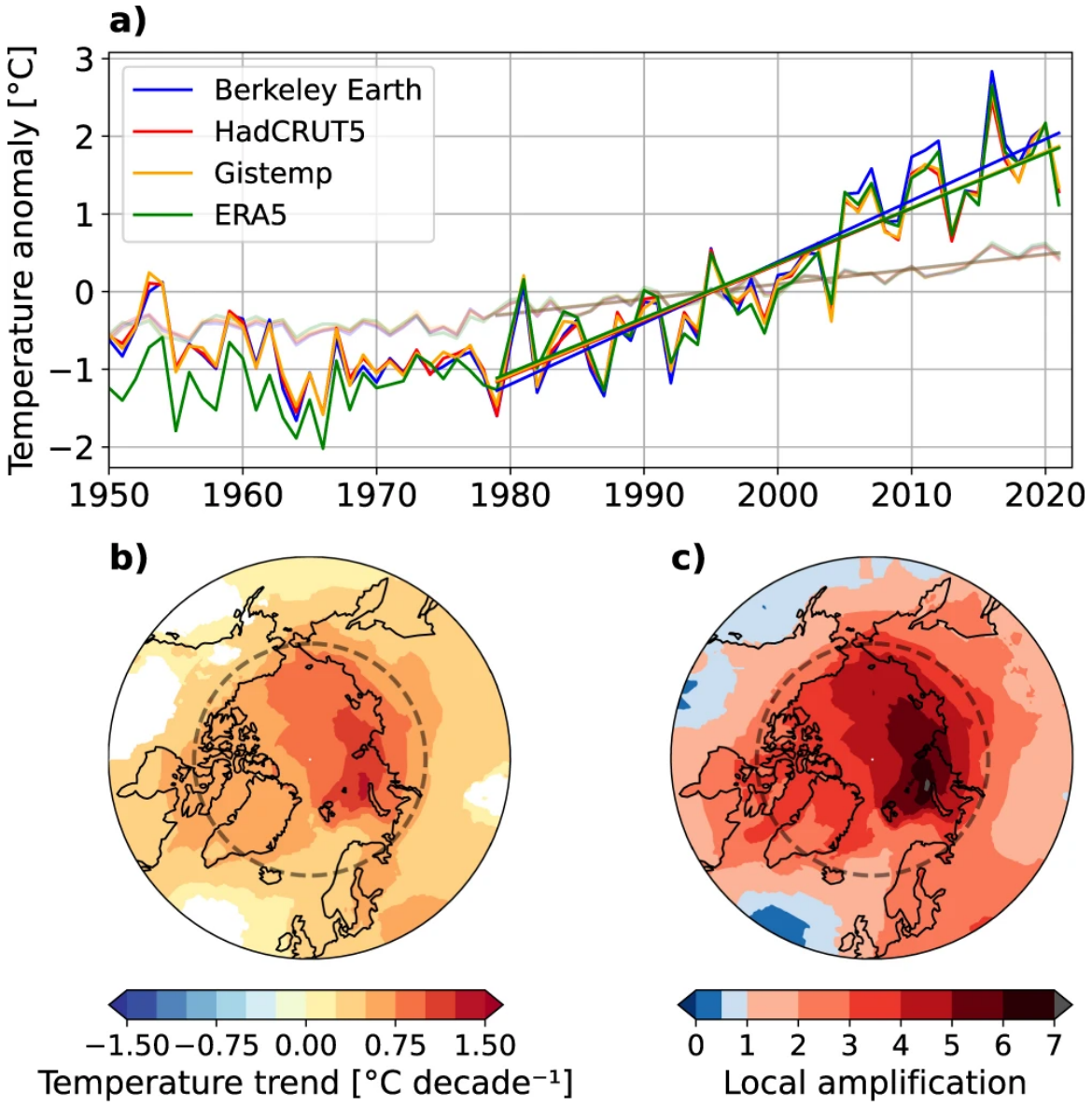
The annual mean temparature of the Arctic area has increased much faster that the global mean temperature

- During 1979-2021 the mean temperature on the arctic areas noth from the polar circle has increased nearly four times faster than the mean global temperature.

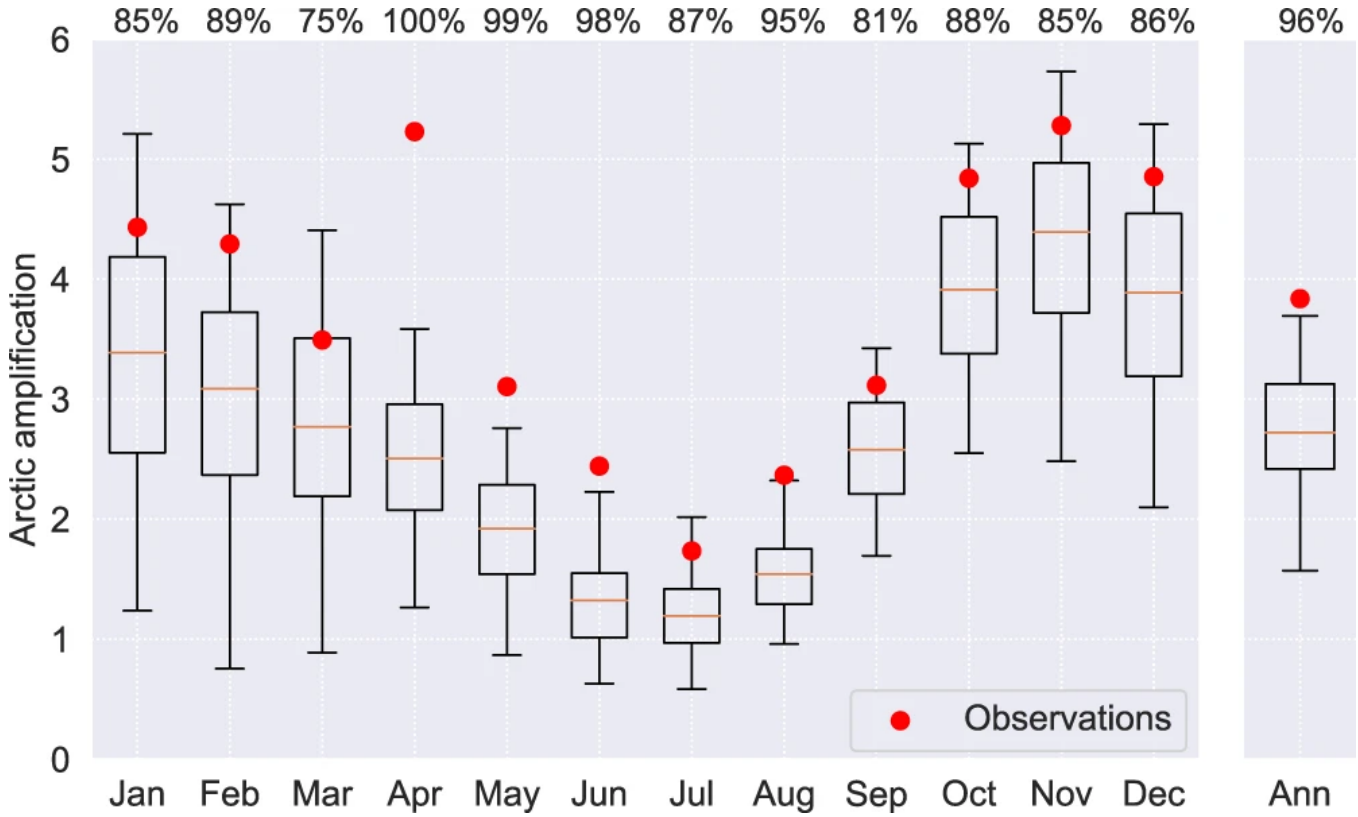


Source: *Rantanen et al. 2022: The Arctic has warmed nearly four times faster than the globe since 1979. Communications Earth & Environment. https://doi.org/10.1038/s43247-022-00498-3*

Especially winters have warmed up

- Especially winter temperatures have increased in the arctic areas during 1979-2021.
- Most notable warming-up has taken place during October-December and April.

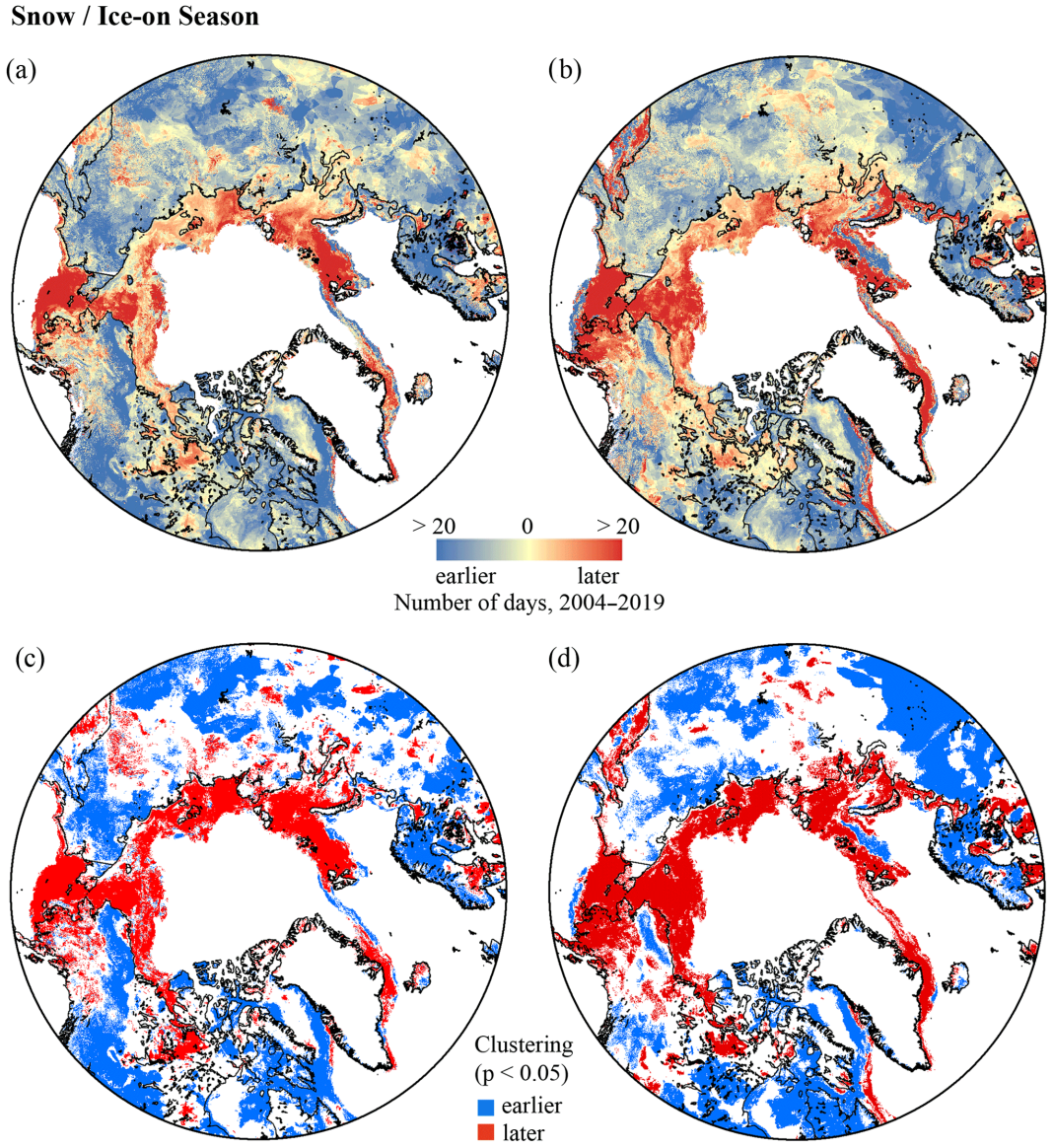
Modelled and observed Arctic amplification in warming



Source: *Rantanen et al. 2022: The Arctic has warmed nearly four times faster than the globe since 1979. Communications Earth & Environment. https://doi.org/10.1038/s43247-022-00498-3*

Arctic oceans and lakes stay longer unfrozen but snow come earlier

- Ocenas and lakes stay longer unfrozed in arctic areas, which obviously increases moisture and precipitation on the mainland areas in late autumn and early winter.
- Despite lenghtening of autumns and warming up of early winters, both first and permanent snow has been observed to come earlier on the ground e.g. in Fennoskandian during 2004-2019.
- However, snow melts earlier in spring, which means that the length of snow cover period has not changed much.



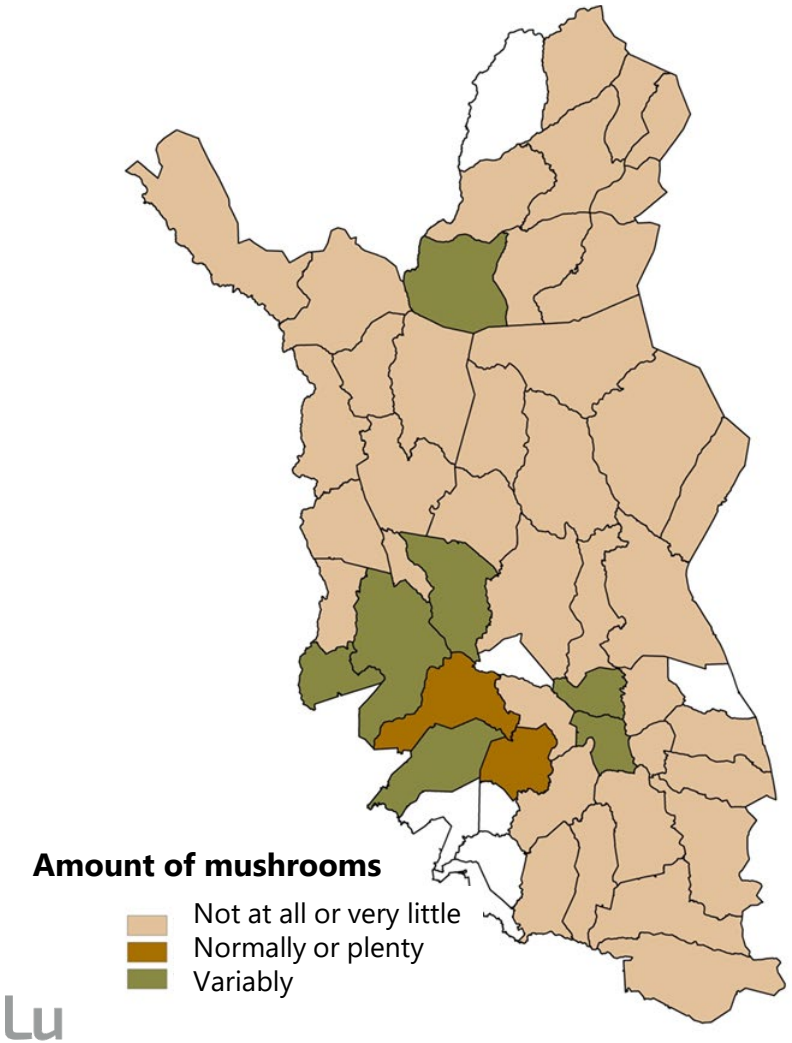
Source: *Dauginis & Brown 2021: Recent changes in pan-Arctic sea ice, lake ice, and snow-on/off timing. The Cryosphere, 15, 4781–4805, 2021, https://doi.org/10.5194/tc-15-4781-2021*

How climate change affects winter pasture conditions in reindeer herding

- Increasing risk of forming hard snow and ice layers on pastures, when thick and wet snow layer covers warm soil and then freezes over vegetation during late autumn or early winter. → Problems on getting food by reindeer from blocked pastures.
- Plusdegrees and high moisture conditions under wet snow can also promote growth of different microfungi and development of mycotoxins on pasture plants (Moulds on pastures). → Health problems for reindeer
- Although winter warming generally decreases depth of snow, there can be still winters with exceptionally deep snow layer.
- Also rain on snow (ROS) events can lead forming of hard and icy layers on snow later in winter.
- Snow melts earlier in spring, but still late snow melting can appear.
- Latest examples of difficult winters for reindeer and reindeer herding were the winters 2019-2020 ja 2021-2022.

Body condition of reindeer in autumn affects considerably how reindeer cope with winter

Herders' evaluation on the availability of mushrooms for reindeer in autumn 2019



Herders' evaluation on the body condition of reindeer in autumns 2019

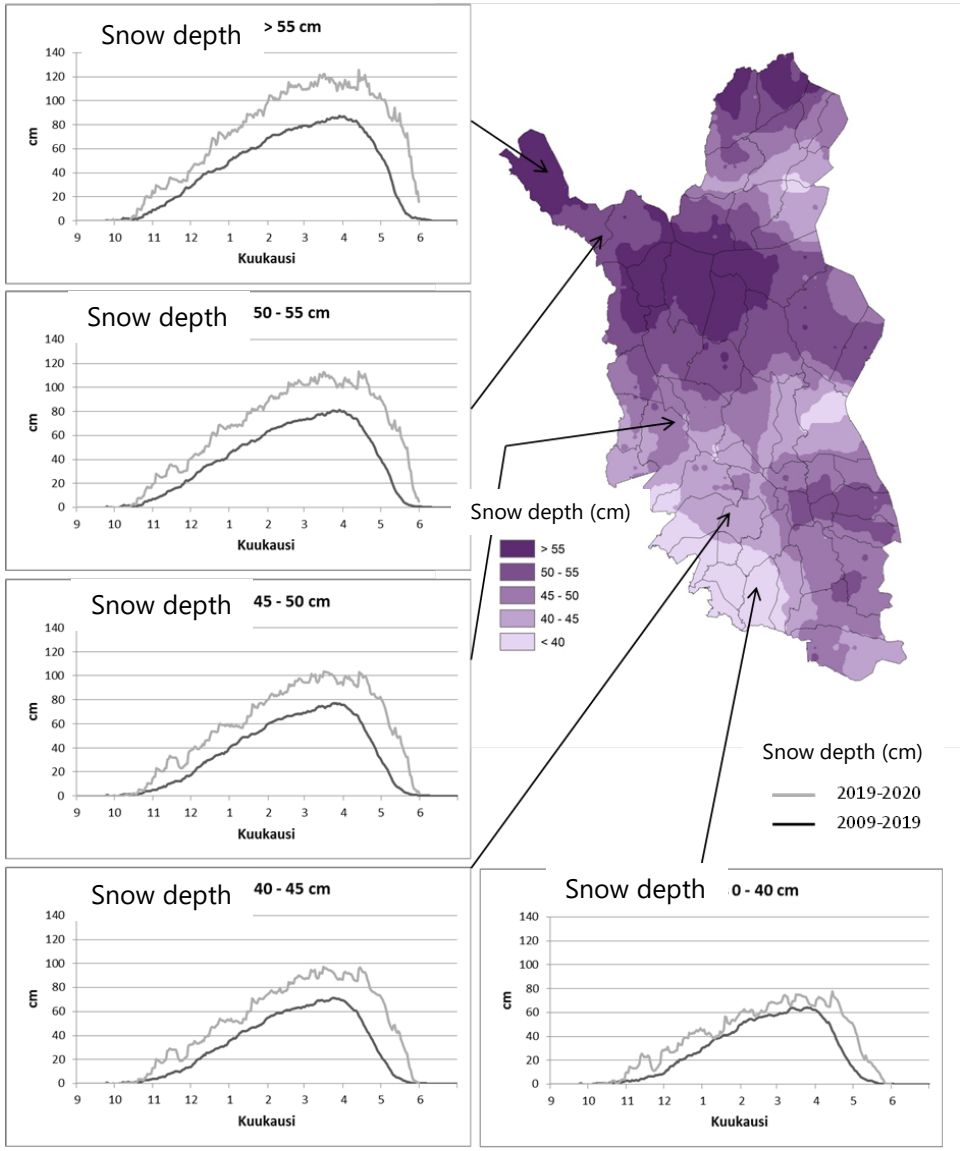
Body condition of reindeer	Decribes well	Decribes somehow	Not decribes at all
Normal	21,3 %	38,3 %	40,4 %
Better than normal	2,1 %	10,6 %	87,2 %
Worse than normal	55,3 %	21,9 %	23,4 %
Variable	40,4 %	19,2 %	40,4 %

Source: *Kumpula, J., Jokinen, M., Siitari, J. & Siitari, S. 2020: Talven 2019–2020 sää-, lumi- ja luonnonolosuhteiden poikkeuksellisuus ja vaikutukset poronhoitoon. Luonnonvara- ja biotalouden tutkimus 58/2020. Luonnonvarakeskus. Helsinki. 57 s.*

Snow conditions developed very difficult for reindeer in winter 2019-2020

Average snow depth during November-April in winters 2009-2019 in different areas (map) and daily snow depth developments in winters 2009-2019.

- In winter 2019-2020 deep and wet snow layer covered unfrozen ground very early.
- During winter continuous snow fall accumulated an exceptional deep snow layer on pastures.
- There was also hard snow and ice layers in snow
- Snow also melted away very late in spring.



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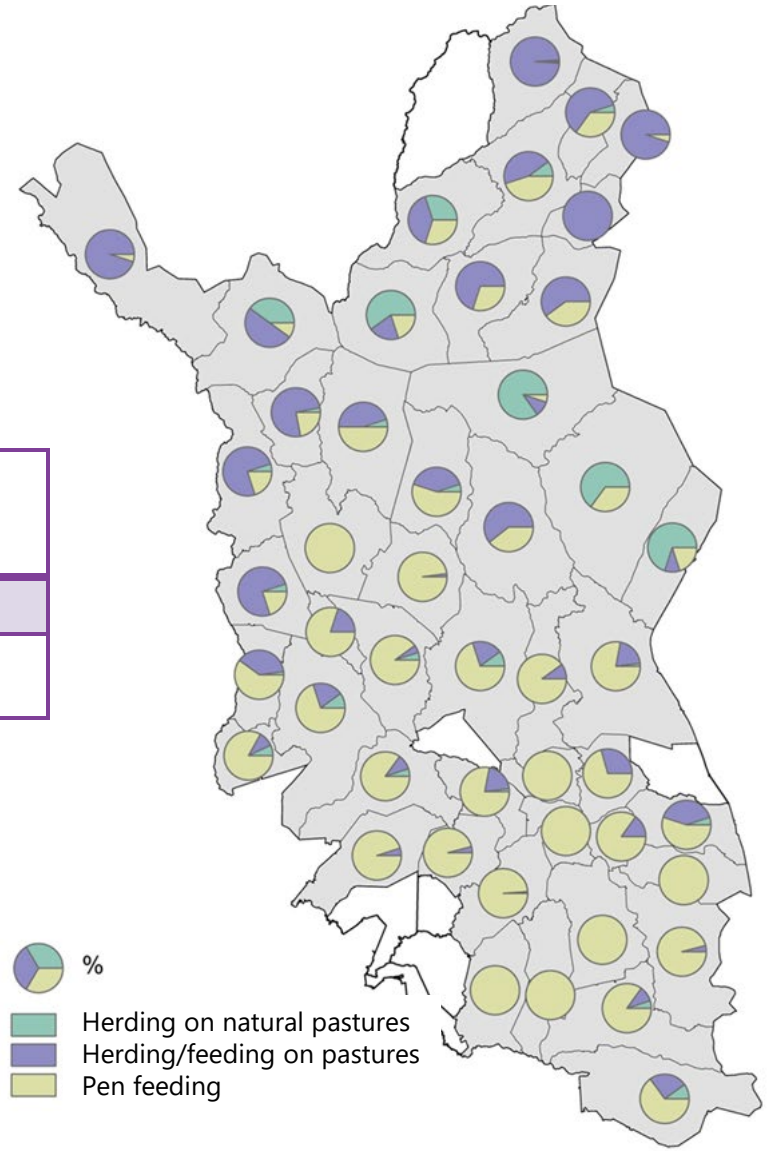
Herding and feeding costs were markedly increased during winter 2019-2020

Percentages of different herding and feeding types of reindeer used in winter 2019-2020



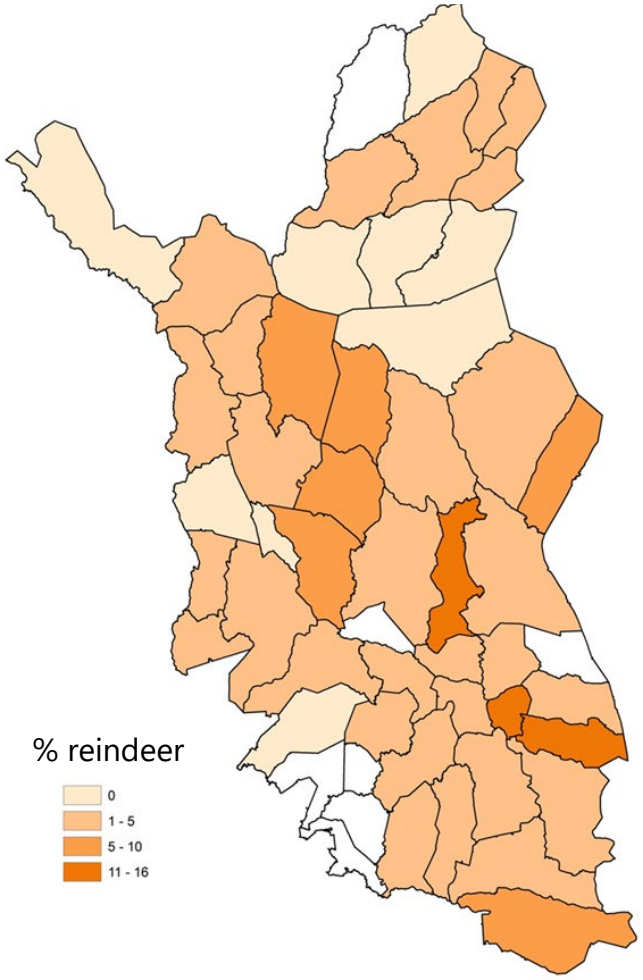
Estimation made by the reindeer herding co-operatives on the increase of feeding amount and herding work (%) in winter 2019-2020 compared to prevuous three winters

Winter 2019-2020 compared to previous three winters	Increase on average %	Increase, median %
Increase of the amount of used feeds	81,0	51,0
Increase of the amount of work used reindeer herding work	91,2	53,0

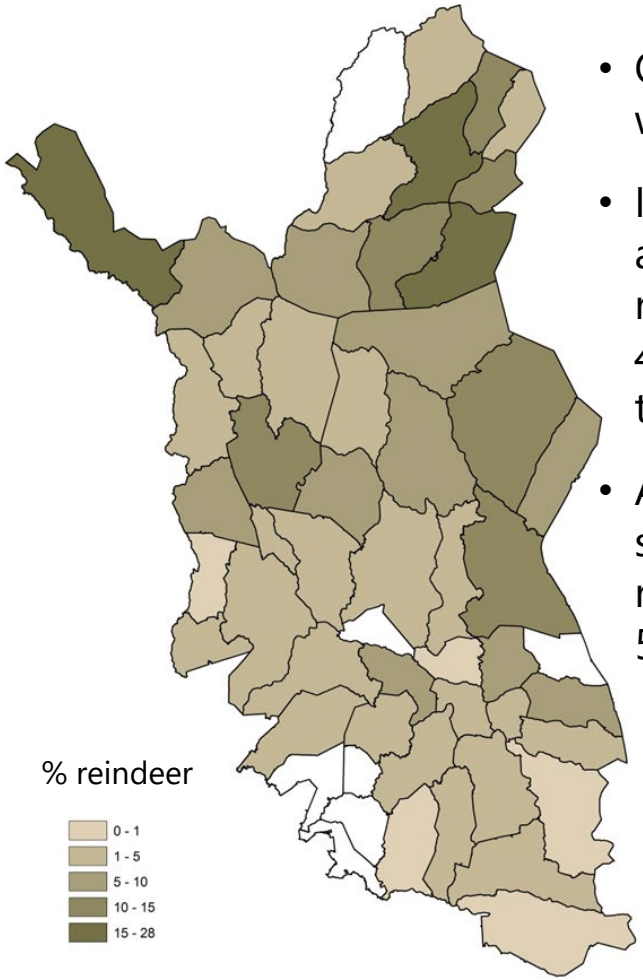
Source: *Kumpula, J., Jokinen, M., Siitari, J. & Siitari, S. 2020: Talven 2019–2020 sää-, lumi- ja luonnonolosuhteiden poikkeuksellisuus ja vaikutukset poronhoitoon. Luonnonvara- ja biotalouden tutkimus 58/2020. Luonnonvarakeskus. Helsinki. 57 s.*

Winter 2019-2020 caused diseases and considerable losses of reindeer

Estimated percentage of observed disease cases of all reindeer



Estimated percentage of observed reindeer deaths of all reindeer

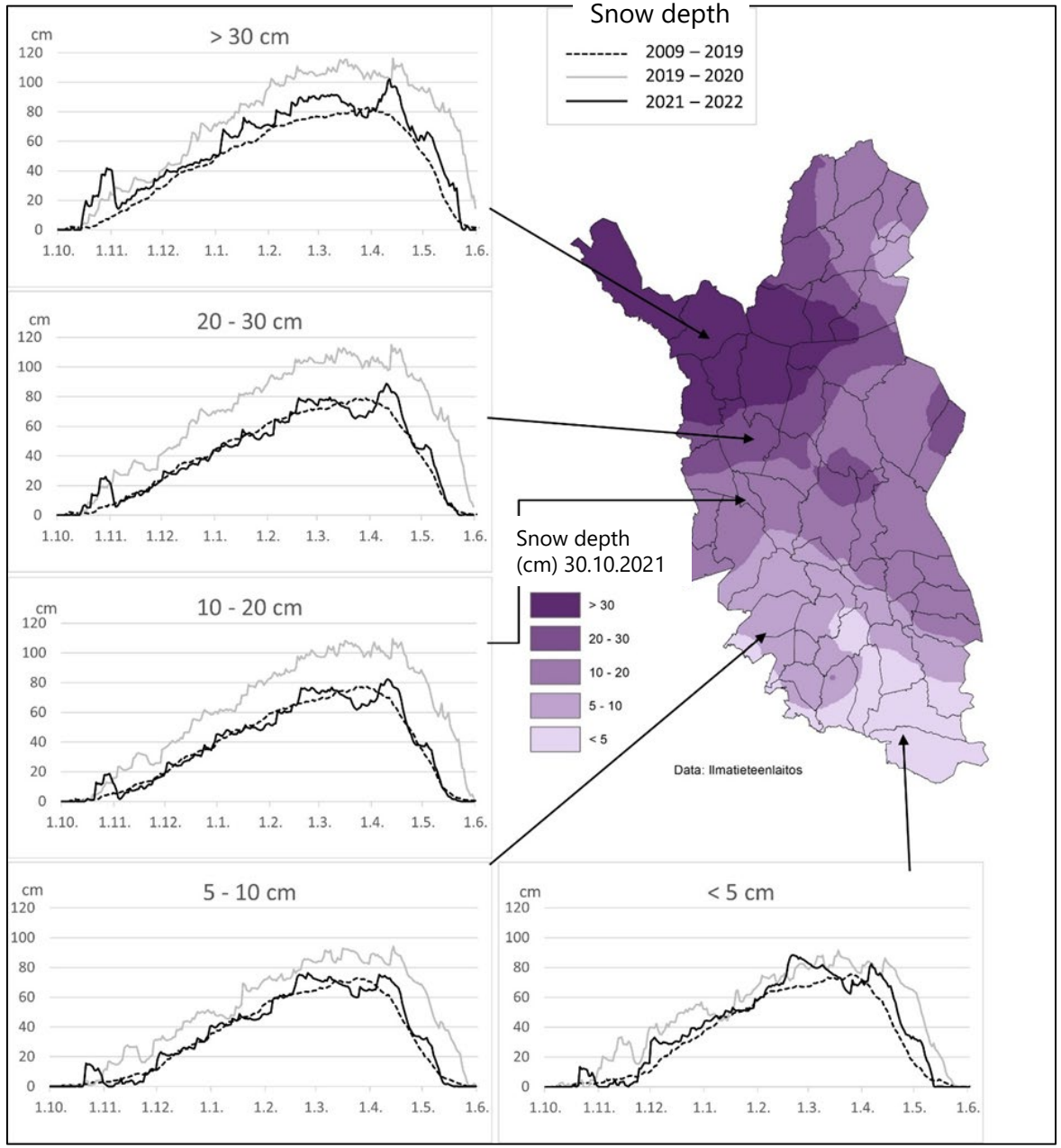


- Over 20 000 reindeer were reported to be lost.
- In the following year the average calf percent was reduced from 60% to 47%, in the nothern part to 37%.
- Also the number of salughtered reindeer was reduced from 83 000 to 57 000 reindeer.

Source: *Kumpula, J., Jokinen, M., Siitari, J. & Siitari, S. 2020: Talven 2019–2020 sää-, lumi- ja luonnonolosuhteiden poikkeuksellisuus ja vaikutukset poronhoitoon. Luonnonvara- ja biotalouden tutkimus 58/2020. Luonnonvarakeskus. Helsinki. 57 s.*

Also winter 2021-2022 was very difficult for reindeer in large area

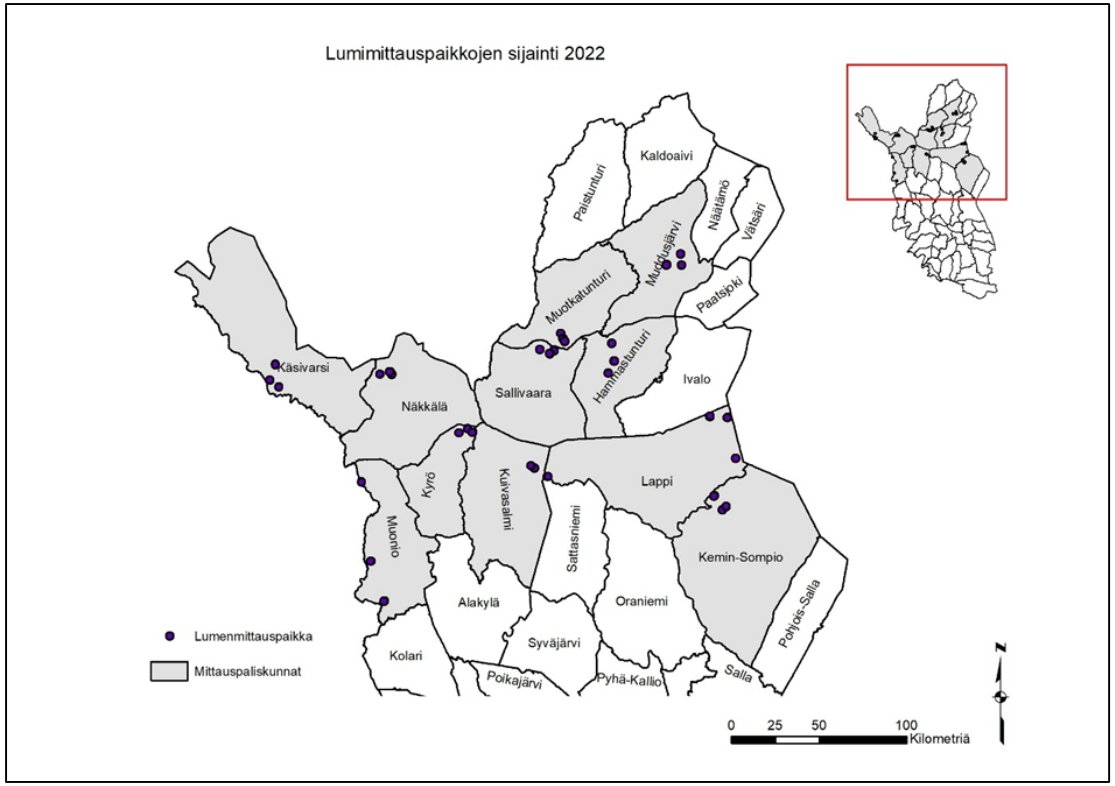
- Wet and deep snow come on unfrozen ground already in the mid of October especially in the north-western parts of the herding area.
- Later in October warm, rainy weather melted most part of snow but after that wet snow was frozen. Especially in north-western parts of the area it formed a hard and icy snow layer on the bottom part of snow, which made reindeer very difficult to dig food during the rest of winter.
- It is also probable that, humid and warm conditions under the snow in late autumn and early winter favoured the growth of microfungi and formation of mycotoxings on pasture plants of reindeer.

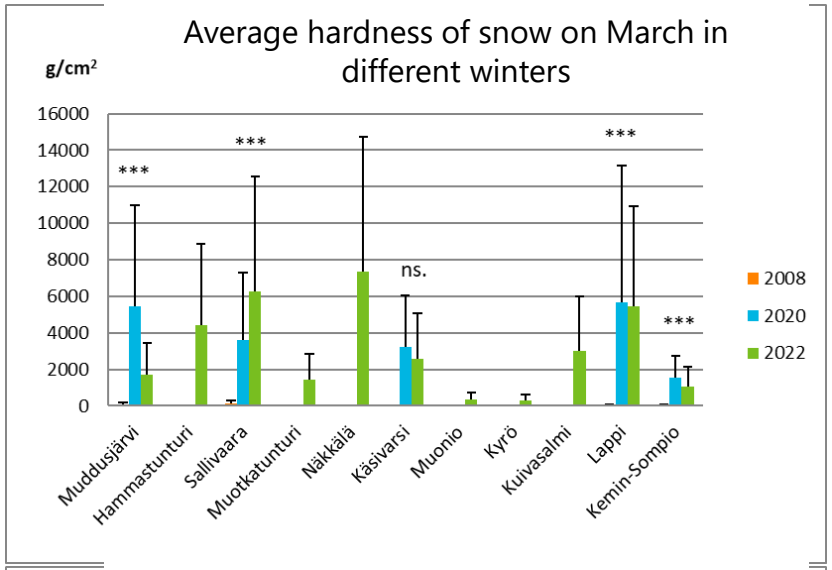


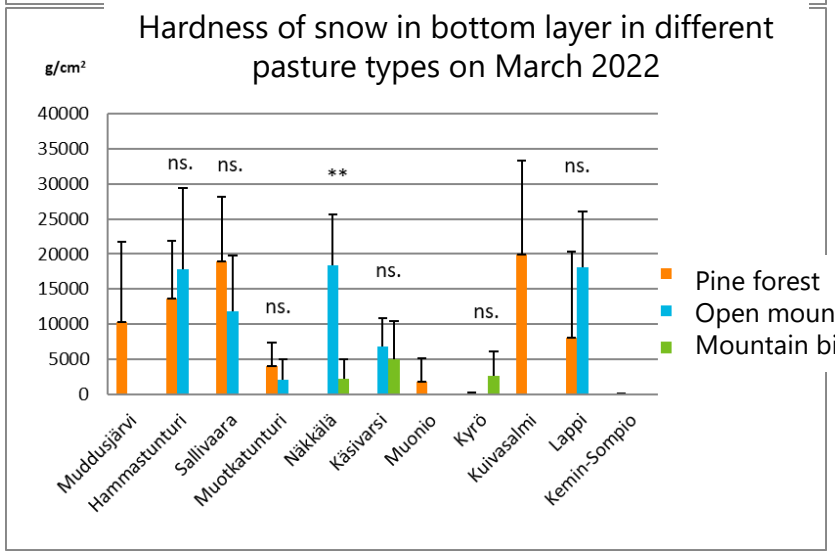
Source: *Kumpula, J., Rämö, S., Siitari, J., Holkeri, L., Pekkarinen, A.-J., & Tauriainen, J. 2022: Talven 2021–2022 lumi- ja kaivuolosuhteet ja niiden vaikutukset poronhoitoon. Luonnonvara- ja biotalouden tutkimus 71/2022. Luonnonvarakeskus. Helsinki. 58 s.*

Measured snow conditions on March 2022, 2020 and 2022

According the snow measurement average snow was markedly harder both on March 2020 and 2022 compared to March 2008 (4 co-operatives). Especially the hardness of snow on the bottom layer of snow was exceptionally hard on March 2022.



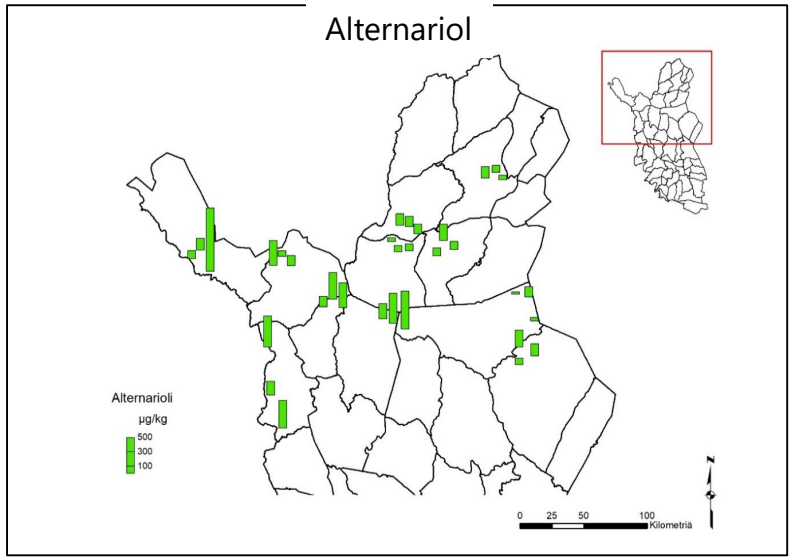


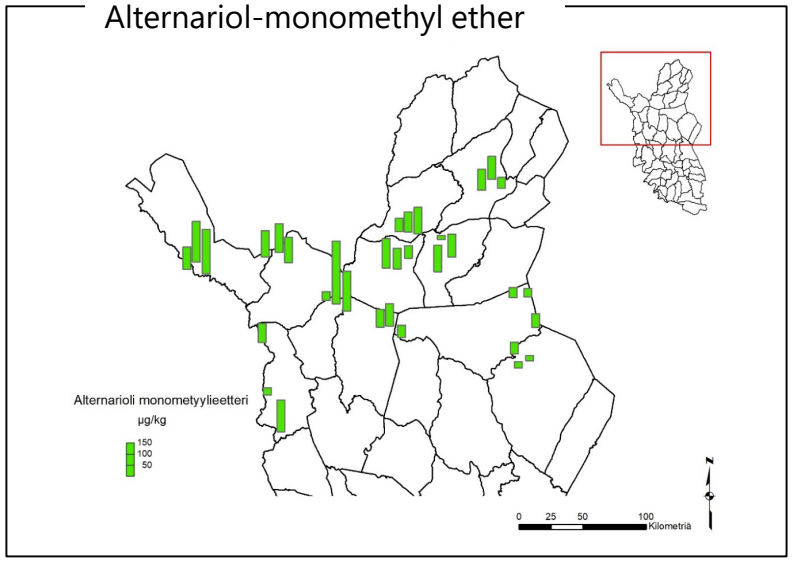


Source: *Kumpula, J., Rämö, S., Siitari, J., Holkeri, L., Pekkarinen, A.-J., & Tauriainen, J. 2022: Talven 2021–2022 lumi- ja kaivuolosuhteet ja niiden vaikutukset poronhoitoon. Luonnonvara- ja biotalouden tutkimus 71/2022. Luonnonvarakeskus. Helsinki. 58 s.*

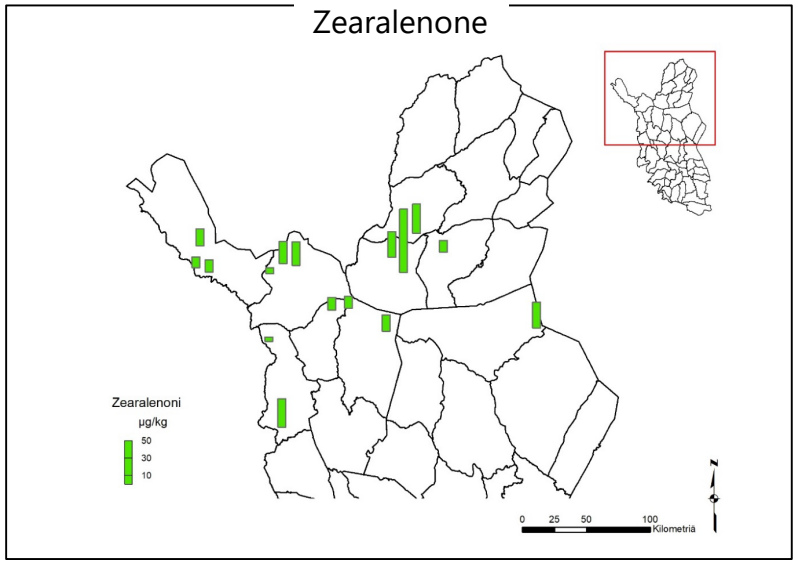
Three types of mycotoxins were found from the pasture plants collected in March 2022

Found *Alternaria* produced mycotoxins





Found *Fusarium* produced mycotoxins

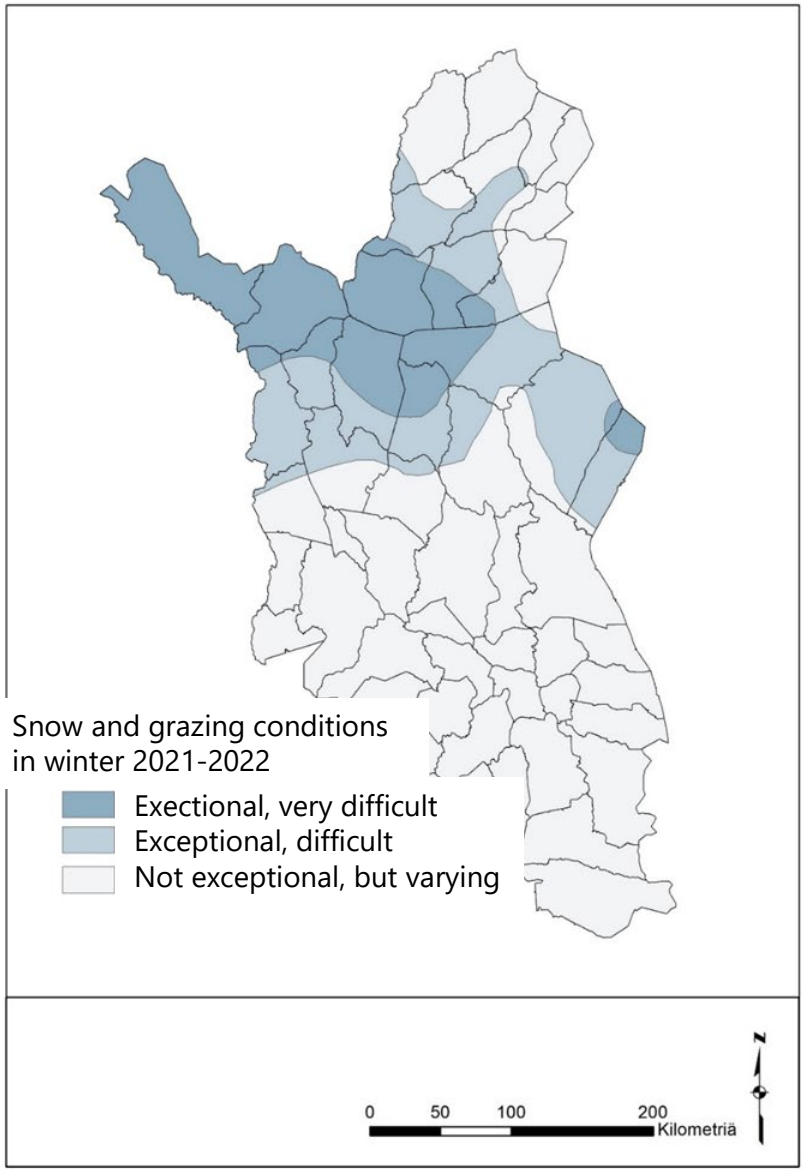


- *Alternaria* produced mycotoxins are known to affect esophagus cancer in human.They are also observed to irritate skin and mucosa and causing different kinds of inflammations in mice experiments.
- Zearalenone is known to disturb reproduction processes, e.g. disturbing implantation of fertilized ovum or development of embryo.
- Nothing is known on their joint effects or impacts on reindeer health.

Source: *Kumpula, J., Rämö, S., Siitari, J., Holkeri, L., Pekkarinen, A.-J., & Tauriainen, J. 2022: Talven 2021–2022 lumi- ja kaivuolosuhteet ja niiden vaikutukset poronhoitoon. Luonnonvara- ja biotalouden tutkimus 71/2022. Luonnonvarakeskus. Helsinki. 58 s.*

Assesment of the areas for exceptional grazing conditions by reindeer in winter 2021-2022

According to the data on snow conditions by the Meteorological Institute, field snow measurements and mycotoxins analysis, the reindeer herding area was divided into three different parts for snow and grazing conditions.



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Conclusions

- Since climate warming is increasing the risk of facing difficult winters in reindeer herding, readiness and adaptability of facing exceptional pasture and grazing conditions have to be developed.
- Better adaptability means developing reindeer herding and feeding methods as well as feeds more suitable for exceptional grazing conditions. This developing work should be made together with reindeer herding, research and governance.
- Also monitoring systems for observing the development on snow and grazing conditions as well as health and body condition of reindeer from early to late winter should be developed.
- Finally more faster and flexible emergency and compensation system for helping and supporting reindeer herders in exceptional grazing conditions should be planned and taken in use in order to avoid serious losses beforehand.

Thank you!