BOAZODOALLOKONFERÁNSA 2022

POSTERGUIDE

REINDEER HUSBANDRY CONFERENCE 2022

GUOVDAGEAINNUS/KAUTOKEINO

30.11.-01.12.2022

Sámi allaskuvla
Sámi University of Applied Sciences

The Research Council of Norway

Rievdan

International Centre for Reindeer Husbandry

Rievdan

Boahtteáiggi sámi boazodoalu suvdilis hálddašeapmi vásiha stuora hástalusaid čatnon Árktisa jođánis rievdamii. Sámi boazoeaháhus ovddasta ealáhusa ja eallinvuogi mii lea vuođđuduvvon práksisii ja máhttui mii lea ovdánan guhkit áigge vásáhusaid bokte, go eallá garra dálkkiid siste ja hirbmat rievdadeaddji dilálašvuođain Árktalaš birrasis. Dát dutkanprošeakta lea Sámi allaskuvlla mihtuid ja strategiija vuođul, ja addá máhttovuođu boahtteáiggi boazoeaháhus masterprográmmii fágarasttildeaddji lahkonemiin.

Prošeakta galgá dutkat árbevirolaš ja kultuvrralaš máhtu Sámi boazoeaháhusas ja vejolašvuođaid mat leat árbevirolaš máhtus ja dieđalašmáhtus go fuomášupmi lea rievdan ja seanadan heiveheapmi, ja geahčča la čilget vuostálasvuođa dán guokte máhttomáilmmis mat leat oktiičatnon ja fátmmastit iešguđet lahkonemiid boazoeaháhusa ja boazobargguid vuođđoosiide.

RIEVDAN háliida buktit ođđa máhtu ja ipmárdusa ja dáinna lágiin lasihit suvdilisvuođa boazoeaháhusas ja boazobargguin, ja loahpas nannet seanadeami gaskal min máhttomáilmmiid.

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The future sustainable governance of Sámi reindeer husbandry will face major challenges related to rapid change in the Arctic. Sámi reindeer husbandry represents a livelihood and way of life based on practices and knowledge developed through long-term experiences in living under harsh and highly variable conditions in the Arctic environment. This research project is based on and according to goals and strategies set by Sami University of Applied Sciences and will provide a knowledge base for a future Master's degree Programme in Reindeer Husbandry Studies using a multidisciplinary approach.

The project will research traditional cultural capabilities in Sámi reindeer husbandry and the opportunities embedded in traditional knowledge and scientific knowledge with a focus on adaptation to change and reconciliation, and will attempt to explain the tensions between the two interlinked spheres of knowledge involving different approaches to basic aspects of reindeer husbandry and herding.

RIEVDAN hopes to contribute to new knowledge and understanding in order to increase sustainability in reindeer husbandry and herding, and finally strengthen the reconciliation between the interlinked and conflicted spheres of knowledge.

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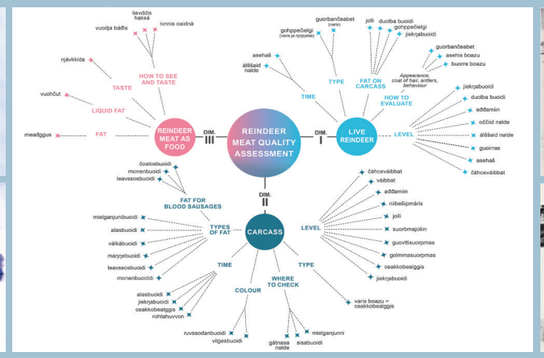
WAYS OF KNOWING ABOUT SÁMI REINDEER HERDER'S FOOD



This research has documented Sámi reindeer herders' traditional knowledge about food system in Guovdageaidnu, Northern Norway.

The work shows there are different ways of knowing in Sámi reindeer herders' food system, which can be shown through language and holistic understanding.

Such knowledge is still alive in Sámi homes where herders utilize the whole reindeer in a sustainable way.

- Main finding from this research is that Sámi reindeer herders have a unique and complex traditional knowledge system of their Indigenous food resources based on holistic understanding and practices developed through generations.
- The quality assessment starts already in the pastures where each reindeer is observed and by careful selection chosen for slaughter.
- These assessments continue until the meat is prepared and eaten.
- Such a selection process and the use of slaughtering method with specialized tenderization procedure in cold conditions with the skin kept on the carcass, provides tender, high-quality meat and blood and hygienic reindeer meat.
- Sámi reindeer herders' advanced and systematic knowledge and ways to assess fat degree provide information about the reindeer meat quality through concepts.
- The ways of slaughtering and butchering determine the type of food the family consumes.
- Conservation methods, based on good practice of traditional knowledge, are used to preserve the meat.
- Sámi reindeer herders food sovereignty can be strengthened through reconciliation of reindeer herders' traditional knowledge with scientific knowledge.

Multidisciplinary study
Methods used:
- interviews
- participating observations
- filming and sound recording
- photographs
- literature review and archival studies review
- Sámi linguistics with concept analysis
- co-production of knowledge
- pH- and temperature measuring

The different methods used gives a rich data material and a possibility to assess the research from different angles.

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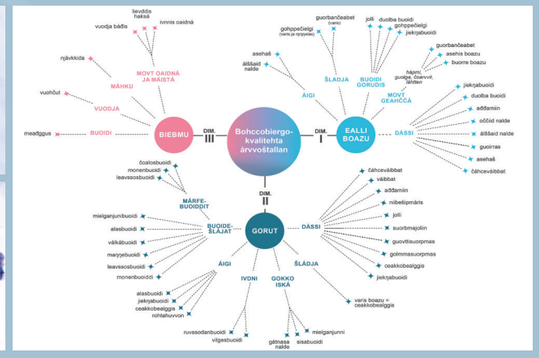
BOAZOSÁPMELAČČAID BIEPMUID MÁHTTOVUOGIT



Dutkanbargu lea dokumenteren Guovdageainnu boazosápmelačča árbevirolaš máhtu biepmu birra.

Bargu čájeha ahte boazosápmelaččain leat iešguđetlágán máhtut biepmuid birra maid ovdanbuktet giela ja holisttalaš ipmárdusa bokte.

Máhttu lea ain anus sámi ruovttuin gos bistevaš vugiin ávkkástallet olles bohcco.

- Dutkamuša váldoboađus lea ahte boazosápmelaččain lea earenoamáš ja ollislaš árbevirolaš máhttovuogádat biepmuset birra mii lea buolvvaid čađa ovdánahttojuvvon.
- Dievás ealo luhtte juo álget árvvoštallet bohccuid go válljejit niestebohcco.
- Biergguid ja buiddiid árvvoštallan bistá dassážii lea ráhkadan biepmu bierggus ja borran dan.
- Árbevirolaš njuovvamin ja bakkahemiin beassá bearaš borrat buori ja dipma bierggu mii lea maid ráinnas. Biergu šaddá buorre ja varra álbmái.
- Dárkilis ja systemáhtalaš máhttu ja diehtu árvvoštallat bohccobierggu kvalitehta ovdanbuktet doahpagiid čađa go árvvoštallet buoidehivvodaga.
- Njuovvan- ja rihttenvuohki mearrida makkár biepmu bearaš borra.
- Riibadanvuogit leat árbevirolaš vuogit vurket biergguid.
- Boazosápmelaččaid biebmosuverenitehta sáhttá buoridit go ovttastahttá sin árbevirolaš máhtu ja dieđalaš máhtu.

Fágaidrasttildeaddji bargu
Metodat adnon:
- Jearahallamat
- oassálasti áicamat
- filbmen ja jiena bádden
- govat
- lohkamušaid- ja arkiivadieđuid analyseren
- doabaanalysa
- máhtuid ovttasbuvttadeapmi
- pH-árvvu ja temperatuvrra mihtideapmi

Go atná máŋggalágán metodaid čohkket diehtovuođu, de šaddet dutkamii bohtosat mat ovdanbuktet iešguđetlágán dieđuid ja beliid áššis.

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Sámi traditional reindeer herding knowledge throughout a year:

HERDING PERIODS ON SNOW- COVERED GROUND

Time	Names of different rest times in English	Autumn/ Autumn-winter	Winter
approximately 03:00 - 06:00	Morning rest	***Guovssolivat*–*beaive-badjánan*-** *livat* ~ *álit livat*: The reindeer's first morning rest in autumn	***Guovssolivat:*** The reindeer's morning rest in winter
09:00-13:00	Noon rest	***Gaskabeaivi-livat:*** The reindeer's noon rest	***Beaivelivat:*** The day rest, the reindeer's evening rest in winter
16:00 -19:00	Afternoon rest	***Veaigelivat*** ~ *eahkedis-beaivilivat* ~ *eahkesbeai*-livat: The reindeer's after-noon rest in autumn	
	Evening rest	*Guovssovuoddjunlivat*: The reindeer's evening rest in autumn	
22:00 -01:00	Night rest	***Gaskaájalivat:*** The reindeer's night rest in autumn	***Idjalivat***- night rest, the reindeer's evening rest in winter (ca 20:00- 21:00)

Period	Name of the period	Approximate time
1	Vuoššas muohta ja njáhču (First Snow and thaw period)	Weeks 41-44
2	Skábma (dark time period)	Weeks 45/46 till week 2
3	Dálvi (winter period)	Week 50 till beginning of February
4	Dálveguovdil (mid-winter period)	Beginning of February till end of march
5	Gidda (spring period)	End of march till end of April
6	Guottet (calving period)	End of April till *Jonssot* (June 24th)- end of June
7	Geassi (summer period)	End of June till middle of August
8	Čakča-geassi (Autumn summer period)	Middle of august till middle of September
9	Ragat (Rutting period)	Middle of September till *dálvevahkku* (from approx. October 14th)

Results
Herders' planning, decision-making and practices are based knowledge on the 8 seasons, different daily or weekly cyclizes, and 9 herding periods in a reindeer year.
These contain different sub-cycles that are a part of a larger system based on the year, the lunar month and day/night.

Cycles; the biological cycles of reindeer, like rutting season, calving season, dropped or cast antlers and moulting fur; sexual behavioral cycles; cycles relative to climate and snow, cycles of extreme years (goavvi) and cycles that include reindeer herding periods throughout the year.

- Aspects of herding in winter are based on experience, knowledge, and the ability to observe (read nature) and calculate how to manage the herd within the framework of a traditional knowledge base. These primarily consists of traditional continuous observation, judgment of the herd, combination of relevant factors in every situation, and mental monitoring of variability and changes in time and space in the use of grazing land and grazing conditions.

- This also consists of anticipating situations and developments in near and more distant futures and make plans and decisions to sustain the herd based on weather conditions related to special weeks and days of the year that can provide information about what to expect are crucial

- This knowledge is articulated and structured linguistically (reindeer herding language) with categories that are passed on to future generations. These includes subsystems linked to different types of science and knowledge such as hydrology, meteorology, biology, topo graphy, animal welfare, land management, adaptation strategies to climatic conditions, etc.

This study is a multidisciplinary study, using methods for communicating with herders, and co-production of knowledge between reindeer herders and scientists

Reindeer herding strategies and practices are highly complicated and systematic enterprises containing different types of knowledge on how the biological and gender-based behavioral aspects of reindeer and their movement in time and space are connected to climate, temperature, and snow metamorphism.

Understanding the field of reindeer herding relies on various categories of thought, namely knowledge of reindeer, environment, landscape, weather, and specific knowledge of the mutual relations in these subjects, and characteristics i.e., specific differences in reindeer, snow, and weather, and on landscapes.

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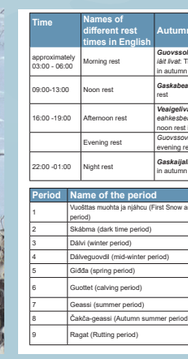
Sámi boazodoalu árbevirolaš máhttu jagi čađa:

GUOĐOHANPERIODAT MUOHTAMÁILMMIS



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Bohtosat
Boazovázziid plánemii ja mearrideapmái ja práksisáidde gullet 8 jagiáiggi, iešguđet beaivvi ja vahkku syklusat ja 9 guođohaperioda boazodoallojagis.

Dát sisttisdollet iešguđet vuolit syklusiid mat gullet stuorit systemii maid vuođđu lea jahki, mánnu ja beaivi/idja.

Syklusat leat: bohcco biologalaš syklusat nugo ragatáigi, guottetáigi, nulpen- ja borgádanáigi; dálke- ja muohtasyklusat, goalvvisyklusat ja syklusat masa gullet guođoheamit jagi čađa.

- Dálveguođoheami aspeavttaid vuođđun leat vásáhusat, máhtut ja luodduipmárdus (máhttit luonddu lohkat) ja árvvoštallat movt ealu hálddašit árbevirolaš máhtu vuođul. Dása vuosttažettiin gullá árbevirolaš bearráigeahčča**n**/observeren, ealu stivret, oaidnit relevánta fáktoriid juohke dilis, ja mentálalaččat gozihit nuppástusaid ja rievdamiid áiggi ja báikki mielde, guohtoneatnamiid geavahettiin ja guohtundiliid mielde.

- Dása gullá maid einnostit diliid ja ovdánemiid sihke lagas ja guhkit áiggis ja maid plánet ja mearridit ealu ceavzima dálkediliid mielde mat čatnasit vahkkuide ja beivviid jagis, mat sáhttet čujuhit maid sáhttá vuordit ja mii lea dehálaš.

- Dát máhttu ovdanbukto ja struktureregjuvvo gielalaččat (boazodoallogiella) kategoriijaiguin mat leat fievrreduvvon buolvvas bulvii. Dása gullet vuolitsystemat iešguđet diehtagiidda ja máhtuide nu go hydrologiija, meteorologiija, biologiija, topografiija, elliidčálgu, eananhálddašeapmi, heivehanstrategiijat dálkkádatdiliide jna.

Dát dutkan lea fágaidrasttideaddjedutkan, mas leat adnon metodat gulahallat boazovázziiguin ja mas boazovázzit ja dutkit ovttasbuvttadit máhtu.

Boazodoallostrategiijat ja práksisat leat kompliserta ja systemáhtalaš doaimmat maidda gullet iešguđetlágan máhtut das movt bohcco biologalaš ja sohkabeallevuđot láhtten ja bohccuid lihkadeapmi áiggi ja báikki mielde čatnasit dálkái, temperatuvrii ja muohttaga rievdamii.

Ipmirdit boazodoallofágasuorggi, de gáibida áddejumi dan jurddakategoriijain, nappo máhttu bohcco, birrasa, eatnama, dálkki birra ja ahte lea earenoamáš máhtu oktiigullevaš oktavuođaid fágasurggiin ja daid dovdomearkkain.

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LEARNING BY HERDING

- Transmission of reindeer herding knowledge and skills

The development of detailed practical reindeer herding knowledge and the accumulation of the learner's personal wisdom are crucial to ensure sustainability and resilience in reindeer herding and reindeer husbandry.

Learning by herding and the process of transferring reindeer husbandry knowledge is a lifelong process.

Learning by herding represents an indigenous learning system and process of learning traditional knowledge and skills.

The characteristics of this learning and transfer process:

- Reindeer husbandry parents organize and facilitate learning strategies for how the children are to achieve reindeer husbandry competence best
- Reindeer herding competence is complex and deals with many different subject areas, which together constitute the body of knowledge necessary to function as a skilled reindeer herder
- Life-long learning with learning levels
- Multiple and systematic learning methods with concretization
- Includes most of the elements indicative of traditional knowledge systems like being informal, intuitive, oral, practical, experimental, inclusive, and holistic
- Multidisciplinary content
- Reindeer herding language is significands in learning outcomes
- Different learning arenas related to various tasks throughout the year
- The responsibility of transmission of knowledge is added to the family, the household, siida members, and other reindeer herders
- Feedback and assessment from tutors /teachers are parts of the learning process

Reindeer herders have developed extensive knowledge of reindeer herding and reindeer husbandry and the environment sound surroundings. A quote from the early 1700s explains that the knowledge transmission among Sami people does not depend on formal school education but traditional knowledge, which provides learning in many disciplines in line with science, e.g., glaciology, topography, place name, weather, animal welfare, land management, the behaviour of reindeer, botany, navigation, astrology, mathematics, economics, strategy thinking a panning, cosmology, and values.

Figure. **Differences between western knowledge systems and reindeer husbandry knowledge systems**

Western school knowledge transmission	Reindeer herding knowledge transmission
Formalized education	The prerequisite for reindeer herders, but not formalized learning
Educational/school-based learning	Learning through work and collaboration
Surface level-processing combined as factual knowledge and including deep level-processing	Deep level-processing, as with in-depth learning, understand and be able to use the knowledge in new situations
Based on written transmission	Based on oral transmission
Special languages related to themes	Learning is rooted in specialized language related to tasks
Themed	Holistic

New generations are introduced to reindeer herding since childhood, and in this way, they already have early knowledge of the various elements and tasks. The transmission of knowledge thus includes these knowledge bases passed from one generation to the next.

The reindeer herding teachers use multiple methods, thought processes, philosophies, concepts, and experiences in their teaching of reindeer herding children for they need to achieve and apply knowledge about reindeer herding and the natural world.

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GUOĐOHETTIIN OAHPPAT

- Fievrredit boazodoallomáhtu ja gálggaid

Guođohettiin oahppan ja dan proseassat fievrredit boazodoallomáhtu lea olles eallima proseassa

Hukset dárkilis praktihkalaš guođohanmáhtu ja hukset pensuvnnalaš jierpmálašvuoda lea mearrideaddji sihkkarastit ceavzilis ja nanu guođoheami ja boazoealáhusa.

Fig. Leat erohusat oarjemáilmmi máhttosystemas ja boazodoallomáhtus.

Guođohettiin oahppat lea boazovázziid oahppansystema birra ja proseassa birra movt oahppat árbevirolaš máhtu ja gálggaid.

Dán oahppan- ja viidáset fievrredanproseassa dovdomearkkat:

- Váhnemat boazoealáhusas organiserejit ja muddejit oahppanstrategiijaid nu ahte mánát buoremusat ožžot boazodoallomáhtu
- Boazodoallomáhttu lea máŋggabealat ja sisttisdoallá iešguđet fágasurggiid, mat oktii addet máhtu mii dárbbašuvvo go galgá šaddat buorren boazobargin
- Dán oahppamis lea dásiid mielde oahppan olles eallima čađa
- Dás leat máŋggat ja systemáhtalaš oahppanmetodat oktan konkretiseremiiguin
- Dát fátmmasta ollu elemeanttaid mat čilgejit árbevirolašmáhttosystemaid, omd. leat eahpeformálan ja intiutiivan, das leat njálmmálaš, praktihkalaš, eksperimentála, fátmmasteaddji ja holisttálaš vuogit
- Fágaidrasttideaddji sisdoallu
- Boazodoallogielas lea mearkkašupmi oahppanbohtosiidda
- Das leat iešguđetlágan oahppanarenat relaterejuvvon birra jagi doaimmaide
- Bearrašis, báikevuođus, siidda olbmuin ja eará boazovázziin lea ovddasvástádus máhtu ja gálggaid oahpahit
- das lea neavvun ja bagadallan, mas oahpaheaddji neavvun ja árvvoštallan lea oassin oahppanproseassas

Oarjemáilmmi skuvla máhtosirdin	Boazodoalo máhtosirdin
Formaliserejuvvon oahpahus	Eavttut boazobargiide, muhto ii formaliserejuvvon oahppan
Oahpahus/skuvlavuođđuduvvon oahppan	Oahppan searvama ja ovttasbargguid bokte
Gierragis guoskkahit fákta dieđuid ja láktit čiekŋalis oahppamii	Čiekŋalis dási proseassa, nu go čiekŋalis-oahppan, ipmirdit ja máhttit geavahit máhtu eará oktavuođain
Vuođđuduvvon čálalaš máhtosirdimii	Vuođđuduvvon njálmmálaš máhtosirdimii
Spesialiserejuvvon giella mii lea fáttaid mielde	Oahppama vuolggasadji lea čatnon bargguide mas lea spesialiserejuvvon giella
Tematiserejuvvon	Holisttalaš

Boazovázzit leat ovdánahttán máhtu guođoheami birra ja boazodoalu ja birrasa dearvvašlaš ieŠvuođaid.
Dadjamušat álggogeahčen 1700 logu čájehit ahte máhttofievrredeapmi sámiid gaskka ii lean čatnasan formála skuvlaoahpahussii, muhto árbevirolaš máhttui, mii attii oahppama máŋgga fágasuorggis mat leat diehtaga vástideaddjit (seamma láđje go dieđalašvuođas, ovdamearkka dihte glasiologiija, topografiija, báikenamat, dálki, elliidčálgu, eananhálddašeapmi, bohccuid láhttenvuohki, botanihkka, navigašuvdna, astrologiija, matematihkka, ekonomiija, strategiija jurddašeapmi, panoreren, Kosmologiija ja árvvut.
Ođđa buolvvat mánnávuođa rájes juo oahppagoahtán boazodoalu , ja nu leat ge sii árrat juo ožžon máhtu ieŠguđet elemeanttain ja doaimmain. Máhttofievrredeapmi sisttisdoallá nie máhttovuođuid mat leat fievrreduvvon buolvvas bulvii.

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WHERE ARE WE TODAY IN THE EPOCH OF CLIMATE CHANGE?

Figure 12. Transportation of gutted reindeer from the kill site to the slaughterhouse in Narsaq, Tuttutooq South Greenland (Photo: Stefan Magnusson)

Figure 4. Manitsiaq John on a range patrol in March, 2022 (Photo: Stefan Magnusson)

Figure 1. Isortuusa South Greenland, 2022 (Photo: Stefan Magnusson)

During the past years, we have been registering changes in our pasturelands connected to climatic conditions. Survival and fertility of reindeer are severely reduced unless we feed the reindeer and maintain stable body weight and nutritional conditions throughout the winter.

The proposed solution is feeding the reindeer during the winter:

1. Secured survival ability
2. Increased fertility from 35% to 90+ %
3. Reindeer become tamer, less patrolling km with snowmobile, reindeer cover less territory during mid-winter as nutrition is abundant.
4. Increased funding from the government to cultivate feed and build access roads to suitable areas for feed production.
5. In Greenland, feed distribution in cultivated areas will fertilize the land as reindeer feces and urine become evenly distributed. This reduces the necessity of buying expensive fertilizers and supports local sustainability.
6. Improved feed harvesting fields by introducing suitable herbs and grasses preferred by reindeer, such as legumes and others. There is already scientific information available from earlier research. We just need to bring the information to the top of the table again.

Cultivation of suitable feed production areas within the reindeer herding districts, as to reduce the cost of transport as well as engaging other relatives and persons from the reindeer herding communities in the synergy of job creation that comes with the reindeer husbandry. Opportunity submerges to reestablish the use of land that was earlier used for dairy cow feed production, with the transition to producing suitable winter feed for reindeer. This implicates research and training of youth in the use of machinery in feed production. This may appear cross-cultural, from pure pastoralism to semi-pastoralism. Yet it is practiced already in reindeer herding in Scandinavia.

Stefan Magnusson
Reindeerhearder
Greenland

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MAKKÁR DÁLKKÁDATRIEVDAMA ÁIGODAGAS MII LEAT ODNE?

Figure 12. Transportation of gutted reindeer from the kill site to the slaughterhouse in Narsaq, Tuttutooq South Greenland (Photo: Stefan Magnusson)

Figure 4. Manitsiaq John on a range patrol in March, 2022 (Photo: Stefan Magnusson)

Figure 1. Isortuusa South Greenland, 2022 (Photo: Stefan Magnusson)

Láidehus:
Maŋemus jagiid, de leat oainnán rievdamiid min guohtuneatnamiin, čadnon dálkkádatdiliide. Bohcco ealiheapmi ja njiŋŋelasaid čoavjun, hirbmosit hedjona jus eat biepma bohccuid ja bisut deattu ja buori biebmodili dálvvi mielde

Bohtosat:
Evttohuvvon čoavddus lea biebmat bohccuid dálvet:

1. Sihkkarasttát ealihan vejolašvuođa
2. Go njiŋŋelasaid čoavjun lassána 35 proseanttas 90+ prosentii
3. Bohccot lodjot, unnit vuoddjin skuhteriin guođohit, bohccot eai nu viidát guođo guovdu dálvvi go ealáhat lea valjit
4. Eambbo ruhtadeapmi stádas fuođđariid gilvit ja hukset geainnuid heivvolaš z fuođđarbuvttadan guovlluide
5. Ruonáeatnamis, gos boazu guohtu rássebáikin, de dat maiddái dukte eatnamiid go gožžá ja baiká. Dat unnida dárbbu oastit divrras duvttaid ja doarju báikkálaš suvdilisvuođa.
6. Buorida fuođđarávkkástallanguovlluid go buktet ođđa urtasiid ja rásiid masa boazu lea váibmil, nugo bađvešattuid ja eará. Dasa gávdnojit dieđalaš dutkanbohtosat ovdalaččas. Mii fertet spežžet daid dieđuid fas beavddi ala.

Metoda:
Gilvit vuogas fuođđarbuvttadanareálaid boazoorohagain, vuoi unnida gálvofievrridanolggosgoluid ja seammás oažžut fárrui lagasolbmuid siidaguimmiid bargoháhkan synergiijii, mii boazodoalus lea. Vejolašvuohta váldit atnui areálaid mat leat ovdal adnon šibitdollui, ja baicce heivehit buvttadeami heivvolaš dálvebiepmu bohccuide. Dat das dárbbašuvvo dutkan ja oahpahit nuoraid gieđahallat mašiinnaid fuođđarbuvttadeamis. Dat neaktá kultuvrrarasttildeaddjin, čielga pastoralismas semi-pastoralismii. Dat goit ge dál juo doaibmá boazodoalus Skandinávias.

Stefan Magnusson
Boazovázzi
Ruonáeana

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Co-production of Knowledge on Climate Change Adaptation in Reindeer Sámi Culture

– RESEARCH METHODOLOGY AND ETHICS

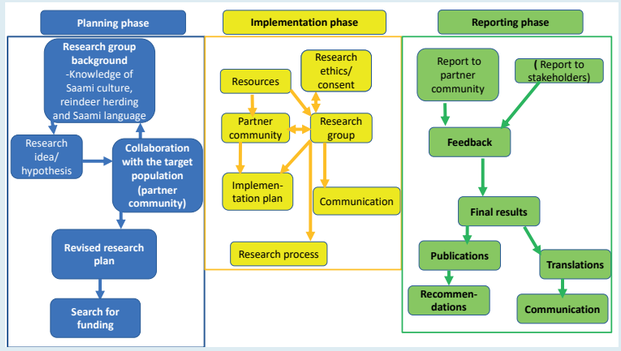

Figure 7: **Concept of co-production of knowledge adapted to the workshop results**

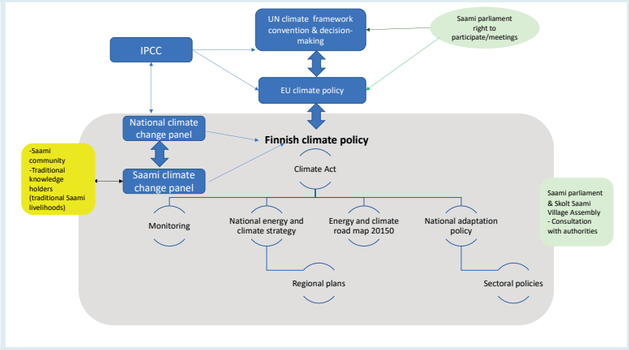

Figure 8: **Proposal to establish Saami Panel on Climate Change**

The research presents the results of the "Feasibility study on co-production of knowledge between researchers and indigenous communities for climate change adaptation"– a project of the International Centre for Reindeer Husbandry (ICR), funded by Nordforsk. The research hypothesis was that with the ethical and systematic co-production of knowledge, the academia and Sámi communities can find ways for culturally sustainable adaptation.

The workshop revealed that reindeer herders want the research to be effective and concrete, finding solutions to the challenges faced by the Sámi together with the Sámi community. Participants considered previous collaborations with academia largely negative. The workshops saw an opportunity for cooperation if herders are treated as equals and the researchers have expertise on Sámi culture, reindeer herding, and knowledge of the Sámi language.

Co-production of knowledge is one of the innovations needed to address climate change. Based on the workshop results, we see the process of knowledge co-production as contextual, ethical, and adaptive. Co-production of knowledge at a local level can be an effective method of climate change mitigation and improvements of legislation and administration. The major challenge is transforming information into State's actions and decisions. The interaction of researchers and the Sámi community alone is not enough.

The workshops have shown that Sámi are interested in ethical cooperation with academia. The traditional system of project planning, where researchers plan a project, apply for funding, and only in the implementation phase collaborate with the target population is no longer sufficient when studying Sámi reindeer herding culture. The workshops have created a basis for ethical and equitable co-production of knowledge together with the scientific community and highlighted themes that are important for the Sámi community to be studied deeper.

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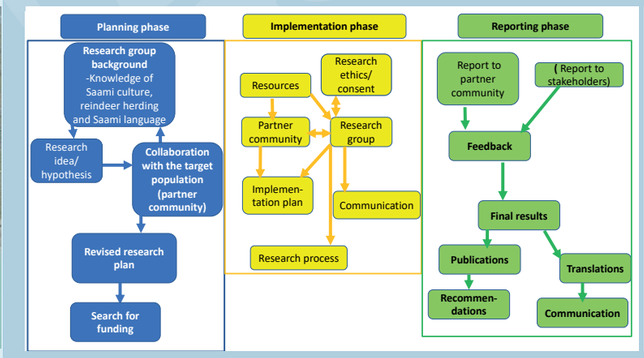
Máhttoovttasbuvttadeapmi dálkkádatrievdama heiveheami dáfus boazosámi kultuvrras

– DUTKAMA METODOLOGIIJA JA ETIHKKA



Fig, 7: **Máhttoovttasbuvttadeami konseaptta heivehuvvon bargobaji bohtosiidda**

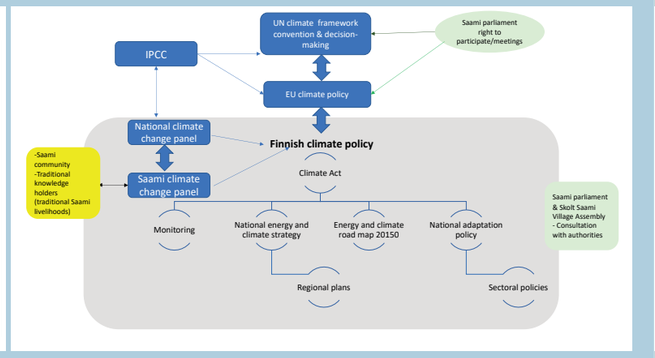


Fig. 8: **Evttohus ásahit Sámi panela dálkkádatrievdamiid váste.**

Dutkan ovdanbuktá "Feasibility study on co-production of knowledge between researchers and indigenous communities for climate change adaptation" bohtosiid – ICR prošeakta man Nordforsk lea ruhtadan. Dutkanhypotesa lei ahte ehtalaš ja systemáhtalaš máhttoovttasbuvttademiin sáhttet sihke akademiija ja sámi birrasat gávdnat vugiid kultuvrralaš suvdilis heiveheapmái.

Bargobájit čájehit ahte boazosápmelaččat háliidit beaktilis ja konkrehta dutkama, ja háliidit oktan sámi servodagain gávdnat čovdosiid hástalusaide maid sápmelaččat vásihit. Oasseváldiid ovddeš vásáhus akademiija ovttasbargguin lei eanet negatiiva. Bargobájiin oidne vejolašvuođa ovttasbargat jus boazosápmelaččaid atnet ovttaárvosažžan ja dutkiin lea Sámi kultuvrra, boazodoalo- ja sámegiela gelbbolašvuohta.

Máhttoovttasbuvttadeapmi lea okta dain innovašuvnnain mii dárbbašuvvon dustet dálkkádatrievdamiid. Bargobájiid bohtosiin oaidnit máhttoovttasbuvttadeami proseassa, kontekstuellan, ehtalažžan ja adaptiivan. Máhttoovttasbuvttadeapmi báikkálaš dásis sáhttá leat beaktilis vuohki unnidit dálkkádatrievdamiid ja buoridit lágaid ja hálddašeami. Stuora hástalus lea oažžut daid dieđuid šaddat oassin stáhta daguide ja mearrádusaid. Ovttasdoaibman dušše gaskal dutkiid ja sámi servodagaid ii leat doarvái.

Bargobajit leat čájehan ahte sámiin lea beroštupmi ehtalaš ovttasbargui akademiijain. Go dutká sámi boazodoallokultuvrra de ii leat doarvái bargat dábálaš prošeaktaplánemiin mas dutkit plánejit prošeavtta, ohcet ruhtadeami ja easka čađahanáigodagas ovttasbarget ulbmiljoavkkuin. Bargobajit leat bidjan vuođu ehtalaš ja vuoiggalaš máhttoovttasbuvttadeapmái dieđalaš servodagain ja fuomášuhtten fáttáid mat leat dehálaččat Sámi servvodahkii dutkat vuđolabbot.

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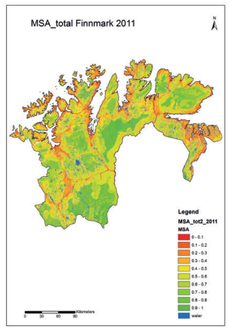
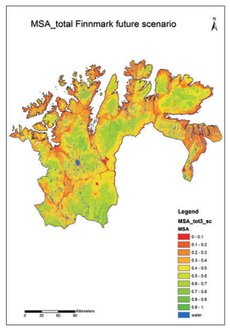
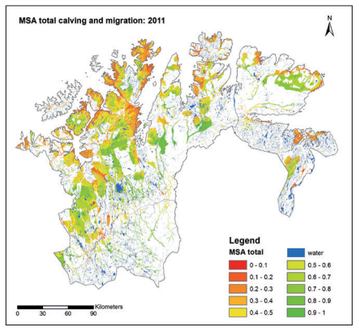
Loss of reindeer grazing land in Finnmark, Norway, and effects on biodiversity:

GLOBIO3 AS DECISION SUPPORT TOOL AT ARCTIC LOCAL LEVEL







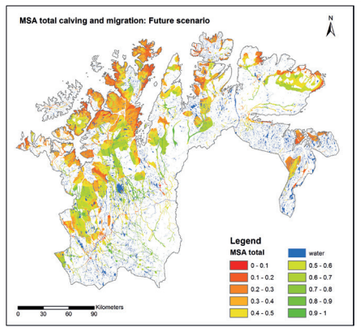


Figure 9.5.
MSA in 2011 versus projected MSA in 2030 for Finnmark, with overall reduction from 0.54 to 0.43.

Figure 9.6. **MSA total for calving grounds and migration routes in Finnmark for 2011 and projected future scenario**

Introduction:
Competing land use and climate change are threats to the pasture land of Sámi reindeer herding. Reindeer pastures are exposed to the development of infrastructure, hydropower, mineral exploration, recreational cabin areas, and wind power. Land use conflicts are exacerbated under climate policy with wind power plants in reindeer herding areas. Analysis of biodiversity loss by the GLOBIO3 model is suggested as a tool for decision support, in consultation with Sámi reindeer owners, taking into account the traditional knowledge of reindeer herding.

Results:
Impacts of climate change and physical developments on Sámi reindeer herding land in Finnmark, Norway, are explored with the GLOBIO3 model, used to assess biodiversity loss. By comparing the situation in 2011 and future scenarios, trends for biodiversity loss and implications of change in biodiversity were discussed with Sámi reindeer owners. Biodiversity loss is measured by a reduction in MSA. The biodiversity loss until 2011 and projected future loss in 2030, due to land use change, infrastructure, fragmentation, and climate change, are shown in maps for Finnmark (Figure 1).
According to this analysis the remaining biodiversity in Finnmark in 2011 was 54 per cent of the intact situation, i. e. MSA was 0.54. Results of the study show that with a scenario of + 7 degrees Celsius in annual mean temperature in the Arctic regions, climate change will be the largest contributor to additional biodiversity loss. For reindeer calving grounds, the analysis indicates that in 2011, compared to a situation of intact biodiversity, about 50 percent of the biodiversity of has been lost, and it is expected to be reduced with another 10 percent in the scenario for 2030. Especially the quality of the calving grounds is essential for reindeer herding. A case study of consequences of the Nussir mining project applies a method of impact zones and provides an in-depth study of the landscape, reporting a great concern among reindeer owners that cumulative impacts on pastures may cause reindeer herding in their district to collapse.

Method:
GLOBIO3 is a spatial model, based on map layers in a geographical information system (GIS). For actual and projected future developments of infrastructure until 2030, data were gathered from national sources, regional plans for Finnmark (county governor's office), and municipal zoning plans, with information from all municipalities in Finnmark, in publicly available reports and websites. The GLOBIO3 results were discussed in consultations with Sámi reindeer owners.

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SarVision and Plansup
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Statistics Norway (SSB)
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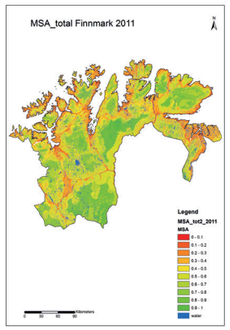
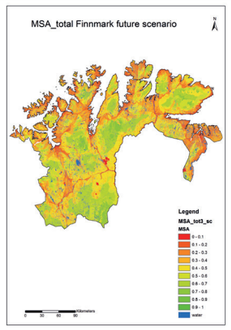
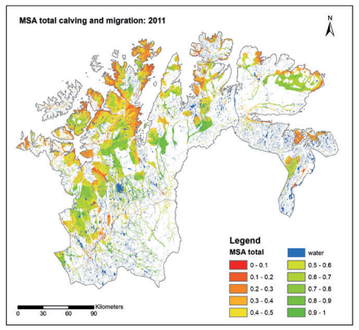
Isak Henrik Eira
Protect Sápmi and International Centre for Reindeer Husbandry (ICR)
Per Arild Garnåsjordet
Statistics Norway (SSB)

Guohtuneatnamiid massin Finnmárkkus, Norggas, ja váikkuhusat biologalaš máŋggabealatvuođaide:

GLOBIO3 VEAHKKENEAVVUN MEARRÁDUSAIDE ÁRKTALAŠ BÁIKKÁLAŠ DÁSIIDE







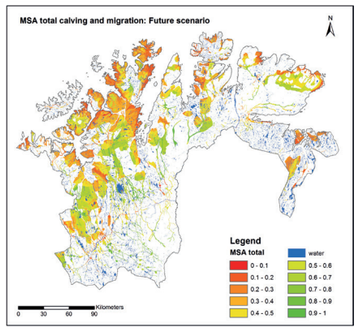


Figure 9.5.
MSA in 2011 versus projected MSA in 2030 for Finnmark, with overall reduction from 0.54 to 0.43.

Figure 9.6. **MSA total for calving grounds and migration routes in Finnmark for 2011 and projected future scenario**

Álggahus:
Gilvaleaddji eanangeavaheapmi ja dálkkádatrievdamat leat áittan Sámi boazodoalu guohtuneatnamiidda. Guorahallamat masson biologalaš máŋggabealatvuođain GLOBIO3 modealla vuođul leat evttohuvvon veahkkeneavvun dahkat mearrádusaid, ovttasrádiid sámi boazodolliiguin, vuhtiiváldimis boazodoallolealáhusa árbedieđuid.

Bohtosat:
Dálkkádatrievdamiid ja prošekterejuvvon ovdánahttimiid váikkuhusat Sámi boazoguohtuneatnamiidda Finnmárkkus, Norggas, leat guorahallon GLOBIO3 modealla vuođul, árvvoštallat biologalaš máŋggabealatvuođa massima. GLOBIO3 ovdanbuktá biologalaš máŋggabealatvuođa dili lunddolaš ollisvuođa indikáhtorin, Mean Species Abundance (MSA), definerejuvvon šlájaid gaskamearalaš gávdnamiin, dán ektui movt gávdnojit álgo (ollisvuođa) dilis. Biologalagaš máŋggabealatvuođa massin lea mihtiduvvon MSA unnumiin. Biologalagaš máŋggabealatvuođa massin 2011 rádjai ja vurdojuvvon boahtteáiggi massin 2030:s, go eanageavaheapmi rievdá, infrastruktuvrra, fragmenteren ja dálkkádatrievdan, leat čájehuvvon Finnmárkku kárttain (Fig. 9.5).

Finnmárkku dalá biologalaš máŋggabealatvuohta jagi 2011 lei 54%. Ollislaš einnostuvvon massin 2011:s gitta 2030 rádjái lohkko sullii 10%. Bohtosat govvidit go 7 lieggagráda Celsius lea jahkásaš gaskatemperatuvrra Árktisis, de leat dálkkádatrievdamat mat eanemusat váikkuhit ahte biologalaš máŋggabealatvuohta vátnu vel eanet. Eanet realisttalaš govvideapmi omd. 4 lieggagráda Celsius, de váikkuhit dat eará noađuheamit eambbo biologalaš máŋggabealatvuođa massimii, earenoamážit báikkálaččat. Ságastallamat boazoeaiggádiiguin lei ávkkálaš oahppu: garrasit váikkuhuvvon eatnamiid ii ábut navdit ahte leat masson muhto baicce oaidnit ovdánahttinvejolašvuođaid, go dat leat ain dehálaččat iešguđet áigodagaide boazodoalus johtingeaidnun ja guohtuneanamin. GLOBIO3 dutkamuš lea čađahuvvon *Nomadic Herders* ja *RIEVDAN* prošeavtta ovttasbargguin.

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Wilbert van Rooij
lea SarVision jodiheaddji ja konsuleantta Plansup, Nederlánddas, implementeren GLOBIO3 modealla.
Iulie Aslaksen
lea seniordutki Statistisk Sentralbyrå:s (SSB), bargá ekovuogadagaid bálválusaiguin, ekovuogadagaid rehketdoaluin ja The Economy of the North ECONOR prošeavttas.
Philip Burgess
bargá Arctic Global Change ásahusas, University of Lapland
Isak Henrik Eira
bargá Protect Sápmi ja International Centre for Reindeer Husbandry (ICR) doaimmaiguin.
Per Arild Garnåsjordet
lea seniordutki Statistisk Sentralbyrå:s (SSB), bargá ekovuogadagaid rehketdoaluin, ja lea oasalasttan internašionala ovdanahttindoibmii System of Environmental-Economic Accounting Ecosystem Accounting:i (SEEA EA).

COMPARATIVE ANALYSES OF LOCAL HISTORICAL AND FUTURE CLIMATE CONDITIONS IMPORTANT FOR REINDEER HERDING

in Finnmark, Norway and the Yamal Nenets Autonomous Okrug, Russia

Figure 1

Figure 1 = Extracted from Figure 8.1 in the manuscript (produced by Julia Lutz)

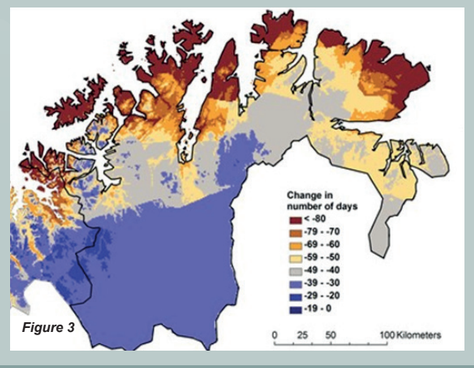

Figure 3

Figure 3 = Figure 8.20 in the manuscript (produced by Dagrun Vikhamar Schuler)

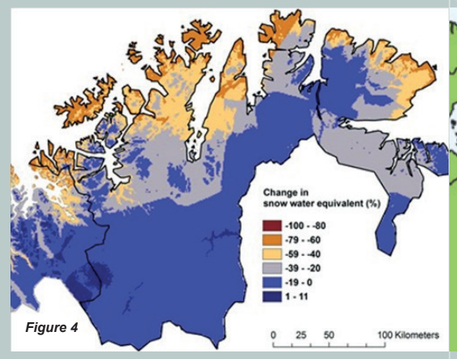

Figure 4

Figure 4 = Figure 8.21 in the manuscript (produced by Dagrun Vikhamar Schuler

Introduction:

At high latitudes, temperatures and precipitation are projected to increase under global warming. It will affect snow cover, snow amounts, and snow structure, which again will affect reindeer husbandry. In this study, we summarise the current climate change and further projections for the future climate in Finnmark and Yamal Nenets Autonomous Okrug (Figure 1). We also point out knowledge gaps.

Results:

In Finnmark, average winter (Dec-Jan-Feb) temperatures in the period 1961-1990 were about -5 °C at the coast, slightly lower in the fjords, and typically 10 °C lower inland. In the Yamal Nenets Autonomous Okrug (YNAO) average winter temperatures were even lower, ranging from -20 to -25 °C. Temperatures are presently increasing in the area, and towards the end of this century, winter temperatures in the YNAO may, under a medium-high emission scenario, while inland Finnmark may experience conditions that were earlier found along the fjords (Figure 2).

The snow season in 1961-1990 typically lasted from 6 to 8 months in Finnmark. Higher temperatures have already led to a reduced snow season, and model calculations indicate a 3-month reduction along the coast, where it is the shortest today, while the inland snow season may be one month shorter towards the end of the century (Figure 3). Along the coast, a 60% reduction in the winter maximum snow amount is projected towards the end of the century. In the interior of Finnmark, considerably smaller changes are projected in maximum snow amounts, as average precipitation is projected to increase, implicating increased snowfall during winter (Figure 4). Maximum snow amounts in the inland have increased during the last 50 years and may continue to increase slightly at some inland sites, though they will decrease in most places. The maximum snow depth will everywhere occur earlier in the season.

Higher winter temperatures will lead to changes in the snow structure. Compared to herders' reports, the SNOWPACK model successfully reproduces high-density snow layers during the past decades. High-density layers result from rain-on-snow events, or simply warm spells in the snow season, followed by below-zero temperatures. An example is shown from the winter of 1967-1968 (Figure 5 and Figure 6).

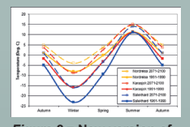

Figure 2 = New version of Figure 8.9 in the manuscript (produced by Inger Hanssen-Bauer)

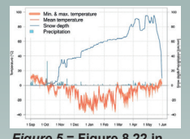

Figure 5 = Figure 8.22 in the manuscript (produced by Julia Lutz)

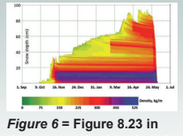

Figure 6 = Figure 8.23 in the manuscript (produced by Dagrun Vikhamar Schuler)

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BUOHTASTAHTTI GUORAHALLAMAT OVDDEŠ JA BOAHTTEVAŠ BÁIKKÁLAŠ DÁLKKÁDAGAIN MAT LEAT DEHÁLAČČAT BOAZODOLLUI

Finnmárkkus, Norggas ja Yamal Nenets Autonoma Okrugas, Ruoššas

Fig. 1

Fig. 1 = Váldán govus 8.1 čállosis (Julia Lutz lea buvttadan)

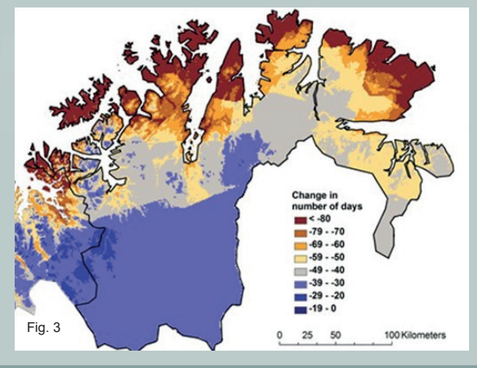

Fig. 3

Fig. 3 = Govus 8.20 čállosis (Dagrun Vikhamar Schuler lea buvttadan)

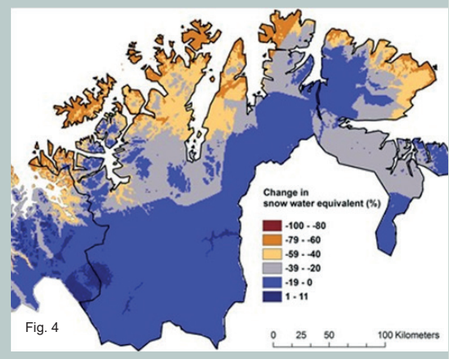

Fig. 4

Fig. 4 = Govus 8.21 čállosis (Dagrun Vikhamar Schuler lea buvttadan

Láidehus:

Davvi guovlluin einnostit ahte temperatuvrra ja njuoskkadat lassána globála liegganeami dihte. Dat čuohcá muohttagii, nu movt hivvodahkii ja struktuvrii, mii fas váikkuha boazodollui. Dán dutkosis mii čoahkkáigeassit dálá dálkkádatrievdamiid ja boahttevaš einnostemiid boahtte áiggi dálkkádaga hárrái Finnmárkkus ja Yamal Nenets Autonomous Okrug (Fig. 1). Mii maiddái čujuhit gelbbolašvuođa váilevašvuođaide.

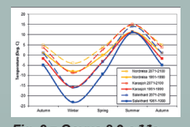

Fig. 2 = Govus 8.9 ođđa veršuvdna čállosis (Inger Hanssen-Bauer lea buvttadan)

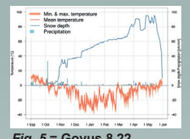

Fig. 5 = Govus 8.22 čállosis (Julia Lutz lea buvttadan)

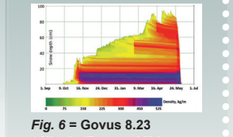

Fig. 6 = Govus 8.23 čállosis (Dagrun Vikhamar Schuler lea buvttadan)

Bohtosat:

Finnmárkkus 1961-1990 lei gaskamearálaš temperatuvra (Juo-Ođđ-Guo) sullii -5 °C gráda rittus, veaháš galbmasit vuonain, ja dábálaččat 10 °C galbmasit siseatnamis. Yamal Nenets Autonoma Okrugas (YNAO) gaskamearálaš dálvetemperatuvra lei vel galbmaset, gaskal -20 °C ja -25 °C. Temperatuvrrat guovlluin liegganit dáid áiggiid, ja čuohtejagi loahpas sáhttet YNOA dálvetemperatuvrrat, jus nuoskiduvvo eambbo go gaskamearálaččat, sulastahttet ovddeš diliid Sis-Finnmárkkus, ja siseatnamiin Finnmárkkus gos sáhttet vásihit diliid nu mo vuotnagáttiin lei ovdal (Fig. 2).

1961-1990 muohttatáigodat Finnmárkkus bisti dábálaččat gaskal 6 ja 8 mánu. Lieggaset temperatuvrraiguin otnot muohtatáigodagat ja rehketmodeallat čujuhit 3 mánnosaš oatnuma rittuin, gos dál lea oaneheamos muohtaáigodat, seammás go muohtaáigodat siseatnamis sáhttá oatnut mánuin loahpas dán čuohtejagi (Fig. 3.) Loahpageahčen dán čuohtejagi vurdo muohtahivvodat riddogáttiin unnut 60 % dan ektui go mo dál lea eanemus muohtaáigge. Sis-Finnmárkkus ii vurdo áktánasat rievdat muohtahivvodat, danin go borggat vurdojit lassánit (Fig. 4). Muohtahivvodat siseatnamis lea lassánan maŋemus 50 jagi ja daidda joatket lassánit veahážiid mielde muhtun siseatnanguovlluin, vaikko eanas guovlluin unnu. Gassa muohta boahtá mihá árabut juohke báikkis.

Lieggasit dálvetemperatuvrrat váikkuhit muohtastruktuvrii. Go buohtastahttá boazovázziid raporttaid, de lea SNOWPACK-modealla lihkostuvvan ráhkadit muohtagertniid daid maŋemus moattelot jagiid. Muohtageartnit ráhkaduvvojit go arvá muohttaga ala, dahje go leat bivvalat dálvet ja dan maŋŋel buolašta. Ovdamearka dása lea 1967-1968 dálvi (Fig. 5 ja 6).

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ADAPTATION TO CHANGE IN REINDEER HUSBANDRY IN THE REPUBLIC OF SAKHA (Yakutia), Russia

Figure 5. Young reindeer herders in the taiga zone of Southern Yakutia must not be left behind and have equal support as those in the Arctic zone of Yakutia. The past hundred years of transforming reindeer husbandry and collectivization has affected traditional knowledge transfer from one generation to another. The original family-based system was gone after the Indigenous lifestyle became sedentary.

Author of the photo:
Yuri Kokovin. Neryungrinsky District: Young Evenki couple with their child (2018)

Figure 9 **. Soviet reindeer husbandry innovations focused on enhancing meat production, which determined the herd structure with a predominance of the female population. this caused a setback in the traditional relationship between humans and reindeer. The reindeer were no longer a family member but a source of meat production.**
Author of the photo: Svein Mathiesen: Even reindeer in Tomponsky District.

Fig. 1 **Sakha (Yakutia) republihkka.**

Fig. 5 **Nuorra boazodoallit Taiga avádagas**

Fig. 9

Figure 1. **The Republic of Sakha (Yakutia) is located in the north-eastern part of the Eurasian continent and is the largest region of the Russian Federation. While 30% of the Republic's territory belong to the protected areas of Russia, global warming and globalization affect the four regions investigated differently:**

Figure 8 c. **There was a sharp decline in reindeer between January and May 2018 in the Nizhnekolymsky District. Icing of pastures and deep snow cover with icy infusion made it difficult for the animals to find food. As a result, 5,316 reindeer died because of the natural catastrophe.**
Author of the photo: Elena Antipina: Chukchi reindeer herder points at ice crust in the layers of snow. Nizhnekolymsky District.

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Introduction

With 170,000 reindeer and 1,295 herders, Yakutia is a vital region for the reindeer herding economy of five Indigenous peoples – Evenki, Even, Dolgan, Yukaghir and Chukchi.
The paper looks at characteristics of reindeer herding and reindeer herding peoples and analyzes historical transformations of reindeer husbandry in Yakutia.
The study shows the climate change impact on the reindeer herding development in four reindeer herding regions of Yakutia and also analyzes herders' adaptation to change and challenges caused by predators

Results:

Unfavorable weather phenomena for reindeer herding are extreme low temperatures, high snow cover (height from 1m and more), sharp warming (thaw) in winter, wet snow (during the hotel period), rain (in winter), blizzards, blizzards and abnormal heat in summer.
This leads to different consequences, such as the death of reindeer, low business output, the death of young animals, exhaustion from lack of food due to pasture endowment. The coralization of reindeer and other work sometimes takes place one month late, which also has a negative impact on reindeer herding. The condition for the success of traditional reindeer husbandry is the informal economic environment. The number of reindeer has reduced in all regions, but the number of reindeer herders decreased more in the south (taiga) than in the north (tundra). The large population of wolves (3,500) and 14,000-17,000 bears in Yakutia became a challenge to reindeer herding communities. Its in important in engaging Indigenous reindeer herding communities and their traditional knowledge in developing mechanisms for adaptation to climate change and predation issues. The industrial Soviet transformation of reindeer husbandry in Yakutia affected the Indigenous communities. The past hundred years of transforming reindeer husbandry and collectivisation have affected traditional knowledge transfer from one generation to another. The original family-based system was gone after the Indigenous lifestyle became sedentary. There is a need for technical and financial assistance in the development of traditional livelihoods. This educational goal should reside on the best available adaptation knowledge. It is necessary to offer new means of delivering education to practitioners of traditional livelihoods, especially those in remote areas.

Method:

Thus, data from stations in four reindeer herding districts of Yakutia were used to analyze changes and data from Hydrometeorological Center of Russia. Primary data was collected through interviews and discussions with reindeer herders from Yakutia.
Statistical reports on reindeer number in Yakutia from 1969-2018 were used to analyze characteristics and statistics of reindeer and reindeer herds in Yakutia.

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HEIVEHEAPMI BOAZODOALU RIEVDAMII SAKHA (YAKUTIA) Republihkas, Ruoššas

Láidehus:

Yakutia lea dehálaš guovlu boazodoalu ekonomiijai viđa álgoálbmogii - Evenki, Even, Dolgan, Yukaghir ja Chukchi. Doppe leat oktiibuot 170.000 bohcco ja 1.295 boazobargi.
Mii geahčadit boazodoalu ja boazobargiid dovdomearkkaid ja analyseret historjjálaš rievdamiid Yakutia boazodoalus.
Dutkamuš čájeha dálkkádatrievdama váikkuhusaid boazodoalu ovdáneapmái njealji boazodoalloguovllus Yakutias ja maiddái analysere boazobargiid heiveheami rievdamiidda ja hástalusaide čatnon borasspirevahágiidda.

Fig. 8 **Muottagearddit Nizhnekolymsky guovllus.**

Bohtosat:

Eahpeávkkálaš dálkkit boazodoalu dáfus leat hirbmat buollašat, gassa muohta (1 mehtera ja eanet), muohtasuddan gasku dálvvi, njáhcut, arvvit dálvet, guoldu ja eahpelunddolaš geassebáhkat. Dat mielddisbuktet iešguđet váikkuhusaid, nugo boazojápmimiid, heittot ealáha, nuorra bohccot jápmet, bohccot nelgot go lea heittot guohtun. Gárddástallan ja eará barggut muhtomin maŋŋonit ovttain mánuin, mas dagahit heajos váikkuhusaid boazodollui. Eahpeformála ekonomalaš biras lea eaktun ahte birge árbevirolaš boazodoaluin. Buot regiovnnain lea boazolohku unniduvvon, muhto boazobargiid lohku unnui eanet lulde (taigas) go davvin (tundras). Gumpevalvvit (3500 gumppe) ja 14000-17000 guovžža Yakutias lea hástalus boazoálbmoga servvodagaide. Dat lea dehálaš ahte eamiálbmot boazodoalloservodagat servet sin árbevirolaš máhtuin ovdánahttit vugiid heivehit dálkkádatrievdamiidda ja borasspire áššiide. Go Sovjeta industrialiserii Yakutia boazodoalu, dat váikkuhii eamiálbmot servodagaide. Maŋemus čuođi jagi boazodoalu rievdademiin ja kollektiviseremin váikkuhii árbevirolaš máhtosirdimii buolvvas bulvii. Bearašvuođđuduvvonvuogádat jávkkai maŋŋel go eamiálbmogiid eallinvuohki rievddai ja šadde unnit lihkadanbarggut. Dárbbašuvvo teknihkalaš ja ekonomalaš doarjja ovdánahttit árbevirolaš eallinlági. Dat oahpahusmihttu berre vuođđuduvvot buoremus heivehangelbbolašvuhtii mii lea gávdnamis. Lea dárbu fállat ođđa oahpahusvugiid sidjiide geat ellet árbevirolačča, earenoamážit doaresbeale báikkiin.

Metoda:

Njealji boazodoalo guovllus Yakutias leat dáhtat stašuvnnain adnon analyseret rievdamiid ja Ruošša Hydrometeorological Center dáhtat. Vuođđodieđuid čohkkeje jearahalle ja digaštalle Yakutia boazodolliiguin. Statistihkkaraporttat Yakutia boazologuin jagiin 1969-2018 váldoje adnui analyseret Yakutia bohccuid ja ealuid ieŠvuođaid ja statistihka.

Fig. 9 **Sovjeta boazodoalu guovddážis lei biergobuvttadeapmi**

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FRAMING ADAPTATION TO RAPID CHANGE IN THE ARCTIC

Figure 3

Figure 2

Figure 3. **Adaptation to climate change in reindeer husbandry must include protection of grazing land and avoiding blocking of migration routes and calving ground. (Photo: S.D. Mathiesen)**

Figure 1. **Yamal Nenets reindeer herders working with the herd during spring migration. (Photo: E.I. Turi)**

Figure 4. **Indigenous reindeer herders from the Circumpolar North met in Guovdageaidnu for a joint training program on the use of traditional knowledge to protect biodiversity at the Sámi University of Applied Science and International Centre for Reindeer Husbandry (2017). (Photo: S.D. Mathiesen)**

Indigenous reindeer herders in the Circumpolar North are facing climate and socio-economic changes that threaten herders' economic and cultural well-being and transform their operational environment.

We suggest the following strategies in the reindeer herding societies:

Co-production of knowledge, an adaptation strategy in which the academia and Indigenous reindeer herding peoples can apply an ethical and systematic co-production framework.

Adaptation through feeding in winter, when access to forage is restricted. Supplementary feed can improve survival in winter and increase the herd tameness.
Adaptation through changing the herd structure and rreducing vulnerability, for example, through castration. Castrated male reindeer do not rut, are calmer, and heavier, and are better at finding feed. The reintroduction of castrates in Norway could be a survival strategy for individual animals and the herd.

Adaptation through the protection of critical grazing land and migration routes.
Adaptation involves maintaining nomadic pastoralism and requires increasing competence locally through research and training: it is important to develop courses on the degradation of grazing land. This also involves a paradigm shift in the perception of reindeer herders' Traditional Knowledge, innovative landscape management, and self-determination.

Adaptation through an improved economy. Adaptation is about securing reindeer herders' control over their value chain. It is possible through the creation of local products rather than competing with imported industrial beef and pork. Adaptation to an improved economy should include a strengthening of the family-based reindeer husbandry.

Adaptation strategies' development depends on using foundational scientific perspectives and insights from herders' Traditional Knowledge. Reindeer herding practices are based on generations of accumulated experience, conserved, developed, and adapted to the climatic and administrative systems of the Arctic. Reindeer herders' resilience is about finding ways to strengthen their societies – from within.

Figure 2. **Nenets reindeer herding brigade on the Yamal peninsula in early June 2009. Drying bread on the sleds after a long spring migration showcases the importance of a family-based economy. (Photo: S.D. Mathiesen)**

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EAMIÁLBMOT BOAZODOALLIT DAVVIGUOVLLUIN VÁSIHIT DÁLKKÁDAT

- ja sosioekonomalaš rievdamiid mat áitet boazodolliid ekonomalaš ja kultuvrralaš čálggu ja mii rievdada bargobirrasa

Fig. 3

Fig. 2

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Eamiálbmot boazodoallit Davviguovlluin vásihit dálkkádat- ja sosioekonomalaš rievdamiid mat áitet boazodolliid ekonomalaš ja kultuvrralaš čálggu ja mii rievdada bargobirrasa.

Mii evttohit čuovvovaš strategiijaid boazodoalo servodagaide:
Máhttoovttasbuvttadeapmi, heivehuvvon strategiija mas akademiija ja eamiálbmot boazodoallit sáhttet váldit atnui ehtalaš ja systemáhtalaš ovttasbuvttadaneavttuid

Dálvebiebmama heiveheapmi, go guohtun lea heitot. Lassi fuoðđarbiebman sáhttá buoridit birgema dálvet ja lodjudit ealu.

Heiveheapmi ealu lágideami bokte ja unnidit raššivuoða, omd. gáldemiin. Spáillihat eai raga, leat láikkibut ja losibut, ja guhtot buorebut. Álggahit fas gáldema Norggas sáhttá leat birgenstrategiija eaŋkil bohccuide ja ealuide.

Heiveheapmi go gáhtte dehálaš guohtuneatnamiid ja johttingeainnuid.
Dat heiveheapmi mearkkaša doalahit nomádalaš pastoralismma ja gáibida loktet gelbbolašvuođa báikkálaččat dutkama ja oahpahusa bokte: lea dehálaš ovdánahttit oahpuid guohtoneatnamiid hedjoneamis. Dat maiddái mearkkaša paradigmamolsun movt ipmirdit boazodolliid árbevirolaš máhtu, sin innovatiiva eananhálddašeami ja ieŠmearrideami.

Heiveheapmi buoriduvvon ekonomiijii. Heiveheamis lea sáhka ahte sihkkarastit boazodolliid ieŠmearrideami árvogeavllis. Dat lea vejolaš go ráhkada báikkálaš buktagiid dan sadjái go gilvalit importerejuvvon oapme- ja spiinnebiergguin. Heiveheapmi buoriduvvon ekonomiijii galggašii sisttisdoallat ahte bearašboazodoallu nannejuvvo.

Heivehanstrategiijaid ovdáneapmi lea čadnon ahte geavahit vuđolaš dieđalaš perspektiivvaid ja ipmárdusa boazodolliid árbevirolaš máhtus. Boazodoalu bargopráksisat leat vuođđuduvvon buolvvaid čohkkejuvvon vásáhusaide, gáhttejuvvon, ovdánahttojuvvon ja heivehuvvon dálkkádat- ja hálddahuslašvuogádagaide Árktisas. Boazodolliid vuostálastinfápmu mearkkaša gávdnat vugiid movt nanne servodaga – ja mas vuolgga lea servodaga siskkobealde

Fig. 2. **Nenets reindeer herding brigade on the Yamal peninsula in early June 2009. Drying bread on the sleds after a long spring migration showcases the importance of a family-based economy. (Photo: S.D. Mathiesen)**

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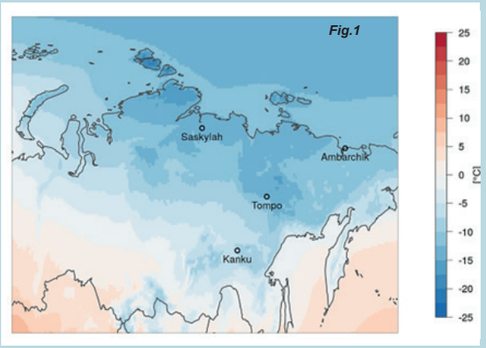
in the Republic of Sakha (Yakutia)

TRENDS AND EFFECTS OFCLIMATE CHANGE ON REINDEER HUSBANDRY



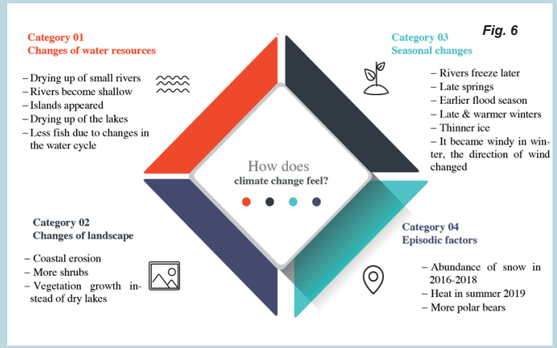


Fig. 1. **Map of the four analyzed weather stations in Yakutia. The colours show the mean air temperature averaged over 1980-2019, taken from the ERA5-Land reanalysis data set.**

Introduction:
This chapter provides an analysis of:
1) meteorological data from four weather stations in the Republic of Sakha (Yakutia) to show the changes in climatic parameters in reindeer husbandry areas;
2) temperature projections for the end of the 21st century;
3) permafrost condition and number of forest fires occurrences
4) indigenous peoples' perception of the impact of climate change on reindeer husbandry;
5) financing of resilience development in the Republic.

Results
Snow cover, precipitation and air temperature data from four weather stations: located in four reindeer husbandry areas in the tundra and taiga zones.
The general trend of changes in the mean annual and seasonal air temperature and precipitation is positive for all stations. An increase in temperature and alteration in the precipitation regime cause changes in snowpack, its time frame and formation, radiation balance, circulation processes, earlier melting and flooding. The intense thawing of permafrost is accompanied by visible environmental changes such as deforestation, waterlogging and other types of land degradation which leads to additional risks associated with it. A very sharp increase in the number of forest fires in recent years isobserved, mostly caused by thunderstorms and human activity. Indigenous peoples in Nizhnekolymsk ulus showed that climate change is most often mention issues related to water resources and changes in the natural cycle as factors of change. Financing of resilience development in the Republic, threats and challenges to the development of reindeer husbandry and proposals for overcoming them are discussed.

Method
Daily data from the stations were used to analyze changes. Student's t-test was applied to test trends of the variables for statistical significance at the 5 % level. Empirical Statistical Downscaling techniques were applied for stations to downscale the simulated temperature of 81 global climate model runs.

Fig. 6. **Climate and weather change features in the perceptions of local people (residents of rural areas) of the Arctic regions of the Sakha (Yakutia) Republic.**

Fig. 7. **Reindeer herd near Neryungry, Republic of Sakha (Yakutia).**
(Photo: Alena Gerasimova)

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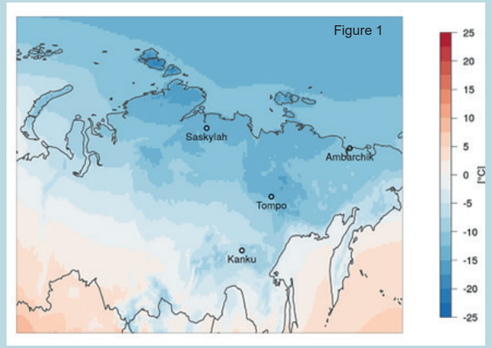
DÁLKKÁDAGAID RIEVDAMAT JA VÁIKKUHUSAT BOAZODOALLO-EALÁHUSSII SAKHA (Yakutia) Republihkas



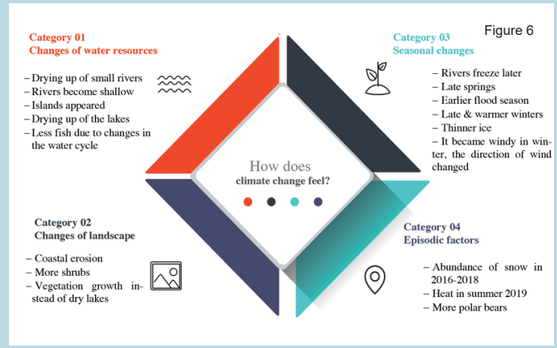


Fig. 1. **Kártta mas oaidná dán njeallje guorahallojuvvon dálkestašuvnna Yakutia:s. Ivnnit čájehit gaskamearalaš áibmotemperatuvrra jagiin 1980-2019, mat leat vižžon ERA5-Land data čoahkkaldagas.**

Muohta-, njuoskkadat- ja áibmotemperaturdáhtat njealji dálkkestašuvnnain sajustuvvon njealji boazodoalloguovlluide tundra- ja táigaavádagain Sahkha Republihkas (Yakutia) analyserejuvvoje – čuovvovaš báikkiin Nizhnekolymsky, Anabarsky, Tomponsky og Aldansky uluses (fig.1). Buot stašuvnnat čájehit ahte obbalaš treanda movt áibmotemperatuvra ja njuoskadat rievdá gaskamearalaččat jagi ja áigodagaid mielde lea positiiva.

Rievdamat dálkkádat paramehterin boazodoalloguovlluin lea áicojuvvon. Bivaldeapmi ja njuoskkadatrievdamat váikkuhit ahte muohta rievdá, nugo man olu muohta lea, goas jagis muohta lea ja movt dat boahtá. Eará bealit leat maiddái suonjardan balánsa, birrajođaldat proseassat, árra suddan ja dulvi.

Go buohtastahttá gaskameari 2071-2100 CMIP5-joavkku simuleremin RCP8.5-dillalašvuođain 1971-2000 gaskameari simuleremiiguin buot jahkeáigodagaid dáfus de buot stašuvnnat čájehit bivaldeami. Eanemusat bivalda čuođi jagis dálvet (8.5 lieggagráda Celsius) ja giđđat (7.5 lieggagráda Celsius) Saskylakh ja Ambarchik stašuvnnain (goappašagat mearragáttis).

Girse jođánis suddama čuovvu oinnolaš biras rievdademiid nugo vuovdejávkan, dulvan ja eará eanan billisteamit mat váikkuhit lassi várálašvuođaid.
Stuora lassáneapmi vuovddebuollimiin daid maŋemus jagiid lea áicojuvvon. Bajándálkkit ja olbmuid doaimmat lea sivvan vuovddebuollimiidda. Eananvuolbuollimat lassánit boazodoalloguovlluin ja buollin joatká vaikko lea ruosti buolaš, birrasat 50 buolašgráda. Go leat jearahallan eamiálbmogiid Nizhnekolymsk ulus guovllus, de čájehuvvo ahte báikkálaš olbmot áicet dálkkádat rievdamiid ja namuhit dávjjimusat áššiid čatnon čáhceresurssaid ja lunddolaš birrajohtima rievdademiide.

Báikkálaš olbmuid ipmárdus movt dálkkádat rievdamat váikkuhit boazodollui rievddada (fig. 6), ja go dálkkádat rievddada eambbo ja eatnamat rivdet de boazodoalo áigodagat heivehuvvojit dan mielde, nugo ragat, guottet, johtingeainnut, go massá guohtuneatnamiid, go eananmearkkat rivdet ja eará rievdamat.

Fig. 6. **Dálkkádat- ja dálkerievdan ipmárdus báikkálašolbmuin (boaittobeale ássiin) Árktalaš guovlluin Sakha (Yakutia) Republihkas**

Fig. 7. **Reindeer herd near Neryungry, Republic of Sakha (Yakutia).**
(Photo: Alena Gerasimova)

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