2. ARTIHKAL/ARTICLE II:

Ođđa siida-vuđot gozihanvuogádat observeret dálveguohtuneatnamiin dálkkádatvariabiltehta váikkuhusaid sámi boazodoalus. (*Giehtačálus*)

Translated to English:

**A novel siida-based monitoring system to observe effects of climate variability on winter pastures in Sámi Reindeer herding. (*Manuscript in preparation)*

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Ođđa siida-vuđot gozihanvuogádat observeret dálveguohtuneatnamiin dálkkádatvariabiltehta váikkuhusaid sámi boazodoalus.

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Abstrákta

Dálkkádat- ja sosioekonomalaš rievdamat leat dál dovdogoahtán boazodoalloservvodagain miehtá árktalaš guovlluin. Ja dálkkádatsenariijat govvidit ahte gaskamearálaš gaskaáibmotemperatuvra dálvet loktana gávcci grádain ja ahte muohtaáigodat gaskamearálaččat oatnu eanet go mánuin Guovdageainnus, mii lea Norgga boazosápmelaččaid váldo boazodoalloguovlu. Dát artihkal gieđahallá jearaldaga movt gozihit diekkár rievdamiid ja variišuvnnaid dálveguohtuneatnamiin árbevirolaš máhtuin, mii lea oassin boazosápmelaččaid fágagielas. Ođđa vuogádat ráhkaduvvui ja dása geavahuvvui earenoamáš hábmejuvvon guođohanbeaivegirji, mii deattuhii muohtadiliid ja dáid váikkuhusaid dálveguođoheapmái. Viđa siidda boazovázzit Guovdageainnus, ieža gozihedje beaivválaččat muohtadiliid, biekka, muohttaga/arvvi variašuvnnaid ja topográfiija, ealu láhttema ja ahtánuššama dáfus vihtta mánu jagis, golmma dálvvi badjel (2007-2009), ja čilgejedje dáid variašuvnnaid iežaset árbevirolaš máhtu ja fágagiela vuođul. Bohtosat čájehit ahte guođohanbeaivegirji sáhttá geavahuvvot gozihanneavvun beaivválaččat observeret guohtundiliid variašuvnnaid ja diversitehta, beivviid gaskka, guohtuneatnamiid ja siiddaid gaskka ja vel dokumenteret boazovázziid guođohanstrategiijaid dálvet. Čohkkejuvvon datat speadjalastet boazovázziid árbevirolaš máhtu muohttaga ja muohtarievdamiid birra. Dát lea maiddái movttidahttán nuorra olbmuid eambbo ságastallat dáid áššiid birra. Moai evttohetne digaštallat vejolašvuođaid geavahit dákkár gozihanvuogádaga, maid boazovázzit ieža geavahit, dokumenteret árbevirolaš máhtu ja gozihit boahtteáiggi dálkkádatrievdamiid váikkuhusaid boazodollui.

Čoavddasánit: Muohtadilit, boazodoallu, siida-vuđot goziheapmi, dálkkádatrievdan, sámegiella, árbevirolaš máhttu.

1. Álggahus

1.1 Dálkkádat ja boazodoallu

Boazodoalloealáhus lea boares ealáhus mii ovddasta ceavzilis vuogi movt davvi eananekovuogádagaid ávkkástallat ja hálddašit, maid vuođđun leat buolvvaid vásáhusat, mat leat čohkkejuvvon, vurkejuvvon, ovdánahtton ja heivehuvvon davvi dálkkádagaide ja hálddašanvuogádagaide. Dán modealla mielde leat badjel 20 iešguđet boazoálbmoga Euraisas sáhttán ávkkástallat biebmobuvttadeapmái árktalaš guovlluid márginála luondduresurssaid (Turi, 2002). Guovdageaidnu Finnmárkkus, mii lea 69°D, 23°N, lea boazosápmelaččaid guovddáš boazodoalloguovlu Norggas, gos leat galbmaseappo ja stábilat dálvvit (gaskameari dálvi) go Atlántara-ábi rittuin Davvi-Norggas (gaskameari dálvi) (Vikhamar-Schuler *et al.*, 2010 b) gosa bohccuiguin johtet jagiáiggi mielde. Dáid guovlluid boazodoalu ja boazodoalloálbmogiid čálalaš historjjá álgá 892 m.kr (Storli, 1994), ja Njenetsa boazodoallu, Jámala-njentsa Autonoma Guovllus Ruoššas, lea aitto báliid daterejuvvon leat boarrasit go 2,000 jagi (Fedorova, 2003). Dát muitala makkár poteansiála mii lea máhtus dálkkádatdiliid birra ja mii lea čoggon guhkes áiggi badjel. Dát sáhttá mearkkašit ahte Davvi Eurohpá sámi boazodoallu ovdánii dan áigodagas goas eai lean stuorát dálkkádatrievdamat dálvet, muhto main ledje variášuvnnat beivviid, mánuid ja jagiid gaskka (Mathiesen *et al.,* 2011, manus).

Boazosápmelaččain lea máhttu movt eallit rievddadeaddji birrasis. Doaba "stabilitehta" lea amas sátni sámegielas. Ja danin eai leat heivehanstrategiijat čadnon stabilitehta doahpagii, muhto baicca deattuha čađat heivehit rievddadeaddji diliide (Reinert *et al.*, 2008). Boahtteáiggi temperatuvrasenariat čájehit ge ahte dálvetemperatuvra (juovlam.-ođđaj.-guovvam.) Guovdageainnus sáhttá loktanit 8°C boahttevaš 100 jagis (Benestad, 2011) ja ahte dálvetemperatuvrrat dálveguohtun-eatnamiin sáhttet šaddat sullásaččat go riddoguovlluid dála temperatuvrrat (Hanssen-Bauer, 2011, manus). Dasa lassin dárkilis-senariat Guovdageidnui čájehit ahte muohtaáigodat sáhttá oatnut eanet go mánuin ja ahte jahkásaš maksimála muohtagassodat sáhttá unnut 60%:in. Boahtteáiggi muohtadilit sáhttet váikkuhit

bohccui ja boazovázziid dála guođohandábiide. Dálkkádatrievdan ja sosioekonomalaš rievdamat vuhttojit sirkumpolára davviguovlluid árbevirolaš boazodoalloguovlluin (Magga *et al*., 2011). Jus galgá ceavzilis boazodoallu oažžut ovdamuni almmolaš hálddašanstrategiijain, lea dehálaš váldit mielde ja dohkkehit eamiálbmogiid árbevirolaš máhtu, kultuvrra ja gielalaš gálggaid (Nuttall *et al*., 2008).

1.2 Boazodoallu ja dálveguođoheapmi

Eamiálbmot máhtu dutkamiin, "The SIKU" prošeakta lea aitto čájehan máŋggaperspektiivva vuoimmi ja introduseren ođđa fágaidgaskkasaš mearajiekŋa dutkama, mas leat ovttastahttán servodatlaš (sosio-kultuvrralaš) luonddu máilmmi aspeavttaid ja masa leat čatnan báikkálaš terminologiija, klassifikašuvnnaid ja báikenamaid (Krupnik *et al.*, 2010).

Dál lea dohkkehuvvogoahtán ahte boazovázziin leat návccat heivehit variašuvnnaide ja rievdamiidda maid vuođđu lea árbevirolaš máhttu, mii gávdno gielas ja boazovázziid guođoheamis ja bargguin (ACIA, 2004; Tyler *et al*., 2007; Magga *et al*., 2011; Eira *et al*., 2011, sisa sáddejuvvon). Ovdamearkka dihte leat boazosápmelaččain riikkis muohta- ja muohtanuppástuhttinterminologiija ja guođohanterminologiija (Eira, 1994; Magga, 2006; Eira *et al*., 2010; Riseth *et al*., 2010; Eira *et al*., 2011 sáddejuvvon sisa; Magga *et al*., 2011). Beaivválaš boazobargu sisttisdoallá ollu iešguđetlágan doaimmaid. Boazovázzi váldobargu lea observeret diliid beaivválaččat, áiggis áigái dálvvi čađa. Boazovázzi ferte mearridit maid ja movt iešguđet diliin dahkat duon áiggis ja duon sajis (Sara, 1990). Dálvebeale jagi gohčoduvvo *guođohit*, ja geassebeale jagi fas *geahččat*. *Geahččat* mearkkaša ahte ovttatládje čuovvut mielde gos eallu lea. Fágatearbma *guođohit* vuolgá *guohtun*-sáni kausatiiva-suorggádusas *guođuhit* ('diktit/bidjat guohtut'). Vuođđomearkkašupmi čájeha bohcco biebmo- ja čáhcedárbbu guovddáš saji, mii lea boazovázzi ipmárdusa mielde dalle go bohccos lea buorre dilli (Eira *et al*., 2010).

Boazovázzi ferte iskat gos lea ealát ja gokko lea buorre guohtun vai diehtá gosa sáhttá ealu doalvut guohtut. Oassin beaivválaš doaimmas leat observeret, geahččat, guorahallat ja iskat muohtadiliid ja daid rievdamiid, mat váikkuhit bohcco ceavzimii

čieža mánu muohtamáilmmis. *Guođoheapmi* maiddái sisttisdoallá suodjaleami ja oadjebasvuođa duddjoma bohccuide (Eira *et al*., 2010). Boazovázzi ferte bearráigeahččat bieđgananvára, mastanvára, muosehuhttin- ja vaháguhttinvára (Sara, 2006). Dán vuolggasajis ferte olmmoš soabahallat jus galgá birget bohccuiguin dainna jurdagiin ahte bohccos leat ollu dárbbut (Magga *et al*., 2001). Bohcco vuođđodárbbut leat guohtut, ja de livvadit, bálgat, johtáladdat, mannat, olbmo bearráigeahčuin. Olmmoš ferte dáid ektui bargat nu ahte bohccos lea buorre dilli (Eira *et al*., 2010.)

Dilit sáhttet dálkki geažil fáhkkestaga rievddihit, ja dan guvlui maid ii ovdagihtii sáhte diehtit. Dáin diliin boazovázzi ferte ieš gávnnahit movt ain bargat, das fertejit leat strategiijat movt čoavdit dillid. Boazovázzi ferte guođohettiin válljet eará báikkiid dahje guođohaneatnamiid jus muohttaga dilit leat nu ahte varohit ahte boazu ii eale. Buot dát dálveguođohanaspeavttat sisttisdollet árbevirolaš observeme ja mentála goziheami variašuvnnain ja rievdamiin áiggi ja báikki dáfus, dálveguohtuneatnamiid geavaheamis ja guohtundiliin. Áitto leat Eira ovttas eáráiguin (2011, sáddejuvvon sisa) gávnnahan ahte boazovázziid muohtamáhttu lea eanet ollislaš ja integrerejuvvon ealu ekoloiijai ja guohtumii go riikkaigaskasaš muohtadoahpagiid standarat leat. Dát dutkan govvida dehálašvuođa geavahit árbevirolaš sámegiela terminologiija boazodoalu heivehanstrategiijaide dálkkádat rievdamiidda, ja deattuha dárbbu geavahit guokte máhttovuogi, sihke árbevirolaš máhtu ja dieđalaš máhtu. Boazosápmelaččaid árbevirolaš máhttu ja sámegiela muohtatearpmat, mat leat čadnon bohccui, boazovázziide ja ellid ahtánuššamii, leat konkrehta ovdamearkkat das movt árbevirolaš máhtu sáhttá geavahit observeret ja gozihit.

1.3 Báikegodde-vuđot goziheapmi

Berkes & Berkes (2009), čálliba ahte eamiálbmogiid dálkkádatrievdamiid observašuvnnat sáhttet addit oppalaš vuogádatipmárdusa ja lassin dieđuid dieđalašlahkonemiide jus váldá fárrui báikkálaš dási máhtu, man vuođđun lea árbevirolaš máhttu.

Báikegottiid árbevirolaš máhttu ja oberservašuvnnat sáhttet addit vuođđodieđuid dálkkádathistorjjá birra; sáhttet veahkehit hábmet dutkangažaldagaid ja

hypotesaid go addet dieđu ja ipmárdusa das movt heivehit dálkkádatrievdamiidda ja dáid váikkuhusaide. Árbevirolaš máhtu sáhttá maiddái geavahit guhkitáiggi báikegoddevuđot geaziheapmái. (Riedlinger & Berkes, 2001; Berkes, 2008).

Árbevirolaš máhttu sáhttá geavahuvvot guhkesáiggi báikegoddevuđot goziheapmái addit vuođđodieđuid dálkkádathistorjjás, mat de sáhttet veahkehit ráhkadit čuolmmaid ja hypotesaid danne go addet dieđuid makkár váikkuhusat lea leamaš ja movt daidda heivehedje rievddadeaddji dálkkádagas. Báikegoddevuđot goziheapmi definerejuvvo proseassan mas báikegottit dahje eaŋkil olbmot oassálastet guhkitáiggi goziheamis omd. šattuid, ekovuogádatproseassaid oktavuođas jna. main váldoulbmilin lea buoridit ekovuogádagaid ja luondduresurssaid hálddašeami (Yarnell *et al*., 2003).

Báikkálaš birasgoziheami vuođđojurdda lea ahte resurssageavaheddjiid lagasvuohta resurssaide addá vejolašvuođa dárkilit gozihit birrasa, ja muhtun dillin sáhttet gozihit rievdamiid beaivves beaivái (Berkes, 2008).

Eamiálbmot-perspektiivvas lea báikegoddevuđot goziheapmi ovdamunnin danne go čohkkejuvvon dieđut leat doarjjan báikegottiid ja báikkálaš servodagaid mearridanproseassaide sin beroštumi mielde, mas báikegottit ollislaččat leat mielde mearrideami. Ovttasbargofállamiin lea gozihanprošeavttain potensiála hukset šalddi gaskkal dieđalašvuođa ja árbevirolaš máhtu (Berkes, 2008; Riedlinger & Berkes, 2001).

1.4 Siida-vuđot dálveguohtundiliid gozihanvuogádat

Dát artihkal gieđahallá jearaldagaid movt geavahit árbevirolaš máhtto-vuđot guođohanbeaivegirjji, ovttas boazosápmelaččaid muohtamáhtuin ja movt dát váikkuhit guođoheapmái, mii lea siidavuđot gozihanvuogádat. Boazovázzit viđa dálvesiiddas Oarje-Finnmárkkus leat gozihan dahje bearráigeahččan iežaset guohtundiliid, dárbbuid ja rievdamiid juohke beaivvi golbma dálvvi badjel. Dán artihkkalis digaštalle 1) heive go ođđa gozihanvuogádaga geavahit metodan dokumenteret guođoheami fágamáhtu ja guohtundovdomearkkaid variašuvnnaid dáin dálvesiiddain. 2) sáhttet go boazovázzit ieža boahtteáiggis geavahit dán vuogi gozihit movt dálkkádatrievdan váikkuha sámi boazodollui boahtteáiggis. De áigo vel digaštallat man dehálaš lea addit eamiálbmot

boazovázziide buoremus teknologiija mii gávdno, mii lea ovttastahtton eamiálbmogiid iežaset máhtuin mainna sáhttet observeret ja gozihit rievdamiid.

2. Metoda

2.1 Dutkanguovlu

Dát dutkan lea 2007, 2008, ja 2009 čađahuvvon Guovdageainnus (69°D, 23°N), guovddáš sámi boazodoalloguovllus Norggas, gos ledje 93,500 bohcco, 53 dálvesiidda ja 1,700 boazosápmelačča. S*iida* lea boazovázziid bargoovttastus masa maiddái gullá eallu ja árbevirolaš guohtoneatnamiid geavaheapmi jagiáiggiid mielde. (Strøm Bull *et al*., 2001). Oarje-Finnmárkku boazodoalloguovllus leat dálvesiiddat juhkkon golbman johtalahkan (oarje-, guovda- ja nuortajohtolaga). Dán dutkamis gohčoduvvojit oassálasti siiddat *guođohanstašuvdnan*, mas juohkehaččas lea sierra nummar. Jahkásaš galbmaseamos temperatuvra lea -16 °C ja gaskamearálaš muohta/arvi dálvet lea 11 mm. Jahkásaččat, earenoamážit dálvvi čađa, lea sis-Finnmárku galbmaseamos ja goikaseamos guovlu Davvirikkain (Tveito *et al*., 1997, 2000).

2.2 *Siidda* oassálastin

Muohta- ja dálveguohtundilit leat dutkojuvvon viđa iešguđet siiddas, mat ledje válljejuvvon sierra eavttuid mielde: 1) Informántan galge leat sámegielat boazovázzit geat eallinagi leat bargan bohccuiguin; 2) ja juohke johtolagas galge leat okta/guokte siidda mielde; 3) Siiddat galge nu bures go lei heivvolaš ovddastit geasseorohagaid (sulluid, njárggaid ja nannanorohagaid) ja dálveorohagaid girjáivuođa; 4) Dálvesiiddat eai galgan leat lahkalaga ovddastan dihte iešguđetlágan dálkediliid Guovdageainnu boazodoalloguovllus (guovtti siidda gaskkas lea eanemus 87 km). Buot boazovázzit leat dievdoolbmot gaskkal 23 ja 65 jagi, geaid namat leat anonymifiserejuvvon dáin datain. Juohke guođohanstašuvnna siiddas leat leamaš guovttelágan informánttat, 1) boazovázzit geat beaivválaččat guođohanbeaivegirjái devde dálke- ja muohtadieđuid (20 boazovázzi oktiibuot) ja 2) juohke siiddas lei okta dahje moadde informántta geain lea leamaš váldoovddasvástádus hálddašit guođohanbeaivegirjji. Jearahallamiin

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muitaledje boazovázziid muohtadiliid ja dáid rievdamiid birra ja movt dát váikkuhit ellui. Jus nuorra boazovázzit bártidedje beaivegirje deavdimiin, de ožžo sii veahki ja bagadallama siidda váldoolbmuin. Beavdegirječállináigodagas lei dutkis ja váldoovddasvástideddjiin dássedis gulahallan juogo telefuvnnain dahje sms:a bokte ja mánnusaš čoahkkimiiguin. Dát dahkkui sihkkarastin dihte dássedis beaivegirječállinproseassa ja vel lassin oažžut liigedieđuid mat eai lean čállon beaivegirjjiide.

Beaivegirječállit ja dutki čálle vuollái šiehtadusa dan birra movt beaivegirjjiid sáhttá geavahit dutkamis ja maŋŋil dutkama. Vaikko dutki lei ráhkadan ja hábmen guođohanbeaivegirjjiid, de válmmasin devdon beaivegirjjit leat siiddaid priváhta dokumeanttat, maid dušše dutki beassá geavahit iežas dutkamii, ja prošeavttas ii leat lohppi almmuhit orginála beaivegirjjiid. Juohke dálvvi maŋŋil leat boazovázzit leamaš mielde analysereme dátaid. Digaštallamiid vuođul leat boazovázzit njálmmálaččat buktán lassi čilgehusaid dáidda. Buot boazovázzit leat maŋŋil dohkkehan dutkananalysaid mat gullet iežaset siidii.

2.3 Gozihanindikahtorat ja beaivegirjji hápmi

Miggal-Niillas Issát-Niillas rohki čálii 1989:s dárkilis dieđuid beaivegirjái iežaset boazobargguid birra, guođoheami, dálkki, temperatuvrra ja muohttaga birra, masttademiid ja gárddástallamiid birra. Dát beaivegirji geavahuvvui mállen 2006:s ráhkadit gozihanbeaivigirjji prototyhpa, mii lea dán prošeavttas geavahuvvon. Beaivegirji lea ráhkaduvvon speadjalastit siidda organiserema ja boazobargguid čađaheami dálvet, movt boazovázzi árvvoštallá diliid mat váikkuhit bohccui ja ellui, movt karakterisere muohtadiliid ja vel makkár strategiijaid atná čoavdin dihte iešguđetlágan dálkediliid mat čuožželit. 2006:s guokte siidda čálle beaivegirjji ovtta mánu geahčalan dihte dán metodan ja maŋŋel dán geahčaleami buoriduvvui dat ovttas "geahččalansiiddaiguin".

Gozihanindikáhtorat mat válljejuvvojedje ledje áššit mat váikkuhit guohtumii ja guođoheapmái beaivválaš muohtadiliid mielde (tabealla 1 ja govus 1). Báikegodde-vuđot gozihanprošeavttain geavahit dávjá árbevirolaš máhtu vuođđun válljemis biraskvalitehta indikáhtoriid (Berkes *et al*., 2005). Indikáhtor lea fenomena maid lea

vejolaš observeret ja mii sittisdoallá dieđuid diliid birra juoga man ear: ektui maid ii sáhte oaidnit (Store Norske leksikon).

Oanehaččat, gozihanindikáhtoriidda gullet muohtašlájat ja daid nuppástuvvamat, muohtakonsisteansa, dálki ja temperatuvra. Dáidda lassin merkejuvvo maiddái movt eallu láhtte ja guohtoneatnamiid geavaheapmi (Tabealla 1 ja govus 1).

Tabealla 1. Indikáhtorat ja guođohanbeaivegirjji sisdoallu, mas leat čilgehusat movt ja manne dát indikáhtorat leat válljejuvvon.

Beaivegirjji sisdoalu indikáhtorat	Movt	Manne
deavdinbagadus	Juohke girjjis lea dárkilis neavva movt deavdit girjji.	Lea dehálaš ahte buot oassálastin lea seammá diehtu movt deavdit dán. Dáinna dáhkidit ahte oažžut seammásullásaš dieđuid.
Kaleandara mielde beaivvit	Beaivegirjeoassálastit galget deavdit girjji juohke beaivvi dálvet	Dehálaš oaidnit movt beaivválaš boazobarggus karakteriserejit ja čilgejit diliid mat váikkuhit bohccui ja bohcco láhttemii.
Dálke- ja temperatuvra-paramehtarat	Registreret áibmotemperatuvrra iežaset mihtidanrusttegiiguin ja čilget makkár dálki lea.	Dáinna registeremiin sáhttit oažžut gova das movt temperatuvra lea dálvvi čađa leamaš guovllus.
Muohtatearpmat	Go isket muohttaga, de registrerejit makkár muohtašlájat lea das. Guoros sadji masa čállá jus muhtun muohtadoaba váilu.	Válljen 38 doahpaga mat gullet muohta-/bievladillái. Ieža sáhttet vel lasihit sániid mat gullet muohttagii.
Biegga	Registreret guđe guovllus biegga bossu, makkár biegga dat lea.	Dáinna registreremiin sáhttit oažžut dieđu das guđe guovllus biegga bossu ja movt dát váikkuha guohtundillái.
Áibmu	Registreret makkár áibmu lea, muitalit leago bivval vai galmmas.	Áibmu sáhttá maid váikkuhit diliide ja rievdadit daid.
Muohtakonsisteansa	Registreret makkár muohta lea; seaggi/gaskamearálaš/gassat; garas.	Dieđut lea go muohta garas ja leago seakka/gassa muohta addá lassidieđuid muohtadoahpagiidda ja dát maid sáhttet čájehit leago buoridan/gáržžidan guohtuma.
Ealu láhtten	Registreret movt eallu láhtte.	Dáinna oažžut gova movt boazu/eallu respondere guohtundilálašvuođain.
Guohtun	Karakteriseret guohtuma (hui buorre, buorre, oalle buorre, oalle heitot, heitot, hui heitot)	Dát addá vuođu árvvoštallat movt namuhuvvon paramehtarat váikkuhit guohtunkarakteriseremii.
Registrerenbáiki	Čilget kárttas gokko báiki lea ja čállit juogo báikki nama dahje merket GPS:ain	Registrerejuvvon báikki mielde sáhttit oaidnit váikkuhit go eananšlájat ja báikkit guohtundilálašvuođaide.
Kárta	Boazovázzi merke kártii gokko eallu lea dan beaivvi.	Dáinna sáhttá čájehit dálvejagi eanangeavaheami.
Sadji gokko sáhttá mearrkašumiid čállit	Čállit vel iežas sániiguin guohtundilálašvuođaid birra.	Ná lea vejolaš oažžut vel dárkilit dieđuid das movt boazovázzi jurddaša ja movt vállje guođohit.
Sátnelistu maŋágeahčen	Girjji maŋágeahčen lea sátnelistu mas leat eanet sánit go dain siidduin maid juohke beaivvi devdet.	Jus beaivvi vuolde váilu okta sátni, de leat čállán dan sáni beaivvi vuollái.

Beaivegirjái leat boazovázzit karakteriseren faktoriid (beaivválaš muohtadilit ja eará áššit) mat váikkuhit bohcco dillái ja guođoheapmái. Beaivegirjjis leat variábelat maid boazovázzi beaivválaččat iská iežas boazobarggus, nugo mat man čoahkis eallu

lea, makkár biegga lea ja guđe guovllus bossu, makkár ilbmi lea ja makkár dálki lea. Okta indikáhtor lea árvvoštallat *guohtuma (*hui heitot *guohtun* – heitot *guohtun* – buorre *guohtun* – hui buorre *guohtun*), mat leat guovddážis beaivválaš boazobarggus.

Guođohanbeaivegirji lea ráhkaduvvon kaleandara mielde, mas leat guokte siiddu juohke beaivvi nammii (Govus 1). Juohke beaiváu leat biddjon merkenvejolašvuođat indikáhtoriid vuođul, mat gullet beaivválaš boazobarggu doaimmaide dálvet.

Govus 1. siiddut guođo-hanbeaive-girjjis, mat čájehit indikáhtoriid gurut bealde ja olgeš bealde rabas sadji masa ieža sáhttet čállit dillid birra.

Guođohanbeaivegirjji sáhttá sulastahttit priváhta beaivegirjjiiguin ja maid boazovázzi ieš beaivválaččat hálddaša. Beaivegirjjis lea guokte oasi, strukturerejuvvon oassi ja struktuvrrakeahtes oassi. Strukturerejuvvon oassi lea biddjon fásta minstara mielde, nu ahte dutkis lea vejolašvuohta oažžut seammálagán dieđuid iešguđet siiddain. Dán oasis lea strukturerejuvvon hápmi masa informánttat devdet dieđuid muohta-ja dálkediliid birra mat gustojit dan beaivái. Go boazovázzit devdet dieđuid fásta minstara mielde, de lea álkit oažžut oppalašgeahčestaga siiddaid diliin, seammás go lea álkit buohtastahttit daid. Beaivegirjji struktuvrrakeahtes oasis informánttat besset muitalit iežaset sániiguin jurdagiid ja reflekšuvnnaid observašuvnnaid birra.

9

3. Bohtosat

Dán barggus muitaluvvo ođđa vuohki mas boazovázzit beaivválaččat geavahit guođohanbeaivegirjjid dálvet, mas dokumenterejuvvojit ollu sámegiela muohtadoahpagat mat geavahuvvojit muohtadiliid birra bohcco ja guođoheami oktavuođas (Tabealla 2). Dasa lassin siidda boazovázziid muohtakarakteriseremiin ja beaivegirjevuogádatgeavahemiin, sáhttiime moai karakteriseret guohtundiliid dálvet, mat speadjalastet boazovázziid guođohanobservašuvnnaid ja –strategiijaid. Siiddaid muohtadoabageavaheamit čájehit alla diversitehta, ja čohkkejuvvon dieđuiguin guovvamánu 5.beaivvi 2008 muohtadoabavariatehtat mat čájehit ahte siiddain ledje iešguđet lágan guohtundilit (tabealla 2). Ovttalágan doahpagat mat gusket muohttagii, bohccui, topográfiijii ja guođoheapmái maid buot viđa siiddas čálle, čájehit giela oktasaš ipmárdusa árbevirolaš máhtus.

Tabealla 2. Sámegiela muohtadoahpagiid beaivválaš geavaheapmi viđa siiddas (guođohanstašuvnnas) Guovdageainnu boazodoalloguovllus nammijat beaivvi, guovvamánu 5. beaivi dálvet 2008:s (ruoksat = temperatuvra, čuvges alit = dálkečilgehusat, ránes = biegga, áibmu ja muohta, alit = muohtatearpmat, fiskat = ealu láhtten, ruoná = *guohtun*karakteriseren, vielgat = topografiija).

s.t.	Temperat.	Dálki		Biegga	Áibmu	Muohta	Oppas	vahca	áidnen	Luotkkus	gaskageardni	Častasat	joavggahagat	čeargan	sanas	Seaŋáš	Ritni	Ritni	Ealu lähtten	Buorre	oalle buor.	oalle heit.	heitot	topográfiija
1	-5	obb/balv	borg/guol	Čavga b	gal	gass		x	x			x	x	x						ruvg			x		váris
2	-11		murku	goalki	biv	gask	x				x											x				váris
3	-14	Obb	murku ruváš	NL spiella	gal	gask/sea			x					x	x	x				lod		x			duoddaris/váris
4	-15	beai		L spiella	gal	gask/sea	x	x										x		lod	x				duoddaris/váris
5	-18	beai	ruváš	NL spiella	ruv	gask			x	x		x		x			x	x		lod		x			váris

Oanádusat: Obba dálki, balvadálki, beaivvádat, borga, guoldu, murku, ruváš, čavga biegga, goalki, spiella, nl = nuorti-luládat, l = lulle biegga, galbma biegga, bivval, gassa muohta, gaskamearálaš muohta, ruvgala, lodji.

Go buohtastahttá jagiid gaskka, seammá áigodagas, čájeha dát muohtadoahpagiid geavaheami girjáivuođa. Govvosis 2 oaidnit muohtadoahpagiid mat govvidit muohtadiliid stašuvdna 1:s 2007-2009. 2007:s leat guovllus merken *seaŋáš* muohttaga ođđajági mánus. Jagi maŋŋil lei seaŋáš juovlamánu loahpas ja 2009:is lei

árabut, dalle lei juovlamánu gaskamuttos seaŋáš, mii bisttii gitta giđasdálvái, ja nu lei 4 mánu buorre guohtun. Govus 2 čájeha ahte ovtta siiddas ledje stuora variašuvnnat guohtumis jagiid gaskka ja jagiáiggiid gaskka. Seammálágan variašuvnnat guohtundiliin čájehuvvojit buot siiddaid ektui dálvvi čađa ja jagiid gaskka.

Muohtatearb.	jahki	Dálvi				Giđđadálvi
		Juovlam	Ođđajagim	Guovva.	Njukčam	cuoŋum
joavggahagat	2007 2008 2009					
čearga	2007 2008 2009					
cuoŋu	2007 2008 2009					
seaŋáš	2007 2008 2009					

Govus 2. Variašuvnnat válljejuvvon muohtatearpmain maid boazosápmelaččat Guovdageainnus geavahit dálvvi čađa ja jagiid gaskka, 2007 (alit), 2008 (ruoksat) ja 2009 (ruoná) ovtta siiddas (stašuvdna 1) čájehit iešguđet lágan guohtundiliid dálvet.

13 iešguđetlágan muohtadoahpaga registerejuvvojedje beaivegirjjiide viđa siiddas. Čájehuvvo ahte dáhton goas dat vuosttaš háve registererjedje variere guovlluid gaskka, mii čájeha muohtadiliid girjáivuođa Oarje Finnmárkku boazodoalloguovllus. (Tabealla 3).

Tabealla 3: Sámegiela muohtatearpmat, mat leat geavahuvvon viđa siidda beaivválaš guođoheami oktavuođas dálvet Guovdageainnus, vuosttaš beaivvi mielde go leat registrerejuvvon beaivegirjjis 2008/2009.

Stašuvdna Sámegiela muohta tearpmat	stašuvdna 1	stašuvdna 2	stašuvdna 3	stašuvdna 4	stašuvdna 5
častasat	21.12	1.1		22.12	21.12
čearga	20.12	1.1	11.1	24.12	24.12
cuoŋu	13.4	18.4	15.4		15.4
gaskageardni		3.1		8.2	
geardni			31.12		
joavgan	19.12	1.1	25.2	10.1	15.12
luotkkus	16.12	15.2	13.1	2.1	1.12
oppas		3.1		6.12	
ritni/rinádat	14.1	20.1	8.12	5.12	1.12
saŋas	16.12		1.1	13.12	1.12
seaŋáš	1.1	25.1	2.1	5.1	1.1
soavli	26.12			13.12	1.12
vahca			1.1	3.12	

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Boazovázzit observereje maiddái beaivválaččat movt ja gos eallu guohtu dahje lea guhton. Boazovázziid beaivegirjjit čájehedje 21 iešguđelágan topográfalaš tearpma mat geavahuvvojedje dálveguohtuneatnamiin (Tabealla 4). Dát čájehii ahte siiddaid gaskka ledje stuora variašuvnnat topográfalaš šlájain dahje duovdagiin, muhto dattege ii lean seammaládje juohke siiddas.

Tabealla 4. Čájehuvvo ahte siiddaid guohtunguovlluid gaskka lea topográfalaš diversitehta (stašuvdna 1-5) maid boazosápmelaččat Guovdageainnus leat dálvet observeren ja geavahan, ja mat leat guođohanbeaivegirjjiid mielde.

Eanan-šlájat/ Stašuvnnat	bohtu	buollan	buolža	čearru	čohkka	čopma	čorru	gielas	jeaggi	johka	luhppo	luokta	luoppal	maras	njárga	oaivi	roavvi	sevdnjes eanan	skáidi	várri	vuopmi
St. 1		x	x				x	x		x		x	x	x	x	X	x			x	x
St. 2		x			x	x		x		x						x				x	x
St. 3				x						x						X				x	x
St. 4			x				x	x	x	x	x								x	x	x
St. 5	x						x	x	x	x			x			X	x			x	x

Dát dutkan čájeha ahte dán viđa siiddas geavahedje seammá áiggis seammá eananšlájaid iežaset dálveguohtuneatnamiin. (Tabealla 5).

**Tabealla 5. Iešguđetlágan topográfalaš oasit dálveguohtuneatnamiin áiggi ja viđa siidda mielde.**

Jagi áiggit	Mánut	St 1	St 2	St 3	St 4	St 5
Čakčadálvi	Skábmamánnu	vuopmi				roavvi várregilga
		vuomi				roviid várre-gilggaid
Dálvi	Juovlamánnu Ođđajagimánnu Guovvamánnu Njukčamánu álgu/gaskamuddui	vuomis roviin, marrasiin, buolžžain	vuomis, giellasiin, čohkain váriin vuopme-gierragis	vuomis johk'gáttiin, váriin	vuomis, giellasis, skáiddis váriin, skáiddis	vuomis, čoruin, bođuin váriin, giellasiin
Giđasdálvi	Njukčamánu gaskamuttos Cuoŋumánnu	čoruid, buolžžaid	váriid, giellasiid	váriid, čearuid	váriid giellasiid,	váriid giellasiid,

Beaivegirjjit ovttas boazovázziid jearahallamiiguin čájehit movt boazovázzi čatná bohcco, muohttaga ja duovdagiid oktii, mii lea vuođđun sin guođohanstrategiijaide (Tabealla 6). Bohtosat čájehit ahte guođohanbarggus leat guokte aspeavtta; 1) Boazovázzit vudjet ealu birra ja gehččet movt eallu guohtu, dahje orru go bissume. Seammás maid gehččet luottaid, ja jus oidnet luottaid mannan badjel birravuodjinluotta, de fertejit guorrat gosa boazu/bohccot leat mannan. 2) Jus oidnet ahte eallu ii šat bisu, lihkadit álgá, de isket mii dasa lea sivvan. Sii isket guohtuma: muohtakonsisteanssa, botni ja ealádaga. Boazovázzit maid gehččet gokko ovdal leat guođohan. Jus oidnet ahte dákko lea garas muohta, bodni soaitá jieŋas, de fertejit ohcat obbasa dahje dakkár báikki gos lea buoret guohtun.

Tabealla 6. Olbmo čanastat bohccui - muohttagii - eatnamii čájeha olbmo, guođoheami ja čoavdinstrategiijaid gaskavuođaid šemáhtalaččat ja ollislaš observašuvnnaid ja gozihemiid mas geavahuvvojit guođohanbeaivegirjjit lasin boazovázziid jearahallamiidda.

Variábelat	Čilgehusat
BIRRAVUODJIN	
Movt eallu guohtu	Bissu go eallu, de doppe lea juoga maid borrá ja muohta lea dakkár ahte besset dan čađa.
	Go bohccot álget lihkadit, vigget vuolgit, iskat manne eai bisu dakko (leago meahce-ealli mii muosehuhttá, leago hedjonan guohtun jna.)
Luottat	Vuodjá birra visot luottaid; guorrá luottaid, nu ahte diehtá ahte ii leat ribahan ruvgalit ealu. Ealu čoahkkisin doallat nu ahte it mastta eaáide, luottat čájehit leat go bohccot vuolgán eret guovllus, birravuodjinluotta badjel eai galgga mannat. Jus mannet badjel, de vižžet daid bohccuid fas ellui.
	Meahce-ealli luottaid maid oaidnit, ahte leago dat mannan birravuodjenluottaid badjel, ealu sisa.
GUOHTUN	
Muohta ja muohtafysihkka	Muohtafysihkka váikkuha dasa movt boazu beassá guohtut. Jus lea oppas, de lea buorre, muhto jus lea čiegar, de ferte sirdit.
	Garra muohta: čearga, cuoŋu jna.
Bodni	Jus bodni lea buorre, de beassá boazu šattuid rádjái, muhto jus botnis dovdo jiekŋa, de dát váikkuha negatiivvalaččat guohtunvejolašvuođaide, danne lea dehálaš iskat botni. Čiegar, botneskárta.
Ealát	Go botni lea iskan, de oaidná maid lea go borus (ealát) dakko. Jus lea guorban eanan, de ii leat ávki das viggat guođuhit ealu, danne go das gal nelgot bohccot, muhto jus lea buorre ealát (jeagil ja eará šattut), de gal guohtu eallu das.
Gokko eallu ovdal lea guhton	Iskat leat go čiehkarat, makkár guohtun: rudneguohtun (garas, muhto rutniid oažžut) dahje gutnaguohtun.
Dálki ja biegga	Dálki ja biegga sihke buorida ja heajuda muohttaga omd. čeargada dahje dipmáda
	Giđđa: manná davás beroškeahttá makkár biegga lea.
	Čakča: boazu lávdá vuostás, doppe gos biegga boahtá.
	Jus jorgala biekka, de eallu jorggiha.
Molssaevttolaš guohtunbáikkit	Jus guohtun lea hedjonan, de fertejit ohcat obbasa eará guovllus, gosa heive sirdit ja lágidit ealu (dassážii go lávdá dohko, bisána ja guođusta).

Boazovázziid muohtadiliid observašuvnnat iešguđet dálveguohtuneatnamiin Guovdageainnus čájehit stuora erohusaid. Go buohtastahttá viđa guovllu *guohtun* karakterisašuvnnaid 3.5 mánu badjel, de čájeha dát stuora erohusaid ja girjáivuođa *guohtun*-diliin dáid guovlluid gaskka. *Guohtun*-karakteriseremis leat sii mihtidan muohttaga konsiteanssa, man garas muohta lea, man ollu muohta lea, leat go muohta- ja jiekŋagearddit, man assás gearddit leat jna. Guohtunkarakteriseren čájeha ahte guohtundilit ledje buorit njealji siiddas (stašuvnnat 2-5); lei *hui buorre guohtun,* 2. ja 4. stašuvnnain, dahje *oalle buorre guohtun*, 3. ja 5. stašuvnnain. Seammás lei 1.stašuvnnas *oalle heajos guohtun*.
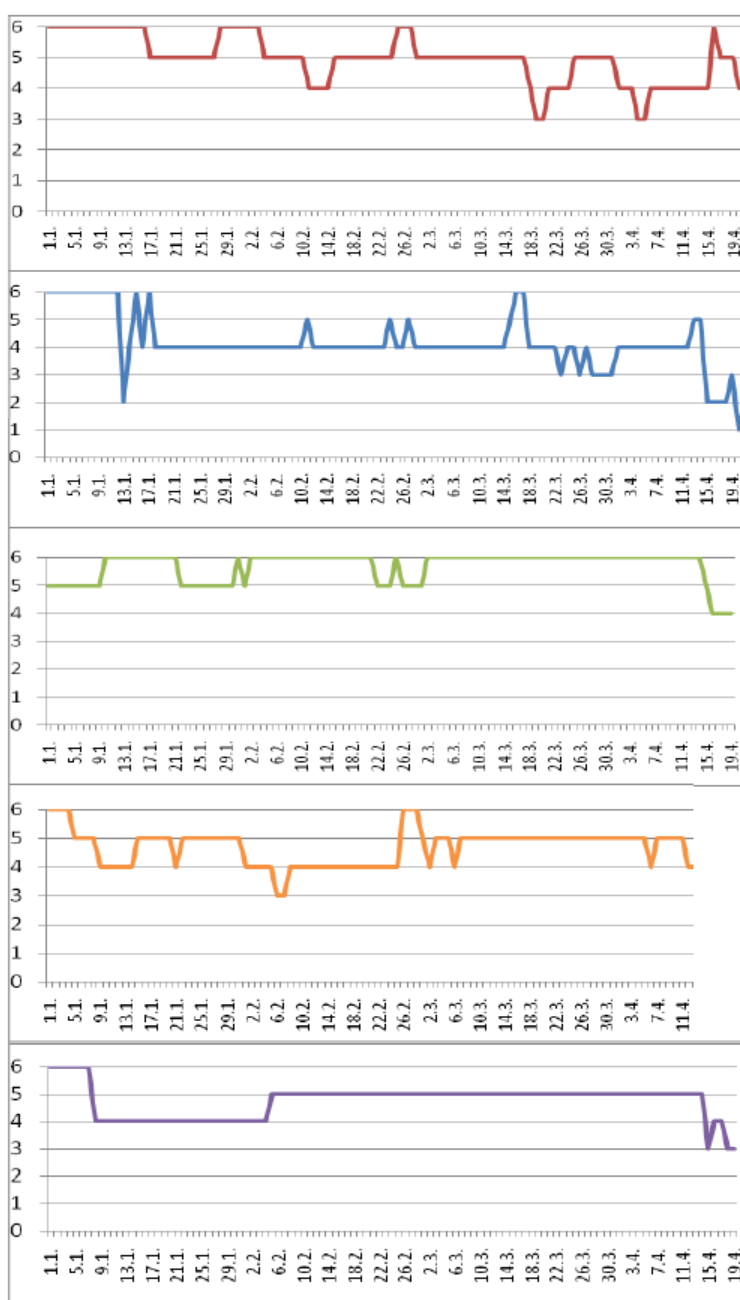

Govus. 3. Čilgehus nummariidda gráfas: 6 = hui buorre guohtun, 5 = buorre guohtun, 4 = oalle buorre guohtun, 3 = oalle heitot guohtun, 2 = heitot guohtun, 1 = hui heitot guohtun. Dán gráfas čájehuvvo makkár guohtun lei viđa dálveguohtuneatnamiin Oarje Finnmárkkus ođđajagimánu 1. Beaivvi rájes gitta cuoŋumánu 19.baeivvi rádjái 2009. Dát čájeha ahte ledje stuora guohtunerohusat. 1. stašuvnnas (ruoksat) lei stabila dilli vuosttaš mánu, dasto šadde eanet molsašuddi dilit; Seammáš ledje 2. stašuvnnas (alit) molsašuddi guohtundilit, hui buori guohtumis 1.1.-12.1, ja das fas heajudii guohtuma dđaistaga. Dán stášuvdna lei stuorimus molsašuddi dilit ja heajumus guohtundili buot stašuvnnaid gaskkas. 3. stašuvnnas (ruoná) ledje stabilamus, measta dadjat optimála guohtundilit čađa dálvvi. 4. stašuvnnas (runta) lei buorre guohtun álggus dálvvi, ja de rievddadii buori ja hui buori guohtuma gaskkas. Seammas ledje 5.stašuvnnas (fioleahtta) stabila dilit, buori ja hui buori guohtuma gaskkas.

Guođohanbeaivegirjjit addet dieđu guođohanstrategiija birra guohtunkvalitehta ja dálveguohtuneanangeavaheami ektui (Govus 4), seammas go maid čájehit movt boazovázzit árvvoštallet ja leat čađahan proseassaid main lea vissis guhkkodat guovllu ja muohttaga ektui. Leat earenoamáš guokte faktora maid boazovázzit geavahit buoridit eavttuid bohccuide, 1) lea dálki ja 2) ealu sirdit eará sadjái gos lea buoret guohtun, čájehuvvon govvosis 4.

Dáhton	Boazovázzi observašuvdnačilgehusat
4.3	Dat lea oalle čearggahat, muhto lea buorre go čeargga čađa boađát, ...ii leat nu assái dat čearga. Čeargga vuolde lea seaŋáš
6.3	Lea bivval ja guohtun lea buorre. Dat lea čearggahat, muhto lea buorre guohtun vumiin. Unnán muohta. Duoddariin gal ain lea garas.
7.3	Dál lea hui buorre guohtun. Leat gal joavggahagat ja čearggat, muhto dat ii leat nu garas. Eallu ii guođo joavggahatbáikkiin. Čearga lea asehaš, nu ahte dat gal ii daga maidege, dan čuolastit čađa.
14.3	Duoddaris lea geardni dain báikkiin gos lea assát muohta. Geardni lea sullii 1 – 2 cm asu. Vuomis ii leat geardni.
15.3	Dál lea veahá čiegar dies gos dál lea eallu. Dat čiegar ii leat nu garas. Suovnnjit lea sekŋon go vahca lea deavdán daid. Vuomis ii leat geardni. Dat lea čearga ja seaŋáš fas čeargga vuolde, ja bodni lea buorre.
19.3	čiegar
20.3	čiegar
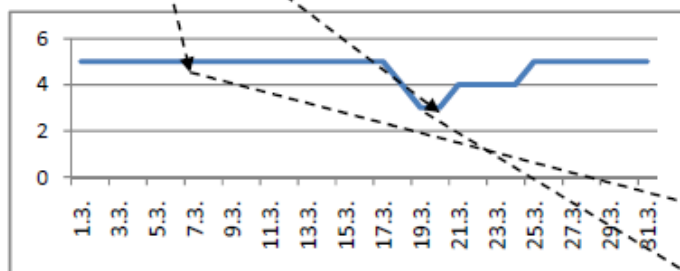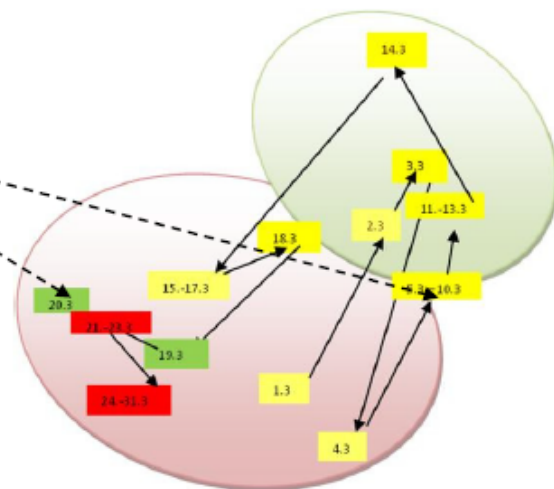
Govus. 4. *Iešguđetlágan guođohanstrategiijat ovtta siiddas (stašuvdna 1) guohtuma ja eanangeavaheami ektui (duoddara ja vuomi ektui) njukčamánu 2009:s. Guovdageainnus, Duottarguovlluin leat unnán šattut ja muorat. Vuopmeguovllut leat gis vuollegis guovlluin main leat vuovdi.*

2,250 beaivválaš beaivegirjeraportta čájehit ahte leat stuora erohusat muohtašlájain ja guohtumis gaskkal guovlluid ja maiddái jagis jahkái. Muhto leat gal stuora ovttaláganvuođat das makkár eatnamiid geavahit, mat sáhttet leat mielde buorideami guohtuma. Dát dátat čájehit ahte vihtta siidda geavahedje juste seammalágan eananšlájaid seammá áiggis. Loahpaláččat vel čájehit bohtosat ahte guođohanbeaivegirjjiid lea vejolaš geavahit gozihit guohtunrievdamiid. Goziheapmi lea addán systemáhtalaš dieđuid beaivegirjjidraporttaid vuođul. Beaivegirjegozihanmetoda lea maid dahkan vejolažžan oažžut ovttalágan dieđuid iešguđet guovlluin seammá áigodagas. Ođđa observrenvuogádat lea leamaš hui ávkkálaš ipmiridit omd. movt boazovázzit geavahit muohtadoahpagiid ja movt muohta váikkuha beaivválaš guođoheami. Dákkár vuogádat lea maiddái váikkuhan dasa ahte boazovázzit leat ieža gaskkaneaset dán vuođul hui ollu digaštallan muohtadiliid ja guohtuma birra ja árbevirolaš máhtu dáid ektui, earenoamážit guoská dát nuorra boazovázziide geat leat ain vuorus. Giellageavaheapmi ja muohtadoahpagiid sisdoalu ipmárdus lea measta ovttaládje dán viđa guovllus.

4. Digaštallan ja loahpahus

4.1 Sámi *siida*-vuđot dálveguohtundiliid goziheapmi

Boazosápmelaččaid máhttu muohttaga ja guohtuma birra (Eira *et al*., 2010) lea oassin sin árbevirolaš máhtus, mii lea systemáhtalaš máhttu bohcco ja dan birrasa birra (Magga, 2006).

Dat ollu muohtadoahpagiid maid boazovázzit geavahit, čájehit man mávssolaččat iešguđet muohtadilit leat topográfiija, temperatuvrra, biekka ja muohttaga/arvi ektui. Dát doahpagat geavahuvvojit čieža mánu jagis, dalle go muohta lea eatnama nalde, mat leat oassin diimmus diibmui ja beaivválaš guođoheami goziheamis, mat áiggi ja saji mielde rivdet ja mat guođoheami oktavuođas registrerejuvvojit. Eira *et al*., (2011 sáddej sisa); Reinert *et al*., (2009) oaivvildit ahte erohusat muohtakvalitehtas lea diversitehta váldoelemeanta, ja ahte topográfiija lea dehálaš komponeanta mii mearrida movt muohta lea ovtta guovllus ja mii fas váikkuha

man álkida duohken ealát lea. Muohttaga diversihtehtain moai oaivvildetne muohtadoabageavaheami variašuvnna, mat spedjalastet iešguđetge muohtašlájaid ja muohtadiliid mat leat dálveguohtoneatnamiin, ja mat dagahit iešguđetlágan ekologalaš niššaid ja vejolašvuođaid bohccui. Moai ákkastalle ahte go muohttagis lea nu stuora hetrogenitehta (masa leat seaguhuvvon iešguđetlágán elementtat) juohke dálveguohtoneatnamis, maid leat observeren dán dutkamis, ovddastit vejolašvuođaid guohtumii ja unnida riskkaid ahte šaddet heajos guohtundilit, mat sáhttá vákkuhit boazodollui.

Beaivválaš dálveguođoheami guovddáš doibmii gullá maiddái árvvoštallat ja karakteriseret guohtuma ja dovdat dáid ekologalaš niššaid báikkálaččat. Dát dagaha ahte *guohtun*-doaba lea okta dain deháleamos doahpagiin sámi boazodoalus. Dát lea maid ovdamearkan movt boazovázzit dovdet muohtadiliid áiggi ja báikki ektui. *Guohtun*-doahpaga geavahit boazovázzit árvvoštallat man álki/váttis lea bohccui beassat muohttaga čađa bodnái, šattuid rádjái (Eira *et al*., 2010). Dán doahpaga geavaheapmi beaivválaš boazobarggus čájeha ahte das lea čielgasit vuoruheapmi, mii mearrida gokko eallu sáhttá birget dálvvis, namalassii ahte árvvoštallat ja responderet muohta- ja dálkediliide. Guohtun lea ovdamearkan movt sámegiela doahpagat ovdanbuktet árbevirolaš máhtu kompleaksa vuogádagaid, mat fas speadjalastet boazodoalu holistalaš ipmárdusa kompleaksa ekovuogáin. Áittoládje čájeheigga Rutorier ja Roue (2009) ahte geavahettiin sámi árbevirolaš máhtu čilget guohtuma dehálašvuođa sámi boazodoalus Ruotas, ja dan riiddu Ruota vuovdeindustriijan, mii lea jođánit rievdadii bohcco guohtundiliid.

Guođohanbeaivegirjjit čajehit ahte boazovázzit Guovdageainnus geavahit doahpagiid "hui heitot guohtun - heitot guohtun - buorre guohtun - hui buorre guohtun" karakteriseret guohtuma goziheami oktavuođas. *Guohtun*-doaba dávjjimusat geavahuvvo oktan adjektiivvalaš antonymaiguin mat graderejit doahpaga árvvu. Dát ii dahkko dárkilis mihtiduvvon loguiguid, muhto giellavuđot-data geavahemiin. Áittoládje leat Eira *et al*., (2011, sáddej. sisa) gávnnahan ahte boazovázziid máhttu muohttaga birra lea eanet holistalaš go seamma máhttu riikkaidgaskasaš muohtafysihkas. Go boazovázzit guohtuma árvvoštallet, de gieđahallet ollu variábelfaktoraid oktanaga, nu go muohta fysihkavariabeliid, mat mearridit man álkit dahje váddásit muohttaga čađa beassá, ja maiddái guohtoneananšlájaid, ealu láhttema ja

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ránnjá siidda ealu vánddardeami. Makkár guohtun ollilaččat šaddá vuolgá muohttaga, borgga ja arvvi, temperatuvrra, biekka gaskavuođain ja maiddái birasvariábeliin nu go eananšlájain. Muohttaga temperatuvrra gradieanta áimmu ja botni gaskka muohttaga čađa leat dehálaš faktorat mat sáhttet stivret proseassaid mat dagahit buori dahje heajos guohtuma (Eira *et al*., 2011, sáddej. sisa). Jus lea heitot guohtun, de muitala dát ahte gearddit muohtagierragis dahje muohttagis leat nu garrasat ahte bohccui lea váttis nagodit čuolastit garra gearddi go lea guohtume. Dát gearddit garret jus lassánit suddan-jiekŋun syklusat (šaddá geardnin, cuoŋun) ja jus lea nu garra biegga ahte dat čeargada muohttaga (šaddá čeargan). Guođohanbeaivegirjjiiguin sáhttit čájehit ahte boazovázzit hui dárkilit observerejedje ja gozihedje dáid gaskavuođaid muohttagis juohke beaivvi, diimmus diibmui.

Semi-struktuvvalaš jearahallamat čadnon guođohanbeaivegirjjiide čájehedje ahte boazosápmelaččat árvvoštalle ahte bodni lea deháleamos faktor guohtuma iskamis. Muohtašlájat mat jiekŋot bodnái, nugo bodneskárta ja bodnejiekŋa, leat muohtadilit mat sáhttet dagahit stuora vahágiid ja ahte bohccot jápmet. Jus dákkár muohta bistá gitta giđđii, de sáhttet ollu bohccot jápmit nealggái, mii dagaha goavádaga. Dákkár goavvejahki lei Guovdageainnus 1917/1918 (Eira, 2011, manus).

Jamál-Njentesa autonoma guovllus boazonjenetsaid heiveheapmi jiekŋadiliide lei johttát ealuin eret dan guovllus nu go Bartch *et al*., (2010) ja Forbes *et al*., (2009) čilgejit. Dattege leat Tyler (2010) ja Helle & Kojola (2008) geažuhan ahte go arvá muohtaga nala, de bohccojámut eai lassán mearkkašahtti. Boazodoallu Guovdageainnus sáhttá johtin responssa čilget ovdalaččas namuhuvvon navdima. Maiddái golmmajagi dutkamis (2007-2009) čájehit viđa Oarje Finmárkku siiddaid guohtunobservašuvnnat ja goziheamit ahte sii sirde ealuid iežaset orohaga siskkobealde muohtadiliid rievdama geažil, vaikko vel oidne ahte guohtun ii orron hedjoneami observerenáigodagas.

Moai letne čájehan ahte guođohanbeaivegirjjiid ja semi struktuvrralaš jearahallamiid ovttastahttin lea vuogas metoda, mii doarju ja indentifisere áššiid mat gusket guođoheapmái ja muohtadiliide. Munno mielas leat dán dutkama guođohanbeaivegirjjit čájehan ahte boazovázziid návccat observeret ja gozihit guohtuma lea ovdamunnin ealu ahtánuššamii. Dán ođđa gozihanvuogádaga čađaheapmi

lea ovdamearkan báikegodde-vuđot goziheamivuogádagas siidda dásis, mas geavahuvvo árbevirolaš máhtu, man bokte sáhttá registereret mearkkašahtti variašuvnnaid muohttagis ja guohtumis siiddaid gaskka.

Moai letne ovdánahttán dán metoda go letne váldán mielde ovttaskas boazoávzziid siiddaid geat galge oberserveret, čállit ja gođihit guohtuma rievdamiid ja vejolaš rievdamiid. Moai evttohetne ahte dákkár observašuvdnavuogádagaid árbevirolaš máhtu vuođul sáhttá geavahit gozihit boahtte áiggi muohtarievdamiid dálveguohtuneatnamiin maid einnostuvvon dálkkádatrievdan sáhttet váikkuhit. Dássážii leat sámi boazodoalloguovllus, Finnmárkkus, temperatuvrrat loktanan earenoamážit giđđat, seammás go eanet arvá/muohttá buot áigodagain (Vikhamar-Schuler et al., 2010 a,b,c). Go buohtastahttá guođohanbeaivegirjjiid buriid ja heajos dálvviid ektui Finnmárkkus ja dán guovllu dálkkádatdataid, de čájehit dát ahte ii leat dušše temperatuvra ja muohta/arvi akto mii dagaha váttsvuođaid bohccui (Magga et al., 2011), muhto iešguđetlágan ovttastumit dáin variábeliin sáhttet dagahit iešguđelágan muohtastruktuvrraid, mat sáhttet váikkuhit buori/heajos guohtumii. Danne moai ákkastalle ahte lea dehálaš guođohanbeaivegirjjiid viidáset ovdánahttimis váldit atnui elektrovnnalaš gozihanveršuvnna gozihit dálkkádatrievdamiid váikkuhusaid guohtundiliide. Moai evttohetne ahte dát observašuvdnavuogádat, mii lea árbevirolaš máhtuin vuođđuduvvon, galggašii ovdánahttot nu ahte boazovázzit sáhttet siiddavuogádagas dan geavahit. Moai ávžžuhetne ahte boazosápmelaččat galget oažžut buot buoremus teknologiija mii lea gávdnamis gozihit rievdamiid ja dáid vuođđun galgá leat sin árbevirolaš máhttu ja fágagiella.

4.2 Guođohangozihanbeaivegirjjit bargoneavvun dokumenteret árbevirolaš máhtu ja dán birra ságastallat

Boazovázzit geat leat vuorus ja vuorulonuhettiin ságástallet dábálaččat iežaset dárkilis muohta- ja guohtundiliid observašuvnnaid birra dálveguođohettiin. Guođohanbeaivegirjjiin mearkkašumit, maid boazovázzit leat čállán, čájehit ahte beaivegirji orru váikkuhan ahte boazovázzit leat ságastallagoahtán eambbo muohtadoahpagiid birra, ja earenoamážit nuorra boazovázzit leat beroštišgoahtán eambbo digaštallat dáid áššiid birra geavahettiin iežaset fágagiela. Magga et al., 2011,
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mielde lea IPY EALÁT bargobájiiguin, logaldallamiiguin, dutkanprošeavttaiguin ja kultuvrralaš lonohallamiiguin láhčán ođđa vejolašvuođaid nuorra boazovázziide deaivvadit eará boazoálbmotnuoraiguin. Ná lea árbevirolaš máhtu geavaheapmi lassánan. Ealát prošeakta lea dorjon eamiálbmotservvodagaid gelbbolašvuođahuksema go lea oččodan báikkálaš nuoraid dutkagoahtit ja go lea doarjon eamiálbmot-organisašuvnnaid ásahushuksemiid. Heiveheapmi dálkkádatrievdamiidda gáibida ahte báikkálaš arktalaš jođiheaddjit ožžot hárjáneami ja oahpu movt bargat guhkes áiggi jurddašeami ceazilvuođain masa atnet vuođđun buoremus heivehanmáhtu mii lea gávdnamis, sihke dieđalaš ja vásáhus-vuđot árbevirolaš ja báikkálaš máhtu. Nášunála heivehanstrategiijat fertejit dohkkehit unnilogu ja eamiálbmogiid árbevirolaš máhtu, kultuvrralaš- ja gielalašvuoigatvuođaid (Nuttall *et al*., 2009). Guođohanbeaivegirjji geavaheami menestuvvan lea ovdamearkan dása. Okta Ealát prošeavtta váldobohtosiin lei movttidahttit boazodoallonuoraid leat fárus boazodoalus ja buoridit oahpahusfáladagaid sidjiide, mat ledje váldofaktoriin ovddideame boahtteáiggi ceavzilis boazodoalu ja dan kultuvravuođuid. (Magga *et al*., 2011). Seammaládje lea Ceavvi prošeakta, mii lei oassin Ealát prošeavttas, maiddái huksen gelbbolašvuođa danne go boazodoallonuorat ožžo oahpu das movt metodaid geavahit ja movt čohkket ja dokumenteret árbevirolaš máhtu ja movt dáid čohkkejuvvon dataid verifiseret. Dán barggu vuođul besse sii maiddái oahpásnuvvat iešguđetlágan árbevirolaš máhtu fáttáiguin. Ulbmiliin lei geavahit árbevirolaš máhtu oažžun dihte buoret ipmárdusa dálkkádatrievdamis seammas go Ceavvi prošeakta maiddái veahkehii gelbbolašvuođahuksema dan bokte ahte vuorrasit boazosápmelaččat oahpahedje boazodoallonuoraid movt geahččat mearkkaid luonddus ja fuomášit jus juoga "earenoamáš" dáhpáhuvvá. Vuorrasit boazovázzit, geat ledje badje 60 jagi digaštalle nuoraiguin movt buorebut ipmirdit ja dulkot daid maid oidnet.

Moai maiddái geavaheimme guođohanbeaivegirjedutkanmetoda ávkin čatnat árbevirolaš boazodoallomáhtu ja dieđalaš máhtu. Geavahuvvon metodaiguin oaččuime ollu dárkilis dieđuid ja mihá eanet go dan maid livččiime ožžon dušše dábálaš observašuvnnaiguin ja jearahallamiiguin. Čohkkejuvvon materiálas ledje oktiibuot 2250 siiddu. Boazodoalus lea ollu máhttu bohcco ja olbmo gaskavuođaid birra ja daid gaskavuođat lundui, mat leat šaddan áiggiid čađa (Magga *et al*., 2011). Ollu dutkamat leat čájehan čatnosiid biologalaš ja eamiálbmot– ja báikkálaš máhtu gaskkal (ibid.).

Vaikko vel lea ge nie, de orru leamen nu ahte sirkumpolára davviguovlluid dutkanbirrasat ja eiseválddit eai leat váldán vuhtii dákkár máhtu. Dáinna prošeavttain letne árbevirolaš máhtu ja dieđalaš máhtu ovttastahttimiin lasihan ipmárdusaid boazodoalu strategiijain. Árktalaš eamiálbmogiid máhttu ja ipmárdus, nugo dokumenterejuvvon prošeavttain, omd. SIKU prošeavttain, dagahit eanet olmmošlaš, holistalaš ja máŋggadimenšunála perspektiivva Arktalaš guovlluid birra. (Krupnik *et al*., 2010). Seammáládje lea Eira *earáguin* (2011, sáddejuvvon sisa) geavahan boazovázziid gozihanbeaivegirjjiid buohtastahttit boazovázziid earenoamáš dieđu ja máhtu muohttaga ja muohtanuppástuvvamiid birra muohta-uđas ekspearttaid máhtuin. Bohtosat ja analysat dáin prošeavttain sáhttet buktit ođđa ja dehálaš prespektiivvaid ceavzilis hálddašeapmái, dutkamii ja oahpahussii Arktalaš guovlluid servodagaide. Boazovázziid gozihandatat leat buktán earenoamáš dieđuid movt boazodoalu beaivválaš bargu lea, ja movt boazovázzit árvvoštallet ja čovdet áššiid mat gullet muohttagii, eatnamiidda ja ealuide mat leat lahká. Boazu ieš, dálki, muohta, eatnamat orrot leamen faktorat mat váikkuhit dasa movt eallu láhtte. Boazovázzái lea dehálaš diehtit ja ipmirdit movt eallu láhtte, omd. movt eallu guohtu dahje jus ii guođu ja movt son de ferte dan mielde guođohit. Jearahallamiin leat boazovázzit čilgen ahte lea dehálaš čuovvut mielde movt láhtte nu ahte hehttet ahte eallu ii biđgan. Guođoheami bargonjuolggadus dálvve-áiggis lea ahte boazovázzi ferte dássedit ravddaid geahččat nu ahte boazu ii mana beare guhkás vissis guvlui, eallu ii galgga beare haga lávdat vai bissu ovtta olis. Beaivegirjjiin árvvoštallet ealu láhttema go ná čilgejit: "Eallu ráhkada ieš rutiinnaid gokko guohtu. Guohtundábiide gullet dat, ahte 1) eallu guohtu biekkaid mielde/dálkesorttaid mielde ja 2) ii guođo dakko gokko ovdal lea guhton (borran), gokko lea čiegar (guđohagat mat leat galbmon ja garran), (stašuvdna 2). Boazovázzit observerejit dárklilit movt eallu lea guhton, leago muohta garas dan báikkis ja jus lea jiekŋa botnis, de ferte iskat guovlluid gos sáhttá fas guođohit. Muohtadilit sáhttet nuppástuvvat ja guohtun sáhttá juogo buorránit dahje hedjonit. Dát váikkuha dasa movt siida geavaha iežas dálveguohtuneatnamiid ja guođohanstrategiija. Munno datat čájehit ahte dálveguođoheamis geavahit boazovázzit máŋga guođohanvuogi omd. birravuodjit, goalgŋat, caggat, sirdit.

4.3 Siidavuđot goziheami rolla hukset resilieanssa boazodoalloservodagaide

Eamiálbmotservodagaid oassálastin dutkanprošeavttain galggašii leat ávkin báikkálaš servodagaide. Guođohanbeaivegirjjiid datat ja čállosat čájehit ahte dát orru doallame deaivása dán prošeavttas. Moai letne dokumenteren ovdamuniid mat leat ávkin sihke dieđalaš birrasiidda ja boazodoalloservodahkii. Bohtosiid digaštallamiin ja árvvoštallamiin, leat boazovázzit dieđihan ahte dát prošeakta lea leamaš ávkkálažžan sin siidda bargguide. Guođohanstašuvdna 2 boazovázzit leat muitalan ahte beaivegirji lea veahkehan ahte sii muitet dárkileappot sin guođohanhistorjjá danne go sii leat sáhttán beaivegirjjiin iskat maid sii leat bargan ja goas leat dan dahkan. Viidáseapput čilgejit sii ahte sis lea dáid vuođul leamaš vejolašvuohta buohtastahttit guohtudiliid jagiid mielde. Okta boazovázzi oaivvildii ahte beaivegirjji sáhttá geavahit dokumenteret sin rivttiid danne go dás leat nu dárkilis dieđut das movt sii leat geavahan dálveguohtoneatnamiid máŋga jagi badjel. Moai jáhkke ahte boahtte áiggi beaivegirjevuogádaga ovdánahttin ii leat dušše boazovázziide ávkkálaš, muhto dát maiddái veahkeha siidda hukset resilience. Reslieanssa jurddašeapmi deattuha dehálašvuođa dohkkehit máŋggadáši sosio-ekologalašvuogádatstivrema doarjun dihte heiveheami rievdamiidda. Danin lea dehálaš hukset gelbbolašvuođa siidda stivrendássái. Dán prošeavttas leat siiddat ieža oassálastán gozihanprošeavttas ja obeserveren sin dálveresurssaid variabilitehta. Siidavuđot gozihanvuogádat lea addán siidda oassálastiide vejolašvuođa hukset resilieanssa man vuođđu lea árbevirolaš máhttu ja mas geavahit sámegiela. Moai oaivvildetne ahte dat nanu siidaoassálastin ja sin eaiggátvuohta beaivegirjjiide doarju resilieanssa huksema boahtteáigge rievdamiidda. O'Brien *et al.*, (2009) ákkastallet ahte politihkalaš ortnegat Norggas eai váldde vuhtii dan máhtu mii lea boazodoalus ja ahte dás leat váikkuhusat sosiálaorgániseremii ja nu maid návccaide hukset sosio-ekologalaš resilieansavuogádaga. Danne ferte vuoruhit addit siiddaide buoret stivrenveahkkeneavvuid nu ahte boazodoalu árbevirolaš máhtu sáhttá váldit mielde mearridanproseassaide. Moai jáhkke ahte siidavuđot gozihanvuogádat sáhttá leat mearrideaddjin dustemis dán gáibádusa.

Giitosat

Moai hálide giitit dan viđa siidda boazovázziid Guovdageainnus go leat čállán guođohanbeaivegirjjiid ja go leat juogadan sin máhtu ja dieđuid muohttaga birra boazobarggu oktavuođas. Moai maid hálide giitit Sámi allaskuvlla, Riikkaidgaskasaš boazodoalloguovddáža, NASA, Norgga Metereologalaš insituhta go leat movttidan ja doarjon prošeavtta. Moai giite earenoamážit Unit-Issáha Juhán Máhte (Johan Mathis Turi) neavvagiid ja doarjaga ovddas dan rájes go beaivegirjejurdda badjánii. Dát prošeakta lea oassin EALÁT-Boazodoalu *rašiivuođa fierpmádat dutkamis*, maid IPY lea dievaslaččat doarjon (ID: 399), ja maiddái Norgga dutkanráđđi lea dorjon, *"Project IPY EALAT-RESEARCH: Reindeer Herders Vulnerability Network Study: Reindeer pastoralism in a changing climate, grant number 176078/S30",* ja mii gullá Riikkaidgaskkasaš polárajagi doibmii, IPY konsortiummii IPY # 399 EALAT. Dán lea maiddái Norgga Ođasmáhttin-, hálddahus- ja girkodepartmeanta ruđalaččat dorjon.

Etihkka

Dát dutkan lea čađahuvvon etihkanjuolggadusaid mielde mat leat Sámi allaskuvllas, Riikkaidgaskasaš boazodoalloguovddážis ja Norgga etihkalaš njuolggaduslávdegottis, luonddudieđa ja teknologiija váste (NENT), mii earenoamážit čujuha daidda osiide main boazodoallu lea mielde. Buot oassálastimat dán dutkamis mas ovttaskas olbmot leat leamaš mielde addime árbevirolaš máhtu (omd. siidda olbmot, boazovázzit) leat anonymat.

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A novel *siida*-based monitoring system to observe the effects of climate variability on winter pastures in Sámi reindeer herding.

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Abstract

Climate change and socio-economic change are both now evident in reindeer herder societies across the Arctic. Furthermore, climate scenarios are projecting an 8°C increase in the mean average air temperature in winter and more than one month less snow cover on average in Kautokeino, which is the main region for Sámi nomadic reindeer husbandry in Norway. This article deals with the question of how to monitor such change and variability in reindeer winter pasture, based on traditional knowledge embodied in the specialist language of Sámi reindeer herders. A novel observational system was developed and a specially designed herding diary used, which focused on snow conditions and their impact on herding practices in winter. Herders from five different *siida*s, or herding groups, from Kautokeino in northern Norway, themselves monitored daily variations in snow conditions, wind, precipitation, and topography related to herd behaviour and welfare for a period of five months over three consecutive winters (2007-2009), expressing these variations in terms of their own traditional knowledge and specialist language. The results indicate that the herders' diary can be used as a monitoring tool to observe variability and diversity in grazing conditions between days, grazing locations and *siida* groups, and to document herders' herding strategies in winter. The collected data mirror the reindeer herders' traditional knowledge of snow and snow change and have stimulated the growth of discussion among young herders on this topic. We propose to discuss the potential for this observational system to document traditional knowledge and to monitor the effects of future climate change on reindeer husbandry, which herders themselves can use.

Keywords: snow condition, reindeer herding, siida-based monitoring, climate change, Sámi language, traditional knowledge.

1. Introduction

1.1 Climate and reindeer husbandry

Reindeer husbandry practices, ancient in origin, represent a model for the sustainable exploitation and management of northern terrestrial ecosystems that are based on generations of experience accumulated, conserved, developed and adapted to the climatic and administrative systems of the north. This model has enabled the use of these marginal natural resources in the Arctic for valuable food production for 20 different reindeer peoples in Eurasia (Turi, 2002). Guovdageaidnu (Kautokeino), at 69° N, 23° E, in Finnmark, is the core region of Sámi nomadic reindeer husbandry in Norway and has colder and more stable winters (mean average winter) than on the Atlantic coast of northern Norway (mean average winter) (Vikhamar-Schuler *et al.*, 2010 b) where the reindeer migrate in a seasonal pattern. The written history of reindeer and the reindeer herding peoples of the region goes back to the year 892 AD (Storli, 1994), while the Nenets' reindeer pastoralism in the Yamal Nenets' Autonomous Okrug in Russia was recently dated at more than 2,000 years old (Fedorova, 2003), indicating the potential long-term accumulation of knowledge related to these climate conditions. This suggests that Sámi reindeer husbandry evolved in northern Europe during a period without big changes in climate in winter, but with variability between days, months and years (Mathiesen *et al.* 2011, in prep).

Reindeer herders have the knowledge of how to live in a changing environment. The term 'stability' is a foreign word in their language. The search for adaptation strategies is, therefore, not connected to 'stability' in any form, but is instead focused on constant adaptation to changing conditions (Reinert *et al.*, 2009). Nevertheless, future temperature scenarios indicate that winter temperatures (Dec-Jan-Feb) in Kautokeino may increase by 8 °C over the next 100 years (Benestad, 2011, in press), and winter temperatures in the inland winter pastures may be more like the temperatures found along the coast today (Hanssen-Bauer, 2011, in prep.). Furthermore, detailed scenarios for Kautokeino show that the snow season may be more than one month shorter, while the annual maximum snow depth may decrease to 60%. Future snow conditions might create grazing problems for reindeer and affect the

herding practices we know today. Climate change and socio-economic change are both evident in the traditional reindeer herding territory in the circumpolar north (Magga *et al*., 2011). To advance the development of sustainable reindeer husbandry in official adaptation strategies, it is important to include recognition of indigenous peoples' traditional knowledge, culture and linguistic skills (Nuttall *et al*., 2008).

1.2 Reindeer husbandry and winter grazing

By exploring indigenous people's knowledge, the "SIKU" project has recently demonstrated the power of multiple perspectives and introduced a new field of interdisciplinary sea ice research, combining the study with social (socio-cultural) aspects of the natural world and incorporating local terminologies and classifications, and place names (Krupnik *et al.*, 2010).

Likewise, the ability of reindeer herders to adapt to variability and change, based on the traditional knowledge embodied in their language, in the institutions of herding and in the actions of individual herders, is now more recognized (ACIA, 2004; Tyler *et al*., 2007; Magga *et al*., 2011; Eira *et al*., 2011, submitted). For example, Sámi reindeer herders have developed a rich terminology about snow, snow change and reindeer herding (Eira, 1994; Magga, 2006; Eira *et al*., 2010; Riseth *et al*., 2010; Magga *et al*., 2011; Eira *et al*., 2011, submitted). The daily work with reindeer comprises many different types of activity. The herder has to inspect and observe the situation regularly during the day, every day during winter. The herders on duty have to make decisions and solve any problems that may arise according to the demands of the situation (Sara, 1990). To herd in winter is called, in the Sámi language, *guođohit*, whereas herding in summer is called *geahččat*. *Geahččat* (to look) means looking after the herd so that the herd is under control. *Guođohit* is a causative verb derived from the noun *guohtun* (grazing) i.e. *guođuhit* =to let or put to graze. The original meaning of the verb shows that the reindeer' need for food and water plays an important role in the herders' conception of the wellbeing of their animals (Eira, *et al.,* 2010).

The herders must examine the area to find *ealát* and to find good *guohtun* (access to forage beneath snow cover) for the herd. It is therefore part of their daily work to observe, watch and examine the snow conditions, and the changes in those

conditions, that may affect the survival of the reindeer during the seven-month long winter. However, the term herding (*guođoheapmi*) also includes the protection and safety of the reindeer (Eira *et al*., 2010). The herder has to make certain that the herd is not getting scattered (*bieđagananvára*), and that it doesnot mix with other herds (*mastanvára*), and also protect the herd from being disturbed (*muosehuhttinvára*) (Sara, 2006). The human part of successful herding implies that the herders are aware of, and act in response to, the many needs of the reindeer and the herd (Magga *et al*., 2001). The reindeer should have enough food, water and shelter, and they must be able to move freely around while under control. The human contribution is to take care both of the individual animal and the herd as a whole, in such a way that the needs of the reindeer are satisfied (Eira *et al*., 2010).

Situations, such as weather conditions, can change quite suddenly, or other unexpected situations may arise. In such cases, the herder who is with the herd has to know what should be done or can be done: he or she must have a strategy to cope with the situation. It is the herder out in the field who has to make decisions on the necessity of moving the herd to another part of the grazing area when snow conditions are such that there is a risk that the animals are not getting enough food. All these aspects of herding reindeer in winter include traditional observation and mental monitoring of variability and changes in time and space in the grazing land used and the grazing conditions. Recently, Eira *et al*., (2011 submitted) have found that the snow knowledge of herders is more holistic and integrated into the ecology of the herd and pastures than the international standard snow terms. This study illustrates the importance of using traditional Sámi terminology when developing climate change adaptation strategies for Sámi reindeer husbandry, and emphasizes the need to incorporate the two forms of knowledge, both traditional and scientific. Sámi reindeer herders' traditional knowledge and Sámi terms of snow related to reindeer, reindeer herders and animal welfare, are concrete examples of how traditional knowledge can be used for observation and monitoring.

1.3 Community-based monitoring

According to Berkes & Berkes (2009), indigenous peoples' observation in relation to climate change can contribute to the overall understanding of the system,

complementing scientific approaches by filling in the local-scale expertise embedded in traditional knowledge. Traditional knowledge and observations by local people provide baseline information on climate history; they can help to formulate research questions and hypotheses by providing insights regarding impacts of, and adaptations to, changing weather conditions. Traditional knowledge can also be used for long-term community-based monitoring (Riedlinger & Berkes, 2001; Berkes & Berkes, 2009). Community-based monitoring is defined as a process whereby community groups or individuals participate in long-term monitoring of selected species, habitats, or ecosystem processes with the ultimate goal of improving the management of ecosystems and natural resources (Yarnell *et al*., 2003). The basic idea behind local monitoring of the environment is that the proximity of the users to the resource confers an ability to observe the environment in detail, and in some cases monitor day to day changes (Berkes, 2008). From an indigenous perspective, community-based monitoring is beneficial in the sense that the gathered information would support local decision-making processes in the interest of the communities, with full participation by the communities. Furthermore, monitoring projects have a potential to bridge the gap between western science and traditional knowledge because they offer the possibility for collaboration (Riedlinger & Berkes, 2001; Berkes, 2008).

1.4 *Siida*-based monitoring system of *guohtun* in winter

This article deals with the question of how to use a traditional knowledge-based diary, including Sámi reindeer herders' knowledge of snow conditions and their impact on herding, is a *siida*-based monitoring system. Five winter *siida*s in the west Finnmark reindeer herding area have participated; they have observed and monitored their own *guohtun* situation daily, and their needs and the changes in natural conditions each day during the winter over three consecutive years. Furthermore, in this article we will discuss 1) whether this novel monitoring method can be used to document special knowledge about the herding activities and variations in *guohtun* characteristics of the respective *siida*s in winter; 2) whether the method can be used by the herders themselves to monitor the effects of climate change in Sámi reindeer husbandry in the future. Finally, we will discuss the critical importance of empowering indigenous

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reindeer herders with the best technologies available, combined with their own indigenous knowledge, in order to observe and monitor change.

2. Method

2.1 Study area

This study was carried out in Guovdageaidnu/Kautokeino (69° N, 23° E), the major Sámi reindeer herding region in Norway, and comprised 93,500 reindeer, 53 winter *siida*s and 1,700 nomadic reindeer herders in 2007, 2008, and 2009. A *siida* is a reindeers herders' working partnership, which includes the herd and the traditional use of different reindeer grazing areas according to season (Strøm Bull *et al*., 2001). In the west Finnmark reindeer area, the winter *siida*s are divided into three different grazing zones (*johtalat*) (western, middle and eastern). The *siida*s that participate in the project are called herding stations and each herding station is assigned its own number. The annual minimum temperature is -16ºC and mean precipitation in winter is 11 mm. On an annual basis, and especially during winter, inland Finnmark is the coldest and driest area in the Nordic countries (Tveito *et al*., 1997, 2000).

2.2 *Siida* participation

Snow and winter grazing conditions were studied at five different herders' *siida*s, which were chosen according to specific criteria: 1) Sámi-speaking reindeer herders and fulltime herders with lifelong experience in working with reindeer; 2) each zone should be represented by one or two *siida*s; 3) the *siida*s should moreover represent a diversity of summer pasture (island, peninsula and inland summer pastures) and winter pasture; 4) the winter *siida*s should not be too close to one another so as to represent different weather conditions within the Guovdageaidnu reindeer herding area (the distance between two *siida*s was maximum 87 km). All herders were males between 23 and 60 years of age and were anonymous in the present data. There were two types of observers in each herding station: 1) herders writing the daily notes in the diary with observations of e.g. snow conditions (20 herders in total); 2) in every *siida* there were one or more reindeer herders who had final responsibility for the internal

administration of the diary. These herders also gave information in interviews about snow conditions and changes in snow conditions and their impact upon the herd. In *siida*s where younger herders filled in the diary, these key persons helped and guided the younger ones in case they had some difficulties in filling in/writing the diary. During the period of diary writing there was regular contact (telephone, SMS, and meetings once a month or even more often) between the main responsible person and the researcher. This was done in order to ensure continuity in the diary writing process, as well as to collect extra information not covered by the diary.

A contract was signed with each *siida* and herder. The contract contained a description of how to use the diary in the research project. The diaries were prepared and designed by the researcher, but owned by each respective *siida*. It was not permitted to use the diaries for purposes other than this special research project, and the project was not permitted to publish the original diaries.

After each season upon finalization of the herding diary, the herders were invited to participate in analyzing the data. During these discussions the herders gave some additional verbal information. All herders endorsed the research analyses as far as their own *siida*s were concerned.

2.3 The monitoring indicators and the design of the herding diary

In 1989 the late *Miggal-Niillas-Issat-Niillas* kept a diary with detailed notes about his reindeer herding which comprised data related to herding activities, weather-, temperature- and snow conditions, and partial mixture of herds and separation of herds. The diary was found in 2006 and used as a model to develop a prototype for the monitoring diary subsequently used in this project. The diary was made to mirror the way in which the *siida* organized and performed the practical reindeer work in the winter, how the herders evaluated different situations that had impact on the reindeer and the herd, how they characterized snow conditions and, finally, what strategies they used to cope with the various weather conditions. In 2006 the diary was used for a one-month period by two *siida*s in order to test it as a method and it was subsequently improved in cooperation with the herders.

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The monitoring indicators chosen were observations that describe the situation for the reindeer concerning access to food that is covered by snow (*guohtun)* and herding activities connected with the respective situations described (Table 1 and Fig. 1). Community-based monitoring projects often use traditional knowledge to choose indicators of environmental quality (Berkes *et al*., 2005). An indicator is an observable phenomenon that contains information about the condition of another, non-observable phenomenon (Store Norske Leksikon). In short: the monitoring indicators comprise snow types and changes therein, snow consistency, weather and temperature. In addition there are entries about the behavior of the herd and the use of pasture (Table 1 and Figure 1).

Table 1: The indicators to and the content of the reindeer herding monitoring diary, with explanations of how and why the indicators were chosen.

Indicators and content of the diary	How	Why
Working instructions	Every diary has an instruction leaflet about how to use it (note down data)	It is important that everybody who uses and notes down data in the diary has the same information about how and what to note down, so as to provide the same kind of information
Days of the calendar	In the diary data are collected for every day during the winter months	It is important to gain insight into the daily activities connected with reindeer herding and how the herders characterize and explain conditions that affect the deer and their behaviour
Weather and temperature parameters	Recording of air temperature with special measuring instruments and descriptions of weather conditions	Measurements of temperature over time can give an indication of temperature during wintertime in a given area
Sámi snow terms	Recording of snow types. Empty space for recording snow types that are not mentioned in the diary	Mentioned are 38 types of snow/no snow cover conditions. The diary gives the herders the option of adding additional terms describing snow
Wind	Recording of wind direction and defining the type of wind according to body experience	Recording wind conditions can give an indication of wind direction and how wind affects *guohtun*
Air	Recording of air conditions, if it is cold or mild weather	Air conditions can affect other conditions and change them
Snow consistency	Recording of snow consistency, hard/soft snow; also little snow/medium/lots of snow	Recording of snow consistency and of how much snow there is gives additional information about the snow terms used. It can also provide information about positive or negative changes in *guohtun*
The behaviour of the herd	Recording the behaviour of the herd	The behaviour of the herd shows how reindeer or the herd respond to different *guohtun* situations
Guohtun	Characterization of *guohtun* (very good, good, quite good, quite bad/poor, very bad/poor)	This characterization can be used to evaluate how the other parameters mentioned affect *guohtun* characterization
Recording area	Noting down the area (place names) where the recording was done, possibly using GPS marking	Area recording can give an indication of how the topography of the area affects the *guohtun* situation
Map	Marking off on the map where the recording was done	Noting down on a map where the recording was done, can tell us in what way the *siida* uses the different parts of its winter grazing areas
Space for notes	Describing the *guohtun* situation in the herder's own words.	The log writer can in his own words give additional information about the situations encountered. This can show how he considers the situation and how he chooses his strategy
Glossary, at the end of the diary	There is a glossary at the end of the diary. This contains more terms than those used as entries in the diary. If one day a snow type occurs that is not already in the book, the herder can choose from this list and fill out this term for the day concerned	

In the diary the herder is asked to characterize the factors (daily snow conditions and other factors) that affect the reindeer and the herding of the deer. The diary

contains variables that the herder has to take into account, e.g. if the deer are keeping together in the herd (not getting scattered), if there is wind, the kind of wind and wind direction, and other weather conditions. One indicator is used to evaluate and characterize the *guohtun (*very bad *guohtun* bad *guohtun–* good *guohtun–* very good *guohtun*), which is the core of the day-to-day herding activity.

The herding diary is prepared like a calendar (Fig. 1). It has two pages for each day. Each day has the same indicators where the herders can write notes concerning the herding situation for that day.

Figure 1: Pages from the reindeer herding monitoring diary, showing indicators on the left page and free space for notes on the right page.

The herding diary can in a way be compared with a private diary: it is the herders themselves who keep the diary (self-accounting diary). The herding diary is divided into two parts, a structured as well as an unstructured part. The structured part of the herding diary is designed according to a certain pattern. This is done to cover situations where the researcher needs the same kind of information from the different *siida*s. This part is made up of a structured outline where the informants fill in information about snow/weather conditions at different times of the day. When the entire herders note down information according to fixed pattern, it makes it easier to get an overview of the conditions in each of the *siida*s, while also making it easier to

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compare the conditions of the different *siida*s. In the unstructured part of the diary the informants can write down their thoughts and reflections about their observations in their own words.

3. Results

This investigation reports on a novel use of reindeer herders' diaries in daily herding in winter, documenting a high number of Sámi snow terms used related to snow conditions, reindeer and reindeer herding (Table 2). Furthermore, with the herders' snow characterizations (use of snow terms) in the different *siida*s and using the diary system, we were able to characterize the winter grazing conditions, mirroring the herders' observations and strategies. A high diversity of snow terms was used in all *siida*s, and with the data collected on that single day of February 5th 2008 we were able to show a variety of snow terms, indicating different grazing conditions pertaining in the respective *siida*s (Table 2). Similar terms with respect to snow, reindeer, topography and herding were recorded in all five *siida*s studied, indicating a uniform understanding of traditional knowledge based on the same language.

Table 2. Sámi snow terms used daily in reindeer herding in Kautokeino, Norway in five different *siida*s (reindeer herding stations) during one specific day (February 5th) in the winter of 2008 (red = temperature, light blue= weather descriptions, grey = wind, air and snow, blue = snow, yellow = behaviour of the herd, green = *guohtun* characterization, white = topography).

s.t.	temperature	Weather		Wind	Air	snow	oppas	vahca	didnen	luotkkus	gaskageardni	častasat	joavggahagat	čeargan	sapas	seanáš	ritni	Ritni	Behavior	Good	quite good	quite bad	Bad	Topography
1	-5	obb/balv	borg/guol	Čavga biegga	gal	Gassa		X	X		X	X	X						ruvg			X		váris
2	-11	murku		Goalki	biv	Gaska	x			x										X				váris
3	-14	Obb	murku ruvaš	NL spiella	gal	Gaska/seaggi		x						x	x	x			lod		x			duoddaris/váris
4	-15	beai		L spiella	gal	Gaska/seaggi	x	x										x	lod	X				duoddaris/váris
5	-18	beai	ruvaš	NL spiella	ruv	Gaska			x	X		x		x		x			lod		x			váris

Translated from Sámi language (table 2): *Obba dálki = heavy weather, Balvadálki = overcast, Beaivvádat = sunshine, Borga = snowy weather, Guoldu = cluod of snow, Murku = winter fog, Ruvaš = cold wind after damp weather, Čavga biegga = fresh breeze, Goalki = calm, Spiella = gentle breeze, NL = Nuorti-luládat = south eastern wind, L = Lulle biegga = southerly wind, Galbma biegga = cold wind, Bivval = mild weather, Gassa muohta = deep snow, Gaskamearálaš = middle deep, Ruvgala = dash of in a long thin line (of reindeer), Lodji = quiet.*

Furthermore, comparisons between different years, but over the same period in winter, show a large diversity of snow terms used. Snow terms expressing the snow conditions for station 1 over the years 2007-2009 are shown in Fig. 2. In 2007 *seaŋáš* (granulated snow at the bottom of the snow pack) first occurred in January, while one year later *seaŋáš* was developed as early as December 2007; whereas in 2009 it appeared as early as the middle of December 2008 and lasted right until the beginning of April, a period of almost four months with good grazing conditions. Fig. 2 expresses the big variations in grazing conditions for reindeer between the years and through the season in one *siida*. Similar variations in grazing conditions were shown for all *siida*s involved during the winter and between the years.
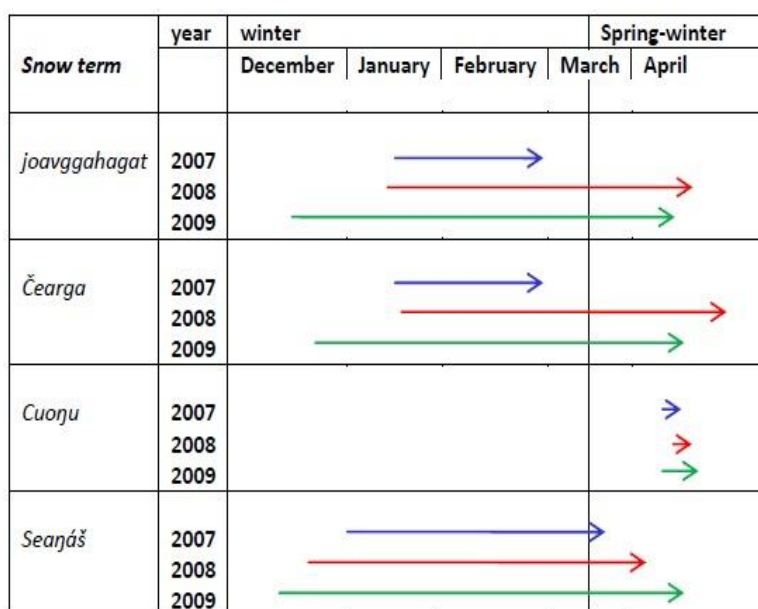
Figure 2. *Variations in selected snow terms used by Sámi reindeer herders in Kautokeino, Norway during the winter season and subsequently between the years 2007 (blue), 2008 (red) and 2009 (green) in one of the reindeer herding siidas studied (station 1) expressing different winter grazing conditions.*

Thirteen different snow terms were recorded in the herders' diaries in all five *siida*s (stations), but the first date the terms were used varied between locations, showing the mosaic of snow conditions in the reindeer herding region in western Finnmark (Table 3)

Table 3. Sámi snow terms used in daily herding of reindeer in winter in Kautokeino according to the first date they were recorded in the diary in the 2008/2009 season, in five different reindeer herding *siidas*.

Stations Sámi snow terms	Station 1	Station 2	Station 3	Station 4	Station 5
častasat	21.12	1.1		22.12	21.12
čearga	20.12	1.1	11.1	24.12	24.12
Cuoŋu	13.4	18.4	15.4		15.4
Gaskageardni		3.1		8.2	

Geardni			31.12		
joavgan	19.12	1.1	25.2	10.1	15.12
luotkkus	16.12	15.2	13.1	2.1	1.12
Oppas		3.1		6.12	
Ritni/rinádat	14.1	20.1	8.12	5.12	1.12
Saŋas	16.12		1.1	13.12	1.12
Seaŋáš	1.1	25.1	2.1	5.1	1.1
Soavli	26.12			13.12	1.12
Vahca			1.1	3.12	

The herders made daily observations of the herd grazing, and in what part of the pasture they grazed. The herders' diary revealed that 21 different topographical terms existed and were used in the winter herding area (Table 4). A large variation of different topographical types was observed between *siida*s, but not identical in each *siida*.

Table 4. Diversity in the type of topographical areas present within the *siida* grazing areas (stations 1-5) observed and used in winter by Sámi reindeer herders in Kautokeino, Norway, recorded using a reindeer herders' diary.

Types of areals/ Stations	bohtu	buollan	buolža	čearru	čohkka	čopma	čorru	gielas	jeaggi	johka	luhppo	luokta	luoppal	maras	njárga	oaivi	roavvi	sevdnjes eanan	skáidi	várri	vuopmi
St. 1		x	x				x	x		x		x	x	x	x	X	x			x	x
St. 2		x			x	x		x		x								x		x	x
St. 3				x						x						X				x	x
St. 4			x				x	x	x	x	x								x	x	x
St. 5	x						x	x	x	x			x			X	x			x	x

Translated from Sámi language (table 4): *Bohtu = isolated small, clump of trees, buollan = place where forest or area covered with reindeer moss has once burnt, buolža = steep ridge of mountain, dry gravelly eminence, čearru = rather flat, usually wide tract high up in the mountains with little vegetation and long stretches of nothing but gavel and stones, čohkka = mountain top, čopma = long, narrow and high ridge, long, narrow and flat elevation, čorru =lengthy eminence, ridge, edge which sticks up, gielas = long, narrow, high mountain ridge, jeaggi = marsh, johka = river, luhppo = steep abrupt hill where there is traffic, luokta = creek, bay, luoppal = small lake through which a river runs, maras = rather low but fairly extensive wooded čorru, njárga = nes, cape, peninsula, oaivi = round-shaped top of mountain, rounded mountain, roavvi = long, not very high wooded mountain, sevdnjes eanan = area of dense forest, skáidi = the land between two rivers which join, várri = mountain, vuopmi = woodland.* (Nielsen, 1979).

Our study shows that the five *siida* at identical times used the same types of topographical area in their own respective winter grazing areas (Table 5).

Table 5. Different topographical sections of the winter pasture used for grazing land related tothe time of the winter season and between the five different locations

Season	Months	St 1	St 2	St 3	St 4	St 5
late fall (fall winter)	*November*	*vuopmi*				*roavvi várregilga*
winter	*December January February March beginning/middle*	*vuopmi roavvi maras buolža*	*vuopmi gielas čohkka várri vuopme-giera*	*vuopmi johk'gáddi várri*	*vuopmi gielas skáidi várri skáidi*	*vuopmi čorru bohtu várri gielas*
spring winter	*March beginning of April*	*čorru buolža*	*várri gielas*	*várri čearru*	*várri gielas*	*várri gielas*

Translated from Sámi language (table 5): *Vuopmi = woodland, roavvi = long, not very high wooded mountain, maras = rather low but fairly extensive wooded čorru, gielas = long, narrow, high mountain ridge, buolža = steep ridge of mountain, dry gravelly eminence, čorru =lengthy eminence, ridge, edge which sticks up, čohkka = mountain top, vuopmegiera = top, upper end of woodland, várri = mountain, johk'gáddi = riverbank, čearru = rather flat, usually wide tract high up in the mountains with little vegetation and long stretches of nothing but gavel and stones, skáidi = the land between two rivers which join, várregilga = mountain side, bohtu = isolated small, clump of trees. (Nielsen, 1979).*

In addition to the diaries, related interviews with reindeer herders show how the herders couple reindeer, snow and area together, as a basis for their herding strategies (Table 6). The results show that daily herding has two aspects: 1) the herder drives around the herd[1] and watches how the herd is grazing. If the herd is grazing quietly and keeping together, the herder looks for tracks of straying reindeer. If there are tracks crossing the circling tracks of the herder's snowmobile[2], the herder has to find out where the reindeer have gone and bring them back to the herd; and 2) if the herder sees that the herd is not grazing quietly and has escaped from the core winter grazing area, he has to find the reason for this behavior. He then checks the *guohtun*-situation, i.e. firstly the snow consistency, secondly the ground beneath the snow cover, and, thirdly the *ealát*, the food situation. Herders also look where the herd has been grazing before. If the snow is hard in the area, or if there is ice under the snow cover, the herder has to find a place where there is *oppas* (untouched snow) or else move the herd to a part of the *siida*'s grazing area with better grazing conditions.

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[1] Driving around the herd: *birravuodjin*

[2]*Birravuodjinluottat*

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Table 6: The human coupling together of reindeer - snow - area shows the relationship between the herder and herding and problem solving strategies in winter, shown schematically and holistically observed and monitored using the herding diary, in addition to interviews with reindeer herders.

Variables	Explanations
DRIVING AROUND THE HERD	
How the herd is grazing	When the herd stays in one place, this means that the reindeer are finding food there and that the snow conditions are such that they can dig through the snow. When the herd starts to go from the area, wandering away, the herder has to check why it doesn't stay where it is (is it caused by predators or poor grazing conditions?).
Tracks	The herder drives around all the tracks and follows tracks crossing the driving circle to find out if some animals have strayed away from the herd. If so he has to get them back to the herd. It is important to hold the herd together so that it will not mix with herds of other *siida*s. The herder also looks for tracks of predators, to see whether they have crossed the driving circle and the predator has got into the herd.
GUOHTUN (GRAZING CONDITIONS)	
Snow and snow physics	The snow physics affect the grazing ability of the reindeer. If there is *oppas*, then it is good, but if there is *čiegar*, then the herd has to be moved to other parts of the grazing area. Hard snow: *čearga, cuoŋu*
Bottom of the snowpack, near the ground	If the bottom of the snowpack is good, then the reindeer can reach the vegetation underneath. But if there is ice at the bottom, this has a negative effect on their grazing ability. It is therefore important to check the condition of the bottom of the snowpack. *Čiegar, bodneskárta*
Ealát	While inspecting the bottom of the snowpack, the herder also looks at the type and condition of the vegetation. If the land is grazed bare it is of no use to put the herd to graze in that area, because it will go hungry, but if there is *ealát* (lichen and other plants), it will start grazing there.
Area where the herd has been grazing before	The herder has to check if there is *čiehkarat* in the area and the state of the *guohtun* there: *rudneguohtun* (hard, but possible for the herd to find food in the grazing craters) or *gutnaguohtun*.
Weather and wind	Weather and wind can both improve snow conditions as well as worsen them; they can, for example, cause *čearga*. In spring time: the herds want to move to the coast irrespective of the direction of the wind. In autumn: the reindeer are wandering against the wind, in the direction the wind is blowing from. If the wind turns around, the herd will turn also and move in the opposite direction.
Alternative grazing grounds	If the *guohtun* deteriorates, the herder needs to look for *oppas* in other parts of the grazing area and to find out if these parts can be used for grazing and, if so, move the herd.

Reindeer herders' observations of snow conditions in different winter grazing areas in Kautokeino show big differences. A comparison of *guohtun* characterizations from five sites over a period of 3.5 months shows that there is great diversity in *guohtun* conditions in these areas. *Guohtun* characterization is done by measuring snow texture, hardness, snow depth, snow and ice layers, the thickness of the layers, etc. The *guohtun* characterization shows that the grazing conditions were generally good in four of the *siida*s (stations 2-5), either extremely good, *hui buorre guohtun,* in stations 2 and 4; or fairly good, *oalle buorre guohtun*, in stations 3 and 5. However, the grazing conditions in station 1 were quite bad, *oalle heajos guohtun.*
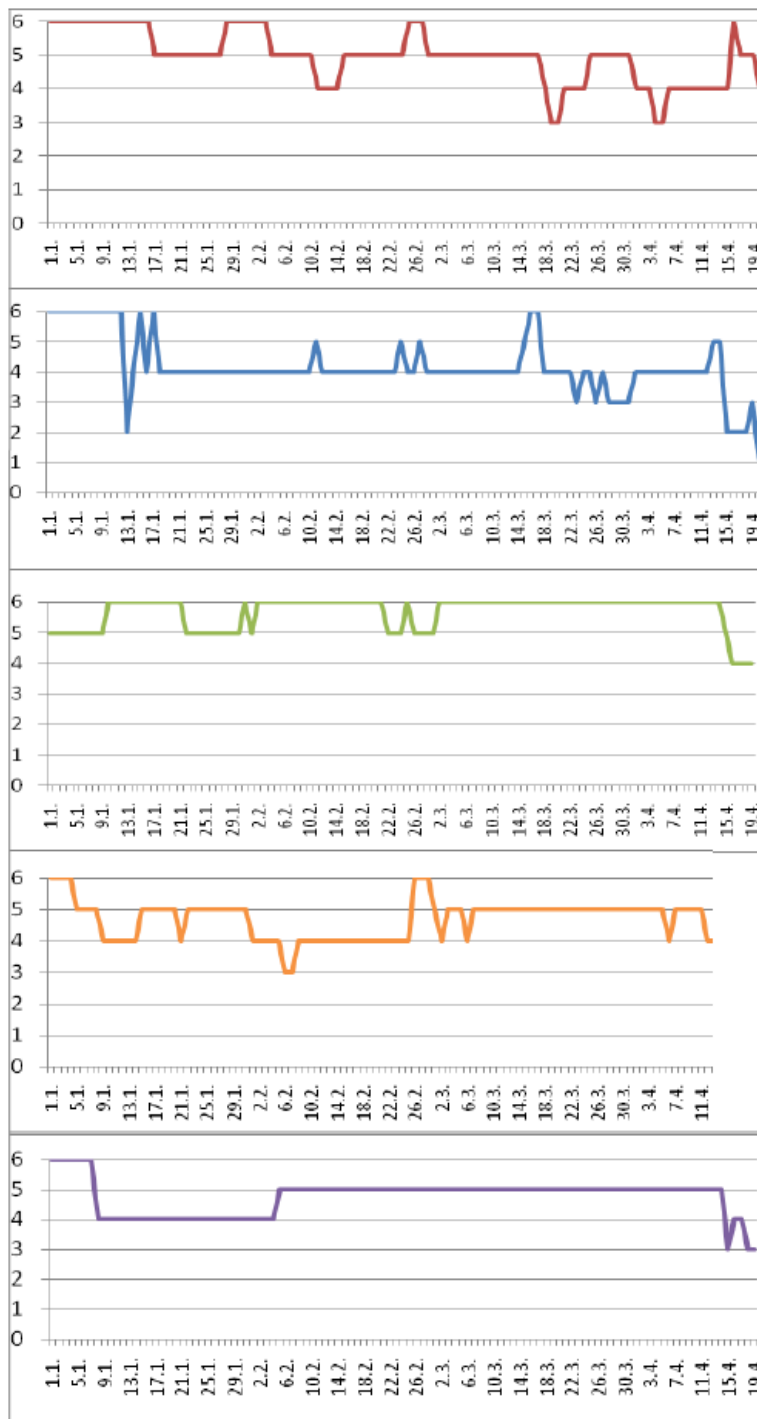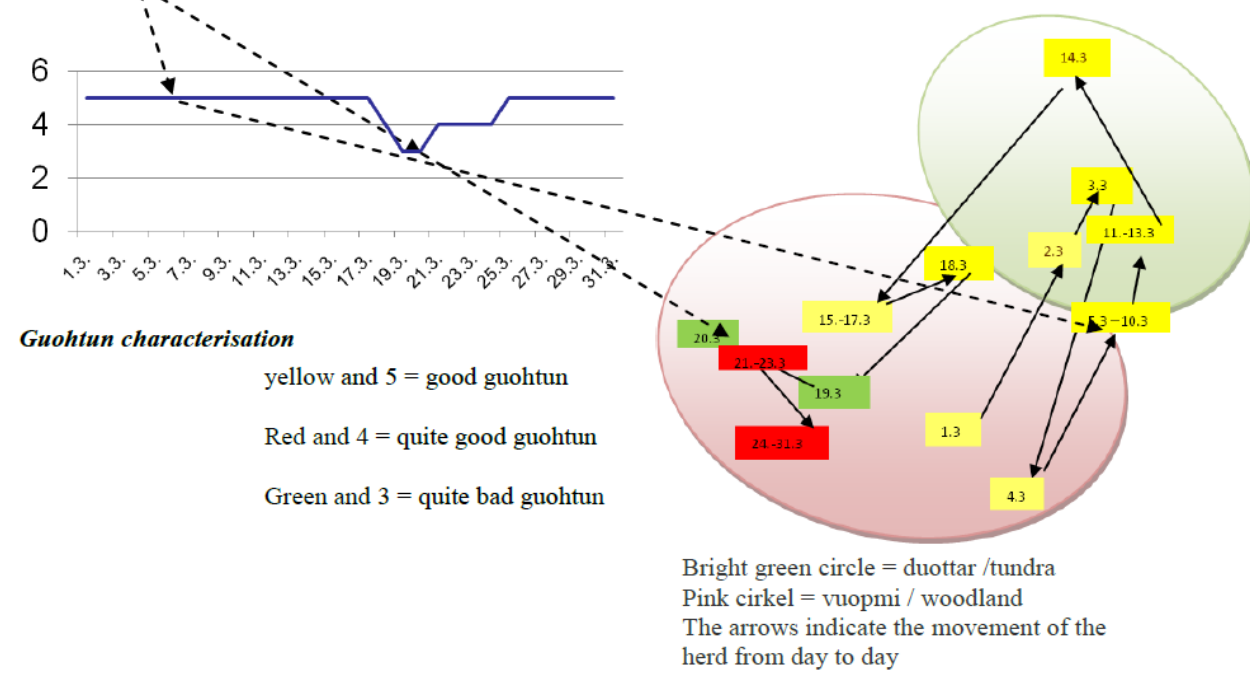
Figure 3: Explanation of numbers in the graph: 6 = very good guohtun, 5 = good guohtun, 4 = quite good guohtun, 3 = quite bad/poor guohtun, 2 = bad/poor guohtun, 1 = very bad/poor guohtun. Presentation of guohtun in five winter pasture areas in west in western Finnmark from January 1st to April 19th in 2009 shows big differences in guohtun conditions. Station 1 (red) had stable conditions in the first month, and then more varied conditions; while station 2 (blue) had diverse guohtun conditions, with very good guohtun from 1.1.-12.1, followed by degrading conditions. This station had the most diverse conditions of all, also the worst conditions of any station; while station 3 (green) had the most stable, close to optimal, conditions throughout the winter. Station 4 (orange) had at the beginning of the period very good guohtun, which then varied between good and quite good; while at station 5 (purple) conditions were stable, varying between good and quite good.

The herding diary provides information about herding strategy in relation to *guohtun* quality and use of grazing areas in winter (Fig. 4), while also showing that herders have evaluated and implemented processes of a certain duration, in relation to the area and to the snow. Two main factors are important for improving grazing conditions (*guohtun*)

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for the herd: 1) the weather; and 2) moving the herd to other areas with better snow conditions (Fig. 4). The grazing conditions are evaluated daily, as shown in Fig. 4.

Date	The herders' descriptions of their observations and evaluations
4.3	There is a lot of *čearga* here (*čearggahat*), but the reindeer succeed in digging through it, because the layer is not very thick. Below the *čearga* there is *seaŋáš*.
6.3	The weather is mild and grazing conditions are good (*good guohtun*). There is a lot of čearga now, but good grazing conditions in areas with wood. There is little snow. There is still hard snow in the plateau (tundra) area.
7.3	Very good grazing conditions (*very good guohtun*). There is both *joavggahagat* and *čearga*, but the snow is not hard. The herd is not grazing in areas with *joavggahat*. The layer of *čearga* is a thin one and the reindeer can easily dig through it.
14.3	On the mountain plateaus (tundra) there is *geardni* in areas where there is somewhat deeper snow. The *geardni* layer is ca 1 – 2 cm thick. No *geardni* where there is wood.
15.3	Now there is some *čiegar* where the herd is grazing, but the *čiegar* is not very hard. The grazing craters have become granulated (*sekŋon*) because they have been filled up with new snow (*vahca*). There is no *geardni* in areas with wood. There is *čearga* and below the *čearga* there is *seaŋáš*. The bottom snow is good.
19.3	*Čiegar*
20.3	*Čiegar*

Guohtun characterisation

yellow and 5 = good guohtun

Red and 4 = quite good guohtun

Green and 3 = quite bad guohtun

Bright green circle = duottar /tundra
Pink cirkel = vuopmi / woodland
The arrows indicate the movement of the herd from day to day

Fig. 4. *The different herding strategies of one siida (station 1) in relation to guohtun quality and the use of terrain (treeless, flat ridges (duottar) and wooded areas (vuopmi)) in winter in Kautokeino, in March 2009. Duottar are areas with mountains with scanty vegetation and almost no trees. Vuopmi are lower-lying areas with woodland, hills, ranges of wooded hills and long ridges*

A total of 2,250 daily diary reports show that there are major differences in snow types and snow conditions between grazing areas and between seasons and years. However, there are major similarities in the use of types of topographical area,

providing similar opportunities for the reindeer to graze. Our data show that five *siida*s in Kautokeino use the same type of topographical area at the same time. Finally, the results show that the herders' diaries can be used to monitor changes in *guohtun*. The monitoring has resulted in systematic information being obtained through the use of reports in the form of diaries. The monitoring diary method has also made it possible to collect the same type of data from different areas for the same time period. This novel observational system has greatly benefited our understanding of, for example, how herders use different snow terms and how snow affects their daily work with the herd. Providing a systematic diary observational system to the Sámi reindeer herders has proved to increase the discussion about snow conditions, grazing and traditional knowledge in particular among the young herders on duty. Finally, the language use and the perception of the content of the snow terms used in the five areas can be said to be almost identical.

4. Discussion and conclusion

4.1 Sámi *siida*-based monitoring of grazing conditions for reindeer in winter

Sámi reindeer herders' knowledge of snow and grazing conditions in winter (Eira *et al*., 2010) is part of their traditional knowledge, which is a systematic knowledge of reindeer and their environment (Magga, 2006). The high diversity of snow terms used daily by the herders indicates the importance of different snow conditions in relation to pasture topography, temperature, wind and precipitation. These terms are used during the seven-month period when snow covers the ground, as part of the hourly and daily reindeer herding monitoring, with changes in space and time recorded in accordance with the herding practice. According to Eira *et al*., (2011 submitted) and Reinert *et al*., (2009), the difference in snow quality is a key element of diversity, and topography as an important component determines how snow is distributed over an area, thus influencing the availability of pasture plants for reindeer. Diversity of snow we understand to mean the variety of snow terms used, which reflect the different types of snow and snow conditions that exist in a winter grazing area,

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providing different ecological niches and opportunities for reindeer. We argue that the great heterogeneity of the snowpack in each winter herding area observed in this study represents opportunities for reindeer grazing and spreads the risks for difficult grazing conditions which could impact on Sámi reindeer husbandry.

The core activity of the daily herding in winter includes evaluation and characterization of *guohtun*, and identifying these ecological niches locally, which makes the term *guohtun* the most important term in Sámi reindeer husbandry and an example of the way in which reindeer herders know snow conditions taking into account space and time. The term *guohtun* is used by the herders to estimate how easy or difficult it is for the reindeer to dig through the snowpack to the plants on the ground beneath (Eira *et al*., 2010). The use of this term in the daily management of herding demonstrates a clear priority, which determines how reindeer herds are able to manage to survive during the winter, namely to evaluate and respond to snow- and weather conditions. *Guohtun* is an example of how Sámi snow terms express a complex system of traditional knowledge, reflecting the holistic understanding of reindeer herding in a complex ecosystem. Recently, Rutorier and Roue (2009) were able to demonstrate, using Sámi traditional knowledge, the importance of *guohtun* in Sámi reindeer husbandry in Sweden, which was in conflict with modern Swedish forestry practices, which have rapidly changed the grazing conditions for reindeer.

Sámi reindeer herders in Guovdageaidnu used the terms "very bad *guohtun*– bad *guohtun*– good *guohtun*– very good *guohtun*" to characterize the *guohtun* after observing the grazing conditions, according to observations recorded in the herders' diaries. The term *guohtun* in relation to snow is most frequently used together with adjectival antonyms, putting the term on a gradual scale. Accordingly, it is not done by using numerical data, but by using language-based data. Recently, Eira *et al*., (2011 *submitted*) found that reindeer herders' knowledge of snow is more holistic than similar knowledge in international snow physics. In order to assess *guohtun*, Sámi reindeer herders deal with many variable factors simultaneously, like snow physical variables that determine whether access through the snowpack is easy or difficult, but also pasture topography, herd behavior, and the mobility of the neighboring herd. The overall formation of *guohtun* depends on the relationship between snow, precipitation, temperature, wind direction and velocity, as well as other environmental variables such

as topography. The temperature gradients between air and ground through the snowpack are one important factor which might control the processes resulting in good *guohtun* or bad *guohtun* (Eira *et al*., 2011 *submitted*). If *guohtun* is poor, it indicates that the layers on the top or within the snowpack are so hard that the reindeer have difficulties in crushing the hard layer in digging through. The strength in the snow layer increases with the number of melt-freeze cycles (*geardni, cuoŋu*), and with the wind's ability to compress the snowpack (*čearga*). We were able to show by using the monitoring diary that Sámi reindeer herders observed and monitored these conditions in the snowpack very closely from hour to hour every day.

Semi-structured interviews connected to the diary revealed that Sámi reindeer herders, in characterizing *guohtun*, consider the ground (*bodni*) to be the most important factor. This types of snow that freeze solid in *bodni* like b*odneskárta* and *bodnejiekŋa* (bottom ice), are snow conditions, which can lead to big losses and death of the animals. If this type of snow lasts until spring, reindeer loss could be high due to starvation. One such year of disaster (*goavvi*) in Guovdageaidnu was 1917/1918 (Eira, 2011, *in prep*.). Herd mobility in response to icing events is documented by Bartch *et al*., (2010) and Forbes *et al*., (2009) in Yamal Nenets AO. Nevertheless, Tyler (2010) and Helle and Kojola (2008) indicate that rain on snow events have not shown to markedly increase mortality in reindeer populations. In the case of Sámi reindeer herding in Guovdageaidnu, the herders' mobility responses to the herd might provide one explanation for this. Likewise, a three-year study (2007-2009) with observations and monitoring of *guohtun* conditions in five reindeer herding *siida*s in western Finnmark, Norway, indicated that mobility within the respective herding areas was induced in response to changes in the snowpack, although no major trends in degradation of *guohtun*, such as for example increased ice crust, were observed in short observation periods.

We have demonstrated that combining herders' diaries and semi-structured interviews is a fruitful form of corroborating and identifying themes related to herding and snow conditions. Clearly, the use of the herding diary in this study has demonstrated the ability of reindeer herders to observe and monitor the grazing conditions to the benefit of the welfare of the herds. The implementation of this novel monitoring system is an example of a community-based monitoring system at *siida*

level using traditional knowledge which is able to record considerable variations in snow and grazing conditions among *siida*s. We have developed this concept further by engaging individual herders in each *siida*, in observing, recording and monitoring variations and potential changes in grazing conditions.

Based on traditional knowledge, we propose the use of this observational system to monitor future snow change in the reindeer herding winter pastures as the effects of projected climate change. So far, the temperature has increased primarily in spring, while precipitation seems to have increased in all seasons in the Sámi reindeer herding region in Finnmark (Vikhamar-Schuler *et al*., 2010 a,b,c). A comparison of reindeer herders' diaries with respect to favorable and unfavorable winters in Finnmark and climate data from the area indicates that temperature and precipitation conditions alone are not critical for the reindeer (Magga *et al*., 2011). However, various combinations of these variables may in future lead to different snow structures, which will make the pastures more or less available for the reindeer. Thus, we argue the importance of further development of herders' diaries, with implementation in an electronic monitoring version to monitor the effects of climate change on pasture conditions. We propose that this observational system, founded on traditional knowledge, should be developed for use by the herders themselves within the *siida* system. We recommend that Sámi reindeer herders should be empowered with the best available technologies to monitor such changes, based on their traditional knowledge and specialist language.

4.2 Herders' monitoring diaries as a tool to document and communicate traditional knowledge

Sámi reindeer herders' close observations of snow and grazing conditions for their reindeer during winter herding are usually communicated verbally between herders on duty and when teams of herders change their duty shift. From the comments made in the diaries by herders themselves, the existence of the diary seems to have strengthened these discussions among herders and, furthermore, increased the interest in, and discussion among, young herders on these topics, using their own specialist language. According to Magga *et al*., 2011, IPY EALÁT has provided new opportunities for young reindeer herders to meet young herders from other reindeer

peoples in the form of workshops, lectures, research projects and cultural exchanges. Today, views of traditional knowledge have evolved. By enhancing the recruitment of young scientists from local communities, and supporting institution-building for indigenous organizations, the EALÁT project has supported capacity-building for indigenous societies. Adaptation to climate change demands the training of local Arctic leaders in long-term sustainable thinking, based on the best available adaptation knowledge, both scientific and experienced-based traditional and local knowledge. National adaptation strategies must recognize minorities, and indigenous peoples' traditional knowledge, cultural and linguistic rights (Nuttall *et al*., 2008). The use of the reindeer herders' monitoring diary is a successful example in this regard. One of the key findings of the EALÁT project was that engaging reindeer herding youth directly in herding practices and providing enhanced education is a key factor in promoting the future sustainability of reindeer husbandry and its cultural foundations (Magga *et al*., 2011). Likewise, in the CEAVVI project, which is a part of IPY EALAT, and is also building capacity, young reindeer herders were provided with greater insight into the methods used, and the collection and documentation of traditional knowledge and subsequent verification of collected data, while also being introduced to various topics of traditional knowledge. The goal was to use traditional knowledge to enable a better understanding of climate change, while CEAVVI also contributed to knowledge-building with experienced reindeer herders teaching young herders about how to see signs in nature and to observe when something "unusual" happens. These reindeer herders, who were more than 60 years old, discussed with the young herders how better to understand and "translate" the observations made.

We also used the herding monitoring diaries as a research method to forge profitable links between traditional reindeer herding knowledge and science. The methods used gave much detailed information and more than can be collected by means of traditional observations and interviews alone, totally 2,250 pages of collected material. Within reindeer herding much knowledge has been generated over time about the reindeer and man's relationship to it, and about the relationship of animals and human beings to the natural environment (Magga *et al*., 2011). Many studies have demonstrated the correlation between biological knowledge and indigenous and local knowledge (ibid). Nevertheless, such knowledge appears to have been neglected by the

research community and the authorities in the circumpolar north. In this project we have increased the understanding of strategies within reindeer herding by combining traditional knowledge with modern scientific knowledge. Arctic indigenous peoples' insights and understanding, as documented by projects such as SIKU, will contribute to more human, holistic and multidimensional perspectives on the Arctic (Krupnik *et al.*, 2010). Likewise, Eira *et al.*, (2011 *submitted*) has used the reindeer herders' monitoring diaries to compare the herders' unique insight into, and knowledge of, snow and snow change with that of snow avalanche experts. The results and analyses provided from these projects will bring new and important perspectives to sustainable management, research and teaching in Arctic societies. Data from reindeer herders' monitoring has brought a unique insight into the daily work of reindeer herding, as well as evaluations and solutions in relation to snow, grazing land and the presence of other close-grazing herds. Factors that appear to affect the behavior of the herd seem to be the reindeer itself, as well as weather and snow conditions and the topography of the area used. It is important for the herder to know and understand the behavior of the herd. In the interviews the herders explained the importance of constantly keeping an eye on the herd and preventing the loss of control of the herd. One of the principles of winter herding is to watch or monitor the edges of the herd: the reindeer should not be too mobile in a certain direction; the herd must not become too scattered. It is important to keep individual reindeer together as a herd. The herders' diaries reflect herd behavior when they state; "The herd itself makes up the routine for where it is grazing" The herd's grazing behavior is formed by certain conditions: 1) they graze according to the direction of the wind and different kinds of weather; 2) they graze avoiding where they have grazed before, due to the difficult *guohtun* created by a snow condition called *čiegar* (*guđohagat mat leat galbmon ja garran, station 2*), meaning the snow where the herds were grazing was very dense. The herders observe closely where the herds have been grazing and, if the snow is hard in the area, and if there is ice under the snow cover, the herders must look for a new place or niche within the grazing area where reindeer can dig through the snow. Snow conditions can change and *guohtun* can improve or deteriorate. This has implications for the *siida*'s use of different parts of its winter grazing area and herding strategy. Based on our data, herders use several herding methods in winter, for example they drive around the herd (*birravuodjit*), bring

it very gently to a certain area (*goalŋat*), stop the herd from escaping (*caggat*), or move the herd (*sirdit*).

4.3 The role of *siida*-based monitoring in building resilience in reindeer herders' local communities

The participation of indigenous societies in research projects should profit their local communities. The data and notes recorded in the herders' diaries indicate that that holds true for this project. We have documented a win-win situation, with gains for both the scientific community and the reindeer herding community. In discussing and evaluating the results, the herders reported that the project had also been useful to them in the work they did in the *siida*. The herders from station 2 reported that the diary made it easier for them to recall more details of their recent herding history, because the diary gave them the opportunity to see what decisions were taken and when. Furthermore, they reported that with the diary it was possible to compare grazing conditions for different years. One of the herders said moreover that the diary could also be used to document herding rights, because it contained detailed information about the use of winter grazing areas over a period of years. We believe further development of the diary system for monitoring *guohtun* can not only make the system even more useful for the herders in future, but also support the *siida*s in building resilience locally. Resilience thinking draws attention to the importance of recognizing multilevel governance of socio–ecological systems to support adaptation to change. Thus, building competence at *siida* governance level is important. In this project the *siida*s themselves have participated in the monitoring project, observing the variability in their own winter resources. A *siida*-based monitoring system has given the *siida* participants the opportunity to build resilience based on traditional knowledge using the Sámi language. We believe the strong *siida* participation and ownership of the diary project support building resilience to future change. O'Brien *et al*., (2009) argue that the political arrangements in Norway fail to recognize the knowledge that underlies reindeer pastoralism and that this has consequences for social organization and hence the capacity to build a resilient socio-ecological system. A priority must therefore be to provide the *siida*s with better management tools so that herders' traditional knowledge

can be included in decision-making. We believe that a *siida*-based monitoring system can be crucial to meeting this demand.

Acknowledgements

Ethics

This research project was carried out according to the ethical guidelines of Sámi University College, Kautokeino, Norway, and the International Centre for Reindeer Husbandry, and the Norwegian Committee for Ethical Guidelines in Science and Technology (NENT) (www.nent.org), with particular reference to any instances where reindeer herders were involved. All participation in the study by individuals who contributed traditional knowledge (e.g. *siida* members, reindeer herders) has been anonymous.

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[3]*EALÁT* is an interdisciplinary, intercultural study that will assess the vulnerability of reindeer herding, a coupled human-ecological system, to change in key aspects of the natural and human environments, actively involving reindeer herders, linguists, lawyers, anthropologists, biologists, geographers, economists, philosophers (to address the ethical dimension) as well as indigenous institutions and organizations, commercial interests and management authorities.

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