

Book of Abstracts



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conference on
**Grazing in a
changing
Nordic region**

**12-15
september 2016**
Reykjavik | Iceland



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Soil Conservation
Service of Iceland



NordGen

Nordic Genetic Resource Center

Grazing in a Changing Nordic Region

12 - 15 September 2016

Reykjavík, Iceland

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NordGen – the Nordic Genetic Resource Center

Soil Conservation Service of Iceland

Scientific committee

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The work of the Nordic Council of Ministers and the Nordic Council revolves around a common understanding of democracy and shared social values, which help to maintain and foster dynamic development, to promote freedom of movement and to enhance skills, competitiveness and cohesion throughout the Region.

Formal co-operation between the Nordic countries is one of the oldest forms of multilateral political partnership anywhere in the world. Rooted in the geographical, historical and cultural affinity between the five Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) and three autonomous territories (Greenland, the Faroe Islands and Åland), it is one of the most comprehensive and popular forms of regional partnership in the world.

The main priorities are: climate, environment and energy; education and research; and welfare and culture. These core issues serve as the foundation for the strong international commitment shown by both the Nordic Council and the Nordic Council of Ministers. The Nordic Council is the official inter-parliamentary body, whereas the Council of Ministers is the official inter-governmental body.

taken from "Nordic Co-operation", Nordic Council of Ministers, Copenhagen 2011, ISBN 978-92-893-2179-2



www.land.is

The Soil Conservation Service of Iceland (SCSI, Landgræðsla ríkisins) was founded in 1907. It is a governmental agency under the Ministry for the Environment and Natural Resources. The main tasks of the SCSI include combating desertification, sand encroachment and other soil erosion, promotion of sustainable land use and reclamation and restoration of degraded land. The work is on different levels, from policy making and research, to extension services and management of large- and small-scale reclamation projects. Ecosystem degradation is by far the largest environmental problem in Iceland. Vast areas have been desertified after over-exploitation – the speed of erosion magnified by volcanic activity and harsh weather conditions. SCSI is dedicated to the prevention of erosion and to reclamation of eroded land.



www.nordgen.org

NordGen, the Nordic Genetic Resource Center, is a joint Nordic institution whose main purpose is the conservation and sustainable use of plant, farm animal and forest genetic resources. NordGen's principal task is to ensure the availability of extensive genetic diversity for food and agriculture through genetic resource conservation, its sustainable use, documentation and associated information work. NordGen is financed by the Nordic countries through the Nordic Council of Ministers. Head Office and NordGen Plants are located in Alnarp, Sweden, whereas NordGen Farm Animals and NordGen Forest are situated in Ås, Norway.

Preamble

Dear participants,

It is with great pleasure that I, as the chair of the scientific committee, welcome you to this conference on grazing in a changing Nordic region.

Grazing is an activity with many facets. It is an agricultural activity producing food, and has a long tradition as such. It has a wide geographical distribution and has been, and to some extent still is, important in all of the Nordic countries. With the current emphasis on the need for increased food production, and limited availability of arable land at a global scale, grazing is receiving renewed attention for its potential contribution. But what resources this increased grazing should be based on is an important issue worthy of attention. What is generally agreed upon, though, is that it must be sustainable.

Many discussions are based on the fact that grazing can be managed in a range of ways. It can be extensive, based mainly on outfield resources. Or it can be included in a more intensive production system, based mainly on infield land resources and imported fodder. At both ends of this spectrum, the effects on the landscape and vegetation can be profound, and whether or not the production is sustainable will depend on the specific details of the management in relation to local environmental conditions. Taking all three bottom lines of sustainability into account, environment, economics and societal considerations, trade-offs will probably be necessary. In addition, the final farm products are likely to reflect the differences in production methods, but to what extent and with what effects also remains a topic of debate.

In addition to its importance as an agricultural production, grazing is important from an environmental perspective, a realization that has received more focus in recent decades. However, the environmental aspects of grazing are also multifaceted. During different time periods, overgrazing has caused environmental damage in many regions, visible for instance through erosion and water pollution. More recently, a lack of grazing is causing loss of environmental qualities and loss of species, in particular but not solely, in more remote areas. A large proportion of red listed species are dependent on conditions created and maintained by long term grazing. Scrub encroachment in landscapes formerly held open by grazing has impacts on e.g. tourism, accessibility, cultural heritage management, climate change and carbon sequestration.

In summary, numerous questions remain related to grazing as an agricultural activity and its environmental effects. During the conference “Grazing in a changing Nordic region” we hope to find, or at least come closer to, some answers.

Wenche E. Dramstad, Chair of the scientific committee

Foreword

The Nordic region is unique in the sense that there are no other regions at similar latitudes with significant agricultural production. This implies that the Nordic countries have a particular need to tackle and resolve the challenges of climate change. Climate change and increased demand for food for a growing population brings about special challenges for the Nordic region, as we are currently highly dependent on imported feeds.

Grazing is an important contributor to food security. Grass and other plants that are not suitable for human consumption are converted into valuable protein. Nordic food self-sufficiency can be increased by promoting production systems relying on increased utilization of grasslands and marginal land areas. However, grazing can have a profound effect on ecosystems. Such impacts span from shaping valuable cultural landscapes to irreversible plant and soil losses. Changes primarily in agriculture, but also societal changes reflected in land use have resulted in a dramatic decline in grazing during the past decades in certain regions of the Nordic countries, while other regions face severe land degradation due to unsustainable grazing practices.

In contrast to the above described trends, there currently is a renewed focus on the potential need for sustainable utilization of areas suitable for grazing. This growing interest is the result of the realization that agriculture has to take into account aspects others than production volume and efficiency, such as mitigation of and adaptation to climate change, protection of endangered and restoration of damaged ecosystems, maintenance of biotopes high in biodiversity, and enhancement of food security.

Despite a variable agricultural infrastructure, Nordic agriculture and livestock production have many similarities historically and culturally that contribute to a Nordic rural identity. Due to massive changes in agriculture, many of the traditional production systems are lost. Consequently, there is a need to strengthen the Nordic rural identity through proper historical and cultural valuation of the rural traditional landscapes and the native farm animal breeds. Grazing management under Nordic conditions faces many challenges in the future. We need to conserve and value the traditional landscapes created by grazing and at the same time acknowledge and respond to the negative effects of grazing. We need to value the socio-economic benefits of grazing in rural areas; link goals of sustainability with support policies for grazing based agriculture and secure sustainable use and conservation of animal genetic resources in grazing. Those are the main issues of the conference: Grazing in a changing Nordic region.

This conference will bring together experts and policymakers for a multi-disciplinary exchange of experiences to summarize the current knowledge and identify knowledge gaps. Hopefully we can contribute to the Nordic strategy for sustainable development, specifically to sustainable management of natural resources currently or potentially utilized for grazing and increase knowledge on the value of derived ecosystem services. The conference will contribute to the implementation of recommendations made in the 2014 report “Climate change and primary industries: Impacts, adaptation and mitigation in the Nordic countries”. The aim is also to strengthen knowledge and networking across the Nordic region. It will promote possible inter-Nordic scientific and societal solutions and innovations to strengthen Nordic competence and competitiveness in food production and management of natural resources.

The preparation of a conference is hard work and I want to thank the staff of NordGen Farm Animals, Anne Kettunen, Linn Groeneveld and Peer Berg and the employees of the Soil Conservation Service of Iceland, Andrés Arnalds, Arna Björk Thorsteinsdóttir and Guðmundur Halldorsson for their good work. Thanks to the scientific committee, responsible for the content of the conference and the selection of invited speakers. Wenche Dramstad, Peer Berg, Andrés Arnalds, Rita Buttenschön, Anders Glimskär, Rólvur Djurhuus, Katriina Soini and Lise Hatten.

Last but not least, thanks to the Nordic Council of Ministers and their Sustainable Development program for financial support.

- Árni Bragason - director, SCSi and former director of NordGen

Conference program



Anna Rehnberg | Norwegian Genetic Resource Centre

Monday, 12th of September 2016

17:30 Registration opens

19:00 - 21:00 Reception with a preview of posters

Tuesday, 13th of September 2016

08:00	Registration opens
08:30 - 09:00	Opening of the conference. <i>Árni Bragason, director of SCSi, Iceland and former director of NordGen, Sweden</i>
09:00 - 09:15	Introduction to the field trip. <i>Andrés Arnalds, SCSi, Iceland</i>

Session I: Grazing – Blessing or curse?

Chair: Peer Berg

09:15 - 09:45	Happy cowboys and cowgirls, a necessity for future survival of semi-natural grassland. <i>Ola Jennersten, WWF Sweden, Sweden</i>
09:45 - 10:15	The ecology of natural and livestock grazing - similarities and differences. <i>Ingibjörg Svala Jónsdóttir, University of Iceland, Iceland</i>
10:15 - 10:45	Coffee break
10:45 - 11:15	Grasslands, future food demand and environmental impact. <i>Pat Dillon, Teagasc - The Agriculture & Food development authority in Ireland, Ireland</i>
11:15 - 11:45	Policy dimensions of sustainable growth in agriculture and food production. <i>Jyrki Niemi, LUKE - Natural Resources Institute Finland, Finland</i>
11:45 - 22:00	Field trip including lunch and dinner. Visit to and lunch at a sheep farm close to Þingvellir Grazed to the bone – degraded areas on the Uxahryggir highland The beauty of grazing – agricultural landscapes of Lundarreykjadalur Farming and tourism – Bjarteyjarsandur Dinner at Hernámssetrið restaurant

Wednesday, 14th of September 2016

Session I: Grazing – Blessing or curse?

08:30 - 09:00 Supporting semi-natural grassland management – policies and governance.
Jørgen Primdahl, University of Copenhagen, Denmark

Session II: Grazing - Contribution to food security

Chair and rapporteur: Wenche E. Dramstad & Rita Buttenschon

09:10 - 09:30 Grazing of free-ranging cattle in south-boreal forests of south eastern Norway.
Morten Tofastrud, Hedmark University of Applied Sciences, Norway

09:30 - 09:50 Beef from natural grassland – sustainable for the farmer while fulfilling consumer expectations. *Eva Søndergaard, Danish Technological Institute, Denmark*

09:50 - 10:10 Effects of grazing previously abandoned grassland on performance in sheep and herbage production. *Lise Grova, NIBIO, Norway*

10:10 - 10:30 Poster session

10:30 - 11:00 Coffee break

11:00 - 12:00 Discussion

12:00 - 12:20 Leg stretcher

Session III: Linking sustainability with support policies

Chair and rapporteur: Jyrki Niemi & Peer Berg

09:10 - 09:30 Developing legislation and policy frameworks for grazing, *Ian D. Hannam, University of New England, Australia*

09:30 - 09:50 Connecting sustainable land use and quality management in sheep farming: effective stakeholder participation or unwelcome obligation? *Jónína Sigríður Þorlákssdóttir, University of Iceland, Iceland*

09:50 - 10:10 Land tenure and policy implications on grazing: lessons from Africa and Central Asia. *Malipholo Eleanor Hae, Agricultural University of Iceland, Iceland*

10:10 - 10:30 Poster session

10:30 - 11:00 Coffee break

11:00 - 11:20 Political and commercial grazing organizations support socio-economic development in rural Denmark. *Peter B. Kristensen, Smag på Landskabet, Denmark*

11:20 - 12:00 Discussion

12:00 - 12:20 Leg stretcher

Session IV: Grazing - History and Future

Chair and rapporteur: Anders Glimskär & Anne Kettunen

- 12:20 - 12:40 Grazing in coastal meadows of the Bothnian Bay in Northern Ostrobothnia – history and present. *Maiju Pesonen, Natural Resources Institute Finland (Luke), Finland*
- 12:40 - 13:00 A Sami-cultural mountain landscape: Towards understanding the ecological legacies of intensive reindeer husbandry in the Swedish mountains. *Dagmar D. Egelkraut, Umeå Universitet, Sweden*
- 13:00 - 14:30 Lunch
- 14:30 - 14:50 Long-term impacts of reindeer grazing on fen vegetation in sub-arctic Lapland. *Bruce Forbes, University of Lapland, Finland*
- 14:50 - 15:10 Successional change after grassland abandonment. *Sigrun Aune, NIBIO, Norway*
- 15:10 - 15:30 Implications for conservation management of hay-meadows; cutting dates and surrounding landscapes. *Sölvi Wehn, NIBIO, Norway*
- 15:30 - 15:50 Saving a threatened breed – Conditions for maintenance and habitat selection of extensively kept Gotland Russ (*Equus caballus*). *Anna Skarin, Swedish University of Agricultural Sciences, Sweden*
- 15:50 - 16:20 Coffee break
- 16:20 - 16:40 Proactive adaptive management with time controlled shift grazing can regenerate landscapes. *Ulf Ullring, Savory Network Nordic Hub*
- 16:40 - 17:00 From wild to domestic to wild again: opportunities with wild grazers. *Carl-Gustaf Thulin, Swedish University of Agricultural Sciences, Sweden*
- 17:00 - 17:20 1000 years of sustainable grazing in Nordic conditions? - what can be learned. *Jesper Brandt, Roskilde University, Denmark*
- 17:20 - 18:00 Discussion

Session V: Grazing, environment and climate: friends or foes?

Chair and rapporteur: Andrés Arnalds & Gudmundur Halldorsson

- 12:20 - 12:40 Ecological responses to sheep grazing in Norwegian mountains: Insight from long-term experimental approaches. *James D. M. Speed, Norwegian University of Science and Technology, Norway*
- 12:40 - 13:00 Ecological impacts of sheep grazing in Iceland – how much do we really know? *Bryndís Marteinsdóttir, University of Iceland, Iceland*
- 13:00 - 14:30 Lunch
- 14:30 - 14:50 Does light stocking rate justify grazing on poorly vegetated land? *Kristín Svavarsdóttir, Soil Conservation Service of Iceland, Iceland*
- 14:50 - 15:10 Ecosystem responses to reindeer grazing along the Scandinavian mountain range. *Robert G. Björk, University of Gothenburg, Sweden*
- 15:10 - 15:30 Long-term grazing by reindeer may shape tundra carbon storage. *Henni Ylänen, University of Oulu, Finland*

15:30 - 15:50	Using coprophilous fungal spores to detect abandoned reindeer milking sites in northern Sweden. <i>Mari Kuoppamaa, University of Lapland, Finland</i>
15:50 - 16:20	Coffee break
16:20 - 16:40	Grazing and tundra soil carbon and nutrients: patterns, mechanisms and future perspectives. <i>Sari Stark, University of Lapland, Finland</i>
16:40 - 17:00	Woodland grazing - a tool for conservation of biodiversity in Denmark. <i>Rita M. Buttenschon, University of Copenhagen, Denmark</i>
17:00 - 17:20	Poster session
17:20 - 18:00	Discussion
20:00	Conference dinner on Viðey island Bus leaving from Hotel Natura: 19:15 Bus leaving from city center: 19:30 Ferry leaving from Skarfabakki: 19:45

Thursday, 15th of September 2016

Session VI: Perspectives, Ideas, Needs & Policies

Chair: tba

09:00 -09:30	The future of reindeer husbandry in Fennoscandia under global change. <i>Jukka Käyhkö, University of Turku, Finland</i>
09:30 -10:00	The challenge of improving our knowledge of European grasslands. <i>Maria Luisa Paracchini, Joint Research Centre, European Commission</i>
10:00 -10:30	Consumer and citizen expectations of grazing. <i>Eija Pouta, Natural Resources Institute Finland (Luke), Finland</i>
10:30 -11:00	Coffee break
11:00 -12:00	Summary including conclusions drawn from Wednesday's discussions. <i>Peer Berg, NordGen, Norway</i>
12:00	Lunch

List of invited speakers

Pat Dillon

Teagasc - The Agriculture & Food Development Authority in Ireland

Ola Jennersten

WWF Sweden

Ingibjörg Svala Jónsdóttir

University of Iceland

Jukka Käyhkö

University of Turku

Jyrki Niemi

LUKE - Natural Resources Institute Finland

Maria Luisa Paracchini

Joint Research Centre, European Commission

Jørgen Primdahl

University of Copenhagen

Eija Pouta

LUKE - Natural Resources Institute Finland

Session I Grazing – Blessing or curse?



Happy cowboys and cowgirls, a necessity for future survival of semi-natural grassland

O Jennersten
WWF Sweden, Sweden
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In cooperation with farmers, researchers, regional administration, municipalities and a national-wide food chain, WWF has worked with semi-natural grasslands for 25 years, in order to increase area, species survival, management and rewards from these species-rich areas. 30 000 ha were restored of which a majority still is maintained, new jobs were created and farmers involved increased their income by 700 million SEK during a decennium. We conclude that it is vital for the future survival of species-rich semi-natural grasslands to have farmers who can make a living from grazing-based animal production, sustainable and stable environmental payments, and a market that asks for certified pasture beef, thus making semi-natural grassland a valuable resource for the farmer.

The ecology of natural and livestock grazing at high latitudes - similarities and differences.

IS Jónsdóttir
The University Centre in Svalbard (UNIS), Norway & the University of Iceland, Iceland
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Large vertebrate grazers play a central role in structuring and the functioning of many terrestrial ecosystems at high latitudes through selective grazing, consumption of large quantities of the primary production, increased rate of nutrient turnover and mechanical disturbances such as trampling. Wild populations are regulated through birth and death rates that are affected by environmental factors, both biotic, density dependent factors such as predation, food availability and diseases and by abiotic factors such as weather. In contrast, the regulation of livestock populations is to a large extent decoupled from these natural environmental factors by humans and energy and matter is continuously removed out of the ecosystems through harvesting. These two situations can be viewed as extremes on a spectrum of herbivore population regulation by natural factors and human management. The ecological impacts of wild and livestock herbivores may therefore differ substantially and the transition from one ecosystem state to another will depend on the resilience of the grazed ecosystems. One aspect of ecosystem resilience is the size of the local and regional species pools and the species diversity of biological communities. On a global scale, species pools of most species groups decline with latitude. Diversity differences between mainland (large species pools) and islands (small species pools) may, however, crosscut the global gradient. We can therefore expect ecosystem resilience to drop from low Arctic to the high Arctic bioclimatic sub-zones and within a zone from mainland to islands.

In this talk I will address the ecological implications of different degrees of herbivore management along latitudinal as well as mainland-island gradient. I will present results from perturbation experiments and observational studies from island ecosystems both in the high Arctic (mainly Svalbard) and the low and sub-Arctic (Iceland) with some comparisons with mainland studies.

Grasslands, future food demand and environmental impact

P Dillon
Teagasc - The agriculture & food development authority in Ireland, Ireland
pat.dillon@teagasc.ie

The livestock sector is increasingly competing with human consumption for edible grains and crop by-products, while the average herbage use efficiency is unlikely to have increased significantly since

the 1960s. In the future grasslands could be relatively more resilient to climate change than arable crops, which could increase their role both as a feed source and as a global carbon stock. Reaching two major goals of our times, global food security and climate stabilization, will require increased investments in grassland improvement and restoration, in livestock health and production efficiency and a global convergence towards nutritionally balanced diets that have potential to reduce both chronic undernourishment and the incidence of metabolic diseases related to obesity. My presentation will outline opportunities to further increase food production through greater reliance on pasture-based systems of ruminant production.

Policy dimensions of sustainable growth in agriculture and food production

J Niemi

LUKE - Natural Resources Institute Finland, Finland

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The major future challenge for the agriculture and food sector is how to increase food production without endangering the future sustainability of production resources. Policies that are designed to improve sustainability in the sector are likely to involve a mixture of market-based and regulatory approaches. Policy options need to be assessed from the perspectives of effectiveness and efficiency, as well as their distributional implications.

Protecting and managing semi-natural grasslands

Challenges and innovations in public policy – from the European level to the local community

J Primdahl

University of Copenhagen, Denmark

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Semi-natural grassland is an important feature in many rural landscapes and the protection and management of semi-natural grasslands is an important issue in environmental policy. A brief overview of policy instruments available is presented.

Both intensification and abandonment of management represent a threat to biodiversity, cultural and aesthetic values and a number of policy initiatives have been taken throughout Europe in recent decades to regulate grassland management. The state of the art concerning European policy schemes for semi-natural grassland management is outlined and critically discussed.

Focusing on the local level current policy challenges and pathways towards more long term and more sustainable landscape management regimes are finally presented and discussed. Through a comprehensive example from a Danish saltmarsh area, future governance approaches to grassland management are discussed.

Notes

Session II

Grazing – Contribution to food security



Linn F. Groeneveld | NordGen

Grazing of free-ranging cattle in south-boreal forests of south eastern Norway

M Tofastrud^{*1} & B Zimmermann²

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Increased efficiency in Norwegian dairy production, in addition to increased consumption of meat has led to an annual market loss of approximately 200 000 kg beef; this is calculated to be an annual loss of value for the Norwegian farmers of approximately 100 million Euros. Imported beef products are mainly from South America and South Africa, and there are concerns regarding environmental and climate impacts of this production. The Norwegian government has focused on increasing the beef production in line with increasing demand.

Increased Norwegian beef production will lead to an increasing number of grazing beef cattle in outlying lands, mainly in forest and mountain areas. South boreal forests of Norway mainly consist of coniferous production forest. Modern forestry management based on clear-cutting transforms dense and dark forest areas to open light areas, a habitat suitable for light demanding plants and herbaceous plant diversity. In highly productive areas it will hardly take more than 12-15 years after harvesting of timber before these areas approach the conditions of the grown forest. Therefore, the availability and the quality of forest grazing areas will be dependent on the number and age of clear-cut areas.

We aim to generate knowledge on grazing mechanisms and production of beef cattle in a forested habitat for management of grazing livestock in outlying lands.

In 2015, we equipped 30 cattle of different breeds and production levels with GPS collars programmed to take positions and activity measures every 5 minutes. The cattle belonged to six different farms. A total of 55 calves and 51 cows and heifers were weighed before and after the grazing period. During summer 2015 suckling calves increased body weight on average with 0.936 ± 0.215 kg/day ($\pm$ SE), and lactating cows gained on average 37.25 ± 15.3 kg throughout the grazing season. Our study showed similar results as studies of suckling beef calves grazing coastal and extensive forest meadows in northern Finland, and a Norwegian study comparing calves grazing infield and outfield pastures during two grazing seasons. The activity of cattle was greatly affected by daylight, but seasonally declining hours of daylight did not affect the total time spent grazing. Cows with suckling calves spent more time grazing and less time resting and walking than cows without calves.

Beef from natural grassland – sustainable for the farmer while fulfilling consumer expectations

E Søndergaard^{*1}, E Skytte¹ & M Therkildsen²

¹*Danish Technological Institute, AgroTech, Skejby, Aarhus N, Denmark*

²*Dept of Food Science, Aarhus University, Tjele, Denmark*

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In Denmark, more than 300 000 hectares of natural grassland needs grazing. To make it a profitable business for the farmers, it is essential to sell the meat with an added value. Most beef cattle in Denmark are slaughtered and payed according to the EUROP classification and slaughter weight, thus it is not attractive for beef producers to bring their stock to areas which might lead to low growth rate hence a poor classification and slaughter weight. In the project “*Smag på Landskabet*” one of the main purposes was to develop a concept for cattle raised on natural grassland. When cattle are grazing their meat will contain a higher level of e.g. omega-3 fatty acids and more polyunsaturated fatty acids compared to non-grazing animals, although not at a level that allows for claiming the fact in marketing of the meat. Many farmers selling meat from their grazing animals would like to take it further and claim that the consumer can taste which area and pasture the animals have been grazing i.e. meadow versus moor etc. We investigated meat from three different breeds in six different areas in a two-year

period and compared it to meat from housed beef cattle. We also did a survey among consumers to see which parameters they valued when buying meat from grazing animals. The results showed that consumers want healthy products with a high eating quality and a high standard of animal welfare. The eating experience is highly depending on the eating quality and the consumer's expectations of natural grassland meat. The meat from beef cattle slaughtered directly from natural grass land do contain more PUFA and N-3 fatty acids whereas the eating quality is variable, and is affected by the feeding but also by other factors such as sex, age, breed and post mortem handling, which may mask any effect on flavor of the meat from various natural grasslands.

Effects of grazing previously abandoned grassland on performance in sheep and herbage production

*L Grøva^{*1}, S A Adler¹, U S Lande¹, E Brunberg² & H Steinsbamm¹*

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Large areas of cultivated grasslands are annually abandoned and no longer used for production in Norway. Such areas will over time be encroached by shrubs and trees. Knowing that access to spring and autumn pastures is a limiting factor for sheep farmers, we tested the effect of grazing abandoned grassland on sheep production. We also assessed herbage production by looking at plant community development, pasture production, herbage quality and pasture utilization by sheep and heifers. The experiment was run for two consecutive years; 2014 and 2015. The sheep production was assessed by studying one sheep flock with 83(88) ewes(lambs) in 2014 and 77(106) ewes(lambs) in 2015, which was assigned each year with respect to age of ewe and number of lambs born to three treatments: 1) control; common farm procedure with short spring grazing period before summer grazing on range pasture, 2) spring extended; 4 weeks extended spring grazing period on abandoned cultivated grassland before summer grazing on range pasture, 3) whole season grazing on abandoned grassland. Assessment of herbage production was done by sheep grazing the whole area for one month in spring and autumn. During the summer, the area was assigned to three replicated treatments: a) control with no management, b) grazing heifers and c) grazing sheep with offspring. The stocking rate was 1.8 LU/ha, in both b and c, for a duration of one month. Pasture production and herbage intake was estimated using grazing enclosure cages. Weight gain from birth to autumn as well as slaughter weight were significantly ($P < 0.05$) higher in lambs assigned to treatment 2 with four weeks extended spring grazing period (259 g/day and 15.7 kg) compared to treatment 1 (238 g/day and 14.3 kg) and treatment 3 (216 g/day and 13.2 kg). Herbage consumed during the summer period was on average 211 g DM/m² and the pasture utilization was 55%. The annual consumption and utilization was 336 g DM/m² and 62% in the grazed treatments and 28 g DM/m² and 15% in the control, respectively. Total annual pasture production was on average 72% higher in the grazed treatments compared to the control. There was no difference between the grazed treatments on annual herbage production, herbage intake or pasture utilization. The use of abandoned cultivated grassland for extended spring grazing improved weight gain and slaughter weight of lambs. Further, grazing stimulated herbage production.

Notes

Session III

Linking sustainability with support policies



Developing Legislation and Policy Frameworks for Grazing

ID Hannam

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It is imperative that national legislation to manage grazing in the Nordic Region draws on international and regional instruments that address human rights and tenure rights. Principles and elements from these instruments provide guidance on internationally accepted practices for legal systems that deal with the rights to the use of grazing land. They can also contribute to the development of policy, legal and organizational frameworks that regulate a range of tenure rights that exist over grazing land and can strengthen the capacity and operations of implementing agencies, judicial authorities, local government, farmer organizations, cooperatives, and small-scale owners or occupiers of grazing land.

Establishing national grazing land policy and law by following various established principles and elements will contribute to better governance. This may involve introducing new laws for grazing, or amending or repealing existing laws. Even without formal implementation, international instruments can stimulate national-level processes and indirectly affect the governance of tenure, focusing more specifically to land administration, transfer of land, allocation of grazing tenure rights, spatial and other land use planning, resolution of disputes over tenure rights, land trust, customary tenure systems and climate change. Principles that are drawn from international environmental law and policy sources relevant to the governance of grazing land in the Nordic Region include, e.g., good governance, sustainable development, inter-generational equity, public participation and access to information, access and benefit sharing regarding grazing resources.

In addition, various “generic” legal and institutional elements can also be drawn on in developing or reforming national law and policy for grazing. National law in the Nordic Region should not only recognize but also protect and promote basic tenure rights. This should include enabling tenure rights holders to secure their rights, even if these are not formalized. The elements provide for the basic rights and entitlements of pastoral people including participation in negotiation and decision-making, development of institutions that can represent grazing rights, the maintenance and transmission of traditional practices, and in this regard, can form a part of statutory law for grazing land use. Legal elements to assist with drafting of grazing laws include e.g., the purpose and intent of legislation, objects of legislation, planning of grazing lands, functions of grazing organizations, assessment of grazing lands, monitoring grazing lands.

Connecting Sustainable Land Use and Quality Management in Sheep Farming: Effective Stakeholder Participation or Unwelcome Obligation?

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A large portion of Iceland’s soil and vegetation has been lost over the centuries, with the productivity of the land often being far below its full potential. In order to address this issue, farmers have become increasingly involved in sustainable land use and restoration efforts, for example through voluntary participation in Quality Management in Sheep Farming (QMS). This study explores the effectiveness of this agri-environmental scheme regarding land improvement measures and participation processes, based on farmers’ experiences, views and expectations. This was especially explored in light of recent regulation changes. Data was collected through semi-structured qualitative interviews with fifteen farmers within a specific study area, who all participated in the QMS scheme. The data was then analyzed using the methods of grounded theory. In addition, ten actors from within the surrounding administrative and regulatory framework were interviewed to provide background information and a wider perspective on the subject.

There is evidence to suggest that carrying out reclamation projects influences environmental behavior to some extent. However, a gap seems to exist between the land use part of the QMS and other aspects of the scheme. The objectives of restoration and sustainable land use within the scheme should be clarified, and subsidies better linked to restoration achievements. A consensus and consistency needs to be developed among the different actors, institutional and legal framework, when it comes to the priorities and methods used within the scheme. The scheme is more or less ‘top-down’ oriented, with farmers regarded as passive assistants for advancing a certain agenda rather than influential or valuable voices within the system. To harness the benefits of the participatory process, proper communication platforms should be in place to gather local knowledge and carry it onward to other stakeholders and policy makers. Thus, if the QMS is to reach its full potential, incentive and innovation should be enabled and encouraged. However, this needs to be accompanied by enhanced information flow and communication within and outside of the system.

Land tenure and policy implications on grazing: Lessons from Africa and Central Asia

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Livestock is a major contributor to livelihoods in Africa and Central Asia. Its significant contribution to Gross Domestic Product (GDP), food security, farm-level incomes, draught power and the socio-cultural importance (ceremonies and bride price) makes it a thriving enterprise.

Grazing management is not given much priority in Africa and grazing lands, arable lands and wetlands are characterized by open access and overstocking. Though open access and overstocking occur in Central Asia, grazing is in designated rangelands where management is accorded. Rangelands in Central Asia are state owned, which makes control to be effectively undertaken. In Africa, customary and private land tenure systems limit governments’ interventions for pasture improvement and ecosystem conservation.

Grazing areas in Africa and Central Asia have been degraded as a result of overstocking. This has led to ecosystem damage – characterized by biodiversity losses, disturbances in energy flow and distortion of trophic levels. Fires, floods and drought have affected grazing negatively through reduction of grazing resources and livestock health. Other land-use pressures – especially cultivation, settlement, mining and infrastructure development driven by population growth has led to encroachment of grazing lands and have caused remarkable conflict with grazing. Furthermore, conflicting livestock and wildlife grazing within or beside conservation areas have also impacted livestock production.

In Africa, existing laws are fragmented and outdated and do not affirmatively address the current grazing issues thereby making enforcement impractical. Low political will to regulate grazing and improve grazing lands is failing the livestock industry in Africa. In Central Asia, pasture laws are implemented by governments alongside pasture users’ association; which is a good basis for regulation of grazing schedules, stocking rates and pasture improvement based on well-developed plans.

Governments of these regions need to review existing policies and laws while enforcing those that favor sustainable grazing. Plausible involvement of all stakeholders, especially pastoralists in grazing land management and improvement besides policy review ought to be done. Governments should

give priority to ecosystem conservation and restoration that increases resilience to climate change and support sustainable grazing management. Innovative alternative livelihood sources, to reduce community dependence on livestock and governments' shift from donor dependence to address grazing land management and natural resources conservation, ought to be pursued. A pragmatic approach to reducing local livestock numbers and replacing local breeds with a few improved breeds is ideal for better economic returns with minimal negative effects on ecosystems.

Political and commercial grazing organizations support socio-economic development in rural Denmark

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The need for nature conservation through grazing in Denmark is vastly unmet. Only half of 300 000 ha are being grazed. Reasons are historically complicated legal framework resulting in farmers met by reimbursement of wildlife management aid, poor publicity and a frivolous reputation amongst consultants and farmers. Along with poor pricing of the by-product of conservation grazing – natural grassland beef, despite of high demand from restaurants and private consumers.

Smag på Landskabet is a young Danish organization with the purpose to enhance conservation grazing as a profitable agricultural practice. To enhance this purpose, *Smag på Landskabet* work for a reasonable legal framework and with other stakeholders of conservation grazing this resulted in a more flexible legal framework in 2015. After two years of consolidation the organization has now been invited to give inputs to the legal frameworks and to political parties. Further, the organization has announced a new commercial concept of natural grassland beef. However, the political and commercial interests in one pot are not ideal. Therefore, a new structure is being developed, maintaining a non-commercial *Smag på Landskabet* as a sort of farm and conservation managers' union, while an independent commercial company will pursue sales of natural grassland beef as a unique product with a unique story. Without continued political focus and an economic incentive to conduct the grazing, authorities cannot expect farmers to realize this societal task.

The potential of conservation grazing as a serious agricultural practice for an agricultural industry in a historic crisis is huge. The structural development in agriculture has created an enormous debt and low prices on bulk-produced products; it has resulted in ghost-like empty farms, local shops and companies in villages have closed, as well as schools. A development enhanced by urbanization and centralization. Conservation grazing offers an agricultural practice for farms, where permits for large scale livestock farms are impossible due to environmental restraints. Conservation grazing offers new agricultural businesses and life on smaller farms where big industrial agricultural buildings are unnecessary. It offers multi- functional socio-economic benefits to rural districts, as need for local craftsmen, shops, doctors and culture will return while children will also need a school to attend. *Smag på Landskabet* encourage a common Nordic cooperation to improve conditions for conservation grazing.

Session IV Grazing – History and Future



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Grazing in coastal meadows of the Bothnian Bay in Northern Ostrobothnia – history and present

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The amount of semi-natural grasslands has decreased in Europe greatly during the last decades. Due to their high biodiversity these habitats are an important target of EU agri-environment support schemes. The remaining semi-natural grasslands are predominantly managed by grazing.

Coastal meadows of the Bothnian Bay in the northernmost part of the Baltic Sea represent a globally unique habitat. The relatively young age and isolation of the area together with special features of the Baltic Sea have provided favorable conditions for genetic differentiation of plant populations. The area also hosts valuable breeding and migrating avifauna. Approximately 280 breeding or staging bird species have been encountered in the area.

Coastal meadows have been classified as semi-natural grasslands in Finland because they were traditionally utilized as a source of forage for livestock. Until the beginning of 20th century the most traditional use was to cut hay for winter forage, after which livestock were allowed to graze the meadows. As cultivation on arable fields in northern Europe gradually started to displace forage collection from semi-natural grasslands at the end of 19th century, coastal meadows were increasingly used only as pastures for livestock and many of them were abandoned during the second half of the 20th century.

At present, decreased traditional use and eutrophication have resulted in overgrowth by taller vegetation on the shores of the Baltic Sea. Consequently, the area of low-growth coastal meadows has diminished and many of the species of the early successional stages have become rare or threatened. At present, approximately 4200 ha of coastal meadows are left in Finland, which is less than 10% of the amount in the 1950s. The habitat type was classified as critically endangered.

There was in total 2874 ha of sea shore managed by 51 farmers in Northern Ostrobothnia at the end of 2008, and 86% of this area was classified as coastal meadows. The rest of the area was composed of forest areas, which also were included into some of the coastal pastures. 89% of the total area was grazed and 11% managed solely by mowing. 86.6% of the pasture area was grazed by cattle, 12% by sheep, and the remaining area by horses or mixed herds. Beef cattle prevailed over dairy cattle: 84% of the cattle pastures were grazed by beef cattle (mainly by beef cows with their calves) and 16% by dairy cattle (heifers in all cases).

A Sami-cultural mountain landscape: Towards understanding the ecological legacies of intensive reindeer husbandry in the Swedish mountains

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Northern Sweden has a long history of reindeer husbandry. The traditional nomadic lifestyle meant that herders and their reindeer had many temporary settlements in the mountain landscape. These settlements were subject to high concentrations of reindeer, and as milking of the reindeer used to be common practice, we refer to them as historical milking grounds. Remnants of these milking grounds are still clearly visible as grass- and forb-dominated grounds in the shrub-dominated tundra; even though their active use has ceased for about 100 years. By comparing historical and modern air photos we show that some of the milking grounds have been shrinking during the last 50 years while others are more stable. Furthermore, our study shows that soil nutrient availability, biological resistance to seedling establishment and levels of herbivory (both vertebrate and invertebrate) differ between

milking grounds and control plots as well as among milking grounds. These historical milking grounds can provide valuable insights in the long-term effects of reindeer grazing on tundra vegetation and advance our understanding of the drivers of stability in a grazed landscape.

Long-term impacts of reindeer grazing on fen vegetation in sub-arctic Lapland

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Reindeer herding is an important form of land use in many arctic and subarctic regions. While effects of reindeer grazing on dry heath vegetation are well known, few studies have focused on mire habitats. We studied the effects of reindeer grazing on fen vegetation in a treeless arctic-alpine study area straddling the border fence between Finland and Norway (68°49', 23° 49'), built in the late 1950s. The vegetation is characterized by an abundance of *Salix lapponum*, an important summer forage willow. The Norwegian side of the border is grazed in winter only, while the Finnish side is intensively grazed also in summer. We explored the effects of this long-term difference in grazing and of 13-year enclosure of reindeer grazing on the Finnish side. We had five study sites in each treatment, all located in separate mire areas. At Finnish sites both fenced and freely summer grazed plots were included. Vegetation data was collected from three 0.25 m² using a pin-point method. *S. lapponum* was measured for height, abundance and number of flowering females, fruit bodies and galls per sample plot. We found differences in abundance, plant size and fruiting of *S. lapponum* between the grazing treatments. Willows on the Norwegian side and in the enclosures were significantly more abundant, grew taller and female plants had heavier and more frequent fruit bodies than in the freely summer grazed sample plots. Cover of bryophytes was highest in the non-summer grazed Norwegian side. Among mosses *Straminergon stramineum* was significantly more abundant in the enclosures and on the Norwegian side than in the summer grazed sample plots. Among vascular plants *Comarum palustre* and *Carex* spp. were more abundant in the absence of summer grazing. On the contrary, *Eriophorum angustifolium* was significantly more abundant in the summer grazed sample plots. On the Finnish side, shrubs were significantly more abundant in the enclosures, than in the summer grazed sample plots. Reindeer grazing treatments did not affect species richness. Ordinations of vegetation data showed some distinction between the Norwegian and Finnish sites in vascular plant community structure, while bryophyte communities had more overlap. Ordinations did not clearly separate the freely summer grazed sample plots and the 13-year enclosures of the Finnish sites. We conclude that summer grazing reduces size and flowering of *S. lapponum* and alters dominance patterns and structure of vascular vegetation over the long-term, while bryophyte communities appear to be more resilient.

Successional change after grassland abandonment

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The present agricultural landscape reflects a long history of changing land-use and farming practices, caused by e.g. technological development, urbanization processes and climate changes. A deeper understanding of how agricultural practices have altered the landscape is essential for the management of biodiversity and conservation of semi-natural grasslands. The vascular plant species composition of a grassland patch is the result of several interacting processes; basically shaped by natural

environmental conditions (e.g. moisture), but modified by reduction or removal of the tree layer and long-term extensive management (grazing, hay-making).

In this study, we examine the influences of agricultural land-use changes on transitions in vegetation composition. How does biodiversity in semi-natural grasslands change after abandonment?

The distribution, patch size, and plant species composition of semi-natural grasslands in a Central Norwegian agricultural landscape (approximately 7 km²) were mapped during two summers. In this area, the number of farms with livestock in the study area have decreased drastically since the 1960s. Consequently, the number of domestic animals grazing have decreased in both infields and outfields. The surveyed grasslands constitute a chronosequence ('space for time') that we use to examine the successional process from managed to late successional semi-natural grasslands. Sampled grassland patches (n=76) include 23 patches presently managed (grazed or mowed), 11 patches in fallow, 32 in early regrowth successional phase and 10 in late regrowth successional phase.

The total number of vascular plant species registered in the grassland patches was 176 (incl. 6 to genus). The number of species per patch ranged from 33 to 71, but the numbers of species were similar in all successional phases when adjusted for differences in patch size. Semi-natural grassland species decreased during succession, while the number of forest species increased. The species composition in the late regrowth phase is to a large extent a result of a mixture of species from open grasslands and forests. Evenness decreased from managed grasslands to early regrowth phase, and increased in late regrowth phase but the differences were only minor. Structural changes, e.g. increasing litter and tree cover, were also seen along the succession. Variation in species composition was related to management intensity and successional phase along the main gradient.

Implications for conservation management of hay-meadows; cutting dates and surrounding landscapes.

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Norwegian livestock farming depends upon harvesting of winter fodder. Historically, extensively managed grasslands were widespread and of high agricultural importance. Today, these semi-natural hay-meadows are of high cultural as well as biological value – including ecosystem services such as pollinators, fodder, and open landscape. These grasslands include high species richness of both plants and insects, but are red listed due to land use changes. In Norway, an agri-environmental scheme (Action plan for hay-meadows) is therefore implemented to protect these values.

An important aspect in maintaining high biodiversity in hay-meadows is a late cutting date that allows seeds to germinate and disperse within the meadow. This is highlighted in the action plan and some agreements between the authorities and the managers include a predefined cutting date; such that cutting is not allowed before this date. Another important factor influencing biodiversity levels within a hay meadow is dispersal from other sources in the surrounding landscape.

In this project, we aim to assess the suitability of the predefined date and the importance of the surrounding landscape based on data from and around hay-meadows. In 28 hay-meadows, we mapped, during two seasons, the phenological stage of 36 plant species defined as associated with semi-natural grassland. We also mapped all vascular plant species (total 193 species) in 87 plots (16 m²) in ten vegetation classes (edges of roads, edges of arable fields, grassland, pastures, pine forests, deciduous forests, mixed forests, plantations of spruce, clear-cuts, and grassland in transition to forest). The study areas of the phenological stage study were two regions in the county of Møre og Romsdal and the study area of the landscape scale study was one of these two regions. This region included 13 of the hay-meadows.

The results showed high yearly variation between the phenological stage reached and even in the warmest year the proportion of species not mature at the defined date, was 26. A Detrended Correspondence analysis (DCA) showed that the species turnover between the vegetation classes was high (Sum of all eigenvalues: 7.58) and a Canonical-Correlation analysis (CCA) showed that vegetation

class significantly influenced the species turnover (F-ratio: 1.82, p: 0.005). To assess the consequences of the landscape surroundings on the semi-natural grassland associated plant species, we will examine functional traits associated with plant dispersal and survival.

Saving a threatened breed – Conditions for maintenance and habitat selection of extensively kept Gotland Russ (*Equus caballus*)

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Gotland Russ is a native Swedish horse breed and one of the oldest horse breeds in Europe. The numbers of Gotland Russ are however relatively few and it is difficult for breeders to find buyers. To aid preservation of this breed, we evaluate if Gotland Russ can be used to manage open landscapes and biodiversity. In May 2014, twelve one-year-old Gotland Russ stallions were released outside Uppsala, Sweden, into three enclosures of 10 ha each, consisting of 3 ha lay and 7 ha forest, respectively. Each enclosure was provided with a man-made shelter and a water trough, but no supplementary feeding was offered. Here, we report preliminary results from the first year (May 2014 – April 2015) of the experiment on nutrient and energy status and habitat preferences. Body condition was scored (9 degree system) weekly and fecal crude protein (CP) contents were analyzed monthly. Horses with BCS <4 were temporarily excluded and fed at another place. To monitor habitat preferences, we equipped two horses in each enclosure with GPS-collars. Shelter seeking behavior (SSB) was monitored with camera traps in the shelters.

Horses started at BCS 4.7-5.0 (range of enclosures means) in May 2014. Mean BCS per month and enclosure was 5.0 until February 2015. In February, four horses were removed to be fed outside the enclosures due to BCS <4. Fecal CP content peaked in June 2014 (10.2-13.3% of organic matter) and was lowest January-February 2015 (4.9-6.3%). Analysis of GPS-data, using resource selection functions, showed that the horses favored lay except during night and when snow was covering the ground. In those cases, forest was preferred. SSB was displayed on average 48 (range 6-338) min/day. Relating the SSB to weather showed that precipitation and days with mean temperature > 15° C made the horses use the shelters longer, while wind speed had no impact on their SSB.

This study shows that the Gotland Russ may survive all year around without supplementary feeding. The horses, as expected, primarily preferred the lay. However, the unexpected preference for forest in night suggests that Gotland Russ have the potential to impact forest vegetation all year round. In comparison, our horses used the shelters less than shown in previous studies of horses in smaller enclosures. This suggests that our horses spent more time foraging and that the landscape in the enclosures provided natural shelters.

Proactive adaptive management with time controlled shift grazing can regenerate landscapes

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A growing number of livestock farmers around the world use time controlled shift grazing integrated with proactive adaptive management ('holistic management') to regenerate their land. Some of these farmers, for example Colin Seis in Australia, Joel Salatin and Gabe Brown in USA, demonstrate impressive results and have become individual role models for other farmers. There are also examples of organizations working with rural communities, like IRDNC in Namibia and the Africa Centre for Holistic Management in Zimbabwe, that have achieved remarkable results. Also in the Nordic countries there is a small number of livestock farmers practicing time controlled shift grazing with proactive adaptive management ('holistic management') to optimize production, biodiversity and the ecosystem processes of their land.

Although the concepts of adaptive management and holistic management are not new to science, rangeland research has generally overlooked this phenomenon or shunned its results as anecdotal. Also it has in general been linked to dry and desertifying areas of the world. Positive and similar results in very diverse environments, however, points to universalities that should not be ignored, but instead be investigated.

In the Patagonia region of Argentina and Chile, Ovis21 – a network of producers and professionals – have launched an advanced evaluation and certification program for grassland/rangeland management which documents management effects on the land: Grassland Regeneration and Sustainable Standard (GRASS). This has been released in collaboration with The Nature Conservancy. A Rangeland Health Index (RHI) was proposed based on widely accepted biological indicators. RHI is one of the outcomes verified by the GRASS Standard. Farms that achieved high scores proved to have higher biodiversity and better ecosystem function. Application of GRASS allows to learn more about the grassland, recover the biological capital, empower people, and demonstrate regeneration with data that can be independently audited. As the southern part of Patagonia resembles in many ways the Atlantic region of Northern Europe, their practices and results should be of high relevance for Nordic grazing. Ovis 21 has so far scored 1.3 million hectares on 54 properties in the Patagonian region. Every grazing division on every property has been evaluated and its grazing planned to regenerate its grassland. Only 20% of the properties qualified as "full sustainable" based on their average RHI, but of these 80% were Holistic Management practitioners. In the drier zones of Patagonia, the only regeneration cases recorded correspond to Holistic Management farms. The data obtained systematically in a wide variety of environments, suggests that the time controlled shift grazing planned within the Holistic Management framework is a tool for regeneration with results that are unprecedented in the region.

The results from Patagonia confirm the results that have been reported from many different environments for a very long time, but mostly overlooked: Proactive adaptive management, such as Holistic Management, with time controlled shift grazing are effective for regenerating the land while at the same time achieving viable livestock production. The example from Patagonia also proved this to be effective under cool and humid conditions as well, like in the Nordic region of Europe. Such practices should be valuable for the management of biodiversity and protected areas, and could be fully integrated with systems for outcome based payments in agriculture.

From Wild to Domestic to Wild Again: Opportunities with Wild Grazers

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Preservation of biodiversity in the open landscape and the grazed ecosystem is a major challenge in conservation biology. Much of today's scientific and applied focus is on domestic grazers, their grazing pressure, and to withhold domestic grazing. The knowledge about wild herbivores and their potential contribution to conservation and management of the open, grazed landscape and its biodiversity is however limited. On the contrary, wild grazers are often problematized, and often regarded as a problem even within biodiversity conservation work. We argue that this is counterproductive, and that wild herbivores may very well assist in the preservation of grazed landscapes, and that the reduced control that undoubtedly follows with wild herbivory is beneficial to biodiversity. We support our arguments with data from a long-term study on grazing preferences of wild fallow deer in Sweden.

1000 years of sustainable grazing in Nordic conditions? - what can be learned

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Sustainability, e.g. as expressed in the Faeroes concept “*skipan*”, has been widely used in the Nordic countries as regulation of sustainable land use since the Viking age. Even land property rights have historically been currently adapted to the need for a sustainable use and management of varied landscapes at different spatial levels. Information on much of this sort of regulation has however been lost through modern times, tended to prefer modern (nature) scientific methods primarily developed as general (meaning not spatially contextual) recommendations for raising productivity. During the later years this modern tradition has also been preferred by investigations to find solutions for non-sustainable types of land use in grazing systems.

However, much sustainability-relevant wisdom has been accumulated in historical grazing-systems that should be included in the repertoire of knowledge to be mobilized in the endeavor to succeed a necessary transformation towards sustainable land use in the future. This is especially relevant since this historical wisdom was often based on a conscious holistic framework for a long-sighted optimal use of grazing potentials under shifting economic conditions, in practice linking detailed contextualized accumulated knowledge on nature processes at landscape level with constant social conflict regulations at a local and regional level. Often it worked, but in some situations (e.g. with marked changes in social or economic conditions, or by changing climatic conditions) it did not. Based on many years of studying the landscape and ecological and social conditions of the Faroese grazing system since the first Faeroese law – the Sheep Letter from 1298 – I have tried to derive some lessons concerning possibilities and limitations in the use of historical knowledge on the Faeroese grazing systems. I cover the interpretation of their historical sustainability, but also give a modern interpretation of general conditions for future sustainable land use, both concerning the ecological functionality of the landscape and its use, and of the social conditions necessary to ensure a holistic management of the land use system.

Notes

Session V

Grazing, environment and climate: friends or foes?



Ecological responses to sheep grazing in Norwegian mountains: Insight from long-term experimental approaches

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Land-use change is an understudied facet of global environmental change. In the mountains of Norway, sheep grazing is the dominant land-use. There is high spatial and temporal variation in sheep grazing throughout Norway, and this is expected to influence ecological processes across spatial scales. The impact of sheep grazing has the potential to both interact-with and feedback-to climatic change. In this presentation, we combine grazing manipulation experiments with chronosequences of forest development to examine the ecological effects of sheep grazing on vegetation, soils and ecosystems.

We will first present results from a long-term enclosure experiment to show how sheep grazing limits treeline advance and shrub expansion in low alpine vegetation. We will next demonstrate how grazing also buffers a climate-change induced elevational shift in the plant community composition, and how the response of plant diversity to sheep grazing varies along an elevational gradient. Using a dendroecological approach we will propose that the influence of grazing on important alpine processes is far greater than the influence of climatic variation. Species distribution modelling will then be used to identify regions where sheep grazing is most influential to the conservation of rare plant species.

In the second part of the presentation we will contrast plant and ecosystem carbon pools in the presence of livestock grazing as well as absence in the decadal time-scale (using experimental exclosures) and centurial time-scale (using a natural exclosure experiment). We will show how the limitation of forest establishment by herbivores can lead to substantial differences in ecosystem carbon storage.

Finally, we will discuss the impacts of sheep grazing in alpine ecosystems in context of the ecosystem services framework. Using output from a wide range of studies across multiple ecosystem processes and taxonomic groups, we will ask whether the provisioning of ecosystem services in the low alpine zone is greater at low sheep densities, high sheep densities or in the absence of grazing.

Ecological impacts of sheep grazing in Iceland – how much do we really know?

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Sheep grazing is a main component of agricultural systems in the North, which has shaped rural economies, landscapes and biodiversity. However, the sustainability of these systems has been questioned as stocking rates often exceed the carrying capacity of the land, leading to irreversible ecosystem degradation. In Iceland, sheep grazing has been associated with extensive soil erosion, particularly in the summer rangelands within the volcanic active zone. The ecological impacts of sheep grazing have been well documented in ecosystems outside Iceland, but to what extent these results apply to the particular conditions in Iceland remains poorly evaluated. There have been a number of studies on the effect of sheep grazing in Iceland, dating back to the 1950s, some of them including multi-site assessments of pasture quality and sheep production. However, the results of these studies have for the most part only been published in Icelandic as internal reports, in local journals or as

abstracts of conferences and meetings, or remained unpublished, and are thus not accessible to a wider, international research community.

We synthesized all available information, with special focus on the gray literature, on the ecological impacts of sheep grazing on tundra rangelands in Iceland. We searched local databases and used expert knowledge to identify relevant studies; we compiled over 300 documents, but only a 16 studies contained extractable information that we could use in our data synthesis. In many cases, insufficient details in reporting data reduced the power of the analyses. Three main types of analyses were identified: those comparing grazed and ungrazed areas, those investigating the effects of varying grazing pressures, and those reporting vegetation dynamics after grazing exclusion. Most studies reported broad vegetation variables, such as plant cover or frequency of main growth forms, few described impacts on soil parameters and one included the effect on invertebrates. There were no studies investigating the impacts of sheep grazing on other ecosystem components.

General trends suggest that sheep grazing in Iceland, together with harsh climatic conditions and soil characteristics, retards succession in sparsely vegetated lands and hampers land restoration efforts. Sheep grazing has long-lasting effects that do not easily revert even after decades of grazing cessation and soil erosion remains one of the main environmental problems associated to sheep grazing in Iceland. A better understanding of the ecological impacts of sheep grazing is required to inform sustainable grazing practices adapted to the local conditions of this region.

Does light stocking rate justify grazing on poorly vegetated land?

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Sheep grazing on barren land is commonly practiced in Iceland. This is controversial, but has often been justified by the light stocking rate. In harsh environments where growing conditions are poor, it can take decades before the cessation of grazing produces noticeable changes at community level and this may lend credence to the belief that sheep grazing has limited impact on the sparse vegetation of barren lands. Changes at the level of individual plants may however be much quicker. The aim of this study is to determine the impact of light summer grazing on early successional vegetation. The study was conducted on Skeiðarársandur, a 1000 km² flat outwash plain in SE-Iceland. Most of the outwash plain has only 1-2% vegetation cover, and around 15% with > 50% cover. The better vegetated areas are moss heathland with herbs and, in the uppermost part, birch and willow shrubs. Since the mid-20th century, approx. 200 ewes with lambs have grazed the central part of the sandur from early June until September, corresponding to ca. <0.01 sheep ha⁻¹. Ecosystem development has been studied there since 1998. In 2004, 10 enclosures were established to evaluate the impact of sheep grazing. We explore changes inside and outside enclosures between 2004 and 2012, both for the vascular plant community assembly and for selected plant-traits. In addition, we compare growth and seed production of three common plant species, *Cerastium alpinum*, *Arabidopsis petraea* and *Juncus trifidus*, inside and outside enclosures. None of these species is regarded as particularly palatable.

Our preliminary results indicate that even such a light stocking rate has a significant negative effect on growth and seed production of individual plants. However, we were not able to detect community level differences between grazed and protected plots. As vegetation development in sparsely vegetated areas is often extremely slow, it probably takes more than eight years of protection before vegetation improvement can be ascertained at the community level. Today, 40% of Iceland is severely degraded or eroded and many such regions are grazed by sheep. Our results support the view that such poorly vegetated areas, should not be grazed, even at light stocking rates, as it will negatively affect ecosystem recovery.

Ecosystem responses to reindeer grazing along the Scandinavian mountain range

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The warming of recent years has caused a shift in plant community structure in arctic areas and one of the most obvious changes is the expansion of shrubs. However, studies have found that reindeer can influence ecosystem responses to warming and inhibit shrub expansion. In this project we have revisited grazed (ambient) and ungrazed (fenced) study plots, at the southern as well as the northern limits of the Scandes mountain range, to investigate how the vegetation had changed in response to increasing temperatures between 1995 – 2012 occurring across the Scandes. Several plant communities within the Forest-Tundra Ecotone (FTE) were studied. Furthermore, we examined the impact of reindeer grazing on the production of extramatrical mycelia (EMM) and community structure of the ectomycorrhizal fungi using ingrowth mesh bags, nitrogen cycling using PRS-probes and fluxes of greenhouse gases.

At shrub and grass heaths the evergreen shrubs nearly doubled from 1995-2012, whether grazed or not. Deciduous shrubs, too, showed a significant increase over time but, contrary to the evergreen shrubs, they also showed a positive effect of reindeer enclosure. Deciduous shrub cover had increased from 11% to 19% in ambient plots and 32% in fenced plots. Reindeer grazing was also found to significantly limit the advancement of tall (over 30 cm in height) dwarf birch and willow species at the grass meadow and shrub heaths. At the mountain birch forest sites, too, evergreen shrubs showed the greatest rise, increasing on average from 20% to 47% with no effect of reindeer enclosure, while the increase in deciduous shrubs was not as large as at the heath sites. Nor was there any treatment effect. The EMM production, at the shrub heath sites in the southern mountains, was three times larger in ambient plots than enclosures, which could be explained by a decreased abundance and an increased carbon (C) allocation to the roots of dwarf birch (*Betula nana*) when reindeer are present. However, this alteration of C did not affect the CO₂ flux at the site, although the CO₂ flux at the most productive site, grass meadow, showed a general pattern of lower fluxes from grazed plots.

We conclude that shrub expansion is occurring rapidly in the Scandes mountain range. Reindeer, however, may restrain the expanding shrub cover and affect the C allocation in plants, in turn influencing the EMM production and in the longer term, potentially, the soil C budget.

Long-term grazing by reindeer may shape tundra carbon storage

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Large herbivores such as the reindeer are known to influence the composition of vegetation across subarctic and arctic tundra landscapes. As traits of the dominant vegetation may regulate the capacity of ecosystems to sequester carbon, grazing can have profound effects on ecosystem carbon storage in the long-term - and not only through the removal of biomass. The impact of grazing on tundra soils is of particular interest due to the vast and globally significant carbon reservoirs stored in tundra soils. In 2014, we investigated how a grazer-induced vegetation transition from dwarf shrubs to graminoids affects ecosystem carbon storage. We approached this question along two pasture-rotation fences in northern Norway, where heavy grazing intensity on one side of the fence had induced a vegetation shift from deciduous and evergreen dwarf shrubs into a dominance of graminoids. The carbon storage

in vegetation, litter and soil in both study locations had been measured already in the year 2000 and hence we were also able to analyze recent changes in vegetation composition as well as ecosystem carbon stocks.

Our results show an increase in ecosystem carbon storage within recent years indicating that the northern Fennoscandian tundra continues to provide an important sink of carbon, irrespective of reindeer management regimes. We also report that the carbon storage under heavily grazed ecosystems was similar at both sites. However, when compared with the adjacent lightly grazed areas, grazing was found to influence ecosystem carbon storage in opposite directions: the organic soil carbon stocks were higher under graminoid-dominated vegetation than under the adjacent deciduous dwarf shrub (*Betula nana*)-dominated vegetation, whereas there was no difference in carbon storage between graminoid tundra and a mixed tundra heath with high abundance of an evergreen dwarf shrub (*Empetrum hermaphroditum*). With these findings, we propose that the long-term consequences of a grazer-induced vegetation shift on tundra carbon storage depend on the functional traits of the dwarf shrubs that graminoids replace in the vegetation. Furthermore, these results bring new insights into identifying tundra habitats where carbon sequestration could be promoted by the management of grazers.

Using coprophilous fungal spores to detect abandoned reindeer milking sites in northern Sweden

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Reindeer (*Rangifer tarandus*) is the single most dominant large herbivore affecting the vegetation of northern Fennoscandia. It has been observed throughout the Arctic, and especially in Fennoscandia and northern Russia that combined human-animal agency, e.g. concentrated grazing and trampling by semi-domesticated reindeer herds, has changed the vegetation by creating graminoid-dominated green patches, which may persist for centuries. The warming that has taken in recent decades has driven vegetation changes in these areas, especially by increasing erect deciduous shrub growth and it remains to be seen if these lawns will persist further. Two sites, Suollagavallda and Viejevágge, located in the Swedish Scandes Mountains, were chosen for a high-resolution pollen and coprophilous fungal spore analysis. Both sites are in mountain valleys with numerous dwellings which are up to 1000 years old. Ancient dwellings are indicated by rows of hearths and circular depressions on the ground. Sami have traditionally practiced reindeer milking in the area from the middle of the summer until autumn, and the animals have been kept on site for some weeks, year after year repeatedly over several generations, which has had a noticeable effect on the vegetation structure, cover, and composition. Recent studies from the Netherlands show that there is a highly significant relationship between the coprophilous fungal spore abundance and local biomass densities of herbivores that can be used in the calibration of fossil records. The aim of this study is to use the coprophilous fungal spores to detect the local presence of reindeer and the timing and duration of the reindeer milking in the area. The initial results from the Suollagavallda profile show up to 35% of coprophilous fungal spore *Sporormiella* along with a decline in the percentages of *Betula* and *Salix* pollen, and an increase in *Juniperus* which are good palynological indicators of grazing in the area. The pattern is very similar to some earlier observations from other reindeer herding sites in Sweden. The high percentage of coprophilous fungal spores in the so far analyzed samples suggests that the method can be used to date the timing and duration of reindeer milking in the Suollagavallda valley.

Grazing and tundra soil carbon and nutrients: patterns, mechanisms and future perspectives

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Grazers exert important effects on soil carbon and nutrient cycling rates across ecosystems through influencing soil microorganisms that mediate soil organic matter decomposition and nutrient mineralization. Through this mechanism, grazers create an important feedback on plant species composition, ecosystem productivity, and soil carbon sequestration. However, there is high spatial variation in the direction of the grazing effect: grazing can either enhance or retard soil microbial activity for carbon decomposition and nutrient mineralization at different tundra ecosystems. Tundra soils store globally important quantities of accumulated carbon, which may be susceptible to increasing microbial decomposition and contribute to atmospheric carbon dioxide concentrations. Here, I discuss mechanisms by which grazing creates long lasting legacies on soil carbon sequestration and nutrient availability in Arctic tundra, and how these effects in turn influence ecosystem responses to climate warming. Grazer-induced shifts in the vegetation influence both the chemical quality of accumulated soil carbon and the temperature adaptation of soil decomposer microbial community, which could be important determinants for soil microbial responses to warming. The consequences of climate warming on plant communities are also highly dependent on grazing intensity and the long-term legacy of grazing on soil nutrient availability. Scientists are faced with a major challenge trying to identify the role of grazing in natural tundra ecosystems; however, this understanding would be crucial for predicting the consequences of global change on ecosystem functioning and the long-term carbon sink in the Arctic.

Woodland grazing - a tool for conservation of biodiversity in Denmark

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Woodlands are the natural habitat of approximately 60% of the Danish species. Many of the woodland associated species have survived the transition from natural forest to cultural landscape. During this process the forest area was greatly reduced as a result of grazing and the harvesting of forest products and forest area accounted for only a few percent 200 years ago. Even though forest area is significantly increased today, many of the woodland species are endangered, because the forests are dark and uniform with few old trees and low amounts of dead wood. The Forest Act of 2004 opened the possibility of using up to 10% of a forest for grazing, as long as the grazing supports the biological diversity and considers both landscape features and the area's cultural history. Extensive grazing can recreate light-open, varied forests. It has been documented in several studies including a study of the effects of 25 years of extensive cattle grazing in acidic oak woodland.

There is an increasing interest in using grazing with wild animals in the management of woodlands, either with free-standing animals or wild animals under fence. Natural grazing systems are expected to enhance a dynamic development between open areas and areas with various degree of afforestation containing a mosaic of different niches with habitats for many of the woodland associated species, including light demanding species, but which are sensitive to a more constant grazing pressure.

There is a significant impact of grazing from the increasing population of wild deer. The question is to which extent free-standing game can be a tool to restore and maintain habitats of the grazing associated species of plants and animals. While there is a comprehensive documentation of deer in forestry and agriculture, there are very few studies that illustrate their nature management effect, many of which describe negative impacts as a result of high grazing pressure. Preliminary studies of the effect of the fallow deer and red deer show that they might be an important tool in nature conservation.

Session VI

Perspectives, Ideas, Needs & Policies



Linn F. Groeneveld | NordGen

The future of reindeer husbandry in Fennoscandia under global change

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The Arctic region is forecasted to warm approximately twice as much as the Earth on average bringing about dramatic transformations in the northern ecosystems. Further pressure to the environment is imposed by changes in land-use by natural resources extraction and tourism. Moreover, simultaneously our societies convert towards urbanized, highly educated, service-based systems, where ever decreasing population will gain its livelihood from primary production. These processes bring about serious challenges to reindeer husbandry, as the livelihood is highly dependent on the diverse tundra environment, and deeply rooted in the indigenous Sámi culture. However, by smartly utilizing the migratory reindeer grazing system of the Sámi as a management tool, we might be able to sustain the high-albedo tundra and mitigate global warming, and support the livelihood against rapid external pressures.

The challenge of improving our knowledge of European grasslands

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EU nature and agricultural policy set ambitious targets for 2020. The Common Agricultural Policy (CAP) in its greening package includes the designation of environmentally sensitive permanent grasslands, which cannot be ploughed or converted, and the maintenance of the ratio of permanent grassland to the total agricultural area, which must not fall by more than 5% compared to the reference year. The EU Biodiversity Strategy to 2020 requires that CAP direct payments to reward environmental public goods such as permanent pastures are enhanced; moreover, it requires that 15% of degraded ecosystems are restored, and to promote the implementation of the Green Infrastructure. Mapping and assessing grassland status and areal distribution is crucial to achieving such targets. Ongoing initiatives to identify, map and assess grasslands at EU level include remote sensing mapping at continental scale, recording at parcel level of CAP direct payments distribution, the set-up of an ad hoc point survey, the reporting of conservation status of grasslands protected under the EU Habitats Directive, the identification of High Nature Value farmland. Timing, access and use of such information, and remaining gaps are discussed in the presentation.

Consumer and citizen expectations of grazing

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Grazing affects the ecosystem services that agricultural landscapes provide to people. Grazing animals are a landscape element that has value for citizens as a public good. Moreover, outdoor access for animals and the use of natural pastures are important characteristics of meat product for consumers. Consumer and citizen attitudes toward grazing will be discussed.

Poster abstracts

According to session and in alphabetical order by first author



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Multi-nutritional feed blocks: a strategy to combat fodder shortages for livestock in Niger

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In Niger, as in most Sahel countries, livestock has an important socio-cultural, economic and food security role for the population. Ranked as the second socio-economic activity after agriculture, livestock represents the second strongest export sector after mining resources. Livestock contributes 11% to the national Gross Domestic Product (GDP) and is 24% of agricultural GDP and 25% of household budget.

Over the past few decades, multiple factors have threatened livestock production and subsequently the livelihoods of Niger's pastoralists, causing pastoralists and agro-pastoralists to be some of the most food-insecure populations in the country. These factors include severe drought, a decrease in accessible grazing land due to increased land pressure from growing crop farming populations, environmental degradation, and changing land tenure laws, which often bring ambiguity and a bias towards settled farmers.

Niger's climate is characterized by mono-modal and unpredictable precipitation and three seasons per year: the cold season when the southwest Harmattan winds blow, the hot season and the rainy season, which runs from June to September. Most of the country depends on the rainy season for cereal and forage production, but the rainfall is highly variable and diminishes sharply as one moves northward. During the rainy season there is abundant grass with good nutrition available for livestock. In the dry season, pastures do not offer nutritious forage and many livestock suffer from this lack of fodder.

Climate change has led to more unpredictable rainfall and increased food insecurity associated with chronic livestock fodder deficit in the dry season. To mitigate the adverse effects of inadequate fodder resources on livestock productivity and income of farmers and agro-pastoralists, Niger researchers are looking for alternative solutions. In this context, the National Institute of Agronomic Research in Niger (INRAN) in collaboration with the Food and Agriculture Organization (FAO) has developed a simple technology of manufacturing feed blocks for livestock.

The materials utilized for the multi-nutritional blocks are: crusted forage (straw and stalks, hay, hulls and woody pods), sub-agro-industrial products (brans, oil cakes, grains and flour), minerals (calcium, phosphate, salt), binders (Arabic gum, cassava flour) and vitamins.

Using such concentrate multi-nutritional blocks in livestock alimentation can:

- Alleviate food crisis for livestock by storing food in excess years;
- Provide good nutritional feed that increase animal production;
- Improve livestock production and productivity by increasing their nutritional status in any season.

Sensor technology in sheep on range pastures to monitor health and welfare

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Loss of sheep on range and mountain pastures is a serious animal welfare problem. In Norway, more than two million sheep graze on unimproved, rough grazing lands during the summer months each year. These free ranging flocks benefit from behavioral freedom with potentially positive impacts on animal welfare. Predator attacks, undetected diseases and accidents compromise these benefits. About 125 000 sheep (6-7%) are lost on such pastures every year, and single flocks may experience losing half their flock. To improve animal welfare, sustainability and profitability in sheep farming in Norway, sheep losses must be significantly reduced. Implanted sensors can monitor physiological

parameters, such as body temperature and heart rate. Real time notification of physiological irregularities to the farmer would enable immediate treatment or other intervention. Integrating such sensors in existing GPS tracking systems could help to detect, locate and treat sick animals. Regarding predator attacks, the system could notify chasing followed by the sudden death of an animal, which in turn would enable target oriented guarding or the prompt evacuation of remaining livestock. Use of technical innovation could be an important tool to reduce the loss of sheep and improve animal welfare on range and mountain pastures. In this study, we test if sensors that measure body temperature and heart rate can detect disease and behavior traits (i.e. predator attack).

Temperature and heartrate sensors (Star Oddi, Iceland) are implanted in 20 lambs in a sheep flock in a tick-borne fever risk area and in 20 lambs and their 10 mothers in a predatory risk area. The telemetry system (Telespor, Norway) provides accelerometer information and real-time positioning data. All animals are closely monitored and an experimental predator test is being performed two times in each of the two flocks.

The project's goal is to test sensors that measure body temperature and heart rate and to assess the sensors' precision and suitability as a monitoring and warning tool for diseases and predator attacks in sheep farming. This is the first step towards developing a monitoring system that enables the early detection of diseases and predator attacks at the individual animal level, also for free-range livestock farming.

Can we prevent alveld in lambs?

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The large loss of sheep and lambs during summer grazing on outfield pastures in Norway is an ethical challenge and prevents the exploitation of such resources for food production. Predators, diseases and accidents cause losses on such pastures and the cause of death is seldom verified. In a survey among sheep producers in six counties, on assumed cause of lamb loss on rangeland, 13% of the respondents suggested that alveld caused lamb losses during summer grazing. In three of the counties in 2014, alveld was reported as the main cause of loss by 22-33% of the respondents.

The disease alveld is caused by toxins that cause liver damage and symptoms of photosensitivity. Saponins from bog asphodel (*Narthecium ossifragum*) and/or toxins from cyanobacteria have been found to be hepatotoxic and can cause photosensitization in mammals. In this preliminary study, we have looked at whether it is possible to develop a bolus with toxin-binding substances for use in the critical grazing period.

A testbolus of three different sizes (3 cm/8 g, 3,5 cm/13 g, 4 cm/ 24 g) was tested in six lambs at two months of age (weight 16-22 kg) with a standard applicator. Each bolus size was tested in two lambs. X-ray photography showed that all boluses were perfectly placed in the reticulum immediately after posting and after 18 days. The lambs were autopsied at slaughter. Residence time of bolus in the reticulum was about four weeks. The bolus did not damage the digestive system.

A polymer compound was tested as a toxin binding substance. Precipitation of saponins was observed when adding a solution of saponins to a solution of a polymer compound in a simulated sheep stomach. The release of the polymer compound from a bolus was controlled by changing the diameter of an opening in the bolus.

A bolus with polymeric compounds and the size described above can be used for binding saponins. Further work should include studies on the suitability of this polymer on several relevant toxins and *in vivo* studies testing toxin-binding bolus in lambs. Combining a bolus with toxin-binding substances and mineral supply can be a useful measure in many pastures.

Improving livelihoods of Smallholder Livestock farmers of Northern Ghana through a sustainable grassland management: the Impact of Innovation Platforms (IPs)

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The three northern regions of Ghana, the Upper West, Upper East and Northern Regions, are the poorest regions of Ghana. The inhabitants of these regions are mainly farmers, engaged in crop production and rearing of livestock. The livestock are mainly sheep, goats and cattle kept on a very small scale. The contribution of income from the sale of these animals to the total income of poor households cannot be overemphasized. In times of emergencies such as crop failure, food insecurity, paying for medical bills, school fees or other expenditures that require a large amount of money, livestock is sold. Also, livestock have cultural importance in the three regions of northern Ghana. They are used for naming ceremonies, dowries and religious festivities.

Despite this socio-economic importance of livestock, grazing lands in Northern Ghana, the main source of feed for livestock, is barely under any form of improved management practices. Annual bushfires continue to destroy grazing lands leading to loss in biomass production, soil erosion and land degradation. There is also indiscriminate felling of fodder trees for charcoal and firewood production reducing the biomass available for livestock feeding. These problems affect the quality and quantity of livestock as well as livelihoods of poor households. Other major problems affecting livestock production are theft and the emerging trend of conflict between herdsmen and crop farmers. Also, conservation of grazing lands at the community level is barely given attention in Northern Ghana, despite its potential contribution to poverty alleviation. There exists no clear governance approach to solving these problems.

This paper looks at improving grassland conditions for livestock production in Northern Ghana through Innovation Platforms (IPs). It views Innovation Platforms as a governance approach to managing grazing lands in Northern Ghana. Innovation Platforms are a way to bring together different stakeholders, to identify solutions to common problems and they can play an efficient role in natural resource conservation and improving grazing lands, at the same time impacting households' livelihoods and security. They ensure that different interests are taken into account and various groups contribute to finding solutions to existing problems. An Innovation Platform provides space for learning and engineers change in a social setting.

Innovation Platforms can contribute to reducing land degradation, prioritizing conservation, improving grazing lands as well as improving income and livelihood of livestock farmers in Northern Ghana.

Implication of cropping systems on conditions of grazing land: A Case of Kyrgyzstan and Malawi

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Grazing lands in Malawi (Sub-Saharan Africa) and Kyrgyzstan (Central Asia) are communal. In Malawi, they are mostly wetlands but in Kyrgyzstan mostly arid lands and steppes. Land tenure and management differs. In Malawi, grazing lands are communally owned and controlled by traditional leaders. In Kyrgyzstan they are state property and managed by pasture users' associations. Both might be properly fitting principles of bottom-up approaches.

In Malawi the best quality vegetation is found during the rainy season while the productivity of Kyrgyz arid and steppe grazing lands depend on the amount of precipitation during the growing period. As a consequence of climate variability and climate change, the two countries are experiencing changes in the distribution of rainfall within seasons, which impacts production of grazing lands in both countries. This influences the traditional timing of grazing as the growing season and productivity is changing.

To avoid overgrazing that leads to degradation, the timing of grazing is important when managing the rangelands. The responsible authorities, traditional leaders and pasture users' associations, are striving to adjust the land use properly. However, they are not successful because of limited knowledge and understanding of grazing land management.

In response to changes caused by climate change and degradation, individual farmers are using cropland management to provide enough fodder for the livestock. At the end of the growing season, the harvested crop fields, maize, groundnuts (Malawi), alfalfa, sainfoin (Kyrgyzstan), become the main fodder source until the next growing season, throughout the dry season in Malawi and winter season in Kyrgyzstan. This management technique greatly reduces grazing during the non-growing season, when the rangeland vegetation is most sensitive to grazing. If stocking rates are not controlled, grazing lands will continue to degrade with a negative effect on small scale livestock production. Therefore, collaborative management of grazing and crop lands is important to avoid land degradation.

Tools to improve nature management and sale of certified meat from semi natural grassland in Denmark

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With more specified aims of nature management, a more concrete outcome of management activities is expected. The management activity to reach specified nature goals may be regulating grazing intensity, grazing at specified times of the year or in combination with other types of management for example cutting. Many farmers are not aware of specific nature management targets. They worry about the economic output and the risk in overlooking some of the demands connected to subsidies from the authorities.

There will be better nature conservation if control of subsidies will address nature conservation/improvement directly, rather than, for example, controlling specified grass heights on the 15th of September or a specified number of cattle per ha during three summer months. When the control is carried out by checking the number of animals per ha in the three summer months, introducing a grazing break to promote flowering, which is important for insects, and seeding on dry grasslands is not possible.

Farmers want simple and clear plans and not a lot of reading. Therefore, we make very short nature action plans, with both a map over the different types of subsidies and a map of the specific nature quality and goals at the sites. Concerning nature quality both positive elements, to be improved, and the negative elements, to be reduced, is described. The plan provides suggestions for a grazing system that takes into account both natural optimization and regulatory compliance. The plan also includes a few focal species to make nature conservation more understandable for both farmers and consumers.

We have tried both plans focusing on types of subsidies and plans focusing on concrete nature management requirements. Now we try to combine the two approaches. In Denmark, the goals of nature management are not in focus for the subsidy systems. Hopefully it will change in the future to give the farmer better guidelines and at the same time persuade the consumers to buy meat from qualified nature management.

In Denmark, a new association for the promotion of meat from nature conservation was established in 2015. A better price can be achieved for the meat by giving consumers added value through the description of the product origin and the specified nature conservation carried out.

UN University Land Restoration Training Programme: Capacity building in land management and restoration

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The land provides us with the majority of our food, energy, building materials, fiber and clean water. This valuable resource, which our lives depend on, is threatened by poor management, climate change and land encroachment. The result is severe land degradation and soil erosion. This challenges the livelihood and well-being of all people, and has especially high impact on farmers and herders in the poorest countries of the world.

To reverse the loss of land and soils, we need to manage them according to their potential so people's livelihood is not compromised. To do that we need to understand the biophysical signs that can be used to determine land condition and recognize when management interventions are required. This is especially true for rangelands which are often communal lands.

Grazing is by far the most common rangeland use and important driver of their degradation worldwide. It has been shown that grazing-driven degradation is dominating in African rangelands, as well as rangelands of Australasia. Proper grazing land management requires good knowledge of land health, active monitoring and adaptive management. Skillful specialists are needed to advise and undertake the necessary management actions. Local specialists know the local condition best, but in poorer countries of the world they often lack up-to-date knowledge and skills to take appropriate actions. The UN University Land Restoration Training Programme (UNU-LRT) focuses on providing such training to specialists from the developing countries.

UNU-LRT core activity is an annual six-month training program which is custom-built for professionals in developing countries. The overall goal of the six-month training program is to train working professionals in the methods and theories of sustainable land management and restoration of degraded land, and to strengthen their capacities to advance and implement those activities in their home countries. Moreover, the program aims to build institutional capacity that helps to improve the health of people and ecosystems.

Can sheep grazing be used to control invasive plants? — Vegetation succession after introduction of sheep grazing into an area with invasive lupin (*Lupinus nootkatensis*)

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The spread of alien invasive species is considered a threat to global biodiversity. Livestock grazing can be used to control invasive plants; especially if they are palatable and there is not a risk of the livestock acting as a vector for their dispersal. Nootka lupin (*Lupinus nootkatensis*) became naturalized in Iceland following introduction to several afforestation sites in the 1950s, and was widely used for reclamation of eroded and degraded land until the end of the twentieth century. It is, however, now classified as an invasive species and its use for reclamation is greatly reduced. A growing number of municipalities, agencies and individuals in Iceland are now trying to control the Nootka lupin, mostly by means of cutting or herbicide use. Although sheep grazing is considered useful for the control of lupin, there are limited studies of its effects on vegetation succession in lupin infested areas. In 1995, experimental plots were established in and around lupin stands on a glacial outwash plain in Svínafell, SE Iceland, to assess the effects of lupin on birch establishment and growth. The plots were established in dense lupin stands, open lupin stands and sparsely vegetated land outside the lupin stands. Lupin density, vegetation composition and birch vigor were assessed in the plots in 1995-1997 and again in 2011. The site was protected from grazing until shortly after 2000, when it was opened for sheep grazing. The ensuing grazing pressure appears to have been quite high, as all birch trees disappeared within a few years. Lupin also disappeared from experimental plots initially established in dense lupin stands, but a few scattered lupin seedlings (<1% cover) were found in plots established in open stands and sparsely vegetated land. In 1995, vascular species richness was much lower in plots in dense lupin stands than plots with sparse or no lupin cover; but was similar in all treatments in 2011. The vegetation succession of plots established in dense lupin stands was on a trajectory towards forb- and moss-rich grassland, while other plots were developing towards dwarf-shrub heathland. The results show that sheep grazing can control the lupin, but studies on the effects of different grazing pressure and timing are needed for development of effective guidelines for this “tool”. The presence of scattered lupin seedlings in 2011 and the long lived lupin seed bank suggest, however, that the lupin could recover once the grazing is discontinued.

Pasture utilization by Norwegian feral sheep grazing calcareous coastal heathland all year round

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Coastal heathland is an endangered nature type, which is maintained by burning and grazing. In Norway, the breed Old Norwegian Sheep is well adapted to graze the habitat type all year round. Especially heather, *Calluna vulgaris*, is supposed to be a key feeding species during autumn and winter. Although *Calluna* is rare in calcareous heathlands, such pasture types are used for sheep grazing all year round.

A survey was conducted during three consecutive years, 2012-2014 at the island Risvær located in Nordland county, Norway. The island is approximately 47 ha and dominated by *Calluna*-poor heathland and former cultivated permanent pastures. Twenty-eight ewes of the breed Old Norwegian Sheep graze all year round on the island.

In order to find out how the breed is utilising *Calluna*-poor heathland we evaluate (1) the diet selection during June/July, September and January/February based on micro-histological analyses of feces and (2) the spatial distribution of sheep in pasture related to registered vegetation types and weather conditions based on their GPS-position.

While there is excess of feed during the summer, winter feed can be a challenge in some years. During the survey we did not find negative consequences of assumed limited feed availability during winter related to meat production and animal welfare. We found that all the ewes had lambs each year (on average 1.2 lambs per ewe) and average weight gain of the lambs during summer was approximately 170 g/day which is considered normal for this breed.

However, results from the micro-histology analyses of diet selection may indicate overgrazing. Thus, management should be modified in order to maintain the coastal heathland in the long term.

Cow dung has the potential to increase methane production and to influence the methanogen community of restored (rewetted) peat soils

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Drainage has been a common practice for the utilization of peatlands for agriculture. Rewetting of drained peatlands aims to recover plant communities and biogeochemical processes typical to pristine peatlands including increases in CH₄ emissions. The potential for very high emissions has been measured in the laboratory and in Central European field sites previously grazed by cattle. In the EU, two-thirds of agricultural CH₄ emissions stem from enteric fermentation within the rumen and one-third from livestock manure having dung. Rumen methanogens are introduced into the environment through cattle dung and can be detected in grazed soils.

We wanted to find out if high CH₄ emissions from rewetted peatland sites in central Europe could be explained by previous land use as cattle pasture. We analyzed the effects of dung application (DA) to peat soils on the methanogenic potential and community in three different experimental approaches: a) DA treatment of peat soil in the laboratory; b) DA treatment to three restored and one pristine peatland in the field in Finland and c) by sampling a restored peatland influenced by cattle grazing in Germany. We measured the CH₄-production potentials, determined the numbers of methanogens by *mcrA*-qPCR and analyzed the methanogen community by *mcrA* T-RFLP-cloning-sequencing.

In the laboratory and in the field experiment, DA significantly increased the CH₄ production potential. Likewise, the cattle grazed site in Germany had higher CH₄ production potentials than the non-grazed reference site; but this effect was not significant. *mcrA* copy numbers correlated with the CH₄ production in the laboratory and at the cattle grazing site but not in the field experiment. We found a shift in methanogen community due to DA and a sequence transfer of dung methanogens (*Methanobrevibacter*) to the peatland soil. Both might have caused the higher CH₄ production potentials after dung application. Our findings indicate that rewetting of previously cattle grazed peatlands might lead to increased CH₄ emissions.

Plan to study: Acclimation of arctic peatlands – through reindeer grazing – to a changing climate

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In arctic peatlands, global warming causes profound changes in their hydrology leading to shrubification. This affects surface energy balance control (albedo) due to changes in vegetation cover and induces earlier snowmelt. Therefore, ecosystem services provided by these peatlands, such as C sequestration and microbial control of greenhouse gas (GHG) release, are affected. As arctic peatlands

serve as spring and summer grazing areas for reindeer, these large animals are in an important role to control shrubification. Under a changing climate we aim to document the effect of reindeer grazing on the peatland carbon cycle. As arctic peatlands differ from grazing influenced tundra and mineral soil forests due to their anaerobic C cycling processes, the scientific knowledge gained from upland soil studies concerning reindeer grazing cannot be directly applied to the GHG emission connected C storage processes of peatlands.

The project will focus on arctic peatlands north of the limits of extensive forestry (ca. 66°40' N), where reindeer herding is by far the most abundant anthropogenic form of peatland use. The combined influence of grazing and climate change will be studied through a combination of fencing, warming by open top chambers and ditching in a full-factorial design as, in addition to direct warming, warming will lower the peatland water table.

We will measure (1) C-fluxes through CO₂ and CH₄ exchange, (2) plant derived above and belowground C inputs, (3) microbial activity (C and N cycle), (4) microbial community structure through Illumina based high-throughput sequencing methods (MiSeq platform) and qPCR of *mcrA* and *pmoA* (CH₄-cycle) as well as *nirK*, *nirS* and *nosZ* (N₂O flux through denitrification) and (5) albedo through Landsat satellite images.

Endozoochorous seed dispersal by sheep on barren land in SE-Iceland

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During summers sheep are free ranging in Iceland. Many of the grazed areas are poorly vegetated, and seed availability may strongly limit plant colonization. While grazing, sheep ingest seeds along with other plant parts, some of which pass unharmed through the sheep and can later germinate from the dung. Therefore, sheep might act as effective seed dispersers in these areas, and thus have a positive influence on vegetation development. This has however not been studied in Iceland until now.

The aim of this study is to determine the importance of endozoochorous seed dispersal by sheep in barren environments. We sampled sheep dung on Skeiðarársandur, a 1000 km² glacial outwash plain in SE-Iceland. Most of the sandur is poorly vegetated with < 10% vegetation cover, while around 15% has > 50% cover. The better vegetated areas are moss heathland, with herbs and in the uppermost part birch and willow shrubs. Despite the low vegetation cover, large parts of the sandur, has been grazed every summer since the mid 20th century by approx. 200 ewes with lambs (< 0.01 sheep ha⁻¹). In these grazed parts of the sandur, we collected sheep dung in September 2015 and identified emergent seedlings from it under greenhouse conditions.

Preliminary results demonstrated that sheep on Skeiðarársandur effectively dispersed many seed through endozoochory, on average > 0.58 seeds/g dung. The most frequent taxa were *Agrostis* spp, *Carex maritima*, *Festuca richardsonii*, *Poa pratensis* and *Rumex acetosella*. Most of the dispersed species were however relatively rare on Skeiðarársandur, e.g. *Campanula rotundifolia* and *Viscaria alpina*. None of the dispersed species had special adaptations to animal dispersal, and most were of low stature (<10 cm tall) and had small seeds. Species regarded as highly palatable and therefore expected to be common in the dung, only represented 30% of the dispersed seeds.

This study demonstrates that sheep on poorly vegetated sites may be effective seed dispersers. The density of dispersed seeds/g dung reported here is comparable to densities found in well vegetated grasslands in Europe. Our results indicate that this rather selective dispersal is likely to have a significant impact on vegetation dynamics and species richness in these grazed systems.

Understanding reindeer effects on willow growth and recruitment in a landslide-rich area on the Yamal tundra

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Rapid climate change in Arctic regions has been linked to the expansion of trees and shrubs: the tundra is becoming greener. Reindeer have been proposed as potentially being able to suppress this greening through grazing. Quantifying reindeer use of different vegetation types in relation to landscape topography can help us understand reindeer impact on the growth of woody taxa (e.g. *Salix* spp.) and their recruitment in naturally denuded landslide areas (i.e. active layer detachment slides). This is important in order to project future patterns of greening, albedo, snow capture, and the overall resilience of tundra rangelands under further predicted climate change. Here we show preliminary results of reindeer habitat use in a tundra region of West Siberia, Russia estimated from pellet-group counts. In July 2013 and 2014, we counted pellets within 322 15m² plots, over a 30km² landslide-rich area on Yamal Peninsula. In 2013, the plots were established and we removed old pellets from the plots. *Salix* leaves and young twigs comprise an important source of forage for migratory reindeer. Our results show high use by the reindeer of dwarf shrub (ridge-top) tundra: exposed ridges provide insect relief during summer when wind is sufficient, and willows on ridge-tops tend to be low erect or prostrate forms with strong evidence of grazing and trampling. In contrast, more concave areas (e.g. old landslides) with tall *Salix* were used less by reindeer, which were observed browsing in tall willow thickets only during cool weather (e.g. <6°C) with high winds.