



GróLind – Sustainable Land Use Based on Ecological Knowledge

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Presenter Information

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Abstract

The highlands of Iceland play an important role as summer rangelands for sheep. Large areas are badly degraded and the sustainability of this practice has been questioned. To achieve sustainable land management it is necessary both to obtain data on ecosystem changes over time and to ensure that the results are used by land users and policy makers in their management plans.

Currently, the first long-term national vegetation and soil monitoring programme (GróLind) is being developed in Iceland. The programme is based on an agreement between the Icelandic National Associations of Sheep Farmers, the Farmers Association of Iceland, Ministry of Industries and Innovation, and the Soil Conservation Service of Iceland. The overall objective is to use ecological data to promote, in collaboration with stakeholders, sustainable land management in Icelandic rangelands.

The focus is on monitoring variables linked to ecosystem function and structure to estimate rangeland condition and detect changes over time. The programme uses an adaptive monitoring approach and focuses on vegetation, soils and land use. Data will be collected at different spatial scales. Satellite images provide data for the whole country, while drones and on-site ecosystem analyses, by land users and specialists, are used for obtaining higher resolution data. The programme will develop indicators of sustainable land use based on experiments, active ecosystem monitoring and other available information.

To ensure that GróLind meets its objectives stakeholders are actively involved in all steps of the project. This includes regular meetings of stakeholders and their integral involvement in the monitoring programme and presentation of results.

Introduction

In Iceland most sheep graze the extensive rangeland commons in summer without shepherding. This grazing system has traditionally been regarded as profitable, with high production at low cost to farmers who utilize the rangelands at no cost. A large part of these rangelands, especially in the highlands, consists of unstable, poorly vegetated and unproductive ecosystems (Marteinsdóttir et al. 2020), many of which are badly degraded (Arnalds et al. 2001). Thus, the sustainability of this grazing system has been questioned (Ross et al. 2016). Until now the condition of these rangelands has not been regularly monitored and only few have studied the influence of this grazing practice on vegetation and soils in the rangelands (but see Marteinsdóttir et al. 2017). Furthermore, information on stocking rates, or even the size and extent of the rangelands, was not systematically gathered until 2020 (Stefánsson et al. 2020).

In an effort to promote sustainable grazing practices the first national vegetation and soil monitoring programme in Iceland was initiated in 2017. The programme was given the acronym GróLind and is based on an agreement between the Icelandic National Associations of Sheep Farmers, the Farmers Association of Iceland, Ministry of Industries and Innovation, and the Soil Conservation Service of Iceland. The programme is run by the Soil Conservation Service of Iceland and funded until 2026, but an independent inter-disciplinary science committee oversees the programme.

In the programme, ecological data will be used to estimate rangeland condition and detect changes over time. Also, information on how the rangelands are being used (e.g. by sheep and other grazing animals) will be monitored. From data gathered as well as from other resources, like experiments, indicators of sustainable land use will be developed. Here, we briefly describe the methods used for monitoring and what is being done to ensure that data gathered will result in more sustainable land management.

Soil and vegetation monitoring

The monitoring is based on methods developed to monitor rangelands in the USA (Herrick et al. 2005, Pellant et al. 2018) and Australia (Tongway and Hindley 1995) and the protocol developed by The Conservation of

Arctic Flora and Fauna (CAFF) for monitoring Arctic biodiversity (Christensen et al. 2013). The focus is on monitoring indicators that are related to key ecosystem functions: 1) the capacity of the ecosystem to withstand soil erosion, 2) the hydrological function and 3) nutrient cycling. The programme follows an adaptive monitoring approach, where the knowledge gained will be systematically used to improve the monitoring (Lindenmayer and Likens 2009, Ringold et al. 1996).

The monitoring will be conducted at a range of different spatial scales by both specialists and land users. A network of over 1000 randomly distributed monitoring points around the country (stratified random) are being set out. At these points a 50 x 50 m plot is laid out where vegetation cover, soil erosion, vegetation stratification and soil texture are estimated. Two 50 m long belt transects are laid within the plot and bare ground, vegetation cover, species richness, soil depth and vegetation height measured. Around 200 points are measured each year by trained field teams and measurement at each point will be repeated every five years. In addition, a citizen science monitoring programme is being initiated so that land users and the public can set up monitoring points with the help of a mobile app. This programme is under development and being tested. The data collected will be a part of the monitoring network in GróLind but land users will also be able to follow the progress of their own sites from year to year.

In addition to monitoring data obtained in the GróLind project, vegetation and soil monitoring data will be gathered from other projects in Iceland, both from the Soil Conservation Service of Iceland and from other governmental institutes. These data will then be combined with drone data and satellite images to provide an estimate of rangeland condition for the whole country.

Monitoring land use

To promote sustainable land use, information on annual stocking rates and the location and extent of the rangelands needs to be available. To obtain this information, GróLind mapped, in collaboration with stakeholders, the extent of the Icelandic rangelands for the first time in 2020 (Stefánsson et al. 2020). That map showed that around 62% of Iceland is used as summer rangelands for sheep divided into over 1500 rangeland units (Fig.1). As of 2021 all farmers that use the rangelands need to register the number of sheep in each rangeland unit in a central data base as part of their registration for agricultural subsidies. From that data accurate annual stocking rates will be calculated and linked to data on rangeland condition.

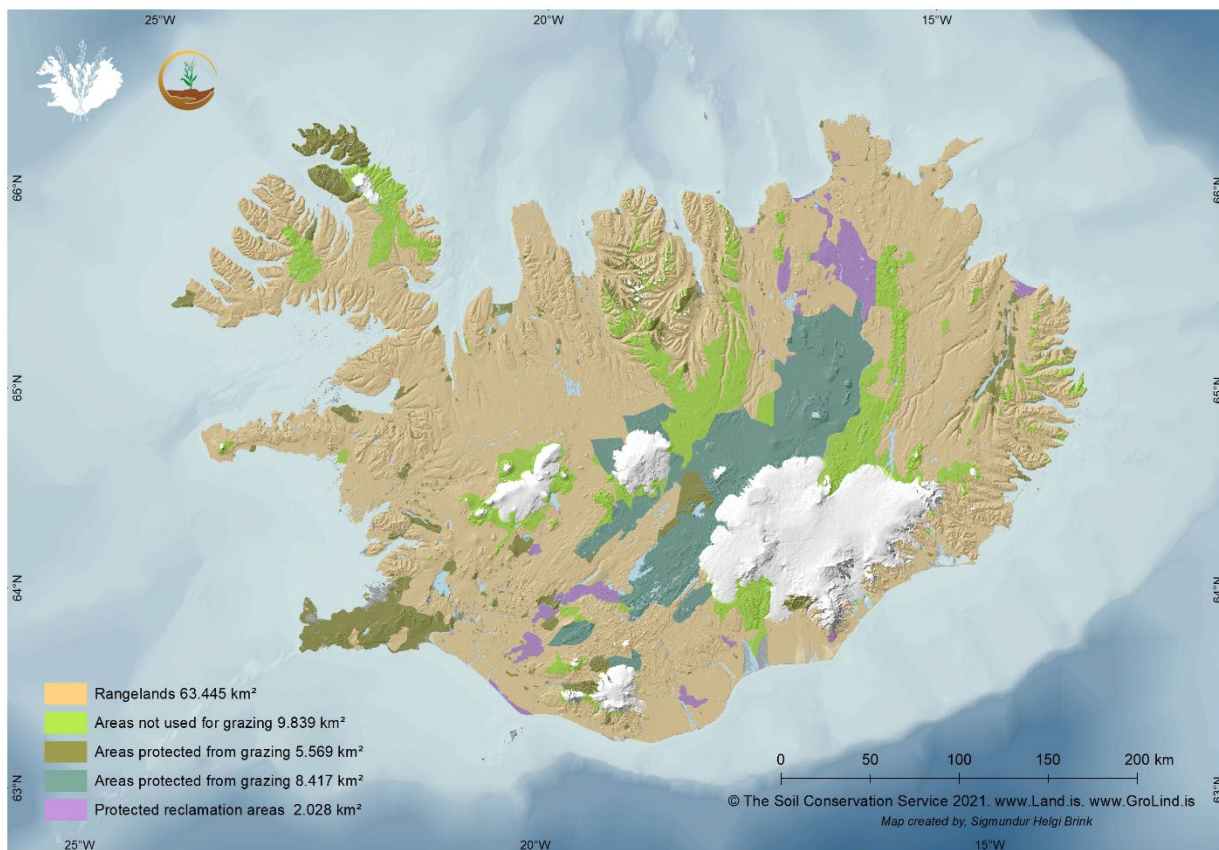


Figure 1. Summer rangelands for sheep cover around 62% of Iceland (light brown).

Icelandic rangelands are not homogenous, but rather a mosaic of different vegetation types (Ottósson et al. 2016). Therefore, to be able to predict the impact of grazing in an area it is important to understand how different vegetation types are being used by sheep. In 2018, a study was initiated, in which around 100 sheep using 10 different rangelands were equipped with GPS collars. The location of the sheep is tracked every 6 hours for the duration of the rangeland grazing period. First results based on data gathered over three summers, indicate that how the sheep use the land is highly influenced by the condition of the land as well as available vegetation types, while behaviour of different flocks and individuals is similar from year to year.

Sustainable land use

In order to ensure that GróLind meets its objective of promoting sustainable land management, stakeholders are actively involved in all steps of the project. Since the beginning there have been regular stakeholder meetings and stakeholders will also be able to participate directly in the monitoring as discussed above. Also, when major results are officially presented it is done jointly by all of the various associations and institutes that support the GróLind project.

To ensure the scientific integrity of the project, the work is regularly reviewed by scientists outside the Soil Conservation Service and an inter-disciplinary committee assigned by the government. Detailed information on the methods used, and their scientific background, are available at the project's website (www.grolind.is). All data and maps produced by the project will also be published there and an interactive map viewer will be developed to assist rangeland managers to sustainably manage their land.

Conclusion

The project is still in its early phase, but now for the first-time stakeholders and scientists are working together to generate data that can be used for sustainable land management. In a country that is extensively used for sheep grazing, and with a long history of land degradation, it is surprising how little has been done to monitor land condition. However, it is not enough to monitor and gather reliable data. For a project like GróLind to work the social-ecological system and policies will have to change. More and better data will make it easier to set evidence-based policies.

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References

- Arnalds, Ó., Þórarinsdóttir, E.F., Metúsalemsson, S., Jónsson, Á., Grétarsson, E. and Arnarson, A. 2001. *Soil erosion in Iceland*. Soil Conservation Service and Agricultural Research Institute, Iceland.
- Christensen, T., Payne, J., Doyle, M., Ibaguchi, G., Taylor, J., Schmidt, N.M., Svoboda, M., Aronsson, M., Behe, C., Buddle, C., Cuyler, C., Fosaa, A.M., Fox, A.D., Henning Krogh, P., Heiðmarsson, S., Madsen, J., McLennan, D., Nymand, J., C. Rosa, C., Salmela, R.S., Soloviev, M. and Wedege, M. 2013. *The Arctic Terrestrial Biodiversity Monitoring Plan. CAFF Monitoring Series Report Nr. 7*. CAFF International Secretariat. Akureyri, Iceland
- Herrick, J.E., Van Zee, J.W., Havstad, K.M., Burkett, L.M. and Whitford, W.G. 2005. *Monitoring manual for grassland, shrubland and savanna ecosystems*. USDA - ARS Jornada Experimental Range, New Mexico.
- Lindenmayer, D. B. and Likens, G. E. 2009. Adaptive monitoring: a new paradigm for long-term research and monitoring. *Trends in Ecology & Evolution*, 24(9): 482-486. doi:<https://doi.org/10.1016/j.tree.2009.03.005>
- Marteinsdóttir, B., Þórarinsdóttir, E.F., Halldórsson, G., Stefánsson, J.H., Þórsson, J., Svavarsdóttir, K., Einarsson, M.Þ., Jónsdóttir, S., and Brink, S.H. 2020. *Stöðumat á ástandi gróður- og jarðvegsauðlinda Íslands*. Soil Conservation Service of Iceland, Iceland.
- Marteinsdóttir, B., Barrio, I.C., and Jónsdóttir, I.S. 2017. Assessing the ecological impacts of extensive sheep grazing in Iceland. *Icelandic Agric. Sci.*, 30: 55–72. doi:[10.16886/IAS.2017.07](https://doi.org/10.16886/IAS.2017.07).
- Ottósson, J.G., Sveisdóttir, A., and Harðadóttir, M. 2016. Vistgerðir á Íslandi. *Fjölrít Nátturufræðistofnunar* 54: 1-299.
- Pellant, M., Shaver, P., Pyke, D.A., Herrick, Busby, F.E., Riegel, G., Lepak, N., Kachergis, E., Newingham, B.A. and Toledo, D. 2018. *Interpreting indicators of rangeland health, version 5*. Tech Ref 1734-6. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver.
- Ringold, P. L., Alegria, J., Czaplowski, R. L., Mulder, B. S., Tolle, T. og Burnett, K. 1996. Adaptive Monitoring Design for Ecosystem Management. *Ecological Applications*, 6(3): 745-747. doi:<https://doi.org/10.2307/2269479>

- Ross, L.C., Austrheim, G., Asheim, L.J., Bjarnason, G., Feilberg, J., Fosaa, A.M., Hester, A.J., Holand, Ø., Jónsdóttir, I.S., Mortensen, L.E., Mysterud, A., Olsen, E., Skonhøft, A., Speed, J.D.M., Steinheim, G., Thompson, D.B.A. and Thórhallsdóttir, A.G. 2016. Sheep grazing in the North Atlantic region: A long-term perspective on environmental sustainability. *Ambio* 45(5): 551-566.
- Stefánsson, J.H., Þorvaldsdóttir, S., Hauksdóttir, I., Þórarinsdóttir, E.F., Marteinsdóttir, B., and Brink, S.H. 2020. Kortlagning beitarlanda sauðfjár á Íslandi. Soil Conservation Service of Iceland, Iceland.
- Tongway, D. and Hindley N. 1995. *Manual for assessment of soil condition of tropical grasslands*. CSIRO, Australia.