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# FUNCTIONAL SILOS AND OTHER GOVERNANCE CHALLENGES OF RANGELAND MANAGEMENT IN ICELAND

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<sup>26</sup> Keywords

<sup>27</sup> Natural resource management, governance systems analysis, restoration, policy,

<sup>28</sup> commons

<sup>29</sup>

<sup>30</sup>

<sup>31</sup> **Highlights**

<sup>32</sup> □ Free roaming sheep during summer is forms the traditional rangeland grazing system in  
<sup>33</sup> Iceland.

<sup>34</sup> □ Many of the grazed rangelands are in a degraded, even eroded, ecological condition

<sup>35</sup> □ The Public authorities public employees within the rangelands' SES have different  
<sup>36</sup> perceptions on what constitutes as SLM.

<sup>37</sup> □ The vertical and horizontal dimensions of the rangelands' SES are not fully  
<sup>38</sup> functionalintegrated.

<sup>39</sup> The Rangelands, as a SES of, are not surrounding the rangelands' utilization is not  
<sup>40</sup> managed through with adaptive governance (AG).processes

<sup>2</sup>

<sup>1</sup> AG and co-adaptive management is needed to achieve sustainable rangeland utilization.

<sup>2</sup>

**Abstract**

<sup>7</sup>Every Social-ecological system (SES) promoting sustainable management of natural  
<sup>8</sup> resources in common ownership area is controlled steered in a complex governance system  
<sup>9</sup> that includes regulations through laws and policies, and, management d by the

<sup>10</sup> administrative authorities operating across structure of the related multi-level institutional  
<sup>11</sup> structures that, in turn, are governance system and shaped driven by stakeholder interests.

In

12 addition, the long-term progress of natural resource management NRM not only thus  
relies  
13 on upon the existence of a well-structured and functional governance system, but needs  
that  
14 system to that adaptably facilitates sustainable resource management, in line with current  
15 knowledge and best practices and in current knowledge.

16 In this research we mapped the administrative structure that of the governance system that  
steers  
17 the of the SES of rangeland management in Iceland and undertook a critical  
18 analysis of the subjected the governance system's process to a critical analysis of its  
structure  
19 and, functions to and governance approaches to estimate examine if the respective  
agricultural  
20 and environmental policy targets had have facilitated system changes towards  
21 improved sustainable rangeland management practices. A survey, based on a  
questionnaire  
22 distributed to selected public sector employees and sheep farmers, was used to gauge the  
23 participants: a) attitude towards rangeland management practices, b) perception of the  
level of  
24 collaboration and state support for rangeland restoration and c) views on current  
agricultural and  
25 environmental policies on rangeland management.  
26 The results strongly indicate that neither the current administrative structure nor the  
governance  
27 process itself have significantly facilitated the expected attitude changes within the  
agricultural  
28 sector or among local authorities. Furthermore, it has neither facilitated significant attitude  
nor  
29 behavioral changes among sheep farmers aimed at towards sustainable improved  
rangeland  
30 management, in line with current government agricultural and environmental policy  
targets. Our  
31 key findings support previous research that shows the governance system for rangeland  
32 management in Iceland to be structurally limited and suffering from weak vertically and  
33 horizontally integration partially integration dysfunctional. Furthermore, our  
34 findings clearly reveal the need for improved governance for rangeland management and  
the  
35 requirement need for increased levels of knowledge application within the system.

36

### 37 **Introduction**

38 Sustainable land management (SLM) was defined by the UN 1992 Rio Earth Summit as:  
"The  
39 use of land resources, including soils, water, animals and plants, for the production of  
goods to  
40 meet changing human needs, while simultaneously ensuring the long-term productive  
potential  
41 of these resources and the maintenance of their environmental functions". In this paper,  
we use

42 it to define sustainable rangeland management. Well-functioning rangelands provide  
multiple  
43 ecosystem services, such as water purification and storage, and biomass production (see  
Havstad  
et al., 2007). They also and have an important role in climate change mitigation due to their  
2 capacity to sequester and store carbon in their biomass and soils (Lal, 2004; Cook et al.,  
2013).  
3 These ecosystems provide economic and social benefits for local communities that rely on  
4 utilizing rangeland resources for human livelihood (Lund, 2007). However, substantive  
parts of  
5 the world's rangeland systems are degraded and often ecologically dysfunctional due to  
6 unsustainable land use and poor resource management approaches (Marques et al., 2016).  
7 Drawing upon Ostrom (2009), rangelands in communal or joint ownership are among one  
8 of among the many combined human-nature systems that are viewed as social-ecological  
systems  
9 (SES). The SESs outcomes are the result of the interrelationship between the resource  
systems,  
10 the actors that utilize the resources through certain resource units, and the related  
governance  
11 system that controls and manages that utilization.

12 UtilizationAn SES surrounding the utilization of rangelands in communal or collective  
13 ownership, when viewed as an SES, is an interconnected complex, one where the current  
social-  
14 ecological condition or changes within one of the SESs subsystems may affect changes  
within  
15 one of the SES subsystem or the system as a whole, by leveraging positive development or  
16 halting back further progress (McGinnis & Ostrom, 2014). Furthermore, the socio-  
economic  
17 functions within the Furthermore, the outcome is SES of rangeland utilization are driven  
by  
18 complex environmental governance processes (see Berkes, 2006 & 2008). The level of  
19 effectiveness and sustainability that a SES can achieve depends on how successfully these  
20 processes are governed vertically and horizontally (Okpara et al. 2018; Torfing et al.,  
2012),  
21 avoiding the creation of institutional fragmentation and functional silos that might  
otherwise  
22 might reduce optimal organizational functionality of within the SES (Zelli, 2015; Serrat,  
2017).  
23 The governance processes need, for instance, to be adaptive to enable them to  
continuously  
24 facilitate best practices within the SES (Schultz et al., 2015), multilayered and cross-  
scaled to  
25 facilitate allow for experimentation and learning (Dietz et al., 2003; Folke et al., 2005;  
Carlson  
26 & Sandström, 2008), and collaborative to address and build social cohesion and resolve  
potential  
27 conflicts among all the stakeholders involved (Karpouzoglou et al., 2016; Paavola, 2007).  
28 Furthermore, a well-functioning rangeland governance process within a defined SES,  
aiming

29 for sustainable resource utilization, needs to provide knowledge for iterative cycles of learning  
30 based on reflexive examination of the outcomes of earlier decisions (Dale et al., 2013) and  
31 continuously link new knowledge continuously to a comprehensive decision-making process.  
32 That way, the risk of knowledge gaps between sectors or stakeholder groups involved in the  
33 respective rangeland SES is minimized (Bouwen & Taillieu, 2004; Cundill & Fabricius, 2009).  
34 If rangeland exploitation is not governed through consensus towards a long-term sustainability  
35 of the SES in place, contrasting interests of various stakeholder groups may collide and even  
36 drive resource over exploitation (Sayre et al., 2013; Brunson, 2012; Karl et al., 2012).  
37 Various governance approaches for natural resource management, such as rangeland  
38 management, are described in the literature (Lemos & Agrawal, 2006; Scarlett & McKinney  
39 2016). An emerging one approach is adaptive governance, that based on references (Berkes &  
40 Folke, 1998; Gunderson et al., 2015; Folke et al., 2005; Olsson et al., 2006), is and defined by  
41 Hurlbert (2018) as a “...range of political, social, economic, and administrative systems that  
42 develop, manage and distribute a resource in a manner that promotes resilience through  
43 collaborative, flexible, and learning –based issue management across different scales“ (p  
44 25).  
44 Adaptive governance is recognized as an approach that includes all the key characteristics  
1 needed for building a well-functioning rangeland governance process (Karpouzoglou et al.,  
2 2016). In addition, a well-functioning rangeland governance process within a SES, This  
includes  
3 the needs to provide knowledge for collaborative and iterative cycles of learning based on  
4 reflexive examination of the outcomes of earlier decisions (Dale et al., 2013) and  
continuously  
5 linking new knowledge to a comprehensive decision-making process. In this way,  
Reflexive  
6 governance helps address the risk of knowledge gaps between sectors or stakeholder groups  
7 involved in the respective rangeland SES is minimized (Bouwen & Taillieu, 2004; Cundill  
&  
8 Fabricius, 2009). Furthermore, if rangeland exploitation is not governed through consensus,  
9 towards a long-term sustainability of the SES in place, contrasting interests of various  
10 stakeholder groups may collide and even drive resource overexploitation, particularly at a  
place-  
11 based scale (Sayre et al., 2013; Brunson, 2012; Karl et al., 2012).  
12  
13 The SESs of rangeland utilization worldwide are complex and various land use practices,  
other  
14 than livestock grazing, are often deeply interwoven in their utilization (Sayre et al., 2013).  
In  
15 Iceland the main methods of utilization of rangelands is is one of the countries in the  
world

16 where rangeland utilization, mainly for through free roaming sheep grazing, which has  
17 traditionally been is of high socio-cultural and economic social-ecological importance.  
Thus,  
18 although other types of utilization are growing in importance. Thus, the corresponding  
SES is  
19 relatively simple compared to other countries where rangeland management has more  
often  
20 embedded in multilayered SESs with has to address a variety of various utilization  
practices.  
21 Rangeland Hence, The SES surrounding rangeland utilization in Iceland provides an  
22 opportunity to therefore well-suited to research that explores the existing governance  
23 arrangements and processes, including related policy targets, and estimate to an  
examination of  
24 whether these if the structure and functions of its SES are supporting a robust SES in  
rangelands.  
25 the implementation of the current rangeland policy targets.  
26 From around 1990 onwards, the Icelandic government has sought to enhanced the  
sustainable  
27 grazing management of the rangelands, introducing approved several new laws and,  
followed by  
28 regulations to help achieve, aimed at achieving achieved policy targets on improved  
ecological  
29 conditions. Various and enhanced sustainable grazing management of the rangelands.  
Since  
30 1990, Various rangeland management strategies, such as agri-environmental schemes and  
31 programs, have been introduced in support of this policy approach (Crofts, 2011).  
However,  
32 Neither the governance processes nor neither the governance processes nor the outcomes  
of  
33 these interventions have been examined in an integrative systematic manner. The  
34 lack of a comprehensive evaluation provides a unique opportunity to explore the  
institutional  
35 arrangements related to the SES of rangeland grazing management at a national level, and  
to  
36 analyze further what type of the sustainability consequences of the governance approaches  
37 and resource management approaches that are being applied within the system.  
38 In this paper we: i) map the administrative structure of for the governance system of the  
SES of  
39 rangeland management in Iceland; ii) subject the system to a critical analysis of its  
structure,  
40 functions and governance approaches; and iii) estimate if the respective agricultural and  
41 environmental policy targets have facilitated sustainable rangeland management practices,  
42 within this SES estimate how well the governance structure is perceived to operate  
vertically and  
43 horizontally  
1 In particular, the paper explores: a) whether the actors in the governance system are  
encouraging  
2 sheep farmers are being encouraged to apply sustainable rangeland management practices,  
in

3 line with existing policy targets, and by whom; b) the perception of the key administrative actors  
4 within the governance system and of stakeholders (the sheep farmers) towards the current  
5 management practices; and c) if the actors and stakeholders favour within the governance system  
6 are favoring sustainable land management practices, as they are defined in Petursdottir, et al.  
7 (2017) over and above other land management practices.

8

### 9 *Background*

10 Iceland is a parliamentary republic and a representative democracy. Although the country's  
11 population counts amounts to only approximately roughly 350,000 inhabitants, Icelandic  
12 governance arrangements are structured in a relatively hierarchical administrative structure,  
13 comparable to the administrative structure found within other European countries. Due to the  
14 nation's small size, the governance arrangement for natural resources uses involve relatively few  
15 public agencies within each administrative level, and it has smaller stakeholder groups than  
16 found in, compared to more populated countries.  
17 Iceland is around 103,000 km<sup>2</sup>, of which nearly 60% is categorized as highlands (>400  
18 mean sea level). Approximately 40% of Iceland's the total land surface is state owned and over  
19 85% of the highlands is categorized as commons (Óbyggðanefnd, 2019). Sheep farming for  
20 lamb meat production is one of the main agricultural activities in Iceland. The lambs are born in  
21 May and roam; roaming free with the ewe mothers on rangelands during summertime but  
22 are gathered in late August or early September for fall slaughtering. Common grazing rights,  
23 such as the right of most farmers to utilize local communal or collectively owned rangelands for  
24 the free roaming sheep grazing during summertime, and traditions concerning collective sheep  
25 gathering in the autumn thus form the social socio-economic backbone of the current sheep  
26 farming system (Petursdottir et al., 2013; Ross et al., 2015). Although rangeland grazing is of  
27 high socio-cultural, economic importance for sheep farmers (Stefánsson, 2018), research  
28 shows that over 50% of the rangelands' ecosystems are severely degraded and may be  
29 considered as ecologically dysfunctional units, not suitable for their current grazing regime  
30 (Arnalds, 2015; Arnalds & Barkarson, 2003; Arnalds et al., 2001).  
31 Apart from the domestic sheep grazing, close to 1000 domestic horses are grazed on several  
32 commons in Northern Iceland during summertime (Halldórsdóttir, 2015). Other herbivores

33 utilizing the rangeland commons include migrating birds, such as geese and whooper swans, and  
34 around 5000 wild reindeer in reindeers in at the Eastern part of the country (Náttúrustofa  
35 Austurlands, 2019).  
36 Rules concerning grazing management of communal areas in Iceland were already documented  
37 in Grágás, a book of law from the Commonwealth period (930-1262 AD) (Karlsson et al., 1992).  
38 Nevertheless, unsustainable land uses, such as domestic livestock grazing and clear cutting of  
39 woodlands in earlier centuries, combined with harsh climate and fragile volcanic soil, led to  
40 severe soil and vegetation erosion and in many cases to ecosystem collapse (Arnalds et al.,  
41 2001). Soil conservation became an official governmental policy goal in the beginning of the  
42 20th century, when recognition of rangeland degradation led to the first Icelandic *Act on*  
43 *forestation, soil reclamation and defences against desertification* (1907); and the first organized  
44 actions to combat land degradation was launched in the same year (Crofts, 2011). This was later  
1 followed up by the establishment of the Soil Conservation Service of Iceland (SCSI) (Crofts,  
2 2011; Aradóttir Petursdóttir et al., 2013). The Act was revised in 1914, 1941 and 1965.  
3 (Aradóttir et al., 2013).  
4 The Act was the first Icelandic Act stating the importance of preventing soil erosion and  
5 promoting improved land use (Aradóttir et al., 2013). The Act was revised in 1914, 1941  
and in  
6 1965 (Aradóttir et al., 2013). Sustainable rangeland management and ecosystem restoration,  
in  
7 addition to soil erosion, gradually started to gain further policy attention in the early 1960s,  
8 (Aradóttir et al., 2013) but only attained a legal status in December 2018 when the Icelandic  
9 parliament finally approved a new environmental *Act on Land Reclamation* (155/2018).  
This  
10 followed after several attempts over more than two decades to push for its revision over  
more  
11 than two decades (Crofts, 2011).  
12 Although the concept of sustainable rangeland use started to gain attention in the  
13 early 1960s, it was not listed officially listed as a task in an agricultural policy until after  
1990  
14 (Table 1) and was first defined within an agricultural regulation in 2003. The concept has  
not yet  
15 been defined within any environmental legislation but according to the new *Act on Land*  
16 *Reclamation* (155/2018), the Mminister of Environment and Natural Resources has the  
17 authority to follow the Act up and set a new regulation with a new definition  
18 of offor what can be considered as sustainable (range)land use/management in Iceland.  
19  
20 but since then, the Icelandic government has approved several agricultural laws and  
regulations  
21 to direct rangeland governance toward sustainable rangeland management. Parallel, the

22 government supported various programs and projects aimed at increasing local and  
national  
23 awareness on the multiple values of soil conservation and land reclamation, as well as to  
24 facilitate sustainable management of rangelands (e.g. Arnalds, 2005; Crofts, 2011;  
Aradottir et  
25 al., 2013; Petursdottir et al., 2013). These practices have focused particularly on building  
up  
26 cross-sectorial agri-environmental actions intended to strengthen the cooperation between  
all  
27 stakeholders involved in rangeland utilization, to improve rangeland management, and to  
restore  
28 degraded rangelands (Crofts, 2011). The main land improvement programs and projects  
29 established or facilitated in the last decades were, in chronological order: i) Farmers Heal  
the  
30 Land program, ii) Local reclamation NGOs, iii) Quality Management in Sheep Farming  
and iv)  
31 Land Improvement Fund.  
32 i) Farmers Heal the Land program (FHL):  
33 The FHL program was established by the SCSI in 1990 with the aim of increasing  
stakeholders'  
34 involvement in rangeland management. The initial objectives of the FHL program were to  
35 encourage restoration of degraded lowland rangelands and enhance trust and ease  
cooperation  
36 between sheep farmers and relevant authorities, and also to facilitate behavioral changes  
towards  
37 sustainable rangeland management (Arnalds, 1999; 2000). FHL is a governmental cost-  
shared  
38 voluntary program that is operated nationwide by the SCSI, in close collaboration with its  
39 participants (mostly sheep farmers). The program mainly supports restoration activities  
40 performed on privately owned lowland rangelands (Petursdottir et al., 2017). Currently,  
roughly  
41 550 farmers around the country participate in the FHL program (Einarsson, 2018).  
42 ii) Local reclamation NGOs:  
43 The *Act on Land Reclamation* approved in 1965 permitted the establishment of local  
district  
44 reclamation NGOs, although the first NGOs were not established until 1992. Since then,  
14  
7  
1 other local restoration NGOs have been established around Iceland, but according to the  
SCSI,  
2 currently only 12 are active. The main aims of these NGOs are to: a) restore degraded  
communal  
3 rangelands and b) strengthen environmental awareness and increase land literacy within the  
local  
4 communities (Petursdottir et al., 2013). All the NGOs work on a voluntary basis, but work  
in  
5 close cooperation with the SCSI. They receive grants from the SCSI and specific  
restoration  
6 funds to buy fertilizer and seed for their projects (Crofts, 2011).  
789

Table 1. Icelandic agricultural laws, regulations and agreements that mention sustainable rangeland management.

10 Phrases or terms that refer to sustainable land use or grazing management are set in bold type (translations by Th.P.)

*Year/no Title/description Phrase or a term referring to sustainable land use or grazing management*

1993/99 Agricultural Product Act If there is a risk that the activity goes against **preferable land use benchmarks**.

1995/124 Agricultural Product Act Sheep farming/grazing must be in line with **environmental protection**.

1998/70 Farming Act Land improvement should promote **sustainable land use** practices and take into

account international commitments regarding conservation of biodiversity.

2000/88 Agricultural Product Act Quality Managed Sheep (QMS) production is verification for lamb meat, produced in

accordance to with standards on defined production process, health and **environmental protection, land qualities and preferable land use benchmarks**. Sheep farming shall be in line with **environmental protection, land qualities and preferable land use benchmarks**.

2002/101 Agricultural Product Act Land use must be sustainable so that the **production capacity of the land is adequate and land utilization limited to keeping the vegetation cover in equilibrium or improving**, in the opinion of the SCSL.

2003/173 Regulation for Quality

Management in Sheep

Farming (QMS)

Definition for sustainable land use: maintaining **adequate biomass productivity and land utilization within the limits of keeping the vegetation cover in equilibrium or? or in improvement**, in the opinion of the SCSL.

2007/58 Agricultural Product Act Sheep farming is practiced in accordance to with **environmental protection, land**

**qualities and sustainable land use practices**. Quality Managed sheep production is verification for lamb meat, produced in accordance to with certificated standards concerning animal welfare, **sustainable land use practices** and healthy products.

2007 Agreement between the

State and farmers, of the

working condition in

sheep farming

Sheep farming is practiced in accordance to with **environmental protection, land qualities and sustainable land use practices**.

2013/1160 Regulation for Quality

Management in Sheep

Farming (QMS)

Definition for sustainable land use: **The use of land resources, including soils, water, animals and plants that do not deplete terrestrial natural resources, while simultaneously ensuring the long-term productive potential of the ecosystems and the maintenance of their functions**.

2016 Agreement between the

State and farmers, of the

working condition in

sheep farming

To promote the production of lamb meat certified by the QMS verification system, including all involved factors such as animal welfare, healthiness of products and **sustainable land use practices.**

2017/1166 Regulation for Quality

Management in Sheep

Farming (QMS)

Definition for sustainable land use: **The use of land resources, including soils, water, animals and plants that do not deplete terrestrial natural resources, while simultaneously ensuring the long-term productive potential of the ecosystems and the maintenance of their functions.**

11

12 Since 1990, the Icelandic government has approved several agricultural laws and regulations,

13 aiming to direct aimed at rangeland governance toward sustainable rangeland management. In

14 Parallel, the government supported new programs and projects aimed at increasing local  
8

1 and national awareness on the multiple values of soil conservation and land reclamation, as well

2 as to facilitate the sustainable management of rangelands (e.g. Arnalds, 2005; Crofts, 2011;  
3 Aradottir et al., 2013; Petursdottir et al., 2013).

4 The “Farmers Heal the Land” (FHL),, a governmental cost-shared voluntary program,

5 established by the Soil Conservation Service SCSI in 1990, was for instance the first

6 governmental program with a clear aim of increasing stakeholder (mostly sheep farmers )

7 involvement in rangeland management. The initial objectives of the FHL program were to

8 encourage restoration of degraded lowland rangelands, to enhance trust and ease  
cooperation

9 between sheep farmers and relevant authorities, and to facilitate behavioral changes  
towards

10 sustainable rangeland management (Arnalds, 1999; 2000). The program mainly supports

11 restoration activities performed on privately owned lowland rangelands (Petursdottir et al.,

12 2017). Currently, roughly 550 farmers around the country participate in the FHL program

13 (Einarsson, 2018).

14 The main land improvement programs and projects established or facilitated in the last  
decades

15 were, in chronological order: i) Farmers Heal the Land program, ii) Local reclamation  
NGOs,

16 iii) Quality Management in Sheep Farming and iv) Land Improvement Fund.

17 i) Farmers Heal the Land program (FHL):

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20 encourage restoration of degraded lowland rangelands and enhance trust and ease  
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24 participants (mostly sheep farmers). The program mainly supports restoration activities

25 performed on privately owned lowland rangelands (Petursdottir et al., 2017). Currently,  
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26 550 farmers around the country participate in the FHL program (Einarsson, 2018).  
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28 The *Act on Land Reclamation* approved in 1965 permitted the establishment of local  
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29 reclamation NGOs, although the first NGOs were not established until 1992. Since then,  
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30 other local restoration NGOs have been established around Iceland, but according to the  
SCSI,  
31 currently only 12 are active. The main aims of these NGOs are to: a) restore degraded  
communal  
32 rangelands and b) strengthen environmental awareness and increase land literacy within  
the local  
33 communities (Petursdottir et al., 2013). All the NGOs work on a voluntary basis, but work  
in  
34 close cooperation with the SCSI. They receive grants from the SCSI and specific  
restoration  
35 funds to buy fertilizer and seed for their projects (Crofts, 2011).  
36 Late in the 1990s, the Icelandic government took another large step towards  
acknowledging the  
37 need for improved rangeland management by adding the issue as a compulsory pillar to  
the  
38 Quality Management in Sheep Farming (QMS). ) Sscheme. iii) Quality Management in  
Sheep  
39 Farming (QMS):  
40 The QMS is a cross-compliance scheme that was formally introduced by the Ministry for  
41 Industry and Innovation in the Agricultural Commodities Agreement in 2000 and came  
into  
42 force in 2003 with the approval of the Legislation for Quality Management in Sheep  
Farming  
43 (QMS) (Table 1) (Arnalds & Barkarson, 2003). One of the aims of the QMS's aims is to  
secure  
9  
1 sustainable rangeland grazing management. Participation in the scheme is voluntary but  
sheep  
2 farmers that apply and successfully fulfill the QMS requirements of good farming practices  
3 and sustainable land use receive close to 30% higher subsidy payments from the State for  
their  
4 production than non-participating farmers (Karlsson et al., 2015; Þorlákssdóttir, 2015).  
Currently,  
5 approximately 1,750 sheep farmers (Ásbjörnsson, 2015), producing more than 90% of the  
6 annual lamb meat production (Karlsson et al., 2015), participate in the QMS.  
7 The Icelandic Food and Veterinary Authority control the QMS approval process, but the  
SCSI is  
8 responsible for: a) estimating the ecological condition of the rangelands utilized by QMS  
9 applicants/participants and b) verifying if the grazing areas under inspection fulfill the  
criteria  
10 for sustainable land use, as defined in the scheme's regulation. If the observed grazing  
areas do

11 not fulfill the minimum ecological requirements, the respective applicants/participants must  
12 provide and follow a ten-year restoration plan with measureable targets to qualify for  
subsequent  
13 participation in the scheme. Once such restoration plans are validated by the QMS system,  
the  
14 grazing of the respective areas is deemed sustainable and the farmers relying on grazing  
15 them for their meat production receive full QMS subsidy payments (Regulation for  
Quality  
16 Management in Sheep Farming, (QMS), 2013/1160). According to Arnalds et al. (2000)  
there  
17 are 72 rangeland commons or collectively owned rangelands in Iceland but it is not clear  
18 how many of these areas are utilized for sheep grazing within the QMS. Nevertheless, 26  
19 rangeland commons or collectively owned rangelands do not meet the minimum  
ecological  
20 condition requirements of the QMS and need to work in accordance to a ten-year  
restoration  
21 plan (Ásbjörnsson, 2015).  
22 In 2003, the government established the Land Improvement Fund (LIF) as a follow-up  
project to  
23 the QMS scheme, mainly to support farmers who, according to the scheme, need to restore  
some  
24 of their grazing areas to receive the annual QMS subsidy payments iv) Land Improvement  
Fund  
25 (LIF):  
26 The LIF was established in 2003, mainly as a follow-up project to support farmers who,  
27 according to the QMS scheme, need to implement restoration to receive the annual QMS  
subsidy  
28 payments. The fund is financed by the state central government and managed by the SCSI,  
but  
29 the Sheep Farmers Associations also give an annual financial  
30 contribution to the Fund. The main goals of the LIF are to: a) halt soil and vegetation  
erosion  
31 and prevent further land degradation, b) restore degraded ecosystems, in accordance with  
32 potential vegetation conditions and land use requirements, c) facilitate sustainable land use  
and  
33 d) mitigate climate change impacts through increased carbon sequestration in soil and  
vegetation  
34 (Eiríksson et al., 2018). Supported projects entitled to support must meet these goals  
35 and applicants that submit a comprehensive restoration/land use plan have priority for  
funding.  
36 Since its establishment, the LIF has emphasized focused on supporting compulsory QMS  
37 restoration projects, which now comprise over 50% of all allocated grants in 2017  
(Eiríksson et  
38 al., 2018).

39

#### 40 **Data collection and analysis**

41 To understand better the rangeland governance system, we mapped the  
42 system's formal administrative structure with through the use of secondary data sources  
and

43 information from respective appropriate webpages. We then used the results from a pilot study

10

1 investigating rangeland management in Iceland from a social-ecological system's perspective

2 (Petursdottir et al., 2013) to structure questions for an online survey. The online survey was  
3 administrated in the winter 2011-2012, and circulated to public employees identified as  
having an

4 administrative role in rangeland management (Table 2). In total, of 503 people received a  
link to

5 the questionnaire, each receiving. Each of them received an email with a personal e-link  
and

6 password. to the questionnaire. Two weeks later, a short reminder was circulated by email  
to those

7 that had not yet replied, and again after a lapse of three weeks and of four weeks.

Participants from

8 the Agricultural University had shorter time to reply and only received two reminders, as its  
9 postmaster inadvertently blocked the survey email for two weeks until this error was  
discovered.

10 **Table 2.** Hierarchical and structural locations of people within the agri-environmental  
governance system, identified

11 by the authors of this paper to have a role in rangeland management. Those that regularly  
are in "face to face"

12 contact with farmers in their work are considered to have direct interactions with them,  
those that irregularly or even

13 never meet with the farmers are considered to have indirect interactions with them.

***Position Role Interactions with  
farmers***

***Institute/ institution/  
organization***

Parliamentarians Elected members of the Icelandic  
parliament. National policies and laws

N/A National Assembly

Ministry experts Administration and communication to all  
related stakeholder groups and institutes.

Preparing laws and regulations for  
approval and implementation

Indirect Ministry for Environment  
and Natural Resources and

Ministry for Industry and

Innovation (incl. agriculture)

Aldermen (regionals) Elected member of regional authorities.

Local administration and decision making,  
regional policy design and implementation

Indirect Regions, defined by the  
state to highly depend on

sheep farming

University lecturers/professors Research and consultancy in her/his field  
of expertise and providing education in  
agricultural and/or environmental science

to students

Indirect/direct Agricultural University

Agricultural advisors Advising farmers on livestock breeding, livestock husbandry, agronomy and farm accounting

Direct Farmers Association

Icelandic Agricultural Advisory Centre

Agricultural experts/managers Administration and interest monitoring for the agricultural sector

Indirect/direct Farmers' Association

Icelandic Agricultural Advisory Centre

Environmental advisors Advising farmers on rangeland grazing and ecosystem restoration, supervisory of land condition

Direct Soil Conservation Service

Environmental experts/managers Administration, monitoring of land condition, control of land management, diverse research focusing on terrestrial ecosystems

Indirect Soil Conservation Service,

Forest Service, Institute of

Natural History, National parks

Afforestation advisors/park rangers Advising farmers/land owners on forestry, planning and monitoring afforestation projects/ controlling of protected areas

Direct/indirect Forest Service, National parks

14 We also sent the survey to sheep farmers to enable comparison of answers with those from the

15 various positions listed in Table 2. In parallel to the online survey, a hard

16 copy with a pre-paid return envelope was posted to 1261 sheep farmsteads. According to the

17 Icelandic Agricultural Statistic (2010) this represented 87% of all registered sheep farms in

18 Iceland at that the time. The sampling method is described in further detail by Petursdottir et al.

11

1 (2017). Both parts of the survey were posed with permission from the Icelandic data protection

2 authorities.

3 The survey questions were divided in three categories: Category 1 measured the attitude of 4 participants in the survey towards rangeland management; Category 2 measured their perception

5 on of the level of collaboration and state support for rangeland restoration; and Category 3

6 asked about their views on current agricultural and environmental policies on rangeland

7 management and on whom should be involved in designing and implementing policy targets

8 concerning rangeland management and restoration.

9 Each category consisted of two to four main questions, followed by two to six sub-questions; 30

10 questions in total. The participants were asked to express how much they agreed or disagreed

11 with given statements, using a five-step Likert scale (Neuman, 2006).

12 A Wilcoxon-Mann-Whitney, non-parametric test (Townend, 2009), was used to compare all

13 replies divided by sectors. Furthermore, in the cases where the Mann-Whitney test showed a

14 significant difference in response between the environmental and the agricultural sectors, the test

15 was run again based on the profession of the participants (Table 2). A Friedman test was used to

16 assess whether the ranking of the replies across all sectors were identical. The test was

17 performed independently for the replies from each sector.

## 18 **Results**

### 19 *Mapping the governance system's structure*

20 Legislation concerning rangeland management is prepared by the Ministry of Industries and

21 Innovation (MII), the Ministry for the Environment and Natural Resources (MENR) and related

22 governmental institutes, in collaboration with all main stakeholder groups (Fig.1). All new law

23 must be approved by the majority of the parliamentarians at Althing but the respective minister

24 prepares new legislations and is granted power to make more detailed provisions of approved law

25 by setting regulations. Currently, only the MENR runs an administrative office dealing with

26 sustainable land management, including restoration and reforestation, whereas the MII has neither

27 an official internal employee office nor a scientific or an administrative institute agency under its

28 auspice that addresses rangeland management. Professional advice and small scale

29 financial support to sheep farmers concerning rangeland management and restoration (including

30 reforestation) are only provided by the extension service of the SCSI and the IFS (Icelandic Forest

31 Service), both institutes agencies under the auspice of the MENR (Table 2). Thus, the MENR

32 holds the scientific and the professional knowledge for designing and following-up environmental

33 policies and regulations related to rangeland management, while the MII holds the official

34 decision-making capacity and the authority to set agricultural policies and regulations concerning

35 rangeland management through the agricultural subsidy system, including the QMS payments.

36 The state government, the above mentioned ministries and related governmental institutes, such

37 as the Soil Conservation Service (SCSI), are key public institutions involved in policy setting and

38 follow-up processes concerning rangeland management. Other main organizations contributing to

39 the design and implementation of agri-environmental policies concerning rangeland management

40 are the Farmers' Association, local authorities and environmental NGOs (Fig. 1).

12

1

2 Figure 1. The political-administrative structure of the Icelandic governance system related to governing rangelands in

3 Iceland. management.

4 Organizations and institutions that play an active role in the process of designing and implementing agri-

5 environmental policies for rangeland management are denoted in by beige shapes; , but agencies that are less actively

6 involved in the process are denoted in by gray. (NPs1= National Parks; IINH2= Icelandic Institute of Natural History;

7 IFS3= Icelandic Forest Service; SCSI4= Soil Conservation Service of Iceland; AUI5= Agricultural University of

8 Iceland; FA6= Farmers Associations; IAAC7= Icelandic Agricultural Advisory Centre).

9 In line with the prevailing law and regulations, the organizations and institutions that play an active

10 role in the process of designing and implementing agri-environmental policies for rangeland

11 management are shown in beige in Figure 1 but the agencies that are less actively involved in the

12 process are gray (Fig. 1). The dashed line from the Ministry of Industry and Innovation to the

13 Farmers' Association symbolizes an indirect administrative connection, as the FA is a private

14 business interest organization, only partially funded by the state. The dotted line from the

15 Agricultural University to the Soil Conservation Service, to the Farmers' Associations and to the

16 sheep farmers symbolizes the indirect lines of influence between these agencies as they fall under

17 or are linked to the political auspices of different ministers (Fig. 1).

18 There is no cross-sectoral team of policy experts focusing on all social-ecological aspects related

19 to rangeland management in place within the governance system. Furthermore, no formal agri-

20 environmental transdisciplinary platform for knowledge application and decision-making exists

21 (Fig. 1).

13

1 The SCSI plays a key administrative role in implementing rangeland management policies. B but

2 the Farmers Association (FA) also has a role in the implementation phase, both as a

3 business interest organization, advocating for the business interests of their sectoral  
member  
4 organizations, and through the Icelandic Agricultural Advisory Centre (IAAC), a  
5 private corporation owned by the FA (Fig. 1) that runs a nationwide network of agricultural  
6 extension offices. The FA is run and financed by the farmers themselves but also receives  
annual  
7 fixed payments from the State in accordance with agricultural agreements from 2015, with  
part of  
8 that amount allocated to the advisory system of the IAAC.  
9 The Agricultural University of Iceland (AUI) is responsible for the education of the  
majority of  
10 acting sheep farmers and many of the employees of FA, IAAC and the SCSI. The AUI is  
only  
11 loosely linked to the policy process concerning rangeland management as it falls under the  
12 auspice of the MESC (Ministry of Education, Science and Culture) but is without any  
formal  
13 land use policy-making connections to the MII (Fig. 1).  
14 According to the *Act on Rangelands* no.6/1986, decisions on rangeland grazing  
management  
15 practices are in the hands of local authorities. Thus, local authorities are also directly  
embedded  
16 in the governance process as most of the rangelands are in public or mixed ownership,  
under  
17 local custody or collectively owned by two or more landowners. Environmental NGOs  
and other  
18 stakeholder groups, including the general public, participate indirectly in the governance  
process  
19 by, for instance advocating for improved rangeland management and commenting on  
20 governmental plans concerning land use.  
21  
22 *Survey*  
23 In all, 234 of the 503 questionnaires distributed online were returned. Of these, 17 copies  
were not  
24 properly filled out, resulting in a sample of 217. (Table 3). 480 of the 1261 questionnaires  
mailed  
25 to sheep farmers were returned. Of these, 13 copies were not properly completed, giving a  
final  
26 sample of 467.  
27 The number of replies varied among numbers based sectors (Table 3). The answering  
28 rate from parliamentarians, for example, was only 14%.% (Table 3). An additional 14% of  
29 parliamentarians wrote a personal mail to the survey coordinator explaining that they tried  
to reply  
30 to the questionnaire but felt they lacked the knowledge and expertise needed to answer.  
The replies from the sheep farmers were distributed among all quarters of Iceland and varied  
32 from 32% reply rate in the South to 48% in the East. There was no significant difference  
( $P < 0.05$ )  
33 in the rate of response between genders or age groups and the average age bracket was 50-  
60  
34 years.

**35 Table 3. Answering rate to the survey from different institutions and organizations, divided by sectors.**

*Name / Sector Type Level Role Sent*

*surveys*

*Received*

*replies*

*Reply*

*rate*

*(%)*

National assembly /

**Officials**

Parliament National National

policies/laws/

democracy/

cooperation

63 9 14

Ministry for environment and

natural resources (MENR) /

**Officials**

Governmental

department

National

Administration/

legislations

environmental

policies/ international

21 6 29

14

cooperation

Ministry for industries and

innovation (MII) / **Officials**

Governmental

department

National Administration/

legislations

agricultural policies/

international

cooperation

17 4 24

Municipalities/

**Local authorities\***

District

government

Regional Administration/

regional policies

131 57 44

The Agricultural University of

Iceland (AUI) / **Education**

State

university

National  
(MESC\*\*\*)  
Secondary and  
tertiary  
education/research/  
policy inputs  
65 18 28  
The Farmers Association (FA)  
**Agricultural**  
Business  
Interest  
organization  
National  
Administration/policy  
interest monitoring  
50 64 65  
The Icelandic Agricultural Advisory  
Centre (IAAC). **Agricultural**  
Sister company  
of the FA  
National Agricultural advisory 48 ↑ ↑  
The Icelandic Institute of Natural  
History (IINH). **Environment**  
Governmental  
institute  
National  
(MENR)  
Monitoring/research/  
policy inputs  
20 76 70  
National parks (NP)\*\*  
**Environment**  
Governmental  
agencies  
National  
(MENR)  
Control/information/  
policy inputs  
17 ↑ ↑  
The Icelandic Forest Service (IFS)  
**Environment**  
Governmental  
institute  
National  
(MENR)  
Practice/control/advis  
ory/  
research/policy  
inputs  
45

↑ ↑

The Soil Conservation Service of  
Iceland (SCSI). **Environment**

Governmental

institute

National

(MENR)

Practice/control/

advisory/

research/policy

inputs

26

↑ ↑

1 Overall 503 234 47

2 ↑Symbolizes that all the replies from respondents within the agricultural sector were merged to one number; so were all the replies

3 from respondents within the environmental sector

4 \*Local authorities of all regions officially defined as economically depending on sheep farming

5 \*\*All permanent staff of the Vatnajökull, Thingvellir and Snæfellsnes national parks

6 \*\*\*Acronym for the Ministry of Education, Science and Culture

78

*Rangeland management*

9 All sectors (Table 3) strongly supported the position that sheep grazing should be practiced on

10 highland commons that according to scientific research results have sufficient carrying capacity

11 (Table 4). Nevertheless, significantly fewer ( $P < 0.05$ ) respondents from the sectors of

12 agriculture, local authorities and sheep farmers, compared to those from the education and

13 environment sectors, felt that decisions on what land is suitable for grazing should depend on

14 expert advice or supported the statement that highland commons should preferably not be grazed

15 (Table 4).

16 The educational and environmental sectors were significantly more ( $P < 0.05$ ) in favor of limiting

17 the grazing period in the highland commons from mid-June to end of August and were also more

**Commented [31]:** I don't think there is need to cite the table more than once in the paragraph, unless you are citing multiple tables and there is a question which one applies.

15

1 supportive ( $P < 0,05$ ) of the practice of sheep grazing on collective lowland areas, compared to

2 the agricultural sector, local authorities and the sheep farmers (Table 4). Furthermore, the

3 educational and environmental sectors and the officials were significantly less ( $P < 0.05$ )

4 supportive of the current rangeland grazing management system, and of grazing rangelands until

5 it starts to snow in the autumn, or of grazing rangelands in winter, than were the

6 regional authorities? s and the sheep farmers.

78

**Table 4.** Mean rankings (1= strongly disagree – 5= strongly agree) of all agents (by sectors of profession; Table 2)

9 and the sheep farmers' attitude concerning how to manage sheep grazing on highland commons and other

10 rangelands. Education = agents working at the AUI (N = 18), Environment = agents working at the IINH, NPs, IFS

11 and SCSi (N = 76), Officials = parliamentarians and agents working at the MENR and MII (N = 19), Agriculture =

12 agents working at the FA and FAS (N = 64), Regionals = members of the local authorities within regions officially

13 defined to be depending on sheep farming (N = 57) and sheep farmers (N = 467). Mean ranks within rows identified

14 with the same superscript letter were not significantly different ( $P > 0.05$ ).

**Attitude towards rangeland management Education Environment Officials Agriculture Regionals Sheep**

**farmers**

*1) Length of the grazing period at the highland commons:*

a) Never before mid of June 3.9 a 3.8 a 3.4 ab 3.0 b 2.7 c 2.5 c

b) Never longer than till end of August 3.2 a 3.1 a 2.4 b 2.1 b 2.2 bc 1.9 c

*2) Sheep grazing shall be practiced on:*

a) currently grazed areas 2.2 a 2.4 a 2.7 ab 3.1 b 3.8 c 3.9 c

b) highland commons that, according to

research have sufficient carrying capacity 4.1 a 4.1 a 4.2 a 4.2 a 4.3 b 4.1 a

c) collective fenced areas in the lowland 3.7 a 3.7 a 3.8 a 3.0 b 2.7 b 2.7 b

d) fenced, privately owned lowland 4.0 a 3.9 a 3.8 a 3.5 a 3.1 b 2.9 b

e) in areas depending on sheep farming 2.7 a 2.8 a 2.9 ab 2.7 a 3.3 b 3.2 b

*3) It's acceptable to graze rangeland in the lowland:*

a) until it starts to snow in the autumn 2.4 a 2.7 ab 3.2 b 3.2 b 3.5 c 3.3 bc

b) never in winter 3.8 b 3.9 b 3.6 ab 3.3 a 3.0 a 3.2 a

*4) Land considered suitable for sheep*

*grazing:*

a) grassland and well vegetated land 4.6 a 4.4 a 4.1 a 4.5 a 4.3 a 4.5 a

b) depends on experts' advices 4.1 a 4.0 a 4.0 a 3.5 b 3.4 bc 2.9 c

c) poorly vegetated land should not be grazed 3.9 ab 4.3 a 3.8 b 3.8 b 3.8 b 3.6 b

d) highland commons should preferably not

be grazed 2.9 ab 3.1 a 2.7 ab 2.2 b 2.3 b 2.0 b

15

*16 Collaboration*

17 Over 75% of all respondents agreed with the statement that farmers work cooperatively on  
18 restoration projects, that they are not only forced by law and legislation to practice  
restoration

19 and that their work is implemented in good collaboration with the SCSi (Table 5). Over  
60% of

20 all respondents see restoration as a societal responsibility that the state should

21 subsidize, although this was significantly less ( $P < 0.05$ ) favored by the officials,  
compared to

22 the agricultural sector and the sheep farmers. The environmental and the educational sectors and

23 the officials were significantly more ( $P < 0.05$ ) in favor of keeping restoration subsidies low low,

24 than were the other three sectors. were (Table 5).

**Commented [32]:** Unclear meaning:

Is it: that they are NOT forced by law..

Or

That they are forced by law ...

The phrase 'not only' is confusing

16

1 **Table 5.** Mean rankings of all employees (by sectors of profession; Table 2) and the sheep farmers' attitude

2 concerning collaboration and incentives in rangeland restoration (1= strongly disagree – 5= strongly agree).

3 Education = agents working at the AUI (N = 18), Environment = agents working at the IINH, NPs, IFS and SCSI (N

4 = 76), Officials = parliamentarians and officials working at the MENR and MII (N = 19), Agriculture = agents

5 working at the FA and FAS (N = 64), Local authorities = members of the local authorities within regions officially

6 defined to be depending on sheep farming (N = 57) and sheep farmers (N = 467). Mean ranks within rows identified

7 with the same superscript letter were not significantly different ( $P > 0.05$ ).

**Attitude towards collaboration Education Environment Officials Agriculture Local authorities**

**Sheep**

**farmers**

*1) Collaboration in rangeland restoration:*

a) Farmers work cooperatively in restoration

projects 3.9 a 4.2 b 4.1 a 4.3 b 4.2 b 3.9 a

b) Law and legislations force farmers to practice

restoration 2.7 b 2.3 ab 2.4 ab 2.3 ab 2.4 ab 2.2 a

c) Good cooperation between farmers and SCSI 3.7 a 4.2 c 4.3 c 4.0 b 4.1 bc 4.0 b

d) The agri-environmental sectors are jointly

planning restoration projects 3.5 a 3.4 a 3.6 a 3.4 a 3.5 a 3.3 a

*2) Direct incentives for increased restoration:*

a) Restoration is a societal task the state should

subsidize 3.9 ab 4.1 ab 3.7 b 4.2 a 3.9 ab 4.1 ab

b) Restoration subsidies should be low 3.2 b 3.0 b 3.2 b 2.7 a 2.7 a 2.6 a

89

*Governance and policies*

10 All sectors, with the exception of the except the officials (the parliamentarians

11 and ministry officials) strongly supported the argument that rangeland restoration should

be 12 managed at a regional level (Table 6). The environmental and the educational sectors

and the 13 officials were significantly less in favor of the statement that rangeland restoration

should be 14 under the control of the Farmers Association, compared to the other sectors

(Table 6). All

15 sectors strongly supported the argument that the study of rangeland restoration should be part of

16 the compulsory curriculum for all those studying agricultural science, although sheep farmers  
 17 were significantly less ( $P < 0.05$ ) in favor of this view, compared to the environmental sector.  
 18 Close to 50% of all respondents supported the argument that state rangeland restoration policies  
 19 lack focus and clarity of purpose. Additionally, around 40% of the respondents neither agreed  
 20 nor disagreed with the statement (Table 6). Responses to the statements that the FA actively  
 21 participates in designing rangeland restoration policies and that rangeland restoration policies are  
 22 designed in collaboration with farmers/land users were ambivalent. All sectors strongly  
 23 supported the statements that municipalities should actively participate in designing restoration  
 24 policies, and that agricultural and environmental institutes should follow a joint policy for  
 25 restoration and sheep grazing, although in both cases the sheep farmers were significantly less  
 26 supportive than were the environmental sector. (Table 6).  
 27  
 28 **Table 6.** Mean rankings of all employees (by sectors of profession; Table 2) and the sheep farmers' attitude towards  
 29 governance and policies concerning rangeland restoration and management (1= strongly disagree – 5= strongly  
 30 agree). Education = agents working at the AUI (N = 18), Environment = agents working at the IINH, NPs, IFS and  
 31 SCSi (N = 76), Officials = parliamentarians and officials within the MENR and MII (N = 19), Agriculture = agents  
 32 working at the FA and FAS (N = 64), Local authorities = members of the local authorities within regions officially  
 33 defined to be depending on sheep farming (N = 57) and sheep farmers (N = 467). Mean ranks within rows identified  
 34 with the same superscript letter were not significantly different ( $P > 0.05$ ).

17

**Attitude towards governance and policies** Education Environment Officials Agriculture  
**Local authorities**  
**Sheep farmers**

*1) Rangeland restoration:*

- a) Should be managed at a regional level 4.1 ab 4.4 a 3.2 c 4.2 a 4.1 ab 3.9 b
- b) Should be under the custody of the SCSi\* 3.2 a 3.5 a 3.5 a 3.6 a 3.3 a 3.5 a
- c) Should be under the custody of the FA\* 2.6 a 2.7 a 2.5 a 3.1 b 3.3 b 3.3 b
- d) Should be part of the compulsory curriculum for all studying agricultural science 4.3 a 4.5 a 4.1 ab 4.1 ab 3.9 bc 3.7 c

*2) Rangeland restoration policies:*

- a) Governmental policies are focused and clear 2.5 a 2.3 a 2.7 a 2.5 a 2.6 a 2.5 a
- b) The FA actively participate in designing governmental rangeland restoration policies 3.1 ab 2.6 a 3.1 ab 2.8 a 3.2 b 3.1 ab
- c) The government design rangeland restoration

policies in collaboration with farmers/land users 3.3 a 3.1 a 3.8 b 3.3 a 3.3 a 3.2 a

d) The ministries for agriculture and environment should jointly form governmental restoration policies

4.2 bc 4.4 c 4.2 bc 3.9 b 3.9 b 3.6 a

e) Municipalities should actively participate in designing governmental restoration policies 4.2 bc 4.3 c 4.2 bc 4.1 b 3.9 ab 3.8 a

f) Agricultural and environmental institutes should follow a joint policy for restoration and sheep grazing

4.1 bc 4.3 c 4.2 bc 3.8 b 4.0 b 3.5 a

12

18

## 1 Discussion

2 This research mapped the political-administrative structure of the governance system for  
3 rangeland management in Iceland. It and assessed through a national survey if the  
governance

4 process within the system was likely to enhance sustainable improved rangeland  
management

5 practices among sheep farmers, in line with current agri-environmental policy. Based on the  
6 results, we also estimated how well the governance structure is perceived to  
7 operate vertically and horizontally. The findings introduced in this paper are based on  
replies

8 from 38% of all Icelandic sheep farmers (480 replies) that were member of the Sheep  
farming

9 association at the time the research was conducted and 47% of all public/partially public  
10 employees (234 replies) identified to have as having a direct or indirect administrative role  
11 within the governance system of rangeland management..

12 The survey revealed substantial difference in what the different sectors considered to be  
good

13 rangeland management practices (Table 4). The public administrators, (officials), the  
environmental and the educational sectors have, for instance,

15 recognized the importance of sustainable rangeland management strategies to a greater  
extent

16 more than does the agricultural sector and local authorities. The latter two sectors, along  
with the

17 sheep farmers, favored the traditional rangeland utilization practices as described earlier in  
this

18 paper, while the replies from the environmental and the educational sectors were more in  
line

19 with contemporary understandings for of what practices should be considered as  
sustainable

20 rangeland management in Iceland, as described in Petursdottir et al. (2017).

21 These results are in line with several other recent Icelandic research findings indicating  
that also

22 indicating that the QMS scheme and above mentioned interventions might not be  
23 facilitating long-term system transition towards sustainable rangeland management as  
intended.

24 Petursdottir et al. (2013; 2017), for instance, found that for instance that even though  
sheep

25 farmers shared positive attitudes among sheep farmers toward restoration and were even their  
26 actively participation in rangeland restoration projects, (governmental ones or on their  
27 voluntary projects own), this did not influence their rangeland management practices in  
28 practice. Furthermore, and that lack of cooperation between the agricultural and  
environmental  
29 sectors might be preventing the desired policy development. Furthermore, Berglund et al.  
(2013)  
30 stated that participatory practices were weak in rangeland restoration projects, with respect  
to the  
31 role of stakeholders in policy development. Similarly, Þorláksdóttir (2015) found that  
farmers in  
32 North East Iceland participating in the QMS for rangeland management felt that they are  
not  
33 given an active voice within the system, claiming that the scheme is too “top down”, that  
there is  
34 limited consensus between different actors in relation to priorities and methods, and that  
the  
35 objectives of sustainable land use and restoration are unclear. Finally, according to the  
findings  
36 of Stefánsson (2018) a selection of governmental employees working on within the  
governance  
37 system of rangeland management find the QMS to be lacking functionality, eventually not  
38 achieving the target of halting unsustainable rangeland utilization.  
39 All these findings can be linked to the limitations on how the characteristics concept of  
40 sustainable land management/land use has been defined and disseminated by the  
agricultural  
41 sector within the governance system of the SES of rangeland management.  
42 A thorough ecological understanding, derived from both scientific and traditional  
ecological  
43 knowledge, is claimed to be a fundamental pillar for sustaining an effective adaptive  
governance  
44 system of an SES (Folke, 2006; Bark et al., 2012). One of the initial aims of the QMS  
scheme  
45 was to build up ecological understanding and facilitate behavioral changes among sheep  
farmers  
19  
1 towards more sustainable rangeland management by setting a legal framework to clarify  
what  
2 can be considered as sustainable rangeland use (Arnalds, 2019). Nevertheless, since 2003,  
the  
3 term sustainable land management (SLM) has officially been defined by the agricultural  
sector  
4 and appeared in agricultural regulations as a short, well-defined scientific term (Table x)),  
rather  
5 than instead of being regarded more as a framework, one that incorporates the various  
6 dimensions of including the various aspects behind sustainability; such as productivity,  
security,  
7 protection, viability and acceptability (FAO skilgreiningin). This narrow approach has been

8 highly criticized by environmental scientists and the SCSI, pointing out that the current  
9 SLM  
10 definition leaves out fundamental ecological principles, such as the current ecosystem  
11 condition  
12 and thus, is incapable of clarifying what can be considered unsustainable land  
13 management  
14 (Arnalds, 2019).  
15 Berglund et al. (2013) stated that participatory practices were weak in rangeland  
16 restoration  
17 projects, with respect to the role of stakeholders in policy development. Similarly,  
18 Þorlákssdóttir  
19 (2015) found that farmers in North East Iceland participating in the QMS for rangeland  
20 management felt that they are not given an active voice within the system, claiming that  
21 the  
22 scheme is too “top down”, that there is limited consensus between different actors in  
23 relation to  
24 priorities and methods, and the objectives of sustainable land use and restoration are  
25 unclear.  
26 Finally, according to the findings of Stefánsson (2018) a selection of governmental  
27 employees  
28 working within the governance system of rangeland management find the QMS to be  
29 lacking  
30 functionality, eventually not achieving the target of halting unsustainable rangeland  
31 utilization.  
32 A thorough ecological understanding derived from both scientific and traditional  
33 ecological  
34 knowledge is claimed to be a fundamental pillar for sustaining an effective adaptive  
35 governance  
36 system of an SES (Folke, 2006; Bark et al., 2012). We detected different understanding of  
37 what  
38 sustainable rangeland management implies between the sheep farmers and the regional  
39 and  
40 agricultural sectors on one hand and the environmental and the educational sectors on the  
41 other  
42 hand (Table 4), indicating a knowledge gap between these sectors. It might be related to  
43 the  
44 previously detected weak emphasis of programs, such as QMS, FHL and LIF, on detailing  
45 what  
46 sustainability actually implies (Þorlákssdóttir, 2015; Berglund et al. 2013; Petursdottir et  
47 al.,  
48 2017).  
49 Furthermore, the Agricultural University is the only educational institute in Iceland that  
50 offers a  
51 university degree in agricultural science and sustainable land management. Thus, its  
52 academic  
53 role in the transfer of scientific knowledge concerning sustainable rangeland management  
54 and  
55 restoration to all studying agricultural science is of high importance. Although the  
56 majority of all

34 participants in our survey agreed that rangeland restoration should be part of the compulsory curriculum for students studying agricultural science (Table 6), this is not presently the case. Although rangeland management and restoration courses are taught at the AUI, the university's course catalogue shows they are optional for students pursuing agricultural science; potentially leaving a scientific gap in knowledge transfer, for instance to new agricultural experts and advisors, and in some cases also to new farmers. Dale et al. (2013) stated argue that institutions tend to build their own culture that, in many cases, creates functional silos and institutional fragmentation within the wider system. Different perceptions of sustainable rangeland management detected in replies from the environmental and educational sectors, on one side, and the agricultural, regionals and the farmers, on the other side (Table 4), strongly indicates the existence of institutional fragmentation (e.g. Zelli, 2015) between the sectors. Our results also strongly indicate that the administrative changes within the 20 system, such as the establishment of the FHL project in 1990 and the QMSQLMS programme in 2003, as well as the transfer of auspice competencies over environmental and academic institutes agencies between ministries, have not enhanced understanding of the ecological knowledge capacity understanding of on what sustainable rangeland management implies involves among related stakeholder groups, in particularly within the agricultural sector (Table 4). Instead, they might have even deepened the previously detected functional silos between the ministries in charge of environmental and those charged with dealing with agricultural issues, as well as between related institutes and organizations (Stefánsson, 2018; Petursdottir et al., 2013). Furthermore, the QMS scheme was intended to have positive impact on the governance structure by, for instance setting the frame for improved rangeland management, based on a "Declaration of Intent" made by major stakeholder groups in the year 2000 (Arnalds, 2019). The first regulation on the QMS, initiated in 2003, drew upon the Declaration. The regulation was revised in 2008 and again in 2013 where considerable changes were made on the QMS scheme concerning the land use factor. According to a recent paper, all these regulations were too lenient, not taking into account the existing ecological knowledge on the rangeland systems (Arnalds, 2019). Furthermore, the SCSI—, that was responsible for verifying the criteria for acceptable land use within the QMS scheme— officially objected to the content of

19 the draft of the 2013 regulation. The agency, for instance, stated that the regulation needed  
to  
20 include more stringent rules regarding what could be considered as sustainable land use,  
but its  
21 concerns were not taken into consideration by the agricultural minister (Arnalds, 2019).  
The  
22 regulation was revised again in 2015 by the agricultural minister and, despite of strong  
23 objections by the SCSi, the conditions for sheep farmers to achieve subsidy payments for  
their  
24 production were extended at the cost of the conditionin trade-off with the conditions  
related to  
25 the status of the rangeland ecosystems (Arnalds, 2019).  
26  
27 Effective governance systems aimed at the promotion of sustainable improved rangeland  
28 management requires a well-defined organizational structures alongside an  
institutionalized  
29 system for inter- and intra- organizational collaboration and for public/private partnerships  
(e.g.  
30 Provan & Kenis, 2008). Our results indicate that, although more than 75% of all  
respondents  
31 positively value share the perception that while stakeholders work on rangeland  
restoration  
32 projects that work in close collaboration with the SCSi (Table 5), the knowledge  
application  
33 within the SES related to sustainable rangeland management and rangeland restoration, is  
34 fragmented, and not fully supporting the knowledge transfer needed, across sectors and  
35 institutions. Furthermore, knowledge on how to analyze the ecological condition status of  
36 rangelands in accordance with robust scientific methods seems to be mainly accumulating  
within  
37 the environmental and the educational sectors of the system (Table 4). Although the  
current  
38 rangeland management and restoration programs and projects, listed earlier in this paper,  
were  
39 designed to gradually increase cross-sectoral collaboration and horizontal and vertical  
40 knowledge transfer within the SES (e.g. Arnalds, 2005; Aradóttir & Halldórsson, 2012),  
they are  
41 not co-managed in ways that would support such cross-sectoral engagement. As such, and  
our  
42 results indicate that they have not significantly strengthened the governance process in  
support  
43 of policy and knowledge integration (Table 6).  
44 Increased institutional capacity concerning to deal with conflict resolution, as well as  
improving  
45 the stakeholders' ability to participate in knowledge generation and in the decision-making  
21  
1 process are seen as key instruments into facilitating the transformation towards  
2 adaptive governance (Brunner et al., 2005; Bark et al., 2012; Chaffin et al., 2014). Our  
results  
3 indicate that the decision-making capacity for rangeland management was low (Table 4 and  
6).

4 For instance, more than half of respondents claimed rangeland restoration policies were  
5 unfocused and unclear in their intent. Furthermore, the content of current policies seemed  
6 were  
7 deemed to be improperly poorly disseminated, within the SES as with around 40% of all  
8 participants in the survey were not sure how to reply to questions related to rangeland's  
9 restoration policies and the majority of the respondents them were not sure who participates  
10 in the policy making process (Table 6).  
11 The officials (i.e. the parliamentarians and ministry officials) were shown to perceive  
12 rangeland  
13 management and restoration activities through a different lens than the other sectors.  
14 Compared  
15 to the other sectors, they were significantly more in favor of the view that rangeland  
16 administration should be undertaken at the national rather than regional level, and of the  
17 view  
18 that the government design rangeland restoration policies in collaboration with farmers  
19 and other  
20 land users. Nevertheless, there was strong support for increased cross-sectoral  
21 collaboration  
22 between ministries and other administrative sections for the design and implementation of  
23 rangeland management policies and for including studies on rangeland management and  
24 restoration in the compulsory curriculum for all pupils studying agricultural science (Table  
25 6).  
26 The findings of Petursdottir et al. (2013) based on interviews of five key stakeholders and  
27 ten  
28 sheep farmers, indicated that the Icelandic SES of rangeland management focusing on  
29 restoration was not fully operational, most likely due to lack of institutional strength  
30 capacity  
31 and internal coherence. Petursdottir et al. (2013) also stated found that key that  
32 necessary institutional key institutional norms, arrangement, such as cooperation and  
33 transparency within the Icelandic SES of rangeland management, were limited weak, with  
34 and  
35 the existence of functional silos within the system was reducing the vertical and horizontal  
36 knowledge transfer within the governance process. The findings introduced in this paper  
37 are  
38 based on replies from 38% of all Icelandic sheep farmers (480 replies) that were member  
39 of the  
40 Sheep farming association at the time the research was conducted and 47% of all  
41 public/partially  
42 public employees (234 replies) identified to have a direct or indirect administrative role  
43 within  
44 the governance system of rangeland management. The findings of this current research  
45 detected  
46 fragmented institutional arrangements, functional silos and limited cross-sectoral  
47 knowledge  
48 management transfer within the rangeland management system, revealed in this research,  
49 which  
50 support are supporting the findings of Petursdottir et al. (2013). They also further  
51 emphasize,  
52 emphasizeing further the need for a comprehensive governance transformation, toward for

35 instance adaptive governance, to achieve sustainable rangeland utilization within the SES  
of  
36 rangeland management and –restoration in Iceland.

37

### 38 **Conclusion**

39 Our results strongly indicate that the current administrative structure hasn't significantly  
has not

40 facilitated either the expected attitude changes within the agricultural sector or among  
local

41 authorities nor behavioral changes among sheep farmers towards improved sustainable  
rangeland

42 management, in line with current agricultural and environmental policy targets.

Furthermore,

43 they support previous findings that the governance system for rangeland management in  
Iceland

44 is structurally limited and partially dysfunctional. This negatively affects the potential of  
the

45 administrative potential of the system to implement and sustain the practices of  
sustainable

22

1 rangeland management among sheep farmers and other land users. The loose complex and  
2 highly fragmented structure of the agricultural administration, as the map of political and  
3 administrative structure of the governance system shows, the exclusion of the MENR and  
its

4 agencies from the policy process, and the lack of direct access of the farmers'

5 business interest organizations (FA) to the policy and decision -making process within the  
MII

6 concerning rangeland management need in particular to be addressed. considered carefully  
in this 7 context addressed. In addition, attention needs to be paid to the detected knowledge  
gaps related 8 to ecological knowledge transfer and use for and sustainable improved land  
management 9 practices. between the various public/partially public employee groups that  
answered our survey. 10 Furthermore, we point to the limitations arising from the lack of ano  
formal platform for 11 participatory forms of rangeland governance exists, leaving few  
opportunities for more active 12 participation and information sharing between and within the  
stakeholder groups, and between 13 them and the administrative districts and other  
institutions operating within the system of

14 rangeland governance.

15 Our results strongly indicate that, although the administration of rangeland structure  
within

16 the SES of rangeland management has changed gradually improved in the last 30 years,  
the

17 system's institutional settings and governance practices have not adopted adaptive  
governance

18 approaches (AG), despite their obvious advantages advantages their processes.

19 Our findings clearly reveal the need for improved governance for rangeland management  
and

20 the need for increased level of knowledge application within the system. Furthermore, no

21 formal platform for participatory forms of rangeland governance exists, leaving few

22 opportunities for more active participation and information sharing between and within the

23 stakeholder groups, and between them and the administrative districts and other  
institutions  
24 operating within the system of rangeland governance  
25 To secure sustainable sheep grazing on rangelands, the related SES should be governed in  
an  
26 adaptive way (AG) and managed toward improving and maintaining ecosystem services  
and  
27 functions prior traditions and socio-economic interests. We thus conclude that the entire  
28 governance structure surrounding the system needs to be reformed to overcome  
institutional  
29 barriers within partly dysfunctional SESs, such as the one investigated in this research. We  
30 propose a three step transformation phase in such a reform, where the first step should be  
the  
31 establishment of a professional trans-disciplinary platform for decision making in the field  
of  
32 rangeland management. The platform should be responsible for creating a comprehensive agri-  
33 environmental policy based on an ecosystem approach and approved and accepted by  
majority  
34 of all public sectors and other involved stakeholder groups. The second step should be to  
35 actively increase cross-sectoral knowledge transfer within the system, including through  
local  
36 involvement in all its decision-making processes. The third step should be to encourage  
system  
37 transform towards adaptive governance and in parallel apply co-adaptive management  
38 approaches with build-in regular evaluation of both the governance process and its  
outcomes.

39

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43

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