System report: Reindeer Husbandry in Central Sweden

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Contents

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1 Context

The AGFORWARD research project (January 2014-December 2017), funded by the European Commission, is promoting agroforestry practices in Europe that will advance sustainable rural development (Burgess et al. 2015). The project has four objectives:

1. to understand the context and extent of agroforestry in Europe,
2. to identify, develop and field-test innovations (through participatory research) to improve the benefits and viability of agroforestry systems in Europe,
3. to evaluate innovative agroforestry designs and practices at a field-, farm- and landscape scale, and
4. to promote the wider adoption of appropriate agroforestry systems in Europe through policy development and dissemination.

This report contributes to Objective 2 by forming part of Deliverable 2.4: "Detailed system description of case study agroforestry systems". The detailed system description includes the key inputs, flows, and outputs of the key ecosystem services of the studied system. It covers the agroecology of the site (climate, soil), the components (tree species, crop system, livestock, management system) and key ecosystem services (provisioning, regulating and cultural). The data included in this report will also inform the modelling activities which help to address Objective 3.

2 Background

Reindeer (*Rangifer tarandus tarandus*) husbandry systems based on forest understorey resources in Finland, Norway and Sweden has been estimated to extend to 41.4 million ha (Jernsletten and Klokov 2002). In Sweden, reindeer husbandry is managed alongside forestry and in the area of the Sami village of Njaarke since the late 19th century. The Sami villages have the legal right to use private and governmentally owned forest land in northern Sweden for grazing. The Sami settlement is older that the late 19th century, but the Sami's relations to the land around their settlements have changed, due to the migration of other groups into the area. The coexistence between forestry and reindeer husbandry is currently regulated by Rennäringslagen (SFS 1993) and the Swedish Forestry Act (Skogsstyrelsen 2012). The former acknowledges the rights of the Sami village to the use of the land and the latter stresses that consultation with concerned residents from the Sami village is obligatory for owners of forest estates larger than 500 ha. In the areas where reindeer are allowed to be kept all year round, clear cuttings and road constructions should be planned in consultations with the local stakeholders. The Sami village is responsible for their management of the land.

In Sweden there are 51 Sami villages and in each village there are normally several reindeer herding companies. In these villages there are about 5,000 reindeer owners, of which 85% live in Norrbotten County in the most northern part of Sweden. About 2,500 people in Sweden have their main income from reindeer husbandry. Reindeer husbandry still plays a major role in the Sami culture having a great symbolic value. To be a reindeer herder is a hard profession and it is a way of life. It is usually a man who works full time at the company. Family members help when needed, for example during the herd separation and collection before slaughter.

The costs for reindeer husbandry are not easy to assess since it is a traditional economy. The incomes from meat is however possible to estimate. According to the statistics for 2013/2014 the number of reindeer slaughtered were 54,400 and with a total meat weight of 1.45 million kg. The

average income from meat per kilogram was 52.84 SEK/kg. Other income consists of hunting and fishing and tourist activities. There is also insurance paid for reindeer killed by predators and traffic. But, this is generally believed not to cover the losses. These losses will also disrupt the structural balance of the herd in terms of the numbers of cows, steers and calves.

Reindeer husbandry of today is primarily focused on meat production. For this purpose the Sami villages uses approximately 24 million hectares, which represents about 50% of Sweden's total land area. The reindeer herd is kept in mountain areas when calving in spring and grazing during summer and autumn. In late autumn the herd is gathered before slaughter where after they walk or are transported to the forest land for winter grazing (Table 1). The number of reindeer in the winter herds varies during the year between 225,000 and 280,000 depending on season. Reindeer herding is dependent on large grazing areas because the reindeer moves to specific areas. The herd moves between grazing areas using certain ancient hiking trails when walking or sometimes by road vehicles. During certain times of the year, before marking, slaughter and transport to the winter grazing areas, reindeer herds are concentrated. During the transport and/or walking between areas it is important to be able to pass barriers and obstacles such as rivers, roads or railways and have areas of land with possibilities of grazing.

During winter the grazing in the forest land are dependent of certain characteristics of the forest. These are open mature stands that enable sight, protection from wind and snow and access to food, as both terrestrial lichens (e.g. *Cladonia* and *Cetraria* species) and arboreal lichens such as *Bryoria fuscescens* and *Alectoria sarmentosa*). Canopy coverage varies with the grazing site. The reindeers move between areas with different stem density depending on their need for protection, rest or food.

The forest management in the area is dominated by a clear cutting system with a rotation period of 100-130 years. The forest management after clear cut is characterized by planting/seeding or natural regeneration with succeeding pre-commercial thinning. Normally, two thinning are made before the final cut. At final cutting standards are left on site to support natural regeneration. Forestry gives net revenues to the society and reindeer herding is locally important for the wellbeing of the Sami. As earlier mentioned the income from reindeer meat alone in Sweden is higher than 75 million SEK. The popularity of reindeer meat is increasing and therefore one can expect an increase also in the income from the meat. The use of GPS collars on the reindeer to make tracking of the herd easier and the utilization of newly developed reindeer plans will be important factors for new initiatives. It will increase the possibilities for fruitful discussions and negotiations between forestry personnel and Sami when silviculture and harvesting measures such as e.g. cuttings, road buildings, and fertilization are planned. The value of these new technologies will also be used in discussions when other land use matters such as building of wind turbines, and mining permits are considered.

Within the study area the combination of reindeer husbandry and forestry provides provisioning services such as food (game and reindeer meat, fish, and berries) and raw materials for saw mills, the pulp and paper industry, and bioenergy. Cultural services include the craftsmanship associated with the use of hides and horns from the reindeer and wood from the forests. Most of this craftsmanship is sold through the Sami's own organization, Sámi Duodji. Forestry in the area is also

valuable for the sequestration of carbon in the growing stock and is thus an important factor in climate regulation.

3 Update on site and reindeer herd specific data

The collection and designing of data collection protocol began in November 2014 and the collection of reindeer data, including hunting and other commercial activities, is currently under way in cooperation with Njaarke same village. Modelling of forest operations data and costs is possible through the use of generic and site specific data, and the aid of partial models. Site specific data about forest and soils is based on Swedish National Forest Inventory data (NFI) (Fridman et al. 2014) and Swedish Forest Soil Inventory (Markinfo 2015).

4 Description of the case study

The study is conducted in the area of Njaarke Same Village (Table 1). The reindeer herd consist of about 2000 animals during winter but the Sami village at Njaarke is legally allowed to have almost 3000 reindeer (Berg et al. 2014).

Table 1. General description of the agroforestry system

General description of system	
Study area	504,500 ha in total including 281,000 ha of productive forest where annual production is greater than 1 m³ ha^{-1}. The forest land is owned by the state (6%), private forest companies (41%), individual private forest owners (52 %) and others (1%).
Co-ordinates:	The Sami village is located at 63.5°N, 14.2°E
Soil type Soil depth Soil texture Soil pH	The area is dominated by podzols Normally deep soils Sand: 40%; Silt: 48%; Clay: 3% 4 – 5.3
Tree species Growing stock Tree density	Norway spruce (50% of growing stock), Scots pine (33%), Birch (12%), Lodgepole pine (2%), other broadleaves (2%), Aspen (1%) 134 m³ ha^{-1} 2500 stems per ha on average in all forests age-classes and 1580 stems per ha forest older than 100 years (Trees > 1.3 m height.)
Vegetation Coverage Other details	Herbs (49% coverage), bilberry (24%), lingonberry and crowberry (13%), grass (12%), sedge and horsetail (1%) Canopy coverage varies with site and degree of grazing Low percentage of lichens < 1 %
Mean temperature Mean annual precipitation Weather station	2.5°C (1961-1990) 543 mm (1961-1990) Frösön (63.1°N; 14.3°E) (Swedish Meteorological and Hydrological Institute)
Livestock characteristics Stocking density	The herd consists of 2000 reindeer in winter, dominated by cows. Density varies during the year depending on season
Habitat services and biodiversity Cultural services	Adaptation to reindeer husbandry promotes increased carbon storage in trees. Reindeer husbandry is a strong cultural tradition in this part of Sweden. Hunting and fishing services are offered by Sami Village.

Photograph of system

Figure 1. Marking of calves

Map of system

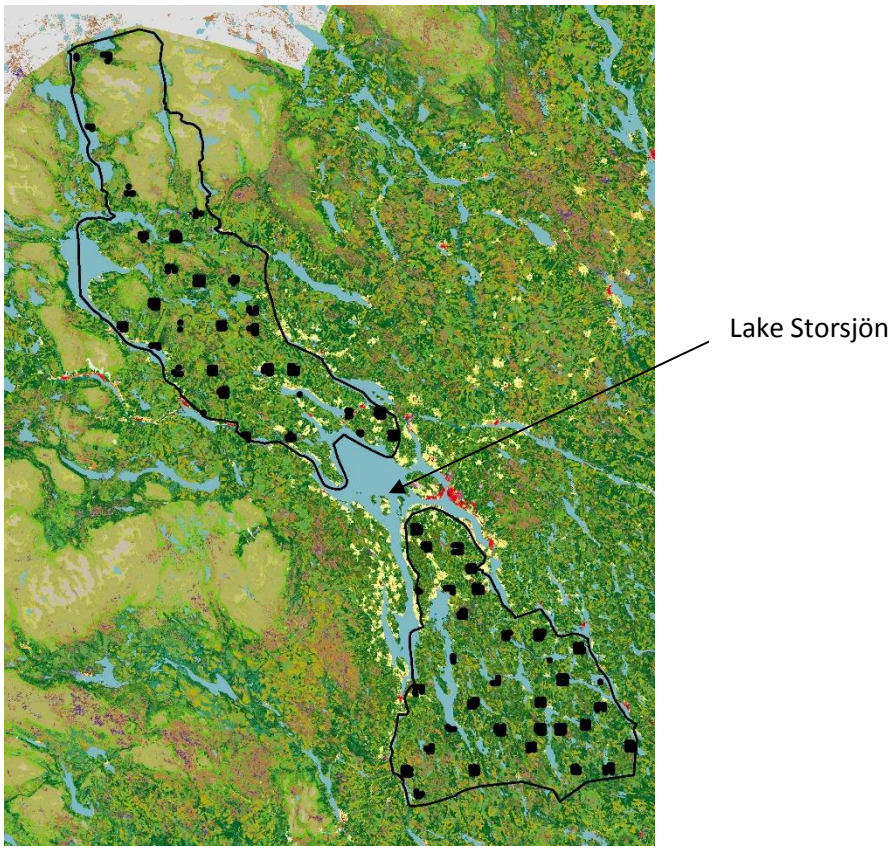

Figure 2. Map of system of the experimental site (black dots indicates NFI sample plots)

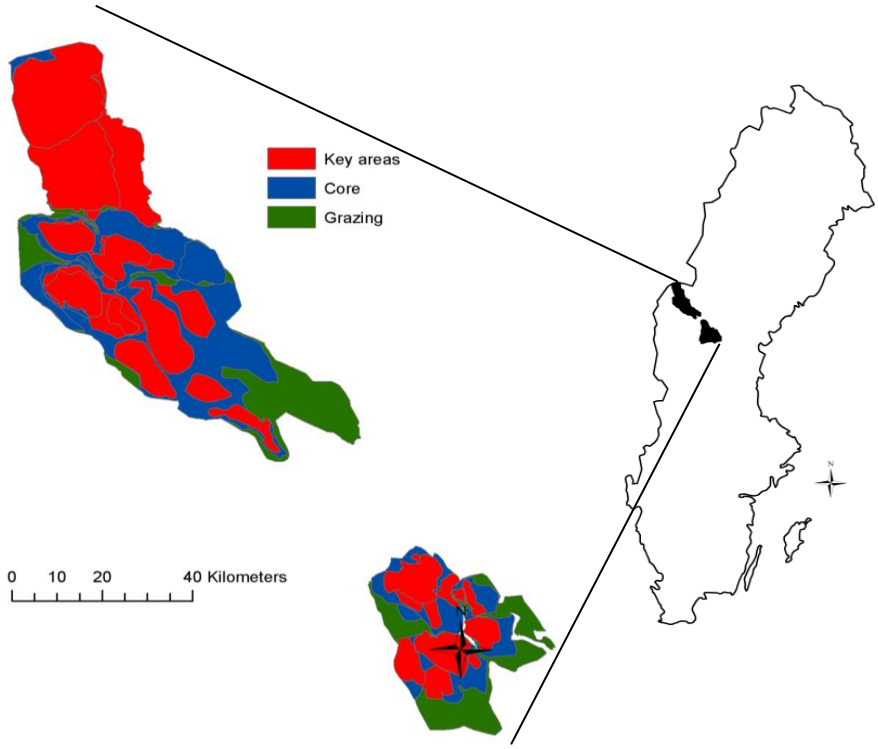

Figure 3. Map of case study area with classification of areas based on reindeer husbandry plan

Table 2. Description of scenarios

Scenarios	
Comparison	Forestry with today´s forest management (Reference scenario); Forestry with adapted management to reindeer husbandry (Reindeer 1); Forestry with adapted management to reindeer husbandry with GPS collars (Reindeer 2)
Forest management – Reference scenario	
Regeneration phase	Soil scarification, planting or artificial seeding, natural regeneration
Young phase	Cleaning
Thinning phase	Thinning and one fertilisation with 150 kg N ha^{-1} in part of the area
Clear-cutting phase	Clear-cut
Forest management – Reindeer scenario 1 and 2 (adaptions compared to Reference scenario)(Samiid Riikkasearvi 2010; Sametinget 2015)	
Regeneration phase	Less soil scarification, no planting of Lodgepole pine (*Pinus contorta*)
Young phase	Cleaning to lower stem density
Thinning phase	Earlier and stronger thinning, no fertilisation
Clear-cutting phase	Longer rotation periods in areas important for grazing by reindeer
Machinery and labour management	
Forestry Reindeer husbandry	Mechanised soil scarification, fertilization, thinning and clear-cut using forwarder and harvesters. Motor-manual cleaning and manual planting. 2-wheel and 4-wheel all-terrain vehicles, snowmobiles, and cars
Forestry Reindeer husbandry	Entrepreneurs and forestry personnel Njaarke Sami families and rented services (transportation with lorries and collection with helicopter)
Fencing	Reindeer husbandry: fencing for collection of reindeer herd in connection to marking, transport and slaughtering.

Table 3. Livestock management

Species and breed	Reindeer (*Rangifer tarandus tarandus*)
Description of livestock system	The reindeer cows typically give birth to one calve per cow in the early spring. In early spring the herd migrates from winter grazing areas in forested land. Calving then takes place near the mountains west of the lake Storsjön (see Figure 2). Around midsummer the herd are collected and the calves are marked with their owner's mark. During summer and autumn the herd is grazing in the mountains in order to gain strength and weight. Before transport or walking to winter grazing in the eastern area of the Sami village, there will be slaughtering mainly of calves, but also some cows and steers.
Period of grazing	Grass and natural herbs: all year when feasible Lichens: predominantly winter; artificial feeding: if needed in winter
Stocking density	Varies during seasons depending on avaliablility of fodder and predators
Animal health and welfare issues	The herd will be monitored during the whole year by Sami family members. Monitoring made without and with GPS collars (Reindeer 1 and 2, respectively). The need of labour input is especially important during transport, slaughtering, collection, marking and when predators are present.
Supplementary feed	Hay or hay pellets will be given to the herd in winter if circumstances call for it.
Date of entry to site	The reindeers are moving between grazing lands inside the area of the Sami village

5 Plans for continuation

Value chains based on scenarios (Reference, Reindeer 1, and Reindeer 2) for forestry and reindeer husbandry will be modelled in accordance to Berg et al. (2016). Results of the scenarios calculated with the software Heureka RegWise designed for long-term analysis of large geographical areas (Wikström et al. 2011). RegWise is a forestry decision support system developed by the Swedish Agricultural University SLU (http://www.slu.se/sha) which simulates the forest development and output of goods and services in periods of five years for the period 2015 to 2035. The results for each scenario will initialise the material flows for the forest chains to the Tool for Sustainability Impact Assessment (ToSIA) (Lindner et al. 2012). The forest chain ends at the mill gate. For the reindeer chains the herd in spring before calving initialise the material flow. The reindeer chain ends at slaughter.

6 Sustainability indicators

The prioritized sustainability indicators listed in in Table 4 will be calculated by ToSIA (Berg et al. 2016).

Table 4. List of sustainability indicators

Type of indicator	Indicator (type)	Indicator Unit	Process unit
Economic	Gross Value Added	€	m^3ub or kg meat
	Production costs	€	m^3ub or kg meat
Social	Full time employment	Number of full time working persons	1000 m^3ub or kg meat
	Fatal accidents	Number of accidents	1000 m^3ub or kg meat
Environmental	Greenhouse gas	kg CO_2eq	m^3ub or kg meat

7 Acknowledgements

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