^{137}Cs in the food-chain of lamb in the Faroe Islands. Measurements in the period 1990-2000.

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Introduction

The paper presents results from measuring ^{137}Cs in soil, grass and lamb meat in nine uncultivated pastures in the Faroe Islands for the years 1990-2000. Effective ecological halflives and transfer factors are presented. Chemical characteristics of the soil have earlier been considered in connection with the observations (Joensen, 1999). Results for 1990-93 have been presented in a Nordic context by Hove *et al.* (1994). The study is part of the BOK 2.1 programme (Important Nordic food chains) of NKS.

The Faroe Islands is a mountainous rocky country consisting of 18 islands at 62^{o}N and 7^{o}W. The total land surface area is about 1400 km^2. Because of the Gulf Stream, the climate of the Faroes is milder throughout the year than the position of 62^{o}N would normally permit. Based on measurements at synoptic weather stations, the yearly average air temperature is around 6-7 ^{o}C, with average winter and summer air temperatures around 3-4 ^{o}C and 9-10 ^{o}C, respectively (Lysgaard, 1969; Cappelen & Laursen, 1998). There are only minor temperature differences between different parts of the archipelago, but significant geographical variation is observed in precipitation rates because of combined effects from wind and topography. There are no woods in the Faroe Islands, but plenty of grass. About 94% of the land is reserved for grazing of around 70000 sheep and some cattle.

Material and Methods

Sampling

Soil, grass and lamb meat have been collected from nine uncultivated pastures across the country in the period 1990-2000 (Fig. 1). Funningur was, however, only included the first four years, and Hvalba and Sumba were not included in 2000. The first soil sampling in Hvalba took place in 1991, i.e. one year later than other pastures. Soil and grass were sampled in July-August from four randomly chosen square 0.25m^2 microplots in each pasture. The grass was cut from each microplot before taking three soil cores with 5.7cm diameter and length 10cm. Lamb meat (neck muscle) was collected in October from typically 5 lambs in each pasture except from Funningur, where no meat sample has been taken. The lamb carcass weight was around 12-13kg. Lamb faeces were collected in the years 1995-99, from fresh manure on the pasture ground, and measured as one sample per pasture each year.

Analyses

Grass samples from the microplots were dried at 105^{o}C and ground before measured separately. Soil samples were dried at room temperature before measurement. The meat samples were kept frozen, thawed and measured separately. All measurements were carried out with a lied shielded Ge detector, and the software Omnigam from EG&G Ortec was used for the spectrum analyses.

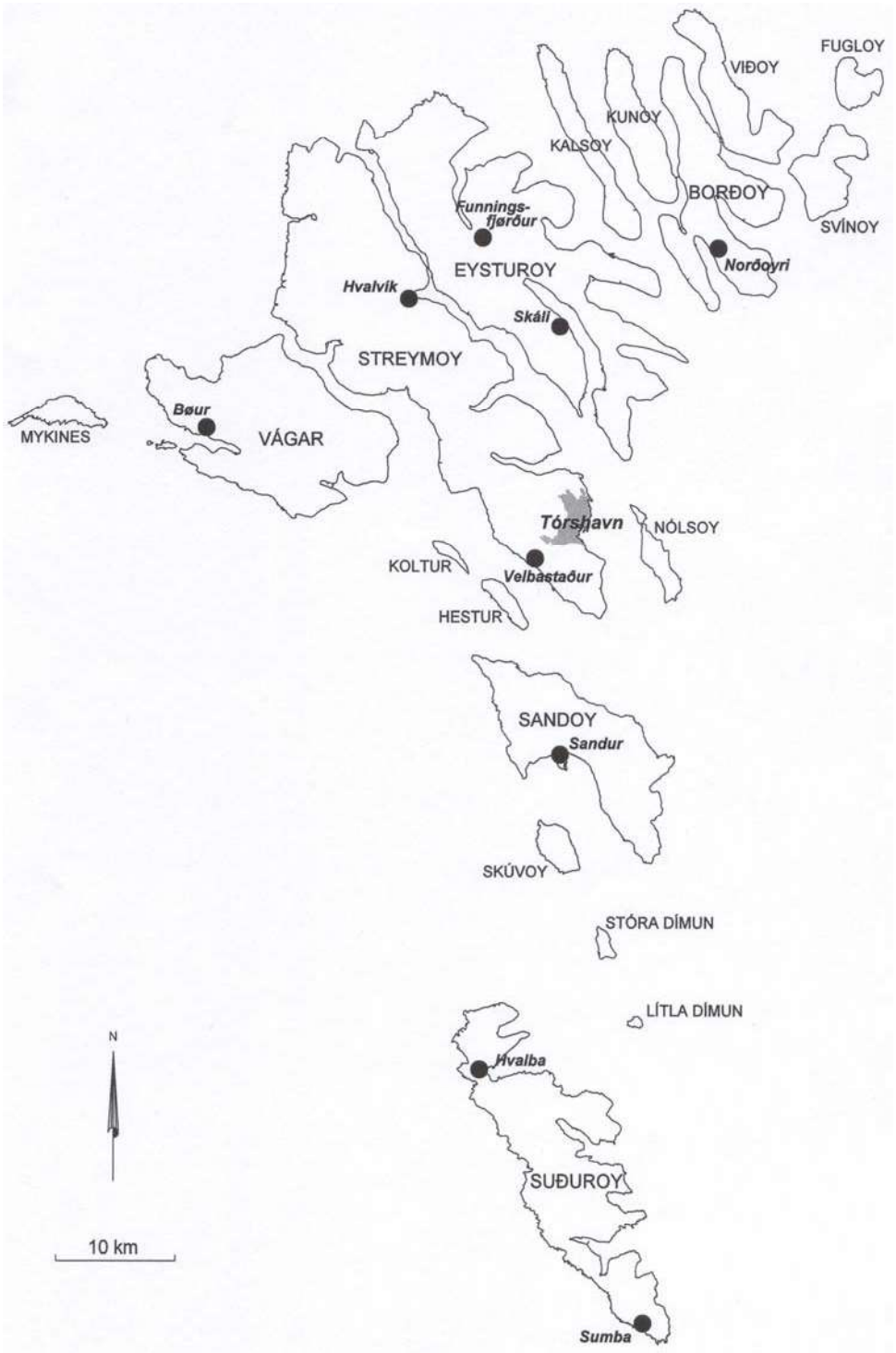

Figure 1. Map of the Faroe Islands showing the locations of the pastures selected for the study.

Results and Discussion

The ^{137}Cs deposition in the uppermost 10cm soil layer is presented in Fig. 2, showing large temporal and spatial variation within and between pastures. An exponential decay model was only acceptable for Hvalvík and Bøur, where the effective ecological half-lives, $T_{1/2}$, (VAMP, 1992), were estimated to 9.9 years (R^2= 0.63) and 11.6 years (R^2= 0.40), respectively. R^2 was below 0.30 for other pastures. If the deposition value for Bøur in 1990 is considered an outlier, we get $T_{1/2}$= 11.6 years for Bøur (R^2=0.40). 50-80% of the deposition in the top 10 cm soil layer is found to be in the uppermost 5 cm. The ^{137}Cs deposition, averaged across the pastures, decreased from 5.8 kBq/m^2 in 1990 to 5.1 kBq/m^2 in 1999 (all pastures were not included in 2000).

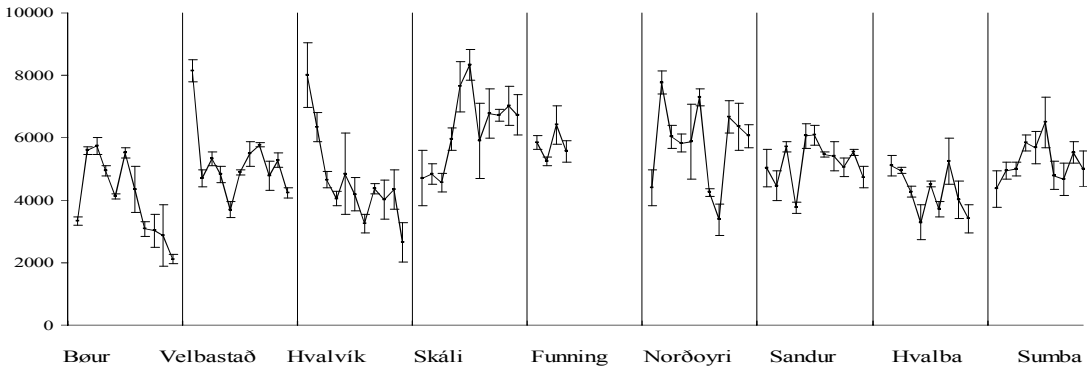

Figure 2. ^{137}Cs (Bq/m^2) in 0-10cm soil layer 1990-2000. Yearly averages ± 1 std. error. Hvalba and Sumba end in 1999.

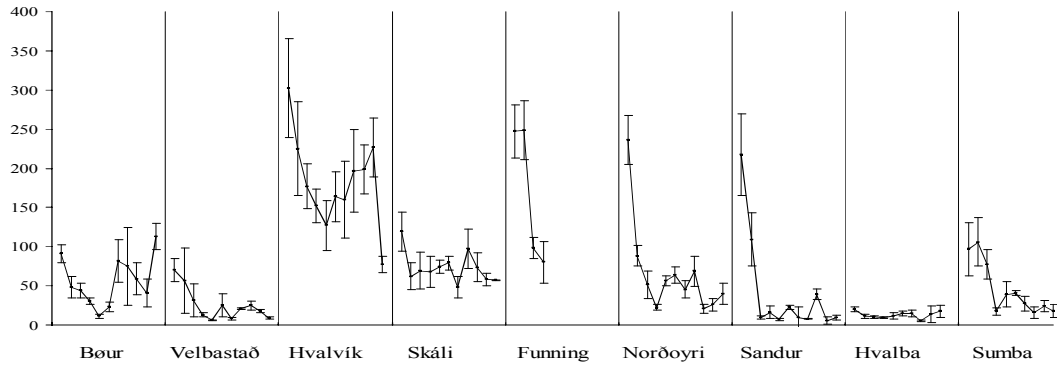

Figure 3. ^{137}Cs (Bq/kg dw) in mixed grass 1990-2000. Yearly averages ± 1 std. error. Hvalba and Sumba end in 1999.

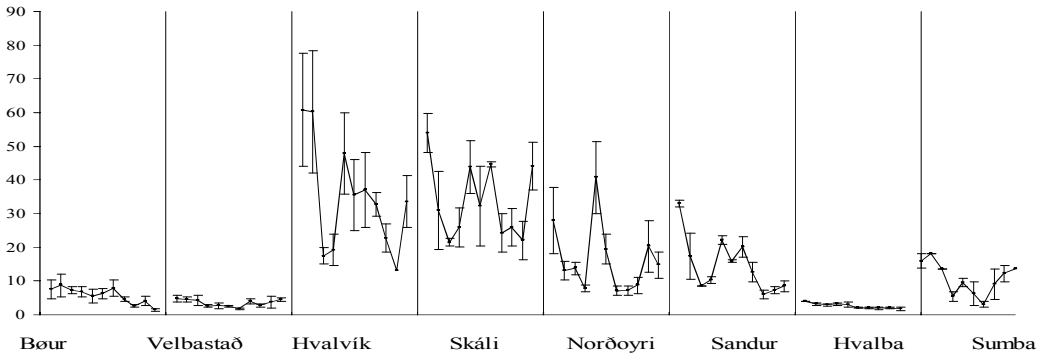

Figure 4. ^{137}Cs (Bq/kg ww) in lamb meat 1990-2000. Yearly averages ± 1 std. error. Hvalba and Sumba end in 1999.

The pH in the soil was between 4.4 and 5.3, and loss on ignition was 50-70% (Joensen, 1999), both reflecting conditions for high uptake of radiocaesium.

The ^{137}Cs concentration in mixed grass (i.e. undetermined botanical composition) is observed to decrease in most pastures, with highest concentration in Hvalvík and lowest concentration in Hvalba (Fig. 3). Estimated effective ecological half-lives are presented in Table 1. The average ^{137}Cs concentration across the pastures was 155 Bq/kg(dw) in 1990 and 51 Bq/kg(dw) in 1999 (all pastures were not included in 2000).

The ^{137}Cs concentration in lamb meat 1990-99 is presented in Fig. 4. Large standard errors express large variations between animals. An effective ecological half-life could be estimated in four pastures (Table 1). The average concentration across the pastures was 26.0 Bq/kg(ww) in 1990 and 10.4 Bq/kg(ww) in 1999 (all pastures were not included in 2000).

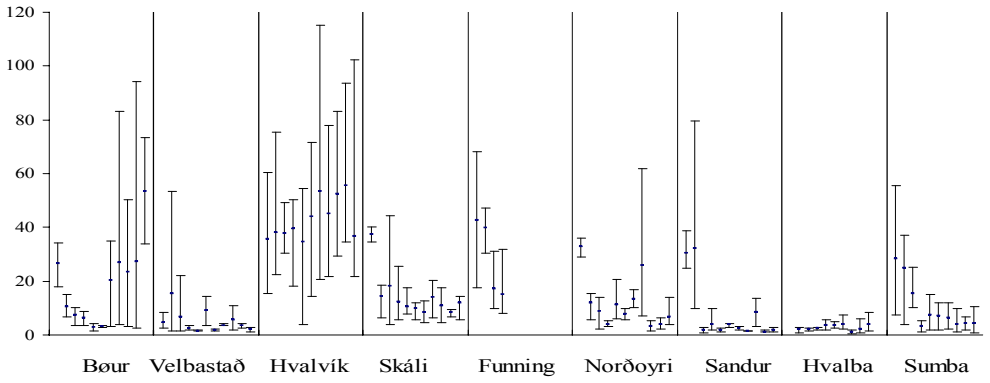

Figure 5. Soil-to-grass transfer factor of ^{137}Cs 1990-2000 (10^{-3} m^2/kg dw). Yearly averages and ranges 1990-2000.

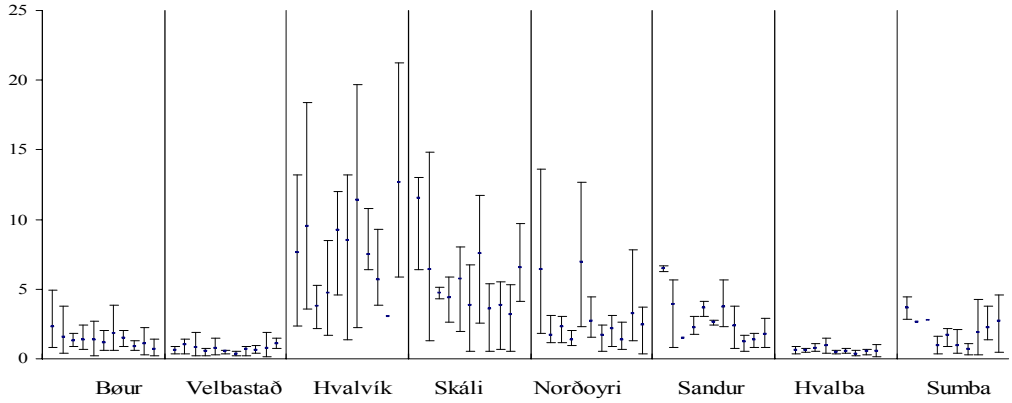

Figure 6. Soil-to-meat aggregated transfer factor of ^{137}Cs (10^{-3} m^2/kg ww). Yearly averages and ranges 1990-2000.

Table 1. Effective ecological halflife in years, based on 11 year time series (1990-2000). Numbers in brackets represent R^2 from a linear regression between time and natural logarithm of ^{137}Cs concentration in the samples. No estimates if R^2<0.3.

	Bøur	Velbastað	Hvalvík	Skáli	Norðoyri	Sandur	Hvalba	Sumba
Grass	- (0.027)	5.3 (0.306)	- (0.235)	- (0.167)	5.3 (0.93)	3.1 (0.379)	- (0.005)	3.6 (0.667)
Meat	5.1 (0.668)	- (0.033)	- (0.199)	- (0.031)	- (0.060)	6.9 (0.392)	8.0 (0.873)	- (0.069)