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- Climate Change and Land Degradation in Iceland -

by

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INTRODUCTION

Our previous desertification research does not confirm the concept of desertification as a mainly man made phenomenon but stress the importance of climate variability and change (Helldén 1991). Iceland was selected for further studies of the issue (Helldén and Ólafsdóttir 1999).

OVERVIEW OF THE ENVIRONMENT

The climate of the north and the highlands (> 600 m.a.s.l.) of Iceland is alpine/arctic. The remaining lowlands are temperate and humid. Annual rainfall averages 400 mm in the NE and 4000 mm in the SE.

The barren soils are infertile glacial and glacio-fluvial deposits. The vegetation covered soils are commonly loessial eolian-andic, 0.3-2 m thick, highly erodible.

25% is vegetated. Grassland, heathland and dwarf shrubland characterize the lowland. Forests cover <1%. Desert patches are frequent, varying in size from a few to several thousand m². The highlands comprises huge arctic gravel/sand deserts similar to the desert like glacial outwash plains.

LAND DEGRADATION

44% of Iceland is suffering serious degradation. Small and medium sized desert patches (< 3 ha) are often located close to hill summits/ridges. Many of them grow along the hill crests forming elongated patches with a secondary water erosion driven expansion in a perpendicular direction, i.e. downhill.

The summit locations are wind exposed and the least snow covered, i.e. the least insulated during winter and spring, exposing them to intense freeze-thaw processes. The process cracks the vegetation carpet. Pockets of soil are exposed for erosion and desert initiation.

CLIMATE CHANGE

Bergþórsson (1967) reconstructed annual temperature back to the time of the settlement (874-930, annual mean temperature 4.4°C). The climate was appreciably colder during the following Little Ice Age (1200-1920). The estimated annual mean temperature was 3.2°C around 1300. It raised to 4.2°C after 1920 (1930-1960 average). Climate data indicate strong negative annual rainfall and temperature anomalies during the cold spells of the second half of 1800.

VEGETATION CHANGE

Pollen studies indicate that $\frac{3}{4}$ of the country was vegetation covered during the climatic optimum of the Holocene, 3000-4000 years ago. The vegetation declined due to a changing climate 2500 years ago. Following the human settlement there is another significant change in the vegetation pattern.

A temperature dependent growth model demonstrated that 60% of 48 examined Icelandic lowland climate stations had the potential to grow birch during the normal period 1931-1960. Only 4% of the same stations had that potential during the cold period 1859-1868. The 0.9°C difference between the two periods indicates the importance of climate for the vegetation cover status.

POPULATION AND LAND USE CHANGE

The Book of Settlement, written about 200 years after the supposed date of the settlement of the Vikings in 874, mentions the existence of 540 farms. The population numbered 50 358 in 1703. It reached 100 000 in 1925 and 270 000 in 1997.

Livestock raising, mainly cattle and sheep, is the basis of the domestic economy since the settlement. The introduction of a colder climate during the Little Ice Age affected the grazing and hay production conditions. A 1°C decrease in annual mean temperature yields a 10-20% decrease in carrying capacity of the rangelands according to an empirical regression model used in Iceland.

Barley was grown in Iceland during the first centuries of the settlement. It diminished during the next centuries and was eventually abandoned at the end of the 16th century because of the changing climate

FARMER CONCEPT

114 farmers returned our questionnaire concerning desertification. Some farmers have no opinion about the age of the desert patches. Many believe that most patches were initiated during the second half of the last century. Still many believe the patches originated before the settlement.

Most farmers have not noted any negative change during the past 50-100 years. The deserts have not grown. The vegetation cover has possibly improved.

There is a common opinion that the origin and the speed of the expansion of the desert patches is weather dependent. The process is discontinuous and related to dry winters and isolated early spring SW storms. Summit locations of the hills are favored because they are often free from snow cover. Many believe the winter grazing tradition played an important role in the degradation process. Desertification is not considered a significant problem.

CONCLUSION

Scientific and political societies in Iceland relate the land degradation to human over use of the rangelands, starting with the introduction of cattle and sheep raising at the time of the settlement in 874. Overgrazing and overuse of the forests for fuelwood and charcoal production are the most important processes opening and exposing the landscape for soil erosion and desertification.

Most farmers believe that the desert patches and deserts are natural phenomena. The initiation and expansion of the phenomena are related to infrequent climatic events, possibly enhanced by the winter grazing custom, no longer practiced.

Our observations underline the importance of climate as a driving force for the development of vegetation cover, land degradation and desertification. The Little Ice Age offered favorable conditions for vegetation cover degradation, frost initiated soil exposure, erosion and desert creation.

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