Mire stratigraphy and peat resources in Latvia

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Summary

At the present time there are more than 6,800 peatlands in Latvia, which cover approximately 10.7% of its territory. The first records on peat extraction in Latvia are from the early 18th century. Peat extraction and utilisation for industrial purposes in Latvia, as in the other Baltic States, started at the beginning of the 20th century; however, large areas of untouched peatlands have remained. It is very important to have reasonable peatland management to avoid the Western European experience, where nearly all peatlands have vanished due to intensive peat extraction for fuel and for horticultural purposes.

Mire stratigraphy has been used for estimation of peat age, calculation of accumulation rate, and understanding of mire formation and development conditions. It helps also to find differences of accumulation rate and resource values between raised bogs and fens. The use of peat resources is considered to be sustainable if the rate of excavation does not exceed the rate of peat growth. Therefore, the main challenge is achieving a sustainable use of peat resources by maintaining the balance between peat cutting, natural growth, peat recultivation and nature protection.

Key index words: Peatlands, peat extraction, Holocene, stratigraphy

Introduction

Approximately 10% of Latvia is covered by peatlands and mires, which include about 6,800 peatlands consisting of raised bogs, fens and transitional bogs formed during the Holocene. There are 1.5 billion tons of peat in the Latvian peatlands, which make up ~0.4% of the global peat resources. Latvia ranks 8th in the world in terms of volume of peat resources per capita. More than 500 peatlands can be used for peat extraction. These contain commercial peat reserves of more than 330 million tons (assuming moisture content of 40%). This includes about 50 million tons in areas prepared for peat extraction, which are 3-4% of all peatlands (Snore, 2004).

Peatlands have been formed under different geological and paleoecological conditions, and preserve a physical record of their history in the form of their 'peat archives'. Mire stratigraphy can reveal a great deal about the conditions resulting in the formation of peat and changes in peat properties. Archaeological and palaeoecological data demonstrate that peat has been used already by ancient man, but extraction and utilisation for industrial purposes in Latvia, as in the other the Baltic States, started at the beginning of the 20th century. Currently existing mire complexes are complicated dynamic systems, growing intensively both in the vertical and horizontal directions, and exerting considerable effect on the dynamics of landscapes. However, during the last hundred years, the development of some mires has been significantly influenced or stopped by drainage and peat cutting.

Peat resources and extraction trends

The first records on peat extraction in Latvia date from the early 18th century. The first publications about peat extraction and utilisation were issued in 1797. Before the First World War peat was extracted in 324 peatlands, including fuel peat that was manually cut in 143 bogs. Peat was mechanically extracted in 48 peatlands. Peat for farming was extracted in 179 peatlands. Intensive peat extraction and peatland research commenced after the establishment of the independent Republic of Latvia in 1918. After the Second World War peat extraction and peatland research continued and new peat enterprises were established. Production of milled peat and peat briquettes was started. The maximum amount of extracted peat was reached during the 1960s. Since then until the early 1990s the annual output gradually decreased. About 6% of Latvia's peat resources have already been utilised (Snore, 2004).

The peat reserve intended for use for heating in Latvia amounts to 230.4 million tons (~ 15% of all reserves) or 663 million MWh of energy and includes 39.3 million tons in areas already prepared for peat extraction. Currently most of the areas prepared for peat extraction, with estimated reserves amounting to about 29.3 million tons or 75%, are not used. If annual peat extraction reaches 730,000 tonnes, then, beginning in 2020, the supply of peat will be sufficient for 300 years according to the Latvian National Energy program.

The status of Latvian peatlands is as follow:

a) 20 % of all peatland areas are protected by the State.
b) 3.5 % of the total peatland area is envisaged for peat production.
c) Almost 70% of peatlands in Latvia are in a relatively pristine state.
d) Cutover peatlands comprise about 17,000 ha in Latvia.

The Latvian extractable reserves consist of about 330 million tonnes. This figure excludes not only currently protected areas, but also those which will be protected in the near future, as well as the amount of peat that could remain after excavation. In Latvia the extractable peat resources are calculated starting from a depth of 1.3m (Kalnina, 2000).

Materials and methods

Mire stratigraphy has been used for the estimation of peat age, the calculation of accumulation rate, and the understanding of different peat layer formation and decomposition. It also helps to find differences in accumulation rates and resource values formed during different climatic periods. Standard methods accepted for mire stratigraphy (Berglund, 1986), peat botanical composition and decomposition degree, pollen analyses, and ^{14}C dates have been used.

Mire development and stratigraphy

Latvian mires date from as long ago as the very Late Glacial period and the beginning of the Holocene. These mires originated by paludification or filling-in of shallow basins. There are strictly defined processes of paludification and peat accumulation. Excessive moisture and climate conditions favour the development of mires. The degree of paludification in certain landscapes ranges from 0.1% to 40%. Maximum degree of paludification is related to the lowlands with gently undulating relief, the Quaternary cover of which consists of tillbeds. Lowlands with glaciolimnic and lacustrine cover are considerably paludified, from 10-15% on the coast of the Gulf of Riga to 30-40% in the Lubans Plain (Lacis and Kalnina, 1996). The degree of paludification in different parts of Latvia shows that the main factors promoting this process are relief and the lithological composition of surface deposits, which determine the intensity of surface discharge. The maximum degree of paludification is related to lowlands, but there are some exceptions (Kalnina and Pakalne, 2003; Pakalne and Kalnina, 2005).

One third of all mires in Latvia have been formed as a result of the filling-in of shallow basins. These basins, mainly the remnants of glacial lakes and glaciokarst depressions, became filled-in during the Preboreal and the Boreal periods, but former lagoons of the Littorina Sea were filled-in at the end of the Atlantic periodor the first half of the Sub-boreal (Kalnina, 2007). At the beginning of the Preboreal, around 10,300 years ago, when the climate became milder, conditions in the depressions around lakes became favourable for gyttja and fen type peat accumulation. Sedge (*Carex*), *Hypnum* and wood grass peat were formed in many mire depressions during the Preboreal (Figs.1, 2).

A number of the largest mires originated as a result of mineral ground paludification under conditions of Boreal climate around 9,000 years ago. Some of these (for example Teici Mire, Fig.2) gradually turned from fens to transitional mires, and the first layers of raised bog peat started to form. The mire vegetation gradually changed from the prevailing eutrophic to mesotrophic plant species.

At the beginning of the Atlantic period 7,400 years ago, the climate became warm and humid. The volume of biomass increased in mire depressions, and thick peat layers formed. This was caused by plants in the central areas of the mires not being able to reach groundwater and vegetation subsisting only on precipitation. In these central parts of the ombrotrophic raised bog, vegetation developed more rapidly, forming raised bog peat represented mainly by cotton grass (*Eriophorum*), *Sphagnum* and wood remains.

During the Sub-boreal period (4,800 years ago) climate became dryer and mean yearly temperatures decreased. During this period raised bog phytocenoses were basically formed by sphagnum and cotton-grass, the decay of which produced thick layers of various types of sphagnum peat with cotton grass (*Eriophorum*) or *Scheuchzeria*.

During the Subatlantic period (2,800 years ago) the climate became cooler and more humid. This period is characterised by very intensive formation of low decomposed sphagnum peat in the largest mires (Fig.1).

Formation of peat resources

The accumulation of peat had already started in the Preboreal period but during the Boreal it was a result of extensive mire formation in Latvia. The oldest fens had already appeared in the lower areas of Latgale and eastern Vidzeme in the Preboreal. According to peat botanical composition, as well as palynological and ^{14}C data, it is found that in the raised bogs the largest thicknesses are characteristic of *Sphagnum* peat, which was formed during the Subatlantic period (Fig.1). The mean annual values of the *Sphagnum* peat layer thickness formed during the Subatlantic reach 1.12 mm, but for some bogs it is even three times higher. In many cases it can be explained by the very low decomposition degree (3-5%). For the Atlantic and Sub-boreal periods, the peat layer accumulation rate was 0.61 -0.65 mm annually; however, for layers formed during the Atlantic period it can be higher, because they have been compressed by the weight of the upper layers. The highest degree of *Sphagnum* peat decomposition (28%) is estimated for peat accumulated in the Sub-boreal period under comparatively dry climate conditions.

Conclusions

- The oldest peat layers formed during the Preboreal are represented by well decomposed fen type peat. These are not widely distributed, have a comparatively small thickness and are not an important peat resource.

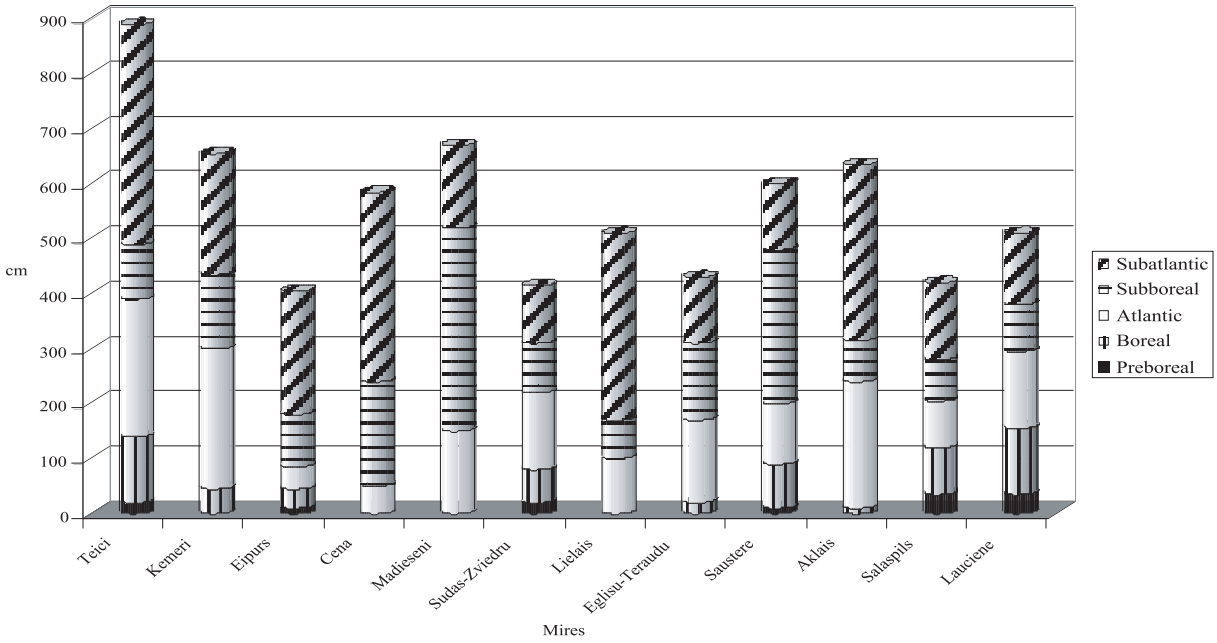

Figure 1. Thickness of peat layers in raised bogs formed during different climatic periods

Period	Index	Teici Mire	Kemeri Mire	Eipurs Mire	Cena Mire
Subatlantic	SA3	*Sphagnum fuscum* (raised bog)	*Sphagnum magelanicum* (raised bog)	*Sphagnum fuscum Eriophorum - sphagnum* (raised bog)	*Sphagnum magelanicum- Sphagnum fuscum* (raised bog)
	SA2		*Sphagnum fuscum* (raised bog)	*Sphagnum-Eriophorum*	*Sphagnum-Eriophorum* (raised bog)
	SA1			*Sphagnum fuscum* (raised bog)	*Sphagnum fuscum* (raised bog)
Subboreal	SB3	*Sphagnum* (raised bog)	wood (raised bog)		
	SB2		*Scheuchzeria-Sphagnum* (raised bog) wood (raised bog)	*Sphagnum-Eriophorum (raised bog)*	*Sphagnum-Eriophorum* (raised bog)
	SB1	*Scheuchzeria-Sphagnum* (raised bog)	*Sphagnum fuscum - Sphagnum-angustifolium*	*Pinus - Eriophorum* (raised bog)	wood-*Carex (transitional)*
Atlantic	AT3	*Eriophorum-Sphagnum* (raised bog)	*Scheuchzeria-Sphagnum* (raised bog)		wood-grass (fen)
	AT2		*Carex-Eriophorum* (raised bog) *Sphagnum fuscum* (raised bog)	*Pinus* (raised bog)	
	AT1		*Eriophorum-Sphagnum* (raised bog)	wood (transitional)	
Boreal	BO 2	grass peat (transitional)	wood-grass (fen)	Carex-Hypnum (fen)	
	BO 1	*Carex-Hypnum* (fen)			
Preboreal	PB			*Hypnum* (fen) wood-grass (fen)	

Figure 2. Sequences of peat types in raised bogs from different areas of Latvia

- Intensive mire development and peat formation took place during the Boreal Time, when the largest mires originated through mineral ground paludification.
- Favourable conditions for peat accumulation and decomposition existed during the Atlantic and the Subboreal periods, when 2-3 m thick layers of medium decomposed peat were formed; these are an important peat resource.
- Lowly decomposed *Sphagnum fuscum*, *Sphagnum magelanicum* and *Sphagnum – Eriophorum* peat is dominant in the upper part of raised bogs in Latvia; layer thickness usually reaches 2 to 5 m, and is greatest during the development of the bog.

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