BIODIVERSITY OF FOREST STAND IN CATCHMENT AREA OF THE LAKE ENGURE

Anda Medene

Forest structure and changes in forest cover in the catchment area of the Lake Engure in the 20th and the beginning of the 21st century were studied. Changes in the forest cover in two periods were compared: in the 1930s to 40s and at the beginning of the 21st century. The aim of this research is to establish forest cover changes and find correlation between forest diversity and relief energy. Since the beginning of the 20th century the forest cover has gradually increased. The Shannon biodiversity index was calculated for forest stand. The catchment area is heterogeneous; all forest types found in Latvia are present here. Dry forest types are the most widespread in the catchment area. The biggest forest stand richness is found in two zones: the North Kurzeme Upland and Baltic Ice Lake plain. Relief energy is not main factor that influence forest stand richness.

Key words: forest stands, diversity, Lake Engure catchment area.

Anda Medene. University of Latvia, Institute of Biology, Miera iela 3, Salaspils, LV-2169, e-mail: andamedene@inbox.lv.

INTRODUCTION

Many researchers have noted that biodiversity is an important topic; factors that potentially influence biodiversity are often important (Cox & Moore 1996, Maczulak 2010, Rūsiņa 2007). Cox and Moore (1996) have concluded that biodiversity encompasses all of the living things that currently exist on Earth. There are three levels of biodiversity - genetic, species, and ecosystem. Ecosystem diversity includes different habitats, biological communities and ecological processes and also variation within individual ecosystems. Forests cover more than 50% of Latvia's territory, but forest biodiversity is increasingly threatened. Woody plants play a significant role in the transformation of biota in Latvia. There are many factors that influence species richness. Hypsometric is a fundamental feature of the Latvian landscape and strongly influence woody plant diversity (Laiviņš 2005, Laiviņš et al. 2009). Clear cutting increases. Human activity as a significant component influences the Earth's ecosystems, and it becomes a relevant object of interest in biogeography.

Some attention has been given to flora structure and also relief influence on species richness (Goulart da Silva et al. 2008, Medene 2012). It has been concluded that relief heterogeneity may influence diversity of vegetation (Goulart da Silva et al 2008). However, little research experience is about relief energy influence on forest stand richness. Slaucītājs (1935) found that relief energy characterizes maximum relative altitude difference. If the relief is heterogenic, there is more powerful influence on territory (sharp moisture and warmth differences, soil erosion

Table 1. Dynamic of forest area

Zone	Forest area, %	
	1930-1940.	2011.
The drained Engure lake bed	21.5	48.8
Littorina Sea plain	61.5	58.1
Baltic Ice Lake plain	73.5	87.1
The North Kurzeme Upland	30.3	33.2

risk, variable landscapes).

In order to better understand the relationship between the relief features and forest stand richness of the forest of the Lake Engure drainage basin, the aim of the present paper is to find a correlation between forest stand structure and relief energy. Another important aspect is to establish forest cover changes in the catchment area of the Lake Engure.

MATERIAL AND METHODS

The study site is located in the western part of Latvia. Lake Engure is one of the largest lakes and the largest one in the Coastal Lowland, and it is one of the relict lagoon lakes of the Littorina Sea. The Lake Engure catchment area covers an area of about 644 km² (Blanka 2011). Human activities have a significant and direct impact on the environment; thus, the study area is actually slightly larger than the Engure drainage basin (Fig. 1).

The study area includes five zones: the North Kurzeme Upland, Baltic Ice Lake plain, Littorina Sea plain, drained Engure lake bed and Limnea Sea plain. (Fig. 1.) Data analyses were done for each zone.

The data by the State Forest Service (*Valsts meža dienests* 2011) containing information about woody species composition were used for the research. The Latvian Army topographic map with a scale of 1:75 000 and CORINE Land Cover Survey data 2006 were used to determine forest area changes since 1935. Cartographic material was created by ESRI ArcView, ArcMap 10.1

software. The Latvian Army topographic map was digitized and georeferenced.

A regular grid was used in data processing (Fig. 2). The size of each grid unit was 1x1 km. Relief energy was calculated for each square as well as the Shannon biodiversity index H (H = - Σ pi x ln pi, where pi - the incidence of forest stand in each square).

A variety of GIS functions: data selection, classification, statistical and mathematical analysis (GIS tools: clip, merge, and dissolve) were used in the analysis of data. Classification represents the spatial data operation, and it allows to divide certain groups. SPSS 5.0 software was used for statistical analyses.

RESULTS AND DISCUSSION

Forest cover has shown an increase of 7.7 % (average 74 hectares in a year) in catchment area of Lake Engure in last 70-80 years. In 20th century thirties forest cover was 43.2 % of catchment area, but it reached 51.0 % in 2011. The increase differs in all zones (Table 1).

The fastest increase of forest area is found in 0.3 – 0.5 kilometres wide zone – the drained Engure lake bed. About 20 % of open area turned into forest area in the last 100 years period after the water table of Lake Engure was lowered in 1842, thus creating about 45 km2 of land (Vīksne, 1997). Nowadays, about half of the drained Engure lake bed is covered with forests. In recent decades overgrowth is more intensive than in the second half of the 19th century and the beginning of the 20th century. Afforestation will continue in
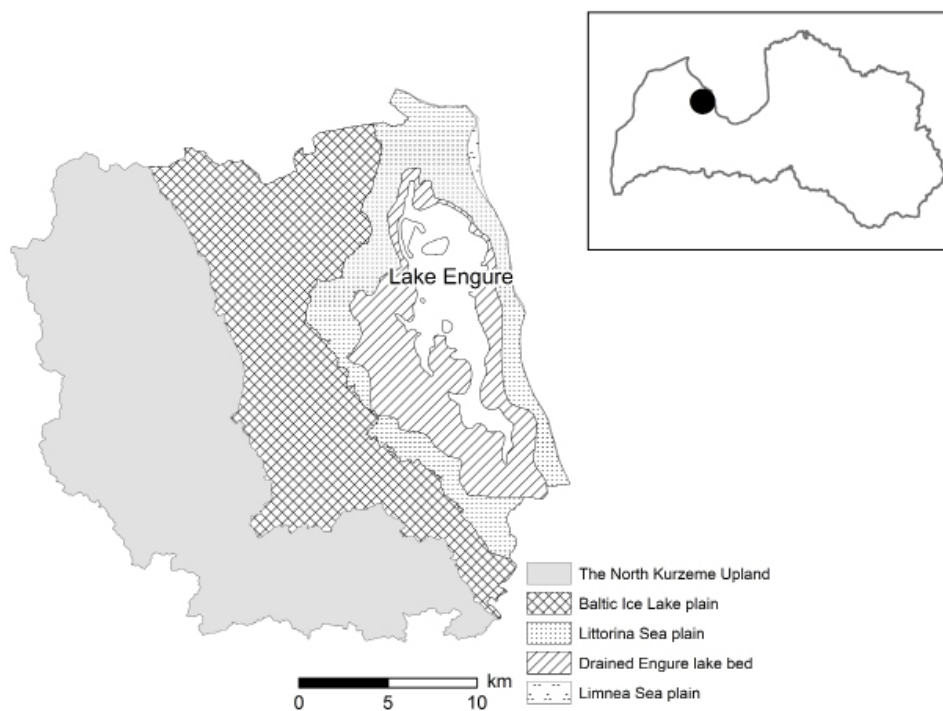
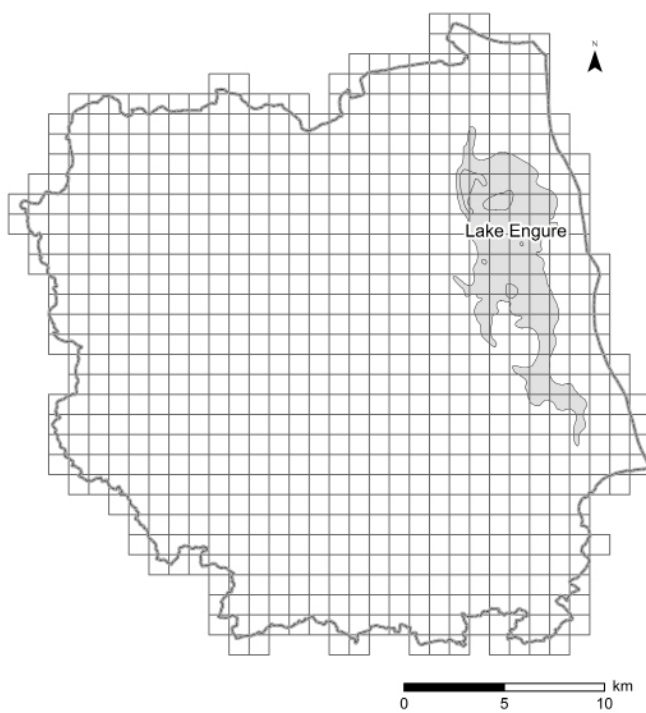Fig.1. Location of the Lake Engure catchment area and zone division.

Fig. 2. 1x1 km grid of Lake Engure catchment area.

this zone because agriculture is not developed around the Lake Engure. Forest area has increased by 13.6 % also in the Baltic Ice Lake plain zone where historically the forest cover has been the largest. Mainly, forest meadows and narrow zones of agricultural land have afforested there.

The forest area has slightly (by 2.9%) increased in the North Kurzeme Upland – territory that is the most intensively managed. There is only one zone where forest cover has decreased by 3.4 % - the Littorina Sea plain. In this area there are several populated places – Mērsrags and Bērzciems which continues to expand but on the east coast villages Ķūļciems, Krievragciems and Dzedri where intensive agricultural production centres were in the post-war period.

Dry forest types are the most widespread in the catchment area. Forest stand form 15 species: aspen *Populus tremula*, grey alder *Alnus incana,* birch *Betula pendula and Betula pubescens,* goat willow *Salix capre,* beech *Fagus sylvatica,* fir *Picea abies,* elm *Ulmus glabra, flattering elm Ulmus laevis,* maple *Acer platanoides, lime Tilia cordata,* black alder *Alnus glutinosa,* ash *Fraxinus excelsior,* oak *Quercus robur, poplar Populus ssp.* pine *Pinus sylvestris* and willow *Salix alba.* Pine forest and birch forest dominate in the territory.

The number of the forest stand forming species is not equal in all of the zones (Fig.3); the drained Engure lake bed – 7 but the North Kurzeme Upland – 15 species.

The data analysis shows that the biggest forest stand richness is found in two zones: the North Kurzeme Upland and Baltic Ice Lake plain. The highest forest stand richness is found in the North Kurzeme Upland zone (105 forest stand type). The Shannon biodiversity index also varies from 0 to 2.88 in this zone (Fig. 4). The maximum Shannon index is found in the northern part of the Baltic Lake plain zone. Probably it is explained by the extensive forest area that concentrates in this part. This research has shown comparatively tight correlation between Shannon biodiversity index and total forest area in each square (the Pearson correlation coefficient 0.58 (confidence limit 0.95). The results of this investigation show that higher biodiversity index is in area where dominate forests of natural origin.

The relative height differences reaches 40 to 50 meter in 1 x 1 km square at south part of the Engure catchment's area. The biggest relief articulation and, consequently, the relief energy are found in the North Kurzeme Upland zone (Fig. 3). The lowest average surface relative height amplitude is in the drained Engure lake bed where it is only 1.84 meter.

Relief energy is the highest in this zone (Fig. 5.), but there was no significant correlation between relief energy and Shannon biodiversity index in
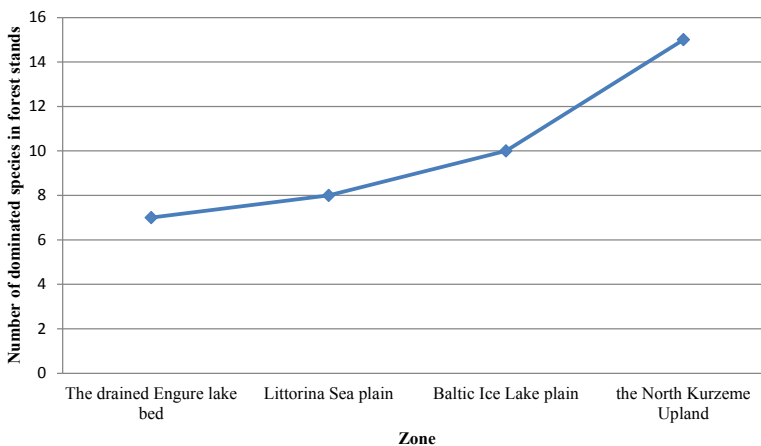

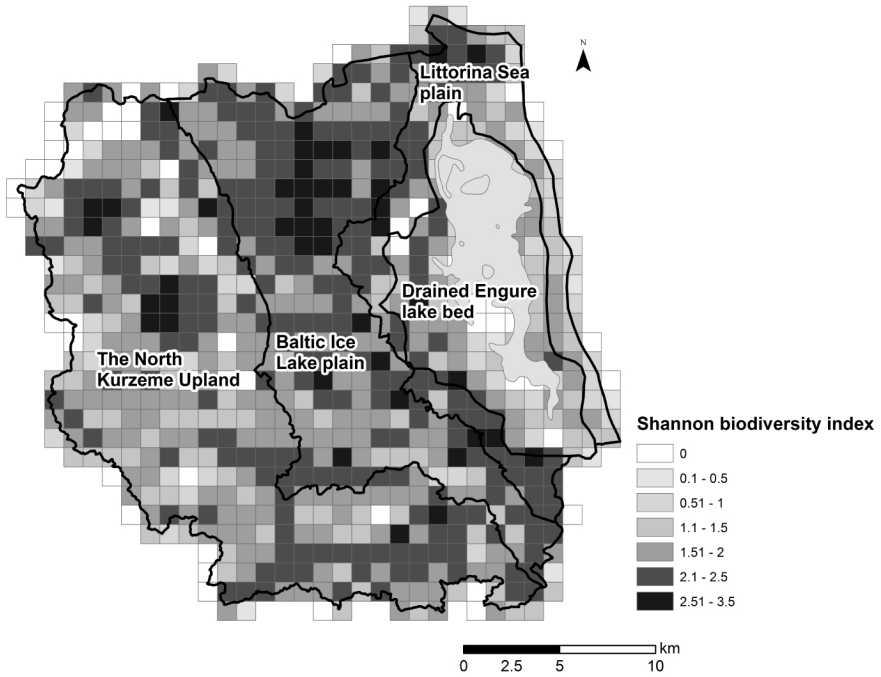Fig. 3. Number of forest forming species.

Fig. 4. 1 x 1 km grid of Lake Engure catchment area and the Shannon biodiversity index of forest stand**.**
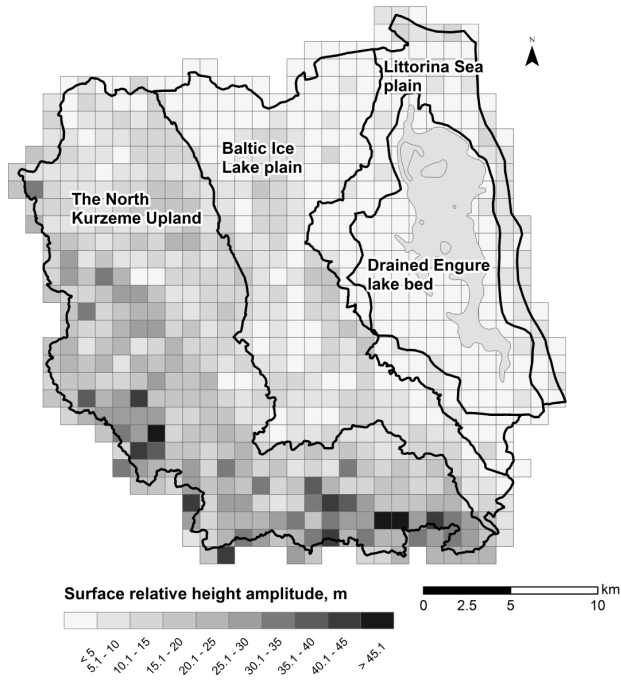

Fig. 5. Relief energy map in 1 x 1 km grid.

each square (the Pearson correlation coefficient 0.01 (confidence limit 0.95). It is explained by human activity and historical development. Anthropogenic factors play important role; there are no territories where there is no human influence on the environment.

CONCLUSIONS

In this investigation, the aim was to assess forest stand richness and changes in forest cover catchment area of the Lake Engure. Important purpose of the current study was to determine relief energy for each square (1 x 1 km) and Shannon biodiversity index.

These findings suggest that in general the forest cover has gradually increased since the beginning of the 20th century. Very significant event happened in 1842 when the water table of Lake Engure was lowered. After draining, forest area increased, especially in the drained Engure lake bed.

This study has approved that there exists a tight correlation between forest area and forest stand biodiversity – the largest forest area in each square, the biggest forest stand biodiversity.

The second mayor finding was that there is no correlation between relief energy and forest stand biodiversity. Probably, human activity playa an important role that is why it is difficult to find connection between environmental factors.

The most obvious finding to emerge from this study is that the biggest forest stand biodiversity is in the forests of natural origin, and the biggest forest stand richness is in parts of high variety of land management and land use.

More broadly, research is also needed to determine other factors that influence forest biodiversity and incidence. It is recommended to assess soil structure, drainage system, density of population and density of roads.

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