ARTICLES

The transformation of forest ecosystems on cutovers in Latvia

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The phenomenon of forest ecosystem transformation after clearcutting, e. g. into glade, is used as an indicator of forest stability. For dry site type forests the risk of the transformation of forest into a glade (most commonly heath) is highest in the oligotrophic part of the site type edaphic row, as the relative proportion of glades here is 2.3 times higher than the relative forest covered area.

A reverse regularity is observed for the wet forests both drained and undrained: the eutrophic forests are most commonly affected by the mentioned transformation. In the drained wetland forests, eutrophic forests comprise 83.6% (oligotrophic only 3.8%), while eutrophic glades constitute 94.3% of the total area of glades in drained forests (oligotrophical glades - 1.1%).

Repeated inventory of the 1967 cutovers 200 to 400 m wide made on drained pine forests and the structure of the ground cover vegetation (Ellenberg's indices) show neither paludification nor soil degradation on the sites in question.

Key words: forest ecosystem, glade, cutover, paludification, drainage.

Introduction

Self-preservation in the form typical of it is an inherent feature of any ecosystem, be it forest, swamp, meadow or some other. It is ensured by the ample feedback each ecosystem is provided with. Ecosystems preservation is often treated as the stability of the system, expressed as an invariability of the system's most significant parameters in time. With regard to forest ecosystems to a greater or lesser degree impacted by humans, the ecosystem's stability, in terms of invariability of its elements over time, notionally assumes different meaning.

In commercial forests, where the ecological regularities are translated into economical goals and the forests productivity becomes the most significant parameter, the forest stands (ecosystems) are highly unstable: nearly all stand elements – the tree height, diameter, stock volume, the ground cover and undergrowth vegetation, and, frequently, the tree stand itself change over a short period of time. The stability in its conventional understanding can be seen only in the climax stage of forest stands.

Economically viable forest management is possible provided we are aware of the dynamics of the ecosystem's development after felling the tree stand, the main producer of organic matter. It is purposeful to describe the stand dynamics by using the principal indices (diameter, height, basal area) at different age. The forest typology of Latvia provides the domination for evaluating the development of a tree stand within a single forest type following statistically comparable indices. Therefore, in forests managed intensively, the stability implies the stability of the system's trajectory within the single forest type.

The stability, i.e. the invariability of the forest elements in time at the stand's climax stage, is often connected with the ecosystem diversity including in this concept the information on the number of species and individuals representing each species. By using the Shannon's index well known in the theory of information for describing the forest diversity one is led to believe the most uniform and less stable are the forests on poor sandy soils: *Cladinoso-callunosa, Vacciniosa, Callunoso-sphagnosa* as well as forest types on drained soils – *Callunosa mel.* and *Callunosa turf. mel.* On the other hand, the maximum stability must be for the fertile forests – *Aegopodiosa, Filipendulosa, Mercurialosa* and *Oxalidosa turf. mel.*

However, the experience in forest management refutes this presumption. In fertile forests after felling the tree stand the forest regeneration is often a failure resulting in the forest ecosystems transformed into a glade where the tree stand is no more the main producer of organic matter, but a ground cover vegetation plant communities emerging instead of it.

From the point of view of the systems methodology, it appears expedient to consider the stability of the system's trajectory in terms of the climatic and abiotic factors that determine the system's (the forest stand's) position in the given edaphic row of forest site types rather than in terms of its biological diversity alone. The forest ecosystems falling into the central part of the row are more stable than those on the pheryphery, both fertile and infertile. The aim of the given study is to test a hypothesis that the most stable and easy regenerating forest ecosystems fall into the central part of the given edaphic row of forest site types represented by *Myrtillosa*, *Hylocomiosa*, *Caricoso-phragmitosa* and also *Vacciniosa mel.* and *Vacciniosa turf. mel.* forest types.

Objects and methods

By using the inventory data and the information derived from the data base "*Latvijas meža fonds*", a comparison of the transformation of forest ecosystems, i.e. changing of forest into a glade after felling,- was made for three forest site type groups: 1) dry mineral soil 2) wet undrained and 3) wet drained forests. Within each group of forest site types three forest groups were identified: olygotrophic, mesotrophic and eutrophic (Table 1). The post-harvest relation forest / glade was analysed for 12 Regional Forestry Districts located on the territory of Latvia to the right and left of the line Rīga – Bauska: West – the Regional Forestry Districts of Bauska, Jelgava, Liepāja, Kuldīga, Talsi, Ventspils and East (Cesvaine, Gulbene, Jēkabpils, Limbaži, Ogre, Rēzekne). The total amount of forest lands in the West is 457 thous. ha, in the East – 584 thous.

Table 1. The division of forest site types in the fertility groups

Forest site type	Fertility groups		
	Oligotrophic	Mezotrophic	Eutrophic
Dry mineral soils	*Cladinoso-callunosa* *Vacciniosa*	*Myrtillosa* *Hylocomiosa*	*Oxalidosa* *Aegopodiosa*
Wet soils, undrained	*Callunoso-sphagnosa* *Vaccinioso-sphagnosa* *Sphagnosa*	*Myrtilloso-sphagnosa* *Caricoso-phragmitosa*	*Myrtilloso-polytrichosa* *Dryopteriosa* *Dryopterioso-caricosa* *Filipendulosa*
Wet soils, drained	*Callunosa mel.* *Callunosa turf. mel.*	*Vacciniosa mel.* *Vacciniosa turf. mel.*	*Myrtillosa mel.* *Mercurialosa* *Myrtillosa turf. mel.* *Oxalidosa turf. mel.*

There is an opinion that substantial changes in forest environment are possible also in large continuous clearings where under the conditions of weak aeration the paludification or intensive overgrowing of clearings by vascular plants can start. To explain this process the 200-400 m wide clearings were analysed, which resulted after logging over the windthrows of 1967 in the Pope and Priedaine (West-Kurzeme) Forest District. The 12 sample plots arranged in 1977 were remeasured, analysing the structure of young stands and the ground cover vegetation in the centre of a clearing and on the edges of it next to an old forest.

The structure of ground cover vegetation on every sample plot was evaluated by determining the projective cover of each species in 200 points. The structure of ground cover vegetation in 1997 was compared with that in 1977, by grouping the plants as humidity indicators in 5 groups: psyhrophytes, mesophytes, mesohygrophytes, hygrophytes and hygrohydrophytes (Буш, Аболинь, 1967).

Discussion

In terms of ecology the felling of tree stand, the main producer of organic matter, and removing trees out of the forest should be treated as an inflow of energy to forest destroying ecosystems. Of course, felling must be followed by the forest regeneration activities as site preparation, the planting, tending and protecting the young trees. However, despite the inflow of energy to preserve the forest ecosystem the actions taken at times result in a failure to achieve forest regeneration.

The transformation of forest into glade was used as an indicator of forest stability: the higher the proportion of glades in the post-harvest performance of the stand belonging to a definite site type, the higher the risk that the sites of just this forest type will change into bog, heath or eutrophic grassland.

The total area of forests in selected sites is 1.041 thous. ha. The area of glades is 7.1 thous. ha or 0.7%; in the West they occupy 0.8%, in the East – 0.6% of the total area of forest lands analysed.

Oligotrophic forests comprise 5.6% of the total area of forest lands investigated; oligotrophic glades – 7.3% from the total area of glades. Mesotrophic forests occupy 46.6%, mesotrophic glades – 42.2%. Eutrophic forests make up 47.8%, but eutrophic glades – 50.5% from the total area of glades. These averaged data prove our hypothesis that the highest risk of forest ecosystems transformation after harvest refers just to the marginal forest types at both ends of the row – fertile and infertile.

A thorough analysis of the data has revealed a number of peculiarities (Table 2). There is a high proportion of oligotrophic forest lands on dry site forest areas in the West part of Latvia – 15.2% from the total area of dry sites; in the East only 4.9%. In the West of Latvia this forest group has the largest area of oligotrophical glades – 32.2% from the total area of glades. In the East oligotrophyc dry site type forests regenerate easily and the area of oligotrophic glades occupies only 1.3% of the total area of glades in the dry site forests. In dry site type forests it is just the oligotrophic part of it that is under a higher risk of becoming a non-forest glade, as the proportion of glades in it (usually heaths) is 2.3 times higher than the forests.

There is an opposite regularity observed in wet drained and wet undrained forests. In both the East and the West of the country the forest transformation into glades more often occurs in eutrophic forests. The regeneration / afforestation of oligotrophic and mesotrophic forest lands is comparatively easy. For example, eutrophic forests in wet drained forests make up 83.6% (oligotrophic only 3.8%), but eutrophic glades comprise for 94.3% of the total area of drained glades (oligotrophic glades – 1.1%).

Table 2. A comparision between the forest covered land and glades in the post harvest performance of forest sites depending on the forest site type.

Dry site forests

	oligotroph		mezotroph		Eutrophical	
	o		m		e	
West	15.2	32.2	60.4	47.0	24.4	20.8

oligotroph.		mezotroph.		eutrophical		
o		m		e		
4.9	1.3	44.4	47.7	50.7	51.0	East

Average

o		m		e	
9.5	21.5	51.5	47.3	39.0	31.2

Wet undrained

	o		m		e	
West	18.0	6.2	57.6	53.1	24.4	40.7

o		m		e		
11.7	6.1	45.8	40.5	42.5	53.4	East

Average

o		m		e	
14.5	6.1	50.9	45.8	34.6	48.1

Wet drained

			m		e	
West	3.7	1.8	18.1	7.0	78.2	91.2

o		m		e		
3.9	1.3	8.7	2.0	87.4	97.7	East

Average

o		m		e	
3.8	1.1	12.6	4.6	83.6	94.3

☐ forest ecosystems ☐ glades

While estimating the risk of forest transformation in exceedingly wide clearings, in 1997 five clearings of the 1967 windthrows were remeasured on the area from 200m (The Pope Forest District) to 400 m wide (The Priedaine Forest District). All sites are found in drained forests of average humidity.

In Pope unsuccessful artificial regeneration by Scots pine was done. The pines have withered away repeatedly as a result of weak seedlings and the damages of insects and wild mammalians. Now (30 years after the windthrow) the tree height is between 1.1 and 3.9 m, and the number of trees in none of the sample plots, irrespective of the distance to the forest wall, is sufficient to have a stand of average density ($\geq 0,7$).

At present the average height of pine stands in the Priedaine Forest District is 9 m and the number of trees is sufficient for pine stand of satisfactory density. Also here the distance from the forest wall has no effect on the composition and other characteristics of the young stands.

To estimate the danger of paludification of wide cutovers in wet (also drained) forests, the analysis of ground cover vegetation's projective cover was conducted. In relation to soil moisture we have a possibility to compare the data of 1997 with those obtained in 1977 (Aire, 1977) (Table 3).

Table 3. The projective cover of ground cover vegetation as an indicator of soil moisture

Group of plants	1977		1997	
	Near the forest edge	Middle of clearing	Near the forest edge	Middle of clearing
Psyhrophytes (1)	5	12	9	17
Mesophytes (2)	29	35	29	18
Mezohygrophytes (3)	43	21	41	50
Hygrophytes (4)	19	32	18	12
Hygrohidrophytes (5)	4	0	3	3
Average	2.9	2.7	2.8	2.7

We designated the gradation of soil moisture by using the following coefficients: 1 – psyhrophytes, 2 – mesophytes, 3 – mesohygrophytes, 4 – hygrophytes, 5 – hygrohydrophytes. The structure of ground cover vegetation, neither in 1977 nor 1997, attest to significant changes in soil humidity in the middle of a cutover and on its edge (within 30 m away from the forest edge).

By using the Ellenberg's indices (H. Ellenberg, 1979) for describing the environment conditions in the middle of clearings and next to a forest, the following average indices were found (Table 4).

Table 4. The environment factors (Ellenberg's indices) on the forest edge and in the middle of clearing.

Environment factors	Ellenberg's indices	
	Cutover edge	The middle of clearing
Temperature (T)	4.5	4.2
Continentality (K)	4.4	4.2
Light conditions (L)	6.6	6.0
Moisture (F)	6.9	7.1
Acidity (R)	4.3	4.0
Nitrogen content (N)	3.5	3.7

Similary to the method of grouping plants following the soil moisture developed by K. Bušs, A. Āboliņa, the Ellenberg's indices, too, show no significant changes in environmental conditions in a wide cutover of drained forests.

Conclusions

1. A hypothesis that post-harvest transformations of forest ecosystems most commonly refer to the marginal (both fertile and infertile) forest site types in the edaphic row appears to be confirmed. When clearcutting forest of the marginal for the given edaphic row site types, an additional input of energy is required to exclude a non-forest ecosystem having a lower level of accumulated energy emerging instead of forest.
2. Repeated measuring of sample plots (after 20 years) established in 1977 in wide (200-400 m) clearings (1967) of drained pine forests and analysing the structure of ground cover vegetation revealed no soil degradation or paludification.

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СТАБИЛЬНОСТЬ И ПРЕОБРАЗОВАНИЕ ЛЕСНЫХ ЭКОСИСТЕМ

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Резюме

Преобразование лесонасаждений на лесосеках после рубки древостоя использовано в качестве индикатора устойчивости лесных экосистем. На суходоле лесосеки чаще всего трансформируются в олиготрофные леса; относительная площадь вересковых прогалин в 2,3 раза больше относительной площади олиготрофных насаждений.

Как в неосушенных, так и в осушенных избыточно увлажненных лесах наблюдается противоположная закономерность: после срубки древостоя лесосеки чаще всего превращаются эутрофные леса. На осушенных территориях эутрофные леса занимают по площади 83,6% (олиготрофные леса всего 3,8%), но эутрофные лесосеки – 94,3% (олиготрофные лесосеки – 1,1%).

В результате повторного изучения структур древостоя и напочвенной растительности (индексы Элленберга) на вырубках (ширина лесосек 200-400 м) 1967 года установлено, что на этих территориях не отмечены процессы как заболачивания, так и деградации почвы.

Ключевые слова: лесная экосистема, вырубка, прогалина, заболачивание.