The ground cover vegetation and tree stand parameters as indicators of condition of drained forests in Latvia

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Background information

During the Holocene in the area of Latvia proceeds the forming of mires and waterlogged forests with poorly aerated soils and low productive tree stands. The most important silvicultural activity for the national economy is the hydro-technical drainage.

The researchers have systematically performed investigations of forest ecosystems in connection with the hydrological regime since 1963 in a drained object in the Veseta River basin. The total area of researched object is 386 hectares. In this study there are measurements of forest phytocenosis in years 1975, 1994 and 2009 analysed.

The total area of forest land cover in Latvia is 50.4% (3 273 971 ha).

Almost half of Latvian forest areas (1.5 mill. ha) are considered as

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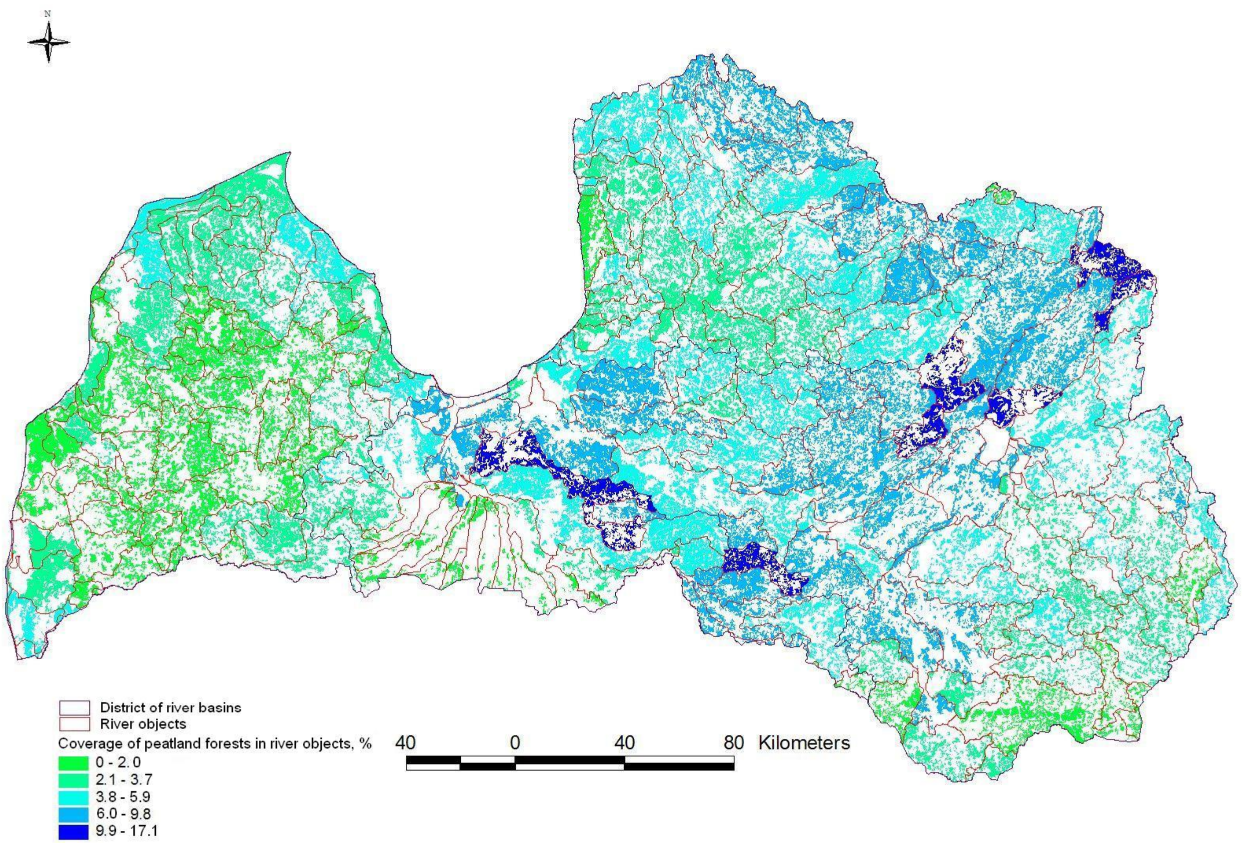
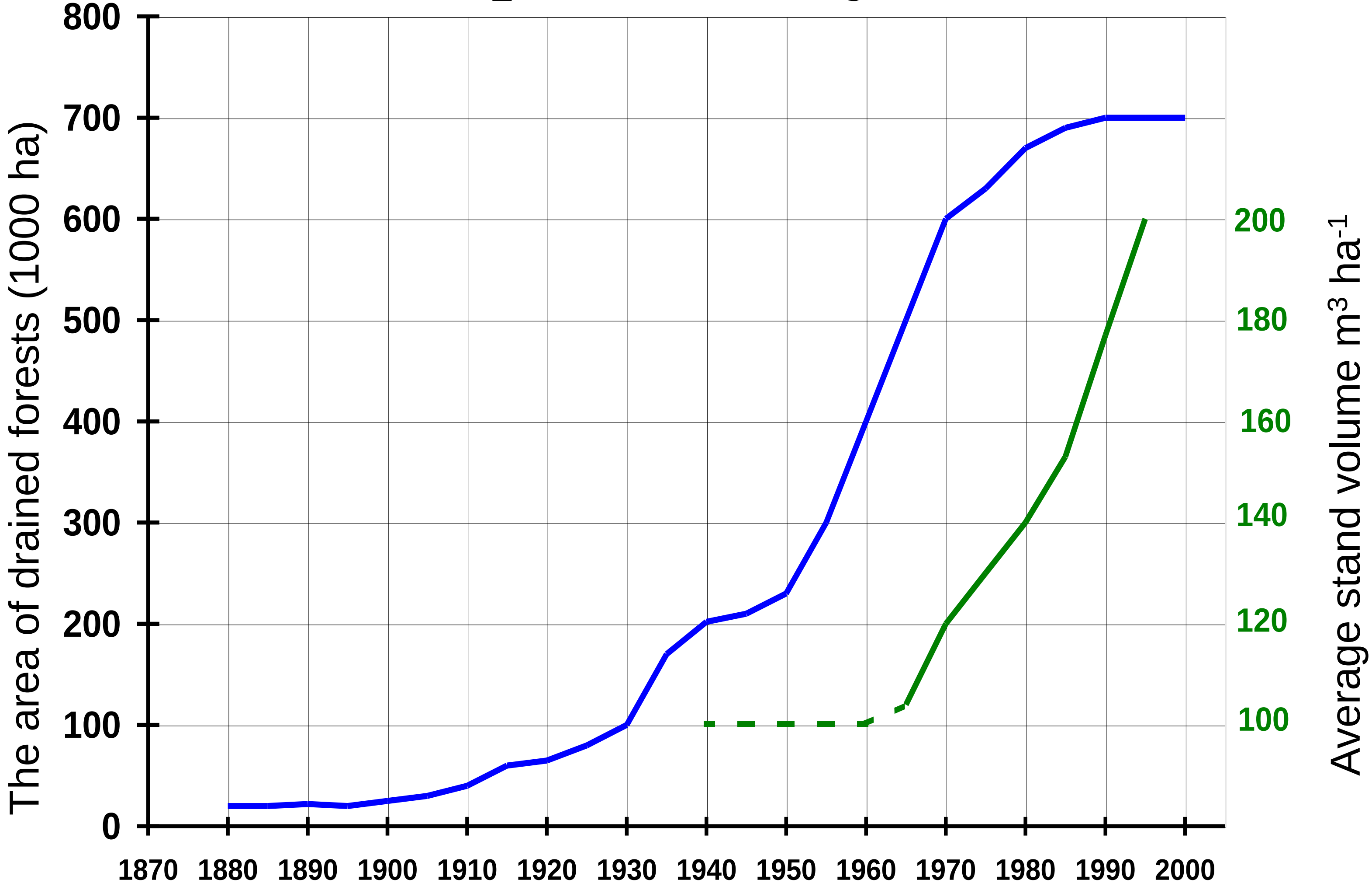


The distribution of drained forests with peat soils (peat layer > 20 cm).

CORINE Land Cover 2000 image.

The drainage of waterlogged forests and tree stand productivity in Latvia



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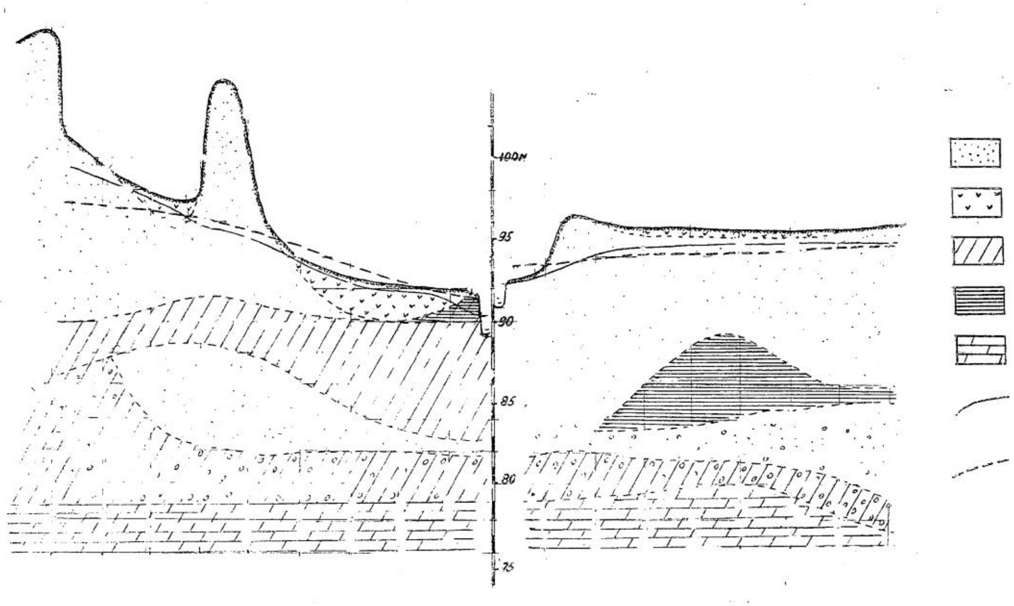
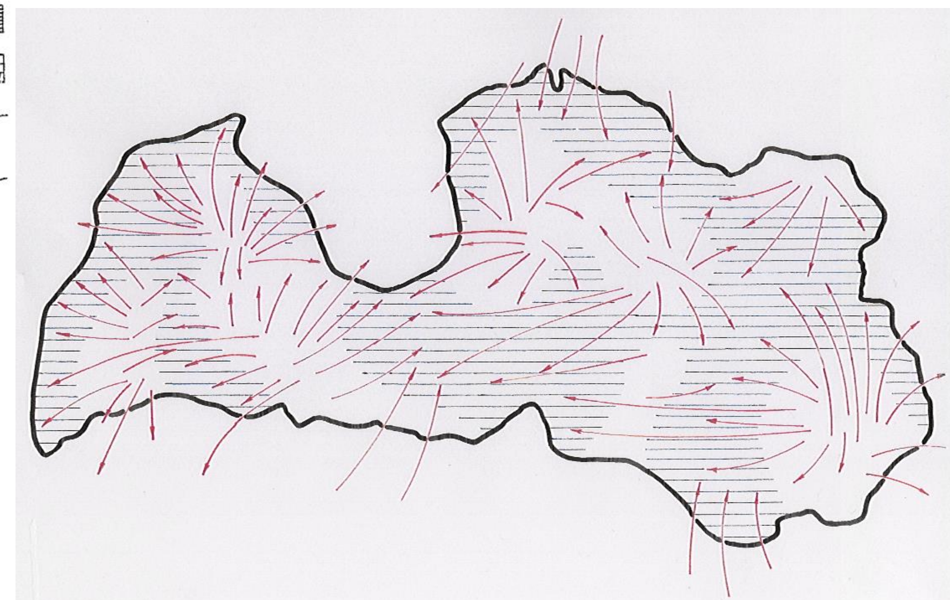
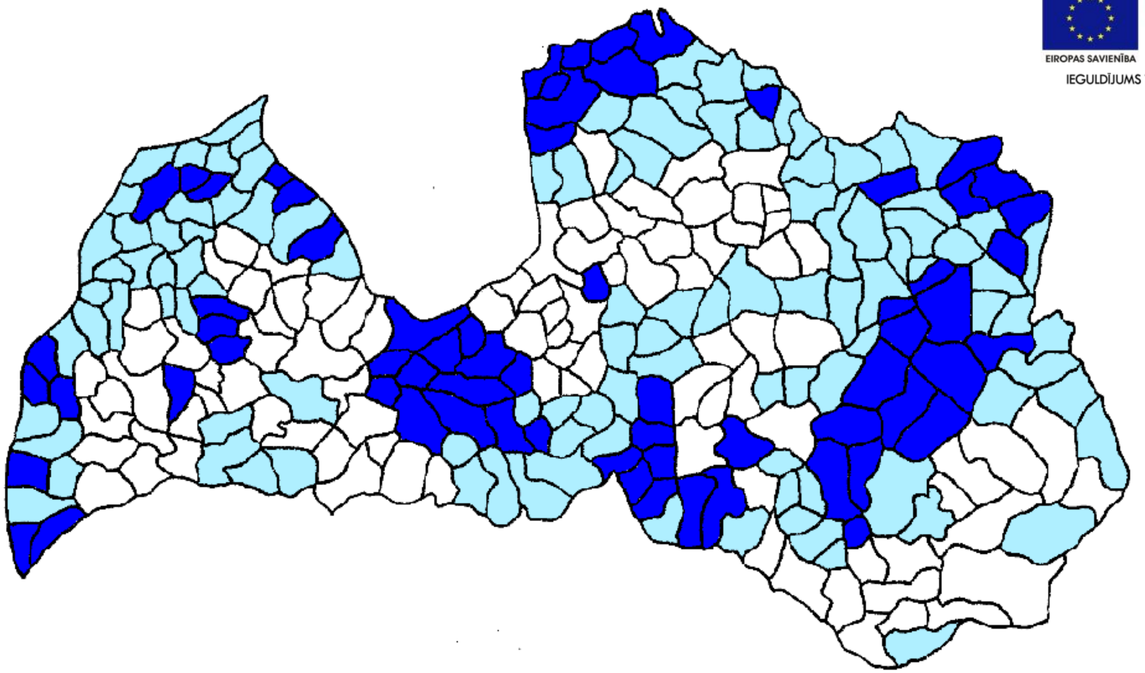
The confined aquifer water (artesian water) discharge is the most important reason of the paludification process in Latvian conditions. 86% of the waterlogged forests in Latvia are located in the areas with intensive confined aquifer water discharge.







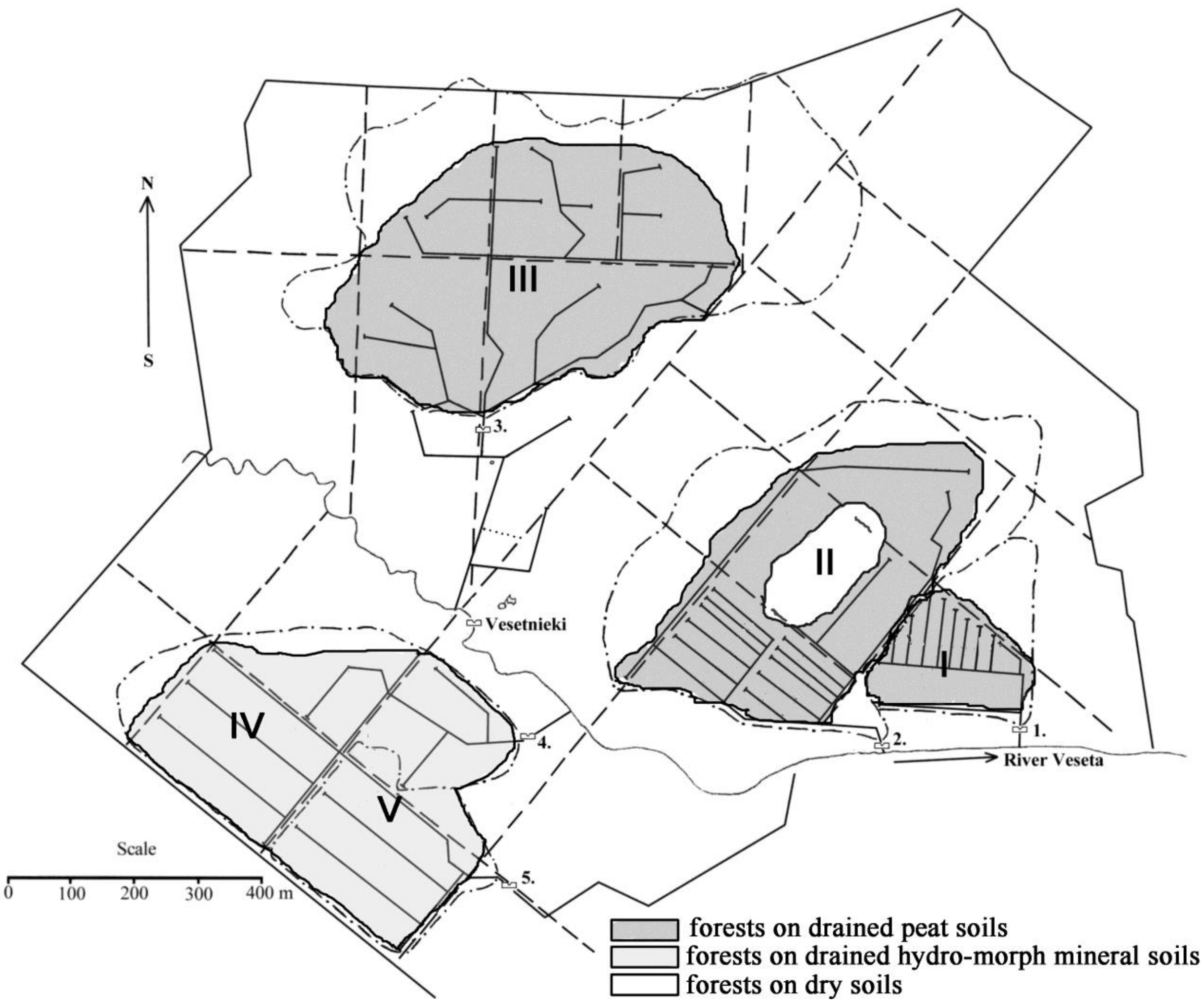
The waterlogged forests are placed in areas, with less amount of precipitation

5 - 30 %	31 - 50 %	51 - 95 %

Proportion of waterlogged forests in forest districts, W

Precipitation (P) 600 - 950 mm $r_{W;P} = -0.24$ $r_{0.05;278} = 0.11$

Scheme of the catchments of *Vesetnieki Station*



Area of catchments:

I – 33.0 ha;

II – 113.7 ha;

III – 139.1 ha

IV – 67.3 ha;

V – 33.2 ha.

- watershed;
- forest crossride;
- drainage ditch;
- 1. hydrometric post and number of catchment.

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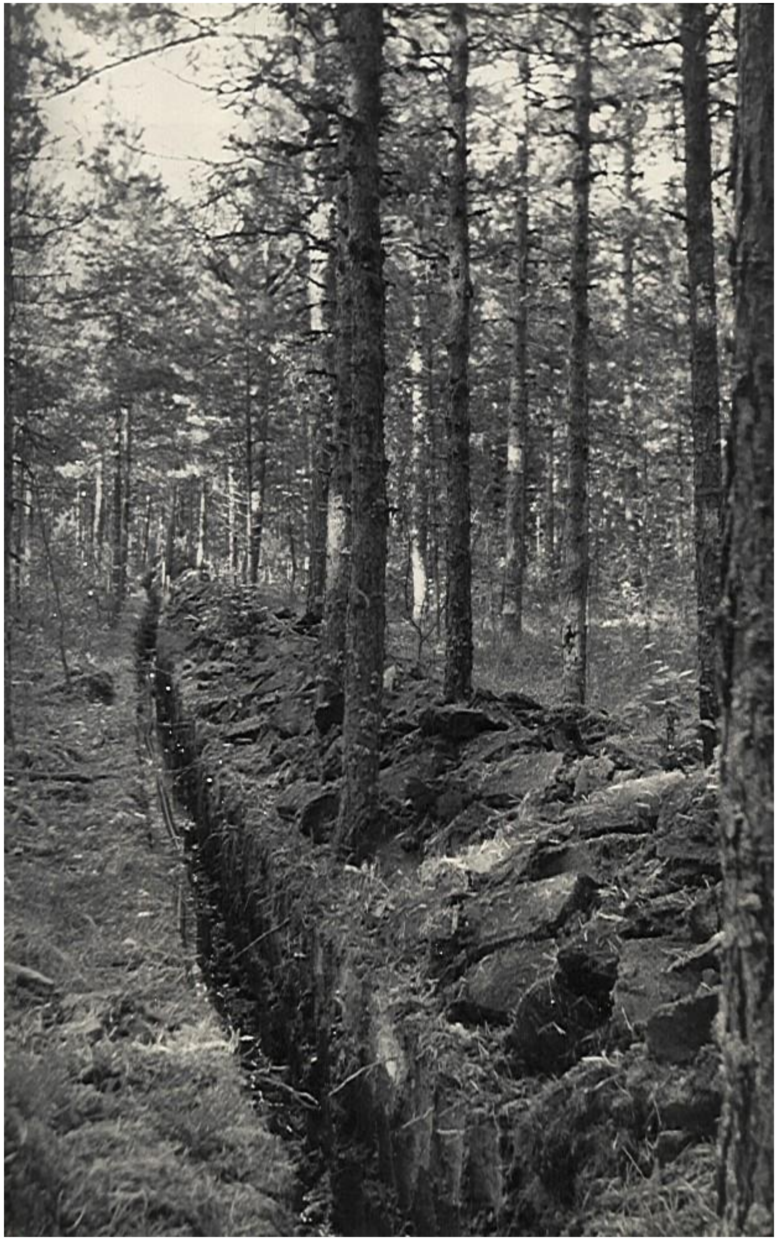

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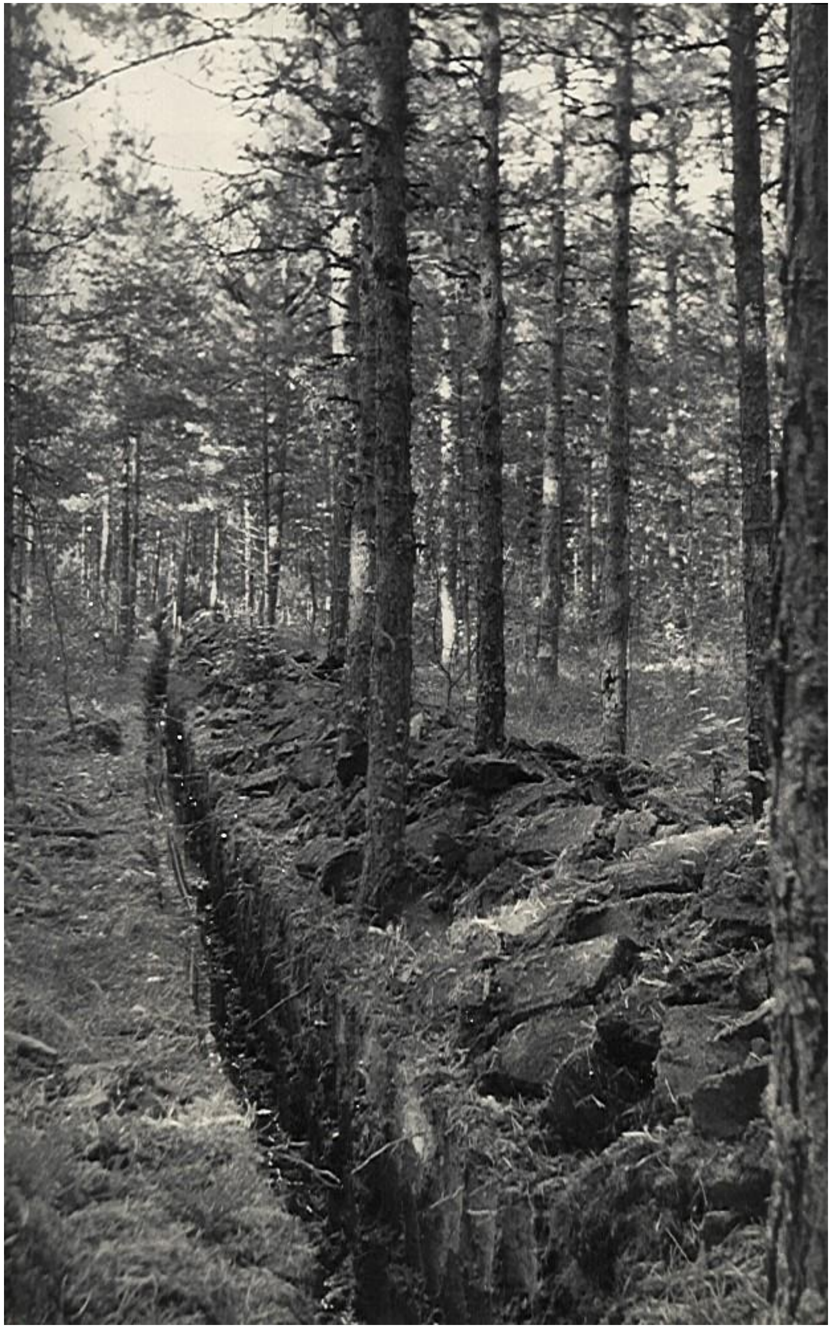

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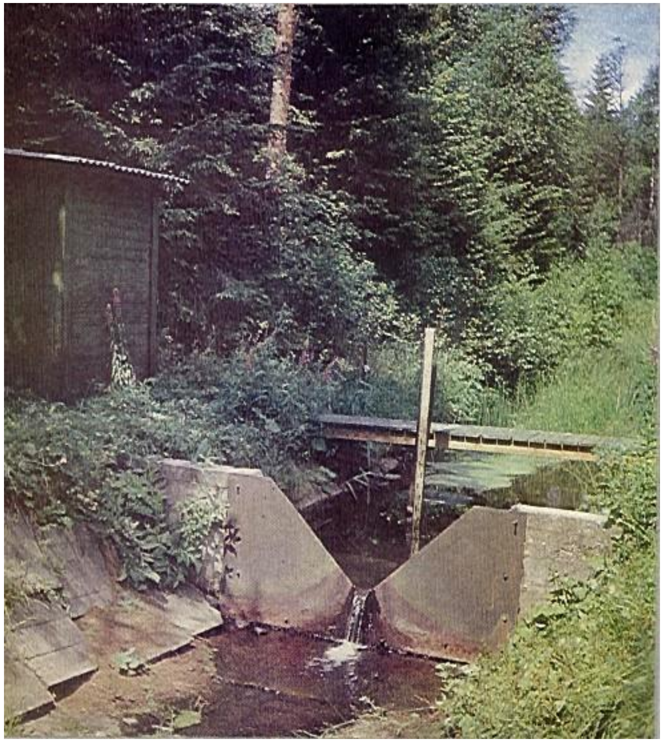

Average long-term water balance in Latvia:

755 mm (precipitation) = 238 mm (discharge) + 517 mm (evaporation).

by Pastors, 1972

Water balance in drained forests in Latvia

Forests on drained peat soils

N (797 mm) + P_p + P_s (330 mm) = Q (500 mm) + $ET_{V\text{-}X}$ (484 mm) + $E_{XI\text{-}IV}$ (143 mm)

Forests on drained hydromorphic mineral soils

N (797 mm) + P_s (90 mm) = Q (239 mm) + $ET_{V\text{-}X}$ (465 mm) + $E_{XI\text{-}IV}$ (183 mm)

by P.Zālītis, 1983

where: N – precipitation,
Pp – confined aquifer water discharge,
Ps – water inflow from surrounding dry areas,
Q – runoff,
ET – evapotranspiration,
E – evaporation.

Objective of research

The objective of research is to characterise the changes in the ground cover vegetation and tree stand parameters after the hydro-technical drainage and to evaluate the present ecological and silvicultural condition of the drained forests.

Methods

One inventory point per hectare (totally 371 hectares) in forest was established. In every inventory point there was the basal area (**G**) for each tree species (pine, spruce, birch) obtained, for the average tree of each species was the stem diameter (**D**) estimated, there was also the height (**H**) of the average tree measured. The tree stand volume (**V**) was calculated by the equation **V=GHF**.

All the inventory points were grouped in three forest growth condition types with percentage land coverage – forests on drained peat soils (43%), forests on drained hydromorphic mineral soils (26%) and dry forests on sandy soils (31%).

Methods

In the above mentioned forest site types also the projective cover of ground vegetation was measured, by estimation of the abundance of every individual of the vascular plants in 1520 inventory points in forests on drained peat soils, in 910 inventory points in forests on drained hydro-morph mineral soils and in 1080 inventory points in dry forests.

Methods

For the calculation of the species diversity there was the equation of **Shannon-Wiener** applied, well known in theory of information and phytocenology.

$$\mathbf{H(s) = -\sum_{i=1}^{m} p_i \log_2 p_i}$$

where **H(s)** – diversity of ground cover vegetation, **i** - each individual's participation in the forest site type, $\mathbf{p_i}$ - individuals relative amount of the **i**-th group, **m** - number of measurement points in forest site type.

Methods

In assessing the internal diversity indicators of the ground cover vegetation, in 1975 (**A**) and in 2010 (**B**) there was appropriate to use the coefficient of **Tschekanovsky**.

$$K_s = \sum_{i=1}^{m} 2\min(A_i, B_i) \Big/ \left(\sum_{i=1}^{m} A_i + \sum_{i=1}^{m} B_i \right)$$

where **Ai** and **Bi** are relative abundance of the similar individuals of ground cover plants in each site type, comparing the changes of ground cover vegetation over the 35 years of measurements.

Results

The changes of dominant tree species, the decimal coefficients of forest stand composition in a symbolically average mixed stand.

Site type	Year	Pine	Spruce	Birch
Forests on drained peat soils	1958	5	1	4
	1975	5	2	3
	1994	4	3	3
	2009	3	4	3
Forests on drained hydromorphic mineral soils	1958	3	3	4
	1975	3	3	4
	1994	3	4	3
	2009	3	5	2
Dry forests	1958	9	1	+
	1975	9	1	+
	1994	9	1	+
	2009	9	1	+

Indicator of high productivity in drained forests is the spruce appearance in forest stands, before the drainage forming the second floor or undergrowth; in 2009 spruce dominates in stand composition taking 40-50% of the total volume of tree stems.

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Results

The basal area forest stand **G** (m^2 ha^{-1}) and stand volume **V** (m^3 ha^{-1}) in a symbolically average mixed stand in different forest site types

Years	Forests on drained peat soils		Forests on drained hydromorphic mineral soils		Dry forests	
	G	**V**	**G**	**V**	**G**	**V**
1958	10	45	11	56	14	102
1975	16	112	16	105	19	174
1994	22	203	23	195	25	245
2009	29	301	30	307	32	346

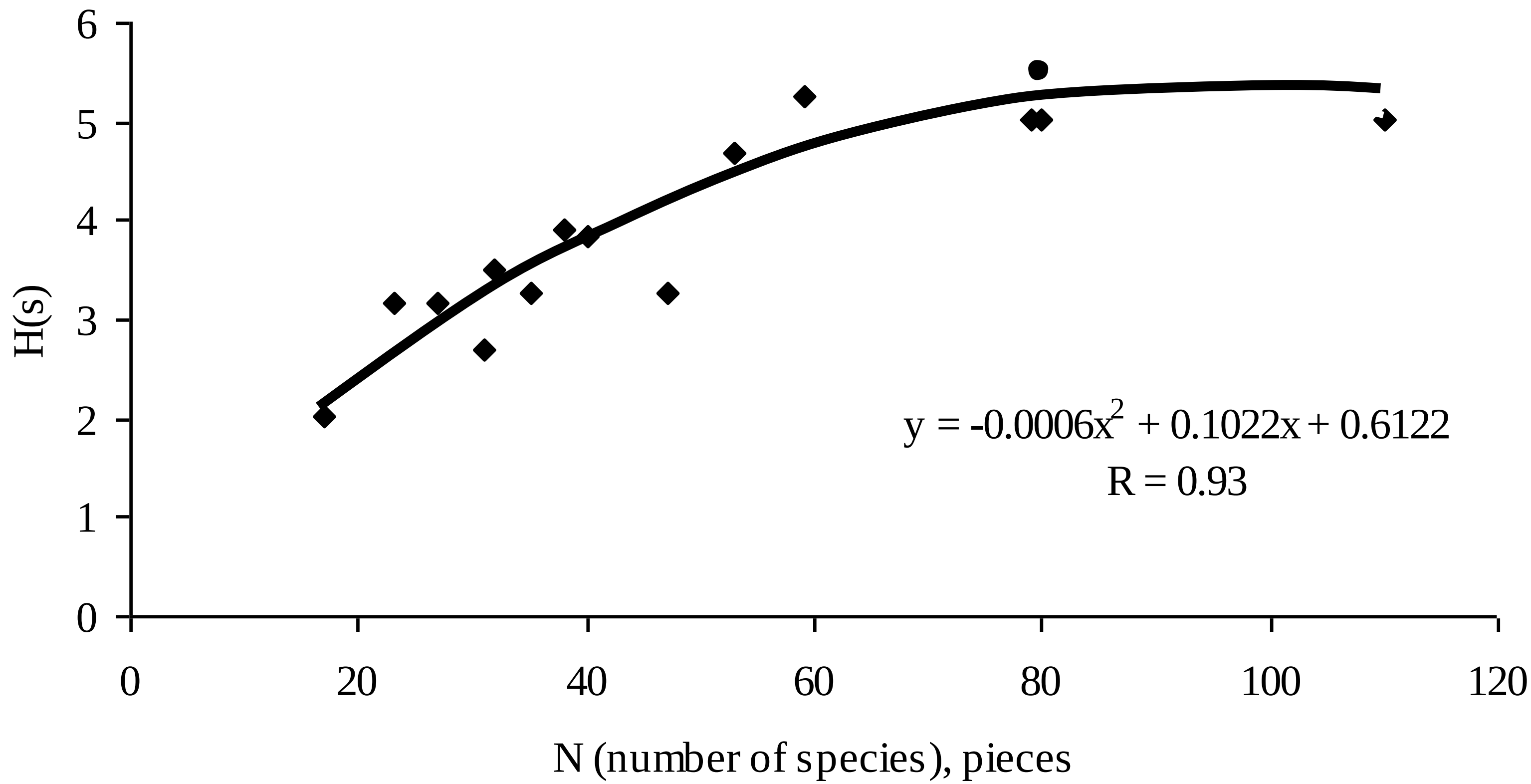
Results

Species composition of the ground cover vegetation in 2009 is the most comprehensive in the forests on drained peat soils: in the Ist floor there are 110 species recorded, in the IInd floor – 35 species; in the forests on drained hydromorphic mineral soils – 80 and 32 species; in the dry forsts – 47 and 31 species, accordingly.

The Shannon-Wiener index **H(s)** of the biological diversity of the ground cover vegetation in the Ist floor of forests on drained peat soils is 5.5, in the IInd floor - **H(s)** = 3.2; in the Ist floor of forests on drained hydromorphic mineral soils - **H(s)** = 5.2 and in IInd floor - **H(s)** = 3.3; in the Ist floor of dry forests - **H(s)** = 3.7 and in IInd floor - **H(s)** = 2.24.

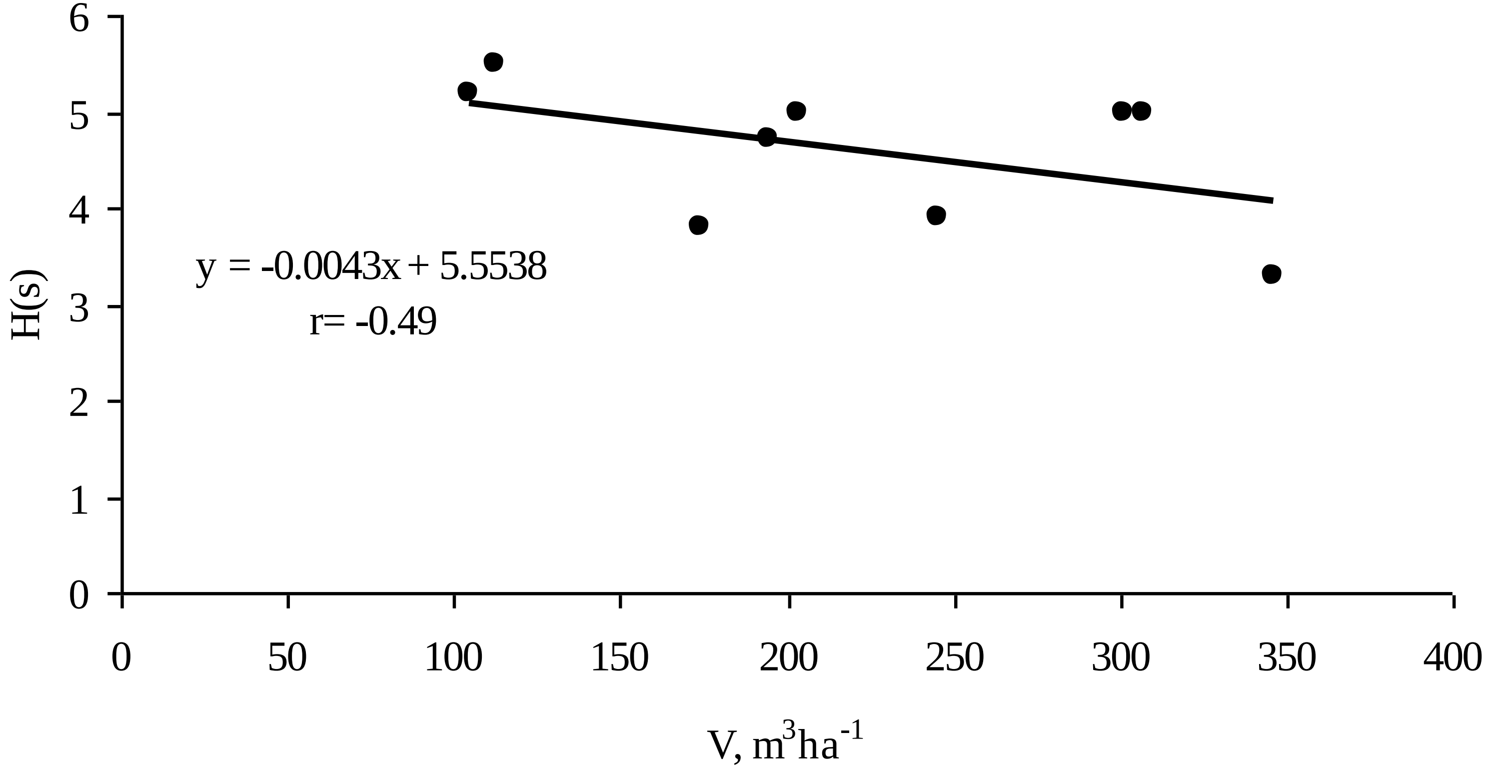
Results

The impact of the number **N** of forest ground cover vegetation species on the values of Shannon-Wiener index **H(s)**.



Results

The impact of the forest stand volume **V** on the values of the Shannon-Wiener index **H(s)**



Results

The comparison of the similarity **Ks** of the ground cover vegetation in Station′s forests after the 35 years.

Site type	1st floor of ground cover vegetation	2nd floor of ground cover vegetation
Forests on drained peat soils	0.433	0.449
Forests on drained hydromorphic mineral soils	0.543	0.586
Dry forests	0.660	0.669

Changes in the number of species and individuals of the biological diversity of ground cover vegetation over the time is characterised by the coefficient of Tschekanovsky **Ks**.

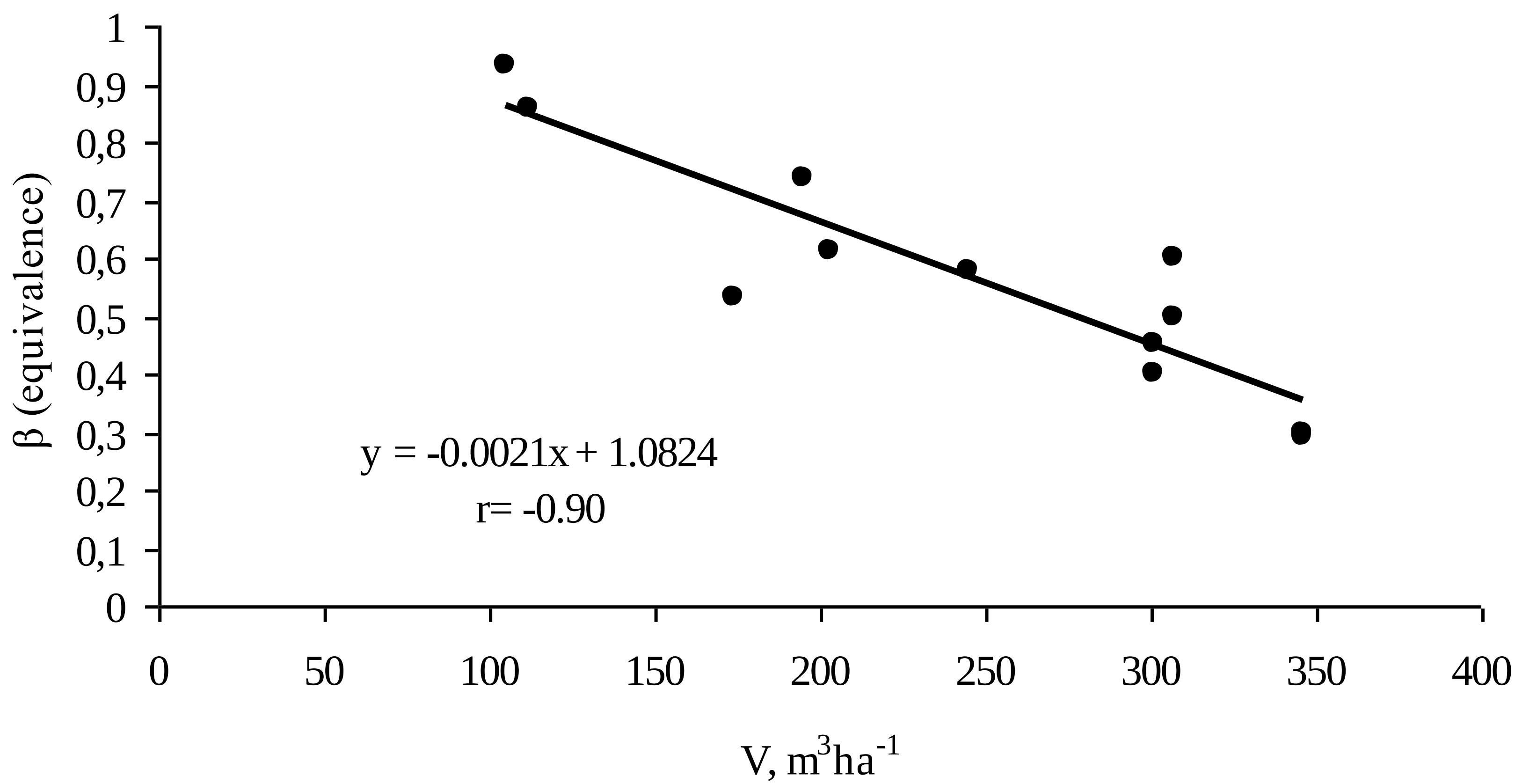
After the 35 years the comparison of the ground cover vegetation is more different in the forests on drained peat soils (**Ks** = 0.44), the similarity is slightly better preserved in the forests on drained hydromorphic mineral soils (**Ks** = 0.56), but in dry forests the ground cover vegetation is the most stable (**Ks** = 0.66).

Results

Approximately 20% of the ground cover vegetation species are represented by the only one individual of a thousand individuals in total. There, in the group of the unique individuals of the Ist floor species of the ground cover vegetation in the forests on drained peat soils, the coefficient of Tschekanovsky is **Ks** = 0.199, in the forests on drained hydromorphic mineral soils **- Ks** = 0.207 and in dry forests **- Ks** = 0.181. It is important to expect that the change of the ground cover vegetation species is an objective reality and the strategy of the nature has to be considered as excellent sound.

Results

The connection between the ecological saturation (equivalence) of the ground cover vegetation **β** and the forest stand volume **V.**



Thank you for your attention!

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