Results of forest soil inventory implemented in 2004-2008 within the scope of the demonstration project *BioSoil*

Soil stability in ecologically and socially vulnerable regions
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International context

- Biosoil project was implemented in the most of European countries within the scope of the *European Council (EC) Regulation No 2152/2003 'Forest Focus'*, including:
  - monitoring of air pollution effects on forests on the basis of the systematic network of observation points (level I);
  - intensive and continuous monitoring (level II).
- The plots were established earlier with the scope of activities of European Economical Comission (EEC) Regulation No 3528/86 and 1696/87 and EC regulation No 1091/94.
- The BioSoil project is aimed to develop European scale harmonized approach in monitoring of forest soil and biodiversity.

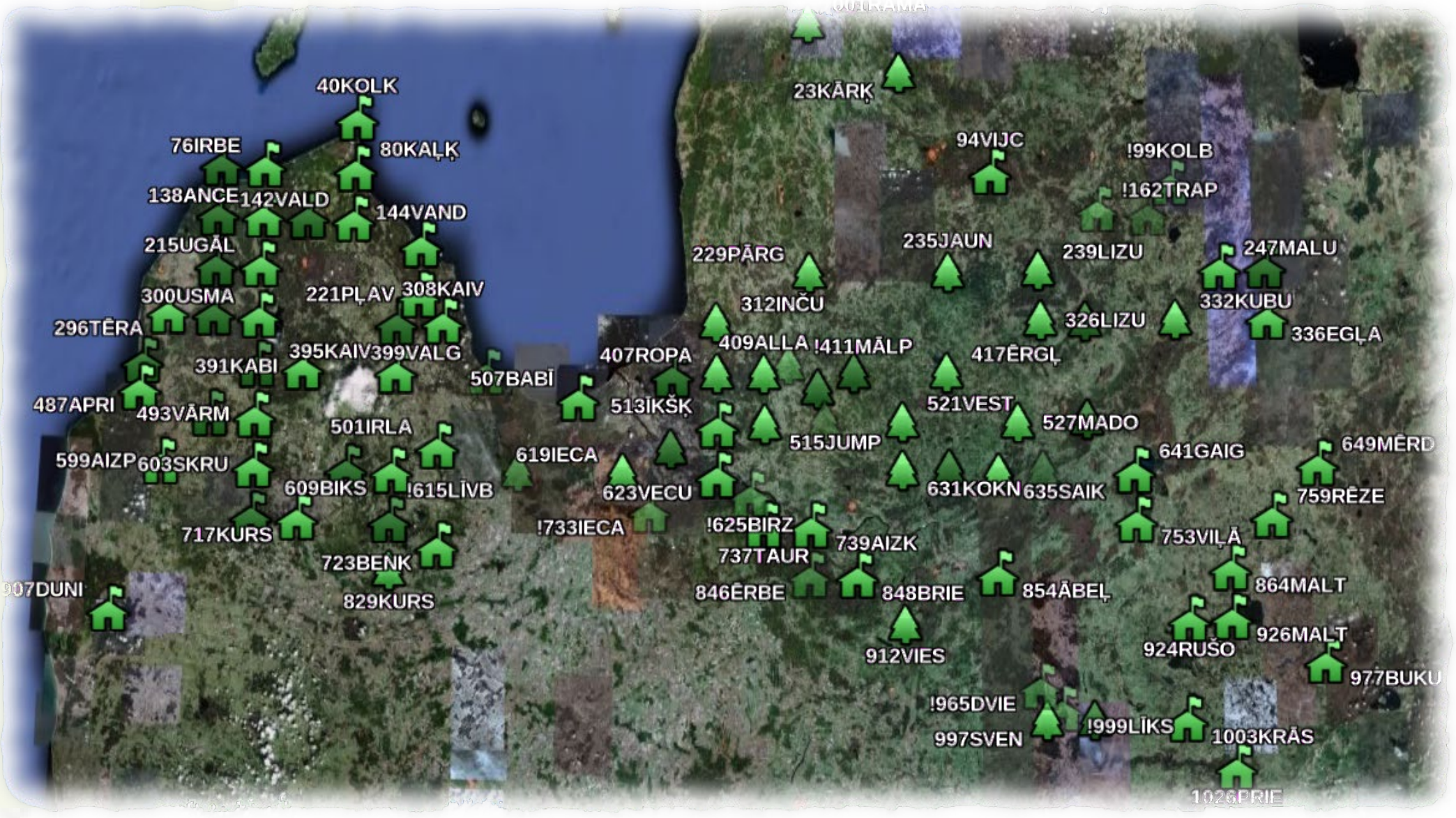
National context

- BioSoil activities in Latvia included:
  - complete soil inventory according to the World Reference Base for Soil Resources (*PAK 2006*) in 16 x 16 km grid (*95 plots*);
  - sampling and analyses of composite soil samples from certain depths (*organic layer, 0-10 cm, 10-20 cm, 20-40 cm and 40-80 cm*);
  - estimated soil properties in composite samples were:
    - bulk density and soil texture;
    - water and calcium chloride ($CaCl_2$) extractable pH,
    - total and carbonate carbon (C),
    - total nitrogen (N) and sulphur (S),
    - barium chloride ($BaCl_2$) exchangeable cations and free acidity,
    - aqua regia extractable cations,
    - reactive (*ammonia acetate extractable*) alluminium (Al) and iron (Fe).

A scope of this presentation

- Evaluation of certain results of analyses of composite samples:
  - methodology applied for composite samples;
  - chemical and physical parameters, including soil pH, texture, total N and C content.

Distribution of sample plots



Materials and methods: sampling

- Soil profile samples:
  - profile pits were located outside monitoringa plot;
  - samples were taken from down to 2.5 m depth from each horizon, including;
    - bulk density samples (3 x 100 cm^3) from each horizon, except upper organic (*litter*) layer, where steal square of certain area were used for full depth sampling,
    - samples for chemical analyses (at least 0,5 kg) from each horizon,
- Composite samples:
  - samples were taken from 8 smaller pits outside monitoring plot (*equal distance from center in N, E, W and S directions*);
  - sampling depth – litter, 0-10, 10-20, 20-40 and 40-80 cm;
    - bulk density samples (*24 x 100 cm^3*) + 24 litter samples, if available,
    - samples for chemical analyses – up to 40 samples from a plot (*1-3 kg each*).

Materials and methods: Profile pit

Materials and methods: Soil inventory

- Soil inventory was done according two systems:
  - Latvian National classification system (Kārkliņš, 2008);
  - World Reference Base for Soil Resources (World Reference Base for Soil Resources, 2006).
- Contractors from Latvian University of agriculture and Latvian University were used for soil inventories.

Materials and methods: Sample preparation

- Soil samples were prepared for analyses according to LVS ISO 11464 standard. Fine earth fraction of soil ($Ø < 2\ mm$) was used for chemical and texture analyses.

Materials and methods: Analyses

- Composite samples (*only parameters evaluated in this presentation*):
  - bulk density according to LVS ISO 11272, 1998;
  - texture according to LVS ISO 11277, 2000;
  - pH in water and calcium chloride ($CaCl_2$) extraction according to LVS ISO 10390, 2002;
  - carbonates according to LVS ISO 10693:1995, 1999;
  - total C according to LECO, 1987 (*organic C calculated by substracting carbonates from total C*);
  - total N according to LVS ISO 11261, 2002.
- All results were validated before submission according to validity tables provides by the ICP Forests.

Results and discussion: Soil acidity

- 45 % of Latvian forests have strong acidic pH of O/H horizons.
- 42 % of the forests has acidic pH of the O/H horizon layer.
- 18 % of soils in 40-80 cm layer has moderately alkaline pH reaction and in 13 % of soils has weakly alkaline reaction.

Dominant specie	*Soil layer (depth)*					
	O horizon	*0-10 cm*	*10-20 cm*	*20-40 cm*	*40-80 cm*	*Average*
Aspen (Populus tremula L.)	4.6	5.6	5.9	6.2	7.1	6.0
Birch (Betula pendula Roth)	5.0	5.5	5.9	6.3	7.2	6.1
Spruce (Picea abies (L.) H.Karst.)	4.4	5.2	5.8	6.3	6.9	5.8
Pine (Pinus sylvestris L.)	4.0	4.7	5.2	5.6	6.0	5.2

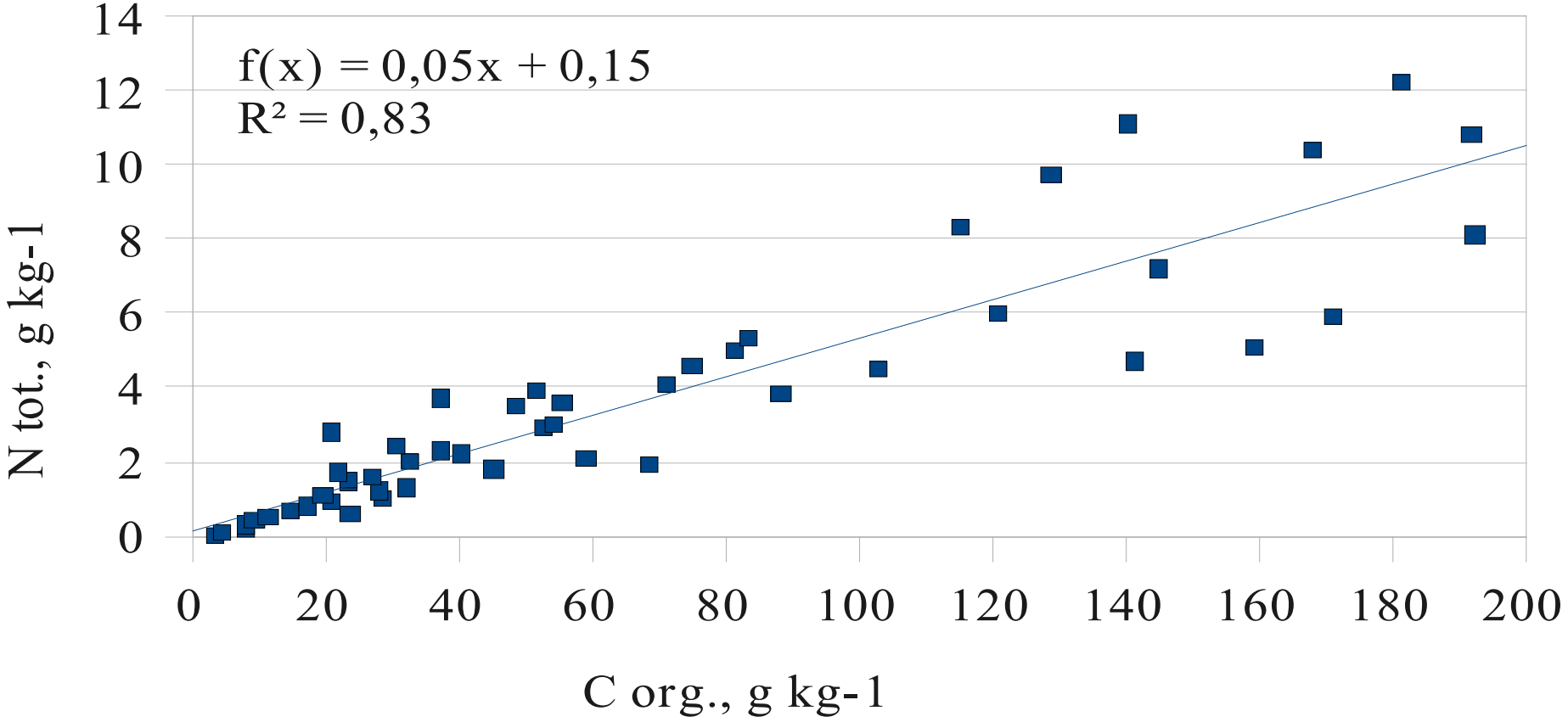
Results and discussion: Total N

- The highest content of N is in O horizon in aspen and spruce stands (*17.8 and 17.5 g kg^{-1}*), but difference isn't significant.
- The highest content of N in deeper soil layers (40-80 cm) found in birch stands (*3.1 g kg^{-1}*).

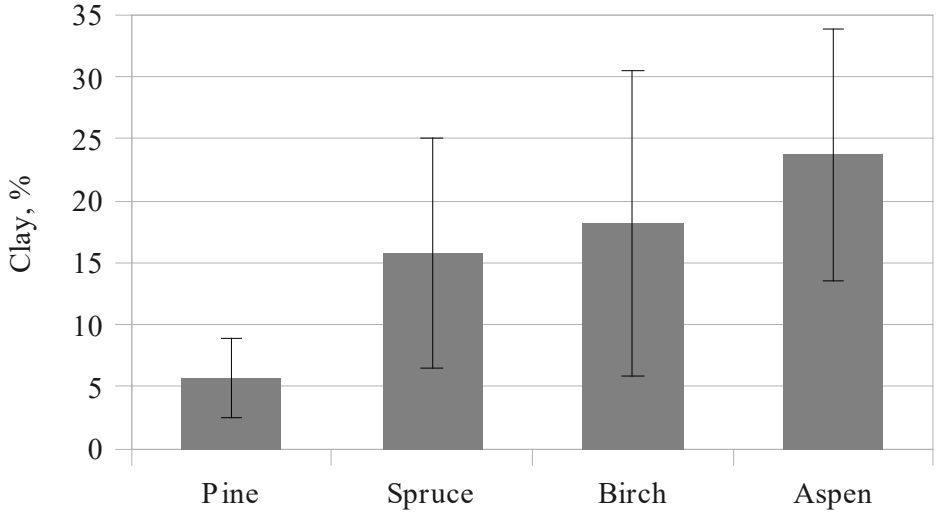
Dominant specie	*Soil layer*					
	O horizon	*0-10 cm*	*10-20 cm*	*20-40 cm*	*40-80 cm*	*Average*
Aspen (Populus tremula L.)	17.8	2.0	0.8	0.5	0.2	2.8
Birch (Betula pendula Roth)	16.9	5.7	4.4	2.8	3.1	5.4
Spruce (Picea abies (L.) H.Karst.)	17.5	5.1	3.7	2.8	2.4	5.4
Pine (Pinus sylvestris L.)	16.1	4.6	2.7	2.1	2.1	5.3

Results and discussion: Corellation between $C_{org.}$ and N

- There is a significant correlation (R^2 of linear equation = 0.83) between organic C and total N in mineral forest soils.



Results and discussion: Soil texture



- The highest content of clay found in aspen and birch stands.
- Soils under pine stands have considerably smaller concentration of clay particles.
- Negative linear correlation (R^2 = 0,82) found between spruce stand index and share of clay particles at 40-80 cm depth.
- In pine stands clay improves growth of trees, correlation between clay content and site index is positive (R^2 = 0,71).

Results and discussion: Carbon stock in Latvian forest soils

Soil layers	$C_{org.}$, *t ha*$^{-1}$	$C_{org.}$, *mill.t*	± *mill.t* $C_{org.}$
	Mineral soils		
O horizon	20.9	55.6	2.1
0-10 cm	65.1	173.1	18.6
10-20 cm	39.7	105.6	20.2
20-40 cm	38.9	103.4	38.1
40-80 cm	50.9	135.3	24.5
Total	215.4	573.0	103.5
	Peat (organic) soils		
O horizon	31.3	8.7	2.2
0-10 cm	71.2	19.8	8.2
10-20 cm	76.4	21.3	7.1
20-40 cm	153.2	42.6	21.2
40-80 cm	319.1	88.8	42.3
Total	651.1	181.2	81.1
Organic and mineral soils	-	754.2	184.7

Summary and conclusions

- Unified approach of the soil monitoring can be used in forest research to characterize growing conditions.
- Organic surface layers (O horizon) of forest soil are acidic or weakly acidic (deciduous stands). The most visible effect of acidification found in spruce stands.
- The lowest content of N in soil found in aspen stands, but in the litter no specie specific difference was found.
- Strong correlation found between dominant specie, site index and content of clay particles in soil (*spruce and pine grows better of loamy soils with clay content 7-10 %*).
- Carbon stock in Latvian organic forest soils (*Histosols*) in 0-80 cm soil layer is 651 t ha^{-1} and in mineral soils – 215 t ha^{-1}, including O horizon, or 754 mill.t in total.

Thank you for attention!

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