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DENDROCHRONOLOGICAL RESEARCH OF SCOTS PINE (*Pinus sylvestris* L.) GROWING IN VILNIUS AND KAUNAS FOREST PARKS

Vida Stravinskienė[1], **Asta Šimatonytė**

Dept of Environmental Sciences, Vytautas Magnus University,
Vileikos al. 8, LT-44404 Kaunas, Lithuania
E-mail: [1]*v.stravinskiene@gmf.vdu.lt*

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Abstract. This study is aimed at dendrochronological indication of unfavourable environmental conditions in Vilnius and Kaunas cities on Scots pine's (*Pinus sylvestris* L.) radial increment and comparison of city trees growth with the tree growth in relatively unpolluted areas (control forest stands). 330 sample trees in Kaunas and 456 sample pines in Vilnius city and forest parks, 72 sample pines in 3 control forest stands at the distance of 30 km west from Kaunas city were chosen for the radial growth analysis. It was determined that tree radial increment (in per cent) of transformed pine dendroscales is lower in cities than in control stands. These alterations were caused by environmental disturbances: exceptionally cold winter in 1979/1980 and air pollution level which was considerably higher in cities than in controlled stands. Though transport emission has constantly been growing since 2000, no clear difference between pine radial growth dynamics in controll stands in Kaunas and Vilnius sample plots was detected.

Keywords: dendrochronological indication, Scots pine, radial increment, urban environment, air pollution.

1. Introduction

Forest ecosystems in cities are exposed to a variety of natural and anthropogenic factors. Trees growing in cities are less protected from negative impacts compared to the trees in natural forest ecosystems (Stravinskienė 1997, 2000; Petersen 1992).

Air pollution is one of the reasons for the forest decline (Schweingruber 1996; Manion and Lachance 1992; Juknys *et al.* 2003; Ozolinčius 1998). The presence of trees affects flow dynamics and associated dispersion of local air pollutants. Vegetation is affected by polluted air directly through assimilation apparatus and indirectly via polluted precipitation and soil. Air pollution intensifies the processes of tree obsolescence (Banks 1992; Lovelius 1997) and often causes the decrease of annual radial increment (Manion and Lachance 1992; Lovelius 1997; Stravinskienė 2002; Juknys *et al.* 2002). Tree resistance to the impact of climatic factors (temperature, precipitation amount) changes in a polluted environment and their sensitivity increases (Juknys *et al.* 2002).

Air emission from Lithuanian industry and energy sectors decreased almost 5 times in the last decade of the 20th century (Juknys 2003). However, there is great concern about the increasing emissions from different transport sources. Due to the increasingly strong restrictions, concentration of pollutants has constantly been reduced by many countries in the world. Nevertheless, concentration of air pollutants remains high in poor countries (Baldasano *et al.* 2003; Mayer 1999).

Air pollution was steadily growing in cities during the last decade, owing to an increase in number of cars, the average car age reaching more than 10 years, and the existence of an inefficient car flow management system (Juknys 2004; Kvietkus 1999). Today transport emission is the main air pollution source making over 80 per cent of total emission in Vilnius and Kaunas cities (Kvietkus 1999; Žičkus *et al.* 1999; Valiulis *et al.* 2002).

According to Kaunas and Vilnius cities municipality data, forests, forest parks and parks cover 31 % of the total Vilnius city area (40 thousand ha) and 24 % of the total Kaunas city area (3.7 thousand ha). Scots pine (*Pinus sylvestris* L.), prevailing in Kaunas and Vilnius cities forest parks and parks, is a very sensitive environmental indicator (Stravinskienė 1997, 2002; Juknys 2004b). Therefore, dendrochronological data can be a useful tool evaluating the impact of the changing conditions in urban environment (Schweingruber 1996; Stravinskienė 2002).

The aim of this study was to test the hypothesis that Scots pine radial growth indicates unfavourable environmental conditions in Vilnius and Kaunas cities in comparison to relatively clean environment in Lekėčiai forest district. For this reason, the level of radial increment of sampled trees in transformed pine dendroscales is lower in cities than in control stands.

2. Methodology

Using international monitoring methodology (UN/ECE 1994) 330 sample Scots pine (*Pinus sylvestris*) trees in 15 sample plots situated in Kaunas city parks and forest

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parks and 456 sample pines in 19 sample plots in Vilnius city parks and forest parks were chosen for radial growth analysis. Sample plots were named after the area they grew. Sample plots, varying in pine age, were divided into 3 groups – 60–70, 80–90 and 160–180 year old pine sample plots.

The distribution of sample plots in Kaunas and Vilnius cities is presented in Fig. 1. Three control forest stands (60–70 year old control stand is shown in Control 1, 80–90 year old in Control 2, and 160–180 year old in Control 3) were chosen in Lekėčiai forest district 30 km west from Kaunas city.

Fig. 1. Distribution of sample plots in Kaunas (A) and Vilnius (B). Sample plots of 60–70 year old pines are marked by circles; sample plots 80–90 year old pines by rectangles; sample plots in ellipses – 160–180 year old pines

Common stocking level of selected sample stands younger than 90 years was from 0.7 to 0.8, stocking level of pines older than 90 years – 0.6–0.5 in Kaunas and Vilnius parks and forest parks. III–IV bonitet class was dominant.

Prevailing forest site types were normal moisture light loamy soils (Ncl) and light sandy loam soils (Nbl). Common forest types were *Pinetum oxalidosum* and *Pinetum vacciniosum*. Forest valuation data for each sample plot was obtained from Lithuanian State Forest Survey Service inventory database (2003).

In order to correspond to the environmental conditions, control stands were selected in normal moisture, light sandy loam soils in *Pinetum vacciniosum* forests in sample plots of Vilnius and Kaunas forest parks.

24 cores were collected in each sample plot with a Pressler's borer in Lekėčiai forest district, Kaunas and Vilnius cities, except the Botanical garden (8 cores) and Raudondvaris_2 (10 cores) sample plots. For radial increment dynamics analysis east-west side wood samples were taken from all selected trees at the height of 1.3 metres.

Wood samples were measured with automatic annual ring parameters, measuring line LINTAB, connected with TSAP (Time Series Analysis and Presentation) program. The accuracy of the measurements was ± 0.01 mm (Stravinskienė 1997, 2002).

In order to reduce the impact of site type and age trend on pine radial growth, sequences of estimated annual radial increment (dendroscales) were transformed into relative dimensions (per cents) in each sample plot. Mean value of estimated radial increment in 1950–1960 was equated to 100 per cent radial increment for 60–70 year old pines, respectively – mean of radial increment in 1945–1955 period for 80–90 and 160–180 year old pines. Estimated radial increment values were divided by the relative 100 % increment value and multiplied by 100 %.

For research of pine radial increment variation in areas with high pollution, methods of control stands, comparison of damaged and healthy individual trees or periods before and after the beginning of pollution are usually applied (Juknys *at al.* 2002; Stravinskienė 2002). For example, results of a study in Hamadera park in Sakai and Takaishi cities (Japan) and Keino-Matsubara park located on Awaji Island showed that the decrease of Japanese black pine increment in 1960–1970 period which was mainly caused by CO_2 gas (Hirano and Morimoto 1999).

Period for relative 100 % pine radial growth was selected reasonably. Firstly, the period had to be short (no longer than 10 years) to avoid the impact of age trend, secondly the environment in cities and in Lekėčiai forest district was relatively clean. Environment in cities in the period after the Second World War was relatively clean till 1960, as industry sector was destroyed and not yet restored, the amount of mobile pollution sources was not significant.

Transformed series of Scots pine radial increment from Vilnius and Kaunas cities were compared with transformed dendroscales from control stands. Student's criterion (Hestie *et al.* 2001) was used to verify the hypothesis that means of radial increment (in per cent) differed in cities and control stands in the period of 1981–1995.

3. Results

As radial growth rate of Scots pine (*Pinus sylvestris* L.) is sensitive to environmental conditions changes , annual radial increment was used as an indicator for climatic and anthropogenic impact assessment. Lower radial increment was expected in cities due to the effect of air pollution and other negative factors of urban environment in comparison with rather favourable for tree growth environmental conditions of Lekėčiai forest district. Transformed dendroscales of Scots pine annual radial increment from Vilnius, Kaunas cities and control sample plots are presented in Figs. 2–7.

Significant annual radial increment decrease of pines in 1977–1982 was related to unfavourable for growth climatic conditions, especially the winter frosts of 1978–1979. Increment decrease was also affected by environmental pollution, the adverse effect of which became even stronger on tree condition and growth after the climatic extremes. Another increment reduction period started in 1990 and continued till 1994. In 1995 and 1996 noticeable stabilization of increment decrease was conditioned by the depression of industrial sector and decline phase of the 11-year solar activity cycle.

Periods of good growth in 1968–1974 and 1983–1989 were close to annual radial increment cycles of Lithuanian forests and facilitated by favourable eco-climatic background.

In most cases fluctuations of Scots pine (*Pinus sylvestris* L.) radial increment in transformed series were more or less similar in cities and in control forest stands, but only till 1980. It can be explained, that pine trees suffered stress caused by freezing winter of 1979 (average winter temperature was –8.8 °C in Vilnius and –8.3 °C in Kaunas cities). Recovering of annual radial increment after the stress was faster in control stands and in sample plots located further from city centres (Burbiškės, Eiguliai, Lazdynėliai, Dvarčionys) than in the city centre areas.

General tendency of decreasing transformed increment through the time scale was determined by the age trend - radial increment decreased gradually with increasing pine age.

Common transformation of radial increment sequences into radial increment index sequences (which uses methods of running averages or exponential age trend elimination) eliminates not only age trend, but also reduces radial growth indicative sensitivity for changes in environmental condition. In this study tree growth indicative sensitivity was very important, thus original transformation way (mentioned above in section 2. Methods) was chosen.

Periods of 1947–1950, 1966–1968, 1974–1976, 1983–1985, and years 1990, 2001 and 2004, having optimum climatic conditions (optimal vegetation period temperature and sufficient precipitation amount), were favourable for pine growth and respectively determined

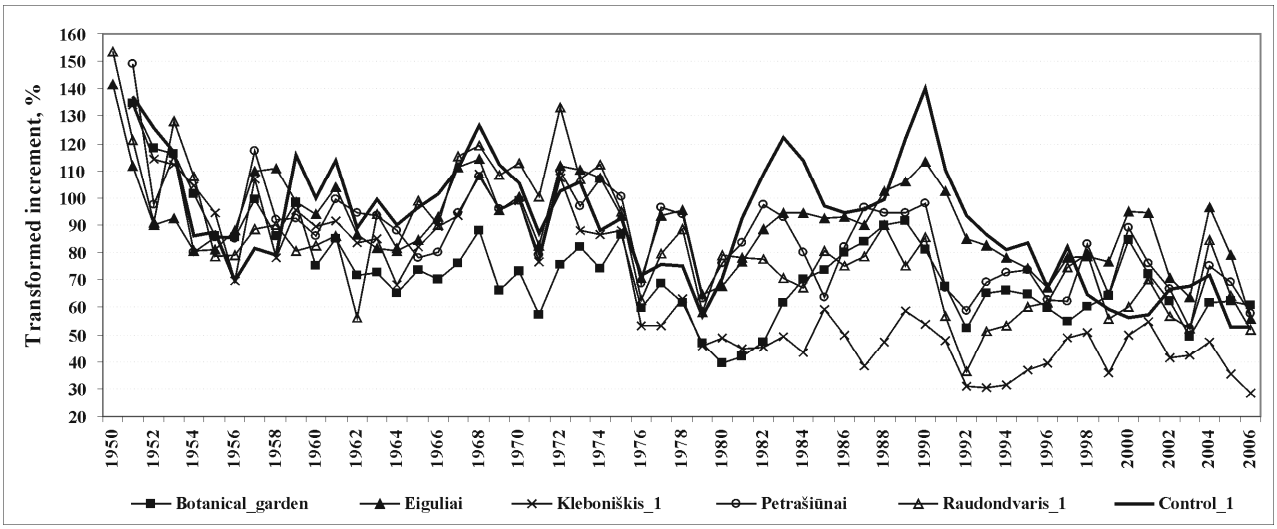

Fig. 2. Transformed dendroscales of 60–70 year old pines in Control_1 and Kaunas city sample plots

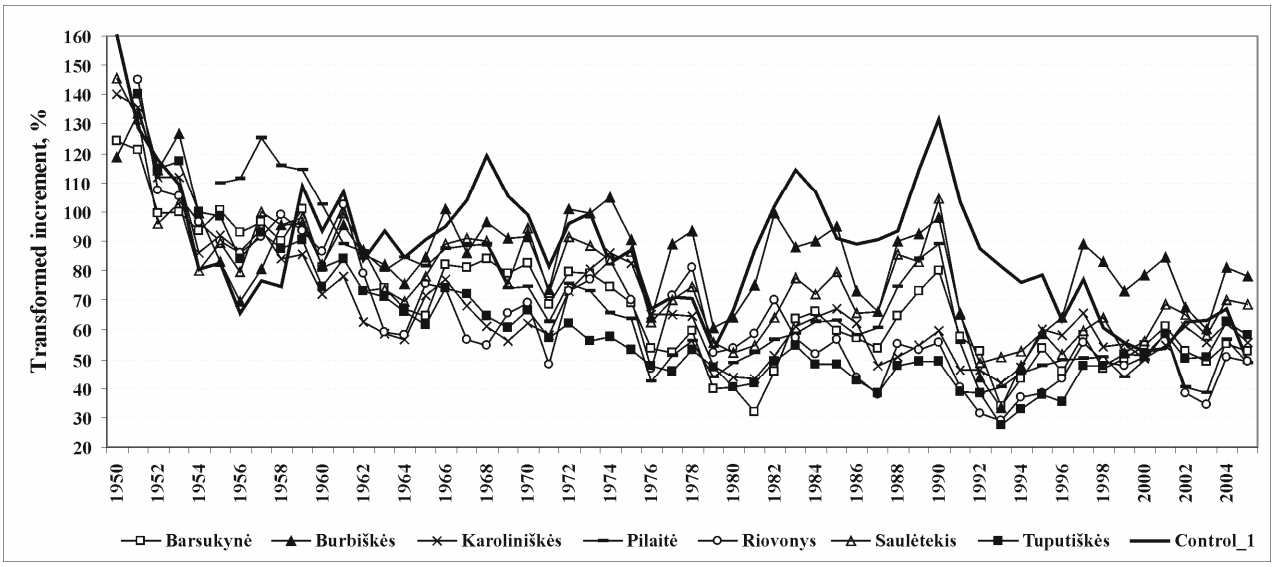

Fig. 3. Transformed dendroscales of 60–70 year old pines in Control_1 and Vilnius city sample plots

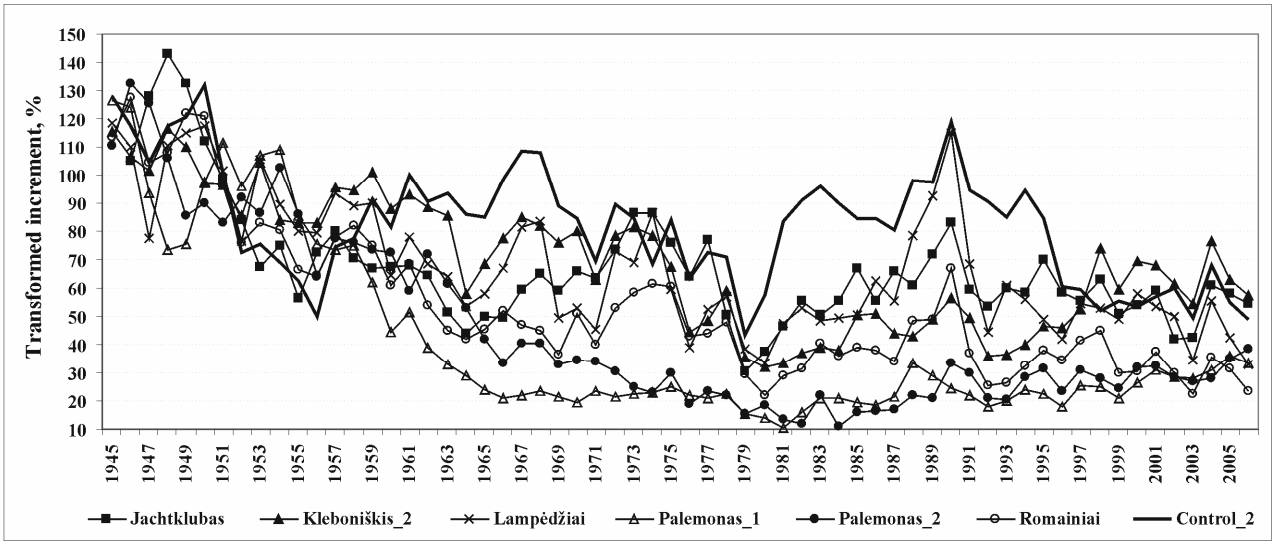

Fig. 4. Transformed dendroscales of 80–90 year old pines in Control_2 and Kaunas city sample plots

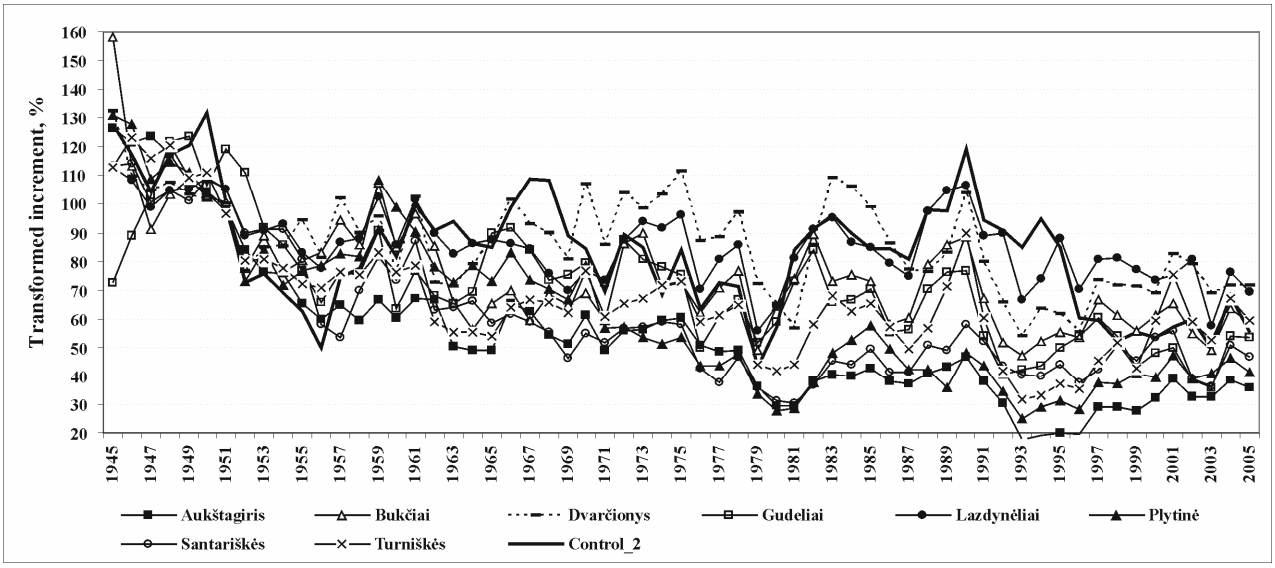

Fig. 5. Transformed dendroscales of 80–90 year old pines in Control_2 and Vilnius city sample plots

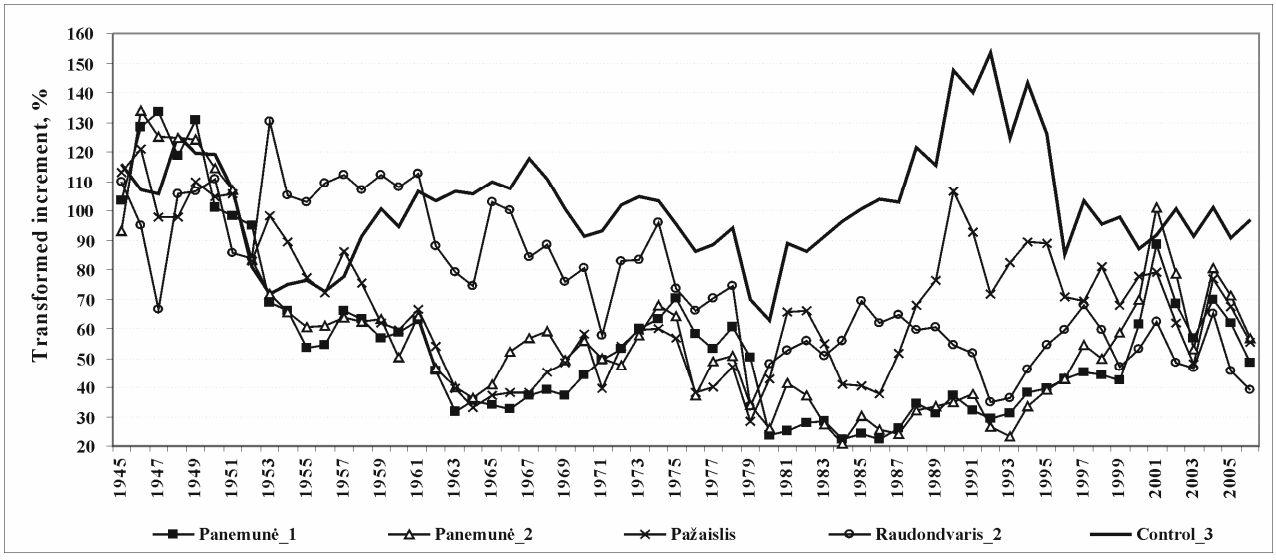

Fig. 6. Transformed dendroscales of 160–180 year old pines in Control_3 and Kaunas city sample plots

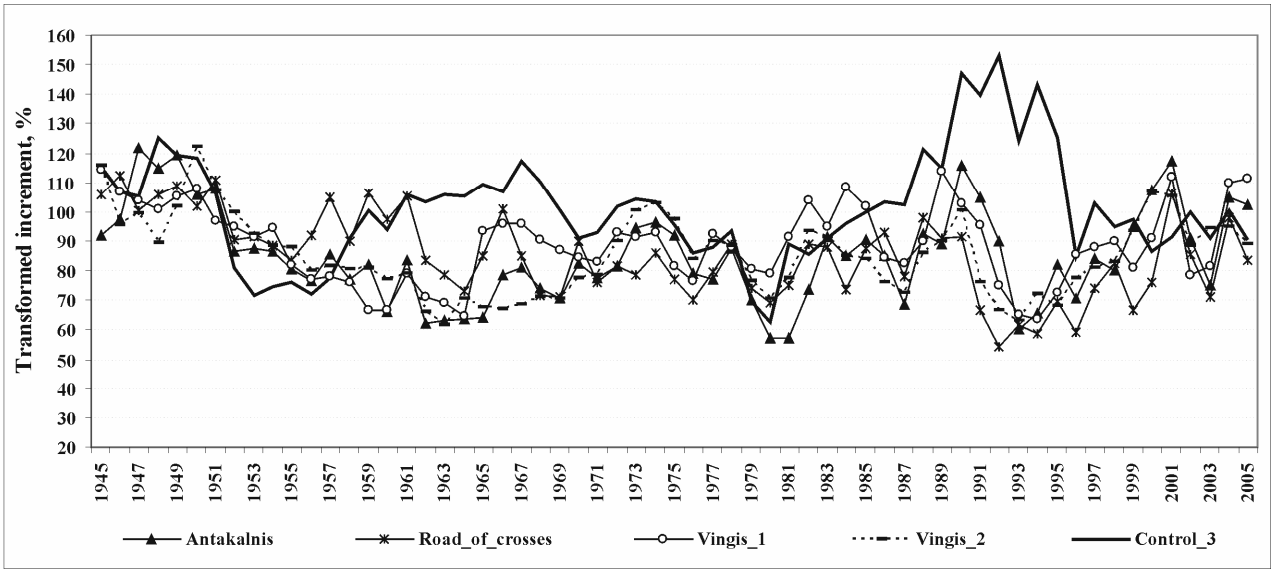

Fig. 7. Transformed dendroscales of 160-180 year old pines in Control_3 and Vilnius city sample plots

maximum values of transformed annual radial increment. Minimum of radial increment values were detected in cold periods of 1956, 1979–1980 and droughts in 1992–1994, 1996 and 2003.

Transformed radial increment series of 60–70 year old trees in Kaunas (Fig. 2) and Vilnius (Fig. 3) cities, of 80–90 year old pines in Kaunas (Fig. 4) and Vilnius (Fig. 5) cities and of 160–180 year old pines in Kaunas (Fig. 6) and Vilnius (Fig. 7) cities reflect three strong climatic disturbances (the cold in 1956, freezing winter of 1956 1979/1980, also drought in 1996), which affected further radial growth dynamics.

No differences were detected in transformed radial increment between cities and control stands until the first climatic disturbance. Stress made trees weaker and more sensitive to changes in environment. Industry sector in cities, recovering after the Second World War, determined gradual increase of air pollution, which might have been the reason for slightly better Scots pine radial growth in control stands than in cities during 1963–1979 period, though significant differences were not detected.

The second climatic disturbance, when pine trees suffered stress caused by freezing winter in 1979/1980 (mean winter temperature was –8.8 °C in Vilnius and –8.3 °C in Kaunas cities), had a major impact on their growth. Weakened pine trees in cities could no longer resist the negative effect of increasing anthropogenic load. 1981–1995 year period revealed that environmental conditions for Scots pine radial growth in Vilnius and Kaunas were significantly worse (Table), in comparison to relatively clean environment of Lekėčiai forest district.

Crisis in industrial sector, following the reduction of air pollution was determined by collapse of the Soviet Union. Reaction of trees to reduction of air pollution was late due to accumulation processes. Pine trees in Kaunas and Vilnius cities fully recovered after 1979/1980 stress and years of high air pollution (1980–1990) only in 1996, when transformed dendroscales became alike both in control stands and sample plots in cities. However, the recovery of annual radial increment after the stress, caused by extreme weather conditions, was most rapid in control stands and in sample plots in Burbiškės, Eiguliai, Lazdynėliai and Dvarčionys, located further from Vilnius and Kaunas central districts.

Although transport emission has constantly been growing in cities since year 2000, the difference between pine radial growth dynamics in control stands in Kaunas and Vilnius sample plots has not yet been detected. Probably next strong climatic disturbance will highlight this difference in transformed series of radial increment of Scots pine.

The comparison of transformed radial increment means of control stands and sample plots in Kaunas and Vilnius cities in 1981–1995

Sample plot in Kaunas city forest parks	Student's criterion (t)	Significance (p)	Sample plot in Vilnius city forest parks	Student's criterion (t)	Significance (p)
60–70 year old pines					
Botanical_garden	5.90	0.000	Barsukynė	7.72	0.000
Eiguliai	2.17	0.039	Burbiškės	3.25	0.003
Kleboniškis_1	11.91	0.000	Karoliniškės	9.48	0.000
Petrašiūnai	3.85	0.001	Pilaitė	6.80	0.000
Raudondvaris_1	5.93	0.000	Riovonys	9.71	0.000
			Saulėtekis	4.96	0.000
			Tuputiškės	12.07	0.000
80–90 year old pines					
Jachtklubas	8.87	0.000	Aukštagiris	16.47	0.000
Kleboniškis_2	15.92	0.000	Bukčiai	5.28	0.000
Lampėdžiai	5.24	0.000	Dvarčionys	2.10	0.045
Palemonas_1	24.96	0.000	Gudeliai	6.93	0.000
Palemonas_2	22.98	0.000	Lazdynėliai	1.14	0.263
Romainiai	14.62	0.000	Plytinė	14.60	0.000
			Santariškės	15.63	0.000
			Turniškės	7.65	0.000
160–180 year old pines					
Panemunė_1	14.33	0.000	Antakalnis	3.72	0.001
Panemunė_2	14.01	0.000	Road_of_crosses	4.35	0.000
Pažaislis	5.94	0.000	Vingis_1	2.60	0.015
Raudondvaris_2	9.84	0.000	Vingis_2	4.09	0.000

The study resulted in a comparative analysis of transformed scales of radial increment for the period from 1945 to 2005 in each pine age group in Vilnius and Kaunas sample plots.

Significant difference was estimated in 66 % cases in 60–70 year old pine group, 67 % – in 80–90 year old pine group and 100 % – in 160–180 year old pine group. Transformed increment was higher in Kaunas city sample plots than in Vilnius. Moreover, 87 % of significant difference cases were in the youngest pine tree group.

In other two groups the results were contrary: in Vilnius city sample plots transformed radial increment of Scots pine was higher than in Kaunas. It was noticed, that 84 % of significant difference cases were in 80–90 year old group and 100 % in 160–180 year old group.

Largest differences of transformed radial increment sequences in control stands in forests and sample plots in cities were estimated in the oldest pine tree group, meaning that the oldest pines were the most sensitive to environmental changes. It seemed that the hypothesis the larger the city, the higher level of air pollution could have been true. Therefore, lower increment sequences were expected to occur in Vilnius. Deeper studies of air pollution dynamics in Kaunas and Vilnius cities revealed that this hypothesis was not true.

In the period of 1988–1990 concentration of some pollutants was higher in Kaunas city than Vilnius (mean annual concentration of nitrogen dioxide in Kaunas was 60.0 μg/m^3, in Vilnius – 30.0–40.0; concentration of dust in Kaunas – 200.0 μg/m^3, in Vilnius – 100.0 μg/m^3; sulphur dioxide in Kaunas was the same as in Vilnius – 10.0 μg/m^3).

In comparison concentration of some pollutants was 1–7 times lower in Kaunas and Vilnius cities (mean annual concentration of nitrogen dioxide in Kaunas was 27.0 μg/m^3, in Vilnius – 30.0 μg/m^3; concentration of dust in Kaunas – 70.0 μg/m^3; sulphur dioxide in Kaunas – 3.0 μg/m^3; in Vilnius – 1.5 μg/m^3) in 2005.

4. Conclusions

1. Till 1980 Scots pine (*Pinus sylvestris* L.) radial growth dynamics in Vilnius and Kaunas cities and in control forest stands, resembling forest site type characteristics, had had a similar trend.

2. Exceptionally cold winter in 1979/1980 reduced Scots pine (*Pinus sylvestris* L.) tree resistance to negative impact of air pollution in cities. Reduction of tree radial increment during 1981–1995 year period was determined by unfavourable environmental conditions in Kaunas and Vilnius sample plots due to higher air pollution compared with relatively clean environment in control stands.

3. It took from 5 to 7 years for Scots pine (*Pinus sylvestris* L.) trees in Kaunas and Vilnius cities to recover after the period of heavy air pollution (1980–1990), thus transformed dendroscales became uniform with dendroscales in Lekėčiai forest district only in 1996.

4. Although transport emission has constantly been growing since 2000, the difference between Scots pine (*Pinus sylvestris* L.) radial growth dynamics in control forest stands and in Kaunas and Vilnius sample plots has not been detected.

References

Baldasano, J.; Valera, E.; Jimenez, P. 2003. Air quality data from large cities, *The Science of the Total Environment* 307: 141–165.

Banks, J. 1992. A review of the use of tree rings for the quantification of forest disturbances, *Tree Rings and Environment, LUNDQUA report* 34: 3–13.

Hestie, T.; Tibshirani, R.; Friedman, J. 2001. *The Elements of Statistical Learning: Data Mining, Inference and Prediction.* Wien-NewYork: Springer. 536 p.

Hirano, T.; Morimoto, K. 1999. Growth reduction of the Japanese black pine corresponding to an air pollution episode, *Environmental Pollution* 106: 5–12.

Juknys, R. 2003. Transition period in Lithuania – Do we move to sustainability? *Environmental Research, Engineering and Management* 4: 4–9.

Juknys, R. 2004a. Pagrindinės Kauno miesto aplinkos pokyčių tendencijos, iš *Kauno miesto ekologinis monitoringas. Aplinkos tyrimai ir vertinimas 1993–2003.* Kaunas: VDU leidykla, 7–16.

Juknys, R. 2004b. Tree-ring analysis for environmental monitoring and assessment of anthropogenic changes, *Environmental Monitoring*. London: CRC Press, 347–369.

Juknys, R; Stravinskienė, V.; Venclovienė, J. 2002. Tree-ring analysis for the assessment of anthropogenic changes and trends, *Environmental Monitoring and Assessment* 77: 81–97.

Juknys, R.; Vencloviene, J.; Stravinskiene, V.; Augustaitis, A.; Bartkevicius, E. 2003. Scots pine (*Pinus sylvestris* L.) growth and condition in a polluted environment: from decline to recovery, *Environmental Pollution* 125(2): 205–212.

Kvietkus, K. 1999. Air pollution tendencies in Vilnius city, *Environmental and Chemical Physics* 21 (3–4): 72–77.

Lovelius, N. V. 1997. *Dendroindication of natural processes and anthropogenic influences*. St. Petersburg: World & Family-95. 320 p.

Mayer, H. 1999. Air pollution in cities, *Atmospheric Environment* 33: 4029–4037.

Manion, P. D.; Lachance, D. 1992. Forest decline concepts: an overviev, in *Forest decline concepts* (eds. P. D. Manion and D. Lachance). St. Paul, Minnesota, USA, 181–190.

Ozolinčius, R. 1998. *Lithuanian conifers: morphological structure transformation and factors indicating them*. Kaunas: Lututė. 298 p.

Petersen, A. 1992. The effect of soil treatment on the growth of damaged street trees, *Tree Rings and Environment* 34: 264–268.

Schweingruber, F. H. 1996. *Tree Rings and Environment. Dendroecology*. Berne-Stuttgart-Viena: Paul Haupt Publishers. 609 p.

Stravinskienė, V. 1997. Pušynų dendroekologiniai tyrimai ir jų taikymas gamtinės aplinkos būklės pokyčių indikacijai [Dendroecological studies of pine forests and their application for indication of the environmental status], *Ekologija* 2: 62–72.

Stravinskienė, V. 2000. Kauno miesto Kleboniškio miško parko pušų (*Pinus sylvestris* L.) būklės monitoringas [Monitoring of Scots pine (*Pinus sylvestris* L.) health condition in Kaunas city Kleboniškis forest park], *Ekologija* 4: 48–53.

Stravinskienė, V. 2002. *Klimato veiksnių ir antropogeninių aplinkos pokyčių dendrochronologinė indikacija* [Dendrochronological Indication of Climatic Factors and Anthropogenic Environmental Trends]. Kaunas: Lututė. 172 p.

UN/ECE. 1994. *Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forest*. Geneva. 172 p.

Valiulis, D.; Čeburnis, D.; Šakalys, J.; Kvietkus, K. 2002. Estimation of atmospheric trace metal emissions in Vilnius City, Lithuania, using vertical concentration gradient and road tunnel measurement data, *Atmospheric Environment* 36:6001–6014.

Žičkus, M.; Kvietkus, K.; Maršalka, A.; Augulienė, V. 1996. An investigation of meteorological effects on urban air quality using carbon monoxide measurement results in Vilnius city, *Atmospheric Physics* 18 (2): 11–20.

PAPRASTOSIOS PUŠIES (*Pinus sylvestris* L.), AUGANČIOS VILNIAUS IR KAUNO MIESTŲ MIŠKO PARKUOSE, DENDROCHRONOLOGINIAI TYRIMAI

V. Stravinskienė, A. Šimatonytė

Santrauka

Dendrochronologiniai tyrimai, atlikti Vilniaus ir Kauno miestų miško parkuose augančiuose paprastosios pušies (*Pinus sylvestris* L.) medynuose ir kontroliniuose medynuose, sąlygiškai neužterštoje aplinkoje (Lekėčių girininkijoje; 30 km į vakarus nuo Kauno), indikuoja blogesnes medžių augimo sąlygas miesto aplinkoje nei vietovėje, kurioje nėra vietinės taršos, tuo laikotarpiu, kai miestų tarša buvo gerokai didesnė ir jos poveikį sustiprino ekstremaliai šalta žiema. Tyrimo tikslas – palyginti paprastosios pušies medžių metinio radialiojo prieaugio dinamiką nepalankiomis miestų taršos sąlygomis su gerokai švaresnėje aplinkoje augančių medžių radialiojo prieaugio rodikliais. Analizei buvo parinkta 330 apskaitos medžių Kauno, 456 apskaitos medžiai Vilniaus miestų parkuose bei miško parkuose ir 72 apskaitos medžiai kontroliniuose medynuose teritorijoje, kurioje nėra vietinės taršos. Nustatyta, kad metinis radialusis prieaugis patikimai skyrėsi tik 1981–1995 m., kai buvo išskirtinai šalta 1979–1980 m. žiema ir oro tarša miestuose buvo daug didesnė nei vietovėje, kurioje nėra vietinės taršos. Nors automobilių transporto emisija nuolat didėja nuo 2000 m., tačiau aiškių skirtumų tarp paprastosios pušies radialiojo augimo kaitos kontroliniuose medynuose bei Kauno ir Vilniaus miestų tyrimo objektuose nenustatyta.

Reikšminiai žodžiai: dendrochronologinė indikacija, paprastoji pušis, radialusis prieaugis, miesto aplinka, oro tarša.

ДЕНДРОХРОНОЛОГИЧЕСКИЕ ИССЛЕДОВАНИЯ СОСНЫ ОБЫКНОВЕННОЙ (*Pinus sylvestris* L.), ПРОИЗРАСТАЮЩЕЙ В ЛЕСНЫХ ПАРКАХ ГОРОДОВ ВИЛЬНЮСА И КАУНАСА

В. Стравинскене, А. Шиматоните

Резюме

Дендрохронологические исследования сосны обыкновенной (*Pinus sylvestris* L.) были проведены в лесных парках городов Вильнюса, Каунаса и контрольных древостоях в относительно чистой окружающей среде (в лесничестве Лекечай в 30 км от г. Каунаса). Целью исследования был сравнительный анализ годичного радиального прироста сосны, произрастающей в неблагоприятной для роста городской среде, по сравнению с произрастающей на территории без локального загрязнения. Для анализа годичного радиального прироста в городских парках г. Каунаса были подобраны 330 учетных деревьев, г. Вильнюса – 456 учетных деревьев и на контрольных участках в лесничестве Лекечай – 72 учетных дерева. Значительное различие в радиальном приросте сосны обыкновенной, произрастающей в городских парках, по сравнению с произрастающей в контрольных древостоях установлено лишь в 1981–1995 гг. (при неблагоприятных для роста климатических условиях экстремально холодной зимы 1979–1980 гг.), когда загрязнение городского воздуха было значительно выше, чем в лесах. Несмотря на увеличение автотранспортной эмиссии с 2000 г., существенных различий в радиальном приросте сосны обыкновенной (*Pinus sylvestris* L.), произрастающей в городских условиях и на территории без локального загрязнения, не установлено.

Ключевые слова: дендрохронологическая индикация, сосна обыкновенная, годичный радиальный прирост, городская среда, загрязнение воздуха.

Vida STRAVINSKIENĖ. Prof. Dr Habil. at Dept of Environmental Sciences, Faculty of Nature Sciences, Vytautas Magnus University (VMU), Lithuania.
Employment: Professor (2001); Associate Professor (1998). Publications: author of 1 monograph, 5 textbooks and study-guides, over 100 scientific publications. Research interests: ecology and environmental sciences, dendrochronology, assessment of anthropogenic impact on natural and urban ecosystems, forest monitoring, biotesting.

Asta ŠIMATONYTĖ. Master (2004), doctoral student (since 2004), Dept of Environmental Sciences, Faculty of Nature Sciences, Vytautas Magnus University (VMU), Lithuania.