[3] Benz-Hellgren1 M., Brandtberg2 P.O., Johansson3 M., Swedjemark4 G., Stenlid5 J., Growth rate of *Heterobasidion annosum* in Norway spruce stand established on forest land and arable land, Scandinavian Journal of Forest Research, vol. 14, pp 402-407, 1999.
[4] Buss1 K., Practical forest typology, Riga: LatZTIZPI, 1981, p 44. (In Latvian).
[5] Gaitnieks1 T., Arhipova2 N., Donis3 J., Stenlid4 J., Vasaitis5 R., Butt Root rot and related losses in Latvian *Picea abies* (L.) Karst. stands. In: Garbeletto1 M., Gonthier2 P. (ed.), 12th IUFRO Conference on Root and Butt Rots, Conference proceedings, USA, pp 177-179, 2007.
[6] Gonthier1 P., Garbelotto2 M.M., Nicolotti3 G., Seasonal patterns of spore deposition of *Heterobasidion* sp. in four forests of the western Alps, Phytopathology, vol. 95, pp 759-767, 2005.
[7] Jansons1 A., Forest management in the context of climate change, LVMI Silava, 2010, p 31 (In Latvian).
[8] Karklins1 A., Gemste2 I., Mezals3 H., Nikodemus4 O., Skujans5 R., Latvian soil identification, Jelgava, 2009, p 240. (In Latvian).
[9] Kiffner1 C., Roßiger2 E., Trisl3 O., Schulz4 R. & Ruhe5 F., Probability of recent bark stripping damage by red deer (*Cervus elaphus*) on Norway spruce (*Picea abies*) in a low mountain range in Germany – a preliminary analysis, Silva Fennica, vol. 42/ issue 1, 2008, Available at: http://www.metla.fi/silvafennica/full/sf42/sf421125.pdf.
[10] Kilevica1 M., Practical plant protection: Diseases and pests, Publishing house Jumava, Riga, 2013, p 79-80. (In Latvian).
[11] Kraft1 G., Dürchforstungen, Schlagstellungen und Lichtungshieben, Beitrage zur Lehre, Hannover, 1884, p 156. (In German).
[12] Langvall1 O., Interactions between Near-Ground Temperature and Radiation, Silvicultural Treatmets and Frost Damage to Norways Spruce Seedlings, Dissertation work, Swedish University of Agricultural Sciences, Alnarp, 2000, p 35.
[13] Lindenmayer1 D.B., Franklin2 J.F., Fischer3 J., General management principles and a checklist of strategies to guide forest biodiversity conservation, Biological conservation, vol. 131, pp 433-445, 2006.
[14] Lindner1 M., Maroschek2 M., Netherer3 S., Kremer4 A., Barbati5 A., Garcia-Gonzalo6 J., Seidl7 R., Delzon8 S., Corona9 P., Kolstrom10 M., Lexer11 J.M., Marchetti12 M., Climate change impacts, adaptive capacity and vulnerability of European forest ecosystems, Forest Ecology and Management, vol. 259, pp 689-709, 2010.
[15] Miezite1 O. Protection and guarding of forests, Part 1. Forest entomology, Salkone, Jelgava, 2015, pp 127-146. (In Latvian).
[16] Miezite1 O., Dubrovskis2 E., Ruba3 J. Tree stem quality and sanitary condition of *Pinus sylvestris* L., *Picea abies* (L.) H. Karst. and *Betula pendula* Roth on afforested agricultural areas, Conference proceedings, Bulgaria, vol. 17/ issue 32, p 999-1006, 2017.
[17] Ozols1 G., Insects living on spruce and pine in Latvia's forests, Zinatne, Riga, 1985, pp 208. (In Latvian).
[18] Pretzsch1 H., Forest dynamics, growth and yield, Springer, Berlin, 2009, p 664.
[19] Ruba1 J., Miezite2 O., Luguza3 S., Impact of risk factor management on the sanitary condition of Norway spruce (*Picea abies* [L.] Karst.) pure stands in Latvia, Journal of Forest Science, vol. 60/ issue 5, pp 181-189, 2014.
[20] Smits1 A. The effectiveness of alternative plant protection against the large pine weevil *Hylobius abietis* L., LVI Silava, Salaspils, 2013, p 16.
[21] Widmer1 S., Saïd2, Miroir3 J., Duncan4 P., Gaillard5 J.-M., Klein6 F., The effects of hurricane Lothar on habitat use of roe deer, For. Ecol. Manage., vol. 195, pp 237-242, 2004.

SOIL TEMPERATURE IN NORWAY SPRUCE STAND: CASE STUDY IN LATVIA

Baiba Jansone [1,2]

Oskars Krisans [2]

Linards Sisenis [1]

Guntars Snepsts [2]

Aris Jansons [1]

[1] Latvia University of Life Sciences and Technologies, **Latvia**
[2] Latvian State Forest Research Institute Silava, **Latvia**

ABSTRACT

Windstorms are one of the main factors causing damages in forest in Northern Europe. The damages are especially severe, if the ground during the storm is not frozen and is wet, therefore the trees are less stable. Cyclonic windstorms primarily happens during the winter, and there is a prediction of notable rise of temperature in this period of the year – thus we can expect more storm damages. It is known, that inside the forest stands specific microclimate exists, affecting also the soil temperature. However, there is lack on the specific of this impact at different depth of the soil in stand on organic soils. Therefore aim of the study was to assess the influence of presence of spruce stand on the peat soil temperature change in winter.

Air (40 cm above ground) and soil (0 to 40 cm) temperature was monitored in open field (on peat soil) and middle age (40 years) and mature pure Norway spruce stands on deep peat soil in central part of Latvia. Observations were made in winter (December to February) and early spring (March) from December 2016 to March 2019 (three observation periods). Mean monthly air temperature in the observation period was from -6.1°C to +6.8°C.

Air temperature during winter in mature stand was on average by 0 to 3.8°C lower than in open area on peat soil. In December and January there were minimal differences, but at the second part of winter the temperature differences reached on average 2.4°C. Similar trend had been observed, comparing the air temperature in open field and middle-age stand. In the soil temperature was notably higher, on average in December to February at the depth of 20 cm by +2.0°C (ranging from -0.1 to +4.6°C), in depth of 40 cm by 5.5°C (from 2 to 8.2°C). However, when the temperature raised in spring (in two out of the three observation years in March – the mean temperature was +6.8°C and +6°C) the temperature in soil was notably lower than in air: in depth of 20 cm by 5.7°C and 4.6°C, in depth of 40 cm by 3.3 and 1.9 C.

Temperature on ground during the winter was by 0.5 to 1°C on average higher close to the spruce tree (1 m) than further away from it (3 m) in middle age stand, but there was much less influence of the distance from the tree in mature stand. Deeper in soil (20 cm)

https://doi.org/10.5593/sgem2019V/1.4

closeness to the tree did not made much difference in temperature (-0.2 cm). The influence of presence of forest stand was various – in milled age stand in 20 cm depth temperature during the winter was by was by 0.2°C higher in in another year by 1.2°C higher. Hoverer, overall, the temperature in peat soil was higher than in the air, and especially it was true in the Norway spruce stands. Thus, the effect predicted in the rise of air temperature will be even more pronounced for the soil temperature, thus influencing the probability of damages in forest stands.

Keywords: frost, freezing depth, organic soil, peat soil, wind damages

INTRODUCTION

Wind damages in forest are influence by numerous factors, including tree species, soil type and status, topography and silviculture [1, 3]. Norway spruce in general is more vulnerable to wind damages, and event is admixture in the canopy layer of the stand increases the probability of such damages [4]. Stands on peat soils are more damaged than stands on mineral soils [4]. Also the ground-water level (affecting the rooting depth) and the soil conditions are important. Trees are most stable against uprooting in dry frozen soil, less – in dry (fresh) and least – in wet soil [11], often present in hemiboreal forest in winter without sufficient frost. Faster growth – thus shorter exposure time to the strong winds until the target diameter is reached – is crucial to reduce the wind damaged probability, thus also its financial consequences. Also larger diameter of trees increase their resistance against wind snapping, causing damages of assortment that can be retrieved in salvage-logging [5]. Increment can be increased via several means: a) lower initial density [9], that also have a positive influence of adaptation of trees to wind; b) intensive thinning of young stands, essentially creating similar effect as sparser planting; however, it needs to be done timely – at later stages of stand development thinning significantly reduced wind resistance for the stand for the period of 3-5 years [4]; c) fertilization, affecting the growth of the trees for up to 15 years [7]; tree breeding, aiming at improvement of growth [6]. While striving to maximize the growth, it is important to minimize the negative side effects: larger trees were more prone to stem cracking that is associated with sudden and significant drops of groundwater table [15] – selection of resistant clones is important. Influence of climate change can be both positive and negative – prolonged growth period in favourable micro-site conditions may lead to increased growth via formation of lammas shoots [8] and positive growth responses to increased temperature, as observed from provenance trials [14]. At the same time limited precipitation in combination with higher temperatures in summer (predicted to be more frequent in future) will have a negative effect on the radial growth of the Norway spruce [12]. Additionally, the maintenance of the growing stock is important to ensure a large carbon pool in old-growth stands [10] and/or improved growth of new generation of trees and additional sequestration in wood products. Damages by cervids – the most frequent cause of stem defects of Norway spruce [13] – may affect the wind-resistance, especially, if the infected by fungi [2]. Also in this respect faster growth of trees – thus shorter time between damages and the final harvest – is important. Overall, amount of wind damages can be reduced also in Norway spruce stands, but, to select the most efficient approach and assess the magnitude of the potential reduction, it is important to understand the soil conditions in the stands, especially during the cold-part of the year. Therefore aim of

our study was to assess the influence of presence of spruce stand on the peat soil temperature change in winter.

MATERIAL AND METHODS

Study was carried out in central and central part of Latvia (Fig. 1). According to data of Latvian Environment, Geology and Meteorology Centre, in this region 30-years mean air temperature in July and January is 18 and -6 °C, respectively. Frost-free period is 140 days in average; annual sum of precipitation varies between 700 and 800 mm. Latvia is affected by cyclones, bringing both precipitation and strong winds (storms); the maximums wind-speeds in the largest storms had ranged from 28 to 48 m s^{-1}. Data from Latvian State Forest Service indicates, that wind disturbance is the reason for 40 to 60% of all sanitary clearcuts.

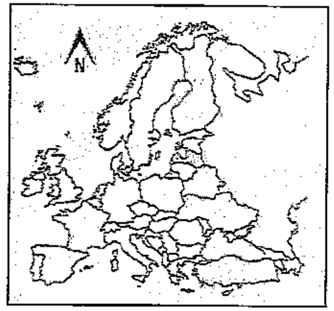

Figure 1. Location of sampling site.

Air (40 cm above ground) and soil (0 to 40 cm) temperature was monitored in open field (on peat soil) and middle age (40 years) and mature pure Norway spruce stands on deep peat soil in central part of Latvia. Observations were made in winter (December to February) and early spring (March) from December 2016 to March 2019 (three observation periods). Mean monthly air temperature in the observation period in the sites was from -6.1°C to +6.8°C.

Changes of soil temperature were characterized since the beginning of the winter using 30-day average values and obtaining their confidence intervals and way to determine the significance of the differences.

RESULTS AND DISSCUSION

Air temperature during winter in mature stand was on average by 0 to 3.8°C lower than in open area on peat soil. In December and January there were minimal differences, but at the second part of winter the temperature differences reached on average 2.4°C. Similar trend had been observed, comparing the air temperature in open field and middle-age stand. In the soil temperature was notably higher, on average in December

https://doi.org/10.5593/sgem2019V/1.4

to February at the depth of 20 cm by +2.0°C (ranging from -0.1 to +4.6°C), in depth of 40 cm by 5.5°C (from 2 to 8.2°C). The predicted changes in the air temperature, as characterized in IPCC reports, are not only the overall rise of the mean, but also larger amplitude and thus negative temperatures for a shorter periods at a time. Our results demonstrated a notable capacity of the soil to buffer such sudden shifts in the temperature and remain uninfluenced. Thus there might be even larger influence of the milder winter conditions on the soil (it remaining un-frozen for longer period of time) than on the air. However, when the temperature raised in spring (in two out of the three observation years in March – the mean temperature was +6.8°C and +6°C) the temperature in soil was notably lower than in air: in depth of 20 cm by 5.7°C and 4.6°C, in depth of 40 cm by 3.3 and 1.9 C, respectively.

Significant differences between the changes and the values of the soil temperature (both the man and the minimum) at different depth (10 and 20 cm) in the open field and in the Norway spruce stands had been found (Fig. 2). Rather large confidence intervals in one of the measurement points in the Norway spruce stands may reflect the malfunctions of the sensor or influence of other factors, like a cover from one side of the measurement point, which may happen to be in up-wind and down-wind direction.

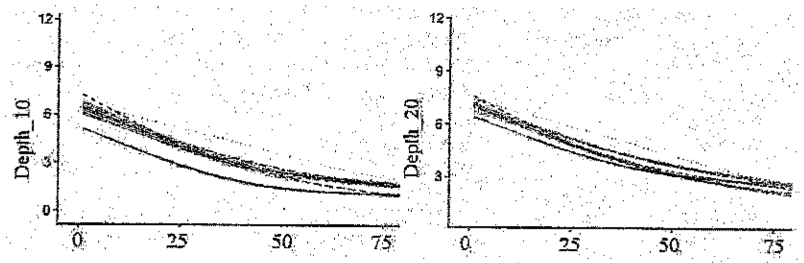

Figure 2. Mean temperature in peat soil at the depth of 10 and 20 cm in open field (red line) and spruce stands (all other lines).

Similar tendency, but rather smaller and not across all the period significant differences were observed also in depth of 40 cm, that is even more isolated from the air. Since the withers were very mild during the observation period, it is not possible to directly characterize the differences in the time period when the soil if frozen in different depth in open field and stand. Therefore measurements are continued. However, from the relationships found in the study it is clear, that shorter periods with freezing soils can be expected in future. This is in line with results in Finland [11].

Temperature on ground during the winter was by 0.5 to 1°C on average higher close to the spruce tree (1 m) than further away from it (3 m) in middle age stand, but there was much less influence of the distance from the tree in mature stand. Deeper in soil (20 cm) closeness to the tree did not made much difference in temperature (-0.2 cm). The influence of presence of forest stand was various – in milled age stand in 20 cm depth temperature during the winter was by was by 0.2°C higher in in another year by 1.2°C higher. Hoverer, overall, the temperature in peat soil was higher than in the air, and especially it was true in the Norway spruce stands. Thus, the effect predicted in the rise of air temperature will be even more pronounced for the soil temperature, thus influencing the probability of damages in forest stands.

Due to complex interactions of the parameters affecting the differences between soil and air temperature (like overall sum of negative temperature before the observation point, duration and length and actual scale of the drops of temperature occurring), additional further analysis should use already existing soil temperature calculation programs and test their performance with the collected datasets of soils in the spruce stands. It will be essential to obtain practically usable relationships (equations).

CONCLUSIONS

Overall, the temperature in peat soil was higher than in the air, and especially it was true in the Norway spruce stands. In the middle-age stand with relative lower green crown, the soil temperature was even higher closer to the tree (i.e., where the roots, ensuring stability of the tree, are) than further away from it. Rise in the air temperature in the winter will be linked to even more pronounced rise of soil temperature, especially in the forest stands, thus influencing (increasing) the probability of wind damages.

ACKNOWLEDGEMENTS

Study carried out in ERDF project "Development of decision support tool for prognosis of storm damages in forest stands on peat soils" (No 1.1.1.1/16/A/260). We acknowledge the help of Didzis Elferts in statistical analysis.

REFERENCES

[1] Albrecht A.T., Hanewinkel M., Bauhus J., Kohnle U. How does silviculture affect storm damage in forests of south-western Germany? Results from empirical modeling based on long-term observations. European Journal of Forest Research 131(1): 229–247. https://doi.org/10.1007/s10342-010-0432-x.,2010.

[2] Burneviča N., Jansons Ā., Zaļuma A., Kļaviņa D., Jansons J. and Gaitnieks T. Fungi inhabiting bark stripping wounds made by large game on stems of *Picea abies* (L.) Karst. in Latvia, Baltic Forestry vol. 22, pp. 2-7, 2016.

[3] Díaz-Yáñez O., Mola-Yudego B., González-Olabarria J.R., Pukkala T. How does forest composition and structure affect the stability against wind and snow? Forest Ecology and Management (401), pp. 215-222., 2017.

[4] Donis J., Kitenberga M., Snepsts G., Dubrovskis E., Jansons A. Factors affecting windstorm damage at the stand level in hemiboreal forests in Latvia: case study of 2005 winter storm. Silva Fennica vol. 52 no. 4 article id 10009., 2018.

[5] Dubrovskis E., Donis J., Racenis E., Kitenberga M., Jansons A., Wind-induced stem breakage height effect on potentially recovered timber value: case study of the Scots pine (Pinus sylvestris L.) in Latvia, Forestry Studies, vol. 69, pp 24–32, 2018.

[6] Jansons A., Donis J., Danusevičius D., Baumanis I. Differential analysis for next breeding cycle for Norway spruce in Latvia. Baltic Forestry, 21(2), pp. 285-297., 2015.

[7] Jansons Ā., Matisons R., Krišāns O., Džeriņa B., Zeps M., Effect of initial fertilization on 34-year increment and wood properties of Norway spruce in Latvia, Silva Fennica, vol. 50/issue 1, id 1346, 8 p., 2016.

[8] Katrevics J., Neimane U., Dzerina B., Kitenberga M., Jansons J., Jansons A., Environmental factors affecting formation of lammas shoots in young stands of Norway spruce (*Picea abies* Karst.) in Latvia, iForest, vol. 11, pp 809-815, 2018.

[9] Katrevičs J., Džeriņa B., Neimane U., Desaine I., Bigača Z., Jansons Ā., Production and profitability of low density Norway spruce (Picea abies (L.) Karst.) plantation at 50 years of age: case study from eastern Latvia, Agronomy Research, vol. 16, pp 113-121, 2018.

[10] Ķēniņa L., Elferts D., Bāders E., Jansons Ā., Carbon pools in a hemiboreal over-mature Norway spruce stands, Forests, vol. 9(7)/issue 435, pp 1-10, 2018.

[11] Peltola, H., Ikonen, V. P., Gregow, H., Strandman, H., Kilpeläinen, A., Venäläinen, A., & Kellomäki, S.. Impacts of climate change on timber production and regional risks of wind-induced damage to forests in Finland. Forest Ecology and Management, 260(5), 833-845., 2010.

[12] Samariks V., Jansone B., Krisans O., Jansons A., The influence of meteorological factors on stem radial variation of the Norway spruce and black alder: Case study, Sylwan, vol. 163/issue10, paper ID: mfnfa, 2019.

[13] Šņepsts G., Bigača Z., Desaine I., Jansons J., Donis J., Strēlnieks K., Adamovičs A., Krišāns O., Characteristics of damages in Norway spruce stands, In: Proceedings of 24th Annual International Scientific Conference "Research for Rural Development 2018", Jelgava, Latvia, vol. 1, pp. 65-71, 2018.

[14] Zeltiņš P., Katrevičs J., Gailis A., Maaten T., Desaine I., Jansons Ā., Adaptation capacity of Norway spruce provenances in Western Latvia, Forests, vol. 10/issue 840, pp 1-15, 2019.

[15] Zeltiņš, P., Katrevičs J., Gailis A., Maaten T., Bāders E., Jansons Ā., Effect of Stem Diameter, Genetics, and Wood Properties on Stem Cracking in Norway Spruce, Forests, vol. 9/issue 546, pp 1-10, 2018.

STRUCTURE INDICES OF ALEPPO PINE IN CHETTABA FOREST (ALGERIA)

Assoc. Prof. Malika Rached-Kanouni [1]

Assoc. Prof. Karima Kara [2]

[1] Département des Sciences de la Nature et de la Vie, Faculté Sciences Exactes et des Sciences de la Nature et de la Vie Université Larbi Ben M'Hidi, Oum EL Bouaghi, **Algeria**
[2] Département de Biologie et Ecologie Végétale, Faculté des Sciences de la Nature et de la Vie, Université des Frères Mentouri, Constantine 1, **Algeria**

ABSTRACT

Stand structural diversity, defined as the diversity of trees in stands, can be indicative of overall biodiversity and habitat suitability, useful in forecasting stand growth, and provide within stand detail for forest inventories. The diversity analysis provides more detail to the traditional stand structure descriptions and enables the approach to stand management more consistent not only with the timber production, but also with other productions and values of the multi-benefit forest stands, and/or transformation processes. A limited number of authors have tried to combine tree variables and spatial position into structural indices. In this study eight diversity indices were used to characterize the horizontal and spatial distribution of the individuals in multi-species stands, using four plots, located in Chettaba forest, East-North Algeria. The results revealed interesting differences and similarities in the behavior of the studied indices.

Keywords: Aleppo pine, structural indices, spatial distribution, horizontal distribution.

INTRODUCTION

The traditional structure analysis does not take into account diversity. In fact, in pure and evenaged stands its evaluation has little importance. On the contrary, in multi-species and especially in unevenaged stands it is important as it enables the analysis of stand characteristics that are not caught in the traditional stand structure analysis.

Stand structure is an important element of stand biodiversity [1]. High biodiversity is associated with stands where there are multiple tree species and sizes [2]. For forested ecosystems, structural diversity can indicate overall species diversity [3]. Managing forests for biodiversity may be accomplished by managing for structural diversity. In addition to being useful as a possible proxy for measuring stand biodiversity, measures of stand structural diversity are also important for predicting future stand growth and development [4]. Oliver and Larson [5] indicated that a variety of patterns of growth are related to structural complexity.

The structural complexity of a forest is largely determined by the number of tree species but of equal importance is the diversity in the size of individual trees. One of the factors affecting the coexistence of species in a mixed forest is the interactions between

https://doi.org/10.5593/sgem2019V/1.4