Ash Dieback and Dutch Elm Disease: Current Situation and Prospects in Slovenia

NIKICA OGRIS *
Slovenian Forestry Institute, Večna pot 2, SI-1000 Ljubljana, Slovenia
** Corresponding author: nikica.ogris@gozdis.si; tel. +38612007800*

Ogris, N. 2018. Ash Dieback and Dutch Elm Disease: Current Situation and Prospects in Slovenia. *Baltic Forestry* 24(2): 181–184.

Abstract

Ash dieback has been present in Slovenia since 2006, and Dutch elm disease since 1929. We have evaluated their current situation in Slovenia based on sanitary felling. Sanitary felling of ash has risen exponentially from 2009 to 2017. In 2017, 76,101 m³ of ash or 69% of total ash felling was due to ash dieback, which represents 2% of ash wood stock. Geographically more damaged forests (0.5–2.1% of ash wood stock per forest management unit) were in the eastern part of Slovenia. We suspect that the sanitary felling of ash will escalate due to the current exponential trend, and wood stock of ash will drop by 20–40% in next 10 years. From 1995 to 2013, between 51 and 59% of elms was sanitary felled due to Dutch elm disease. Trend of sanitary felling was disturbed between 2014 and 2016 because of the catastrophic ice damage that happened in 2014. The most damaged areas are in the southern part of Slovenia, where 11–75% of elms wood stock per forest management unit was damaged due to Dutch elm disease. However, in the most cases, only up to 2% of elm wood stock was sanitarily felled. The prospect for elms is becoming better over the years as sanitary felling due to Dutch elm disease in slightly lower, and the total wood stock of elms has risen from 2007 to 2013 and remained on that level since then. Therefore, we believe that elms are slowly recovering from Dutch elm disease. However, other damaging factors threaten elms.

Keywords: *Hymenoscyphus fraxineus*, *Chalara fraxinea*, *Ophiostoma ulmi*, *Ophiostoma novo-ulmi*, sanitary felling, *Fraxinus*, *Ulmus*, trend

Introduction

Ash dieback caused by *Hymenoscyphus fraxineus* (T. Kowalski) Baral, Queloz et Hosoya (anamorph *Chalara fraxinea* T. Kowalski) was reported in 2006 in Slovenia (Ogris et al. 2009). In 2007, the incidence became widespread throughout Slovenia. Since then, sanitary felling due to ash dieback has significantly risen. Two native species of ash are damaged, i.e. common ash (*Fraxinus excelsior* L.) and narrow-leafed ash (*F. angustifolia* Vahl).

Dutch elm disease (*Ophiostoma ulmi* (Buisman) Nannf.) has been present in Slovenia since 1929 (Maček 2008). A second wave of Dutch elm disease caused by *Ophiostoma novo-ulmi* Brasier reached Slovenia in the 1980s. In Slovenia, three species of elm are naturally present: White elm, *Ulmus laevis* Pallas, Field elm, *Ulmus minor* Mill., and Wych elm, *Ulmus glabra* Huds. All three species are believed to be decimated by Dutch elm disease (up to 50%) (*ibidem*).

The purpose of our study was to evaluate current situation regarding ash dieback and Dutch elm disease and their prospects in Slovenia.

Methods

To assess the current situation regarding ash dieback and Dutch elm disease (DED), we used database about tree felling that is managed by the Slovenian Forest Service (ZGS 2017). We used a time series from 1995 to 2017. The data are gathered by Slovenian Forest Service (ZGS) on the forest sub-compartment level, the average area of which measures about 22 ha. Data about the felling of a tree include tree species (66 species), type of felling (47 reasons), number of trees, the volume of trees, location. For our study, we used data for the following groups of tree species: (1) Ash dieback – *F. excelsior* and *F. angustifolia*; (2) Dutch elm disease – *U. glabra* and *U. minor*. Only sanitary felling of those tree species due to diseases were considered. To compare data, we used a relative expression such as the proportion of damaged trees as to wood stock. The wood stock of selected tree species was acquired from the Forest Funds database, also managed by ZGS; it is based on the forest inventory data and description of forest stands (ZGS 2016). Trends of sanitary fellings were calculated using simple regression, where exponential model for Ash dieback and linear model for Dutch elm disease were chosen. Trends were given with slope estimate of simple regression model.

ZGS determine the pathogens only visually by looking for their typical symptoms. Symptoms for ash dieback include dieback of young shoots, necrotic lesions on the leaves, stems and collar, presence of apothecia on the previous year leaf rachises in the leaf litter. DED symptoms include yellowing and wilting (flagging) of leaves on indi-

vidual branches, which often turn brown and curl up as the branches die, and eventually the leaves may drop off; brown staining in the sapwood that can be seen by removing the bark of infected twigs; presence of galleries of small and large elm bark beetle (*Scolytus multistriatus* and *S. scolytus*).

Results

Ash dieback

Sanitary felling of ash due to diseases, before ash dieback reached Slovenia (before 2006), was up to 366 m³ or 4% of total ash felling per year (Figure 1 and Figure 2). After the arrival of ash dieback in Slovenia, the first rise of the sanitary felling of ash was recorded in 2009, three years after the first record. Sanitary felling of ash has exponentially risen from 2009 to 2017. In 2017, 76,101 m³ of ash or 69% of total ash felling was due to ash dieback. However, the sanitary felling of ash in 2017 was only 2% of ash wood stock (Figure 1). In 2014, a slight drop of the sanitary felling of ash was recorded due to the catastrophic ice storm, which happened in Slovenia that year, and many ash trees were damaged due to the heavy ice (Figure 1, Table 1). Interestingly, the wood stock of ash was growing for the whole study period from 1995 to 2017, i.e. from 1.1 Mm³ to 3.8 Mm³ (Figure 2). Wood stock was stagnating in the last three years (2015–2017). Geographically, more damaged forest management units (0.5–2.1% of ash wood stock) were in the eastern part of Slovenia (Figure 3).

Trends of sanitary felling were calculated using simple regression where exponential model was chosen. Regression coefficient for portion of sanitary felling of ash due to ash dieback with regard to total ash felling was 0.15 (r^2 = 58.3%). Regression coefficient for portion of sanitary felling of ash due to ash dieback regarding wood stock was 0.19 (r^2 = 56.7%).

Other damaging agents of ash were recorded during 2013–2017, where the second most damaging agent was ice storm which was responsible for 21.9% of sanitary felling of ash (Table 1). The only additional significant damaging agent was wind which represented 4.5 % of sanitary felling of ash. Along *H. fraxineus* additional diseases were noted on *F. excelsior* and *F. angustifolia*: *Armillaria spp*., *Neonectria galligena*, *Phytophthora spp*. and *Pseudomonas savastanoi pv. fraxini* (Table 2). However, they represented only 2.1 % of sanitary felling of ash.

Dutch elm disease

From 1995 to 2004, up to 69% of elm per year was sanitary felled due to Dutch elm disease (Figure 4). In the next period, to 2012, the total portion of sanitarily felled elms due to Dutch elm disease dropped to 56%. In 2014, a catastrophic ice storm damaged more than half of Slovenian forests (ARSO 2014, ZGS 2014, Marinšek *et al.* 2015). Elms were also damaged, and this is the reason that sanitary felling of elms due

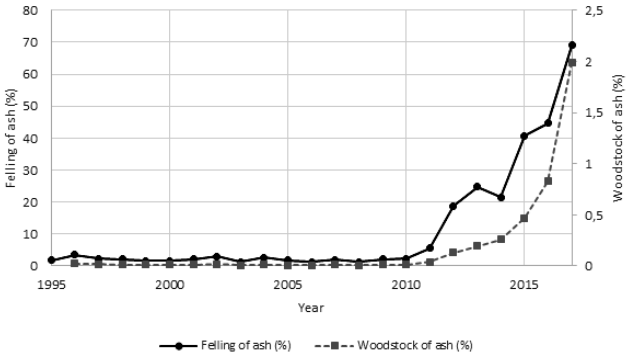

Figure 1. Portion of felling of *F. excelsior* and *F. angustifolia* in Slovenia due to ash dieback from 1995 to 2017: with regard to total ash felling and wood stock of ash

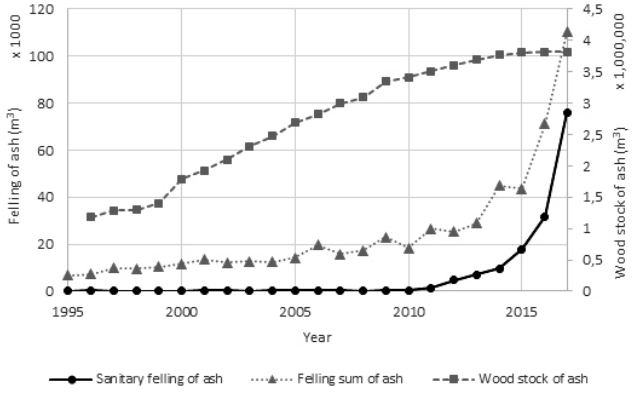

Figure 2. Sanitary felling of *F. excelsior* and *F. angustifolia* due to ash dieback in Slovenia from 1995 to 2017. Felling sum designates felling of ash due to all reasons

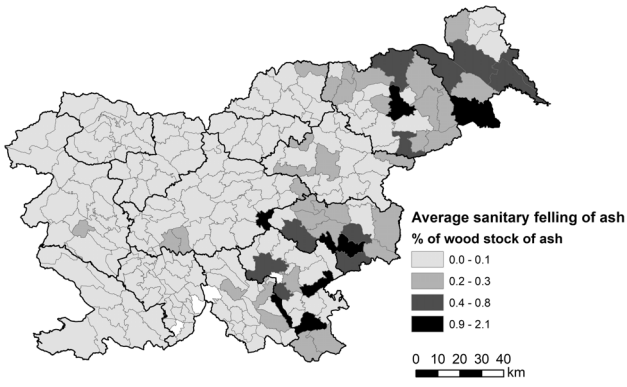

Figure 3. Average sanitary felling of ash (*F. excelsior and F. angustifolia*) due to ash dieback in Slovenia from 1995 to 2017, expressed as % of wood stock of ash in forest management unit

Table 1. Damaging agents of *F. excelsior* and *F. angustifolia* in Slovenia 2013-2017

Damaging agent	Sanitary felling (%)
Insects	0.3
Diseases	69.9
Wind	4.5
Snow	0.5
Ice	21.9
Other (unknown)	2.9

Table 2. Diseases of *F. excelsior* and *F. angustifolia* in Slovenia 2013-2017

Disease	Sanitary felling (%)
Armillaria spp.	1.3
Hymenoscyphus fraxineus	97.9
Neonectria galligena	0.1
Phytophthora spp.	0.6
Pseudomonas savastanoi pv. *fraxini*	0.1

to Dutch elm disease decreased from 2014 to 2016. In 2017, sanitary felling of elm due to Dutch elm disease rose again, nearly to the same level as before the ice storm. Interestingly, only 1.5% of wood stock per year was damaged because of Dutch elm disease. Generally, the prospect for elms is becoming better over the years as sanitary felling due to Dutch elm disease is slightly lower, and total elms wood stock has risen from 2007 to 2013 and remained on that level since then (Figure 5). Even though sanitary felling of elms due to Dutch elm disease has decreased, the total sum of sanitary felling has risen because of other damaging factors, such as the ice storm in 2014. The most damaged areas are in the southern part of Slovenia, where 11–75% of elms wood stock is damaged due to Dutch elm disease (Figure 6). In most forest management units, only up to 2% of elms wood stock was sanitarily felled.

Trends of sanitary felling were calculated using simple linear regression, where data before catastrophic ice storm in 2014 were used. Regression coefficient for portion of felling of elms due to Dutch elm disease with regard to total elms felling was –0.63 (r^2 = 35.1%). Regression coefficient for portion of felling of elms due to Dutch elm disease regarding wood stock was 0.002 (r^2 = 0.7%).

The ice storm in 2014 was very damaging to elms as 32.3% of sanitary felling of elms was cut due to this damaging agent (Table 3). There was a noticeable amount of sanitary felling that has been caused by unknown agents (9.6%).

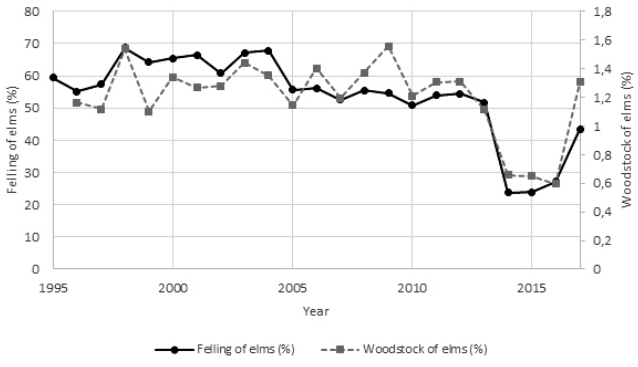

Figure 4. Portion of felling of *Ulmus glabra* and *U. minor* in Slovenia due to Dutch elm disease from 1995 to 2017: with regard to total elms felling and wood stock of elms

Armillaria and other root rots were recorded as diseases of elms. However, they represented only 0.3% of sanitary felling of elms.

Note: The wood stock shown in Figure 2 and Figure 5 was based on the data from forest management plans that are renewed every 10 years and only about 1/10th of plans per year are renewed. Therefore, the data about the wood stock is generally five years old on average.

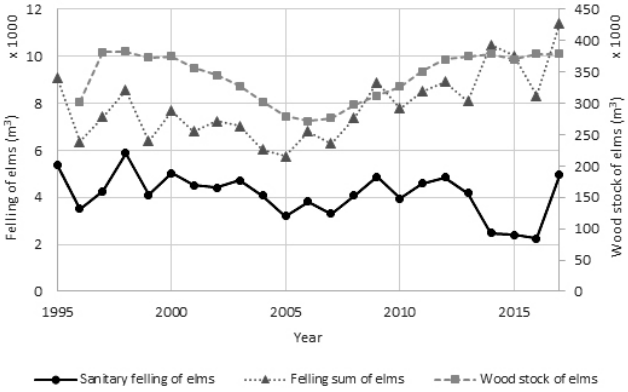

Figure 5. Sanitary felling of *Ulmus glabra* and *U. minor* due to Dutch elm disease in Slovenia from 1995 to 2017. Felling sum designates felling of elms due to all reasons

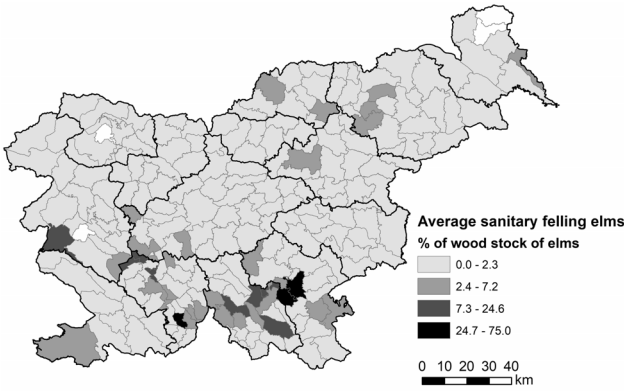

Figure 6. Average sanitary felling of elms (*Ulmus glabra* and *U. minor*) due to Dutch elm disease in Slovenia from 1995 to 2017, expressed as % of wood stock of elms in forest management unit

Table 3. Damaging agents of *Ulmus glabra* and *U. minor* in Slovenia 2013-2017

Damaging agent	Sanitary felling (%)
Insects	0.3
Diseases	54.7
Wind	1.9
Snow	1.2
Ice	32.3
Other (unknown)	9.6

Table 4. Diseases of *Ulmus glabra* and *U. minor* in Slovenia 2013-2017

Disease	Sanitary felling (%)
Armillaria	0.1
Ophiostoma ulmi	99.7
Root rots	0.2

Discussion and Conclusions

Sanitary felling of ash because of ash dieback has exponentially risen from 2009 to 2017, a period in which 2% of the ash wood stock per year was felled. The level of ash wood stock has stagnated in the previous three years (2015–2017), which shows that the amount of sanitary felling has reached an annual increment (65%). We suspect that the sanitary felling of ash will escalate and continue the exponential trend to 4–10% of wood stock per year and wood stock of ash will drop by 20–40% in 10 years. However, we suspect that the fast-growing trend in damages will continue just to some level as maybe mycoviruses will play a considerable role as potential biological control agents for *H. fraxineus* (Čermáková et al. 2017). In long term sense the most important role will be played by natural selection where only resistant trees will survive. Natural resistance to the ash dieback disease was recorded in several studies in Denmark and Sweden (McKinney et al. 2011, 2012, Kjær et al. 2012, Stener 2013), and the presence of genetic variations of dieback resistance was proved in the progeny trials (Pliūra et al. 2014).

We expect different prospects for elms. Wood stock of elms was stagnating during last five years (2012–2017) and regression coefficient for sanitary felling of elms due to Dutch elm disease regarding wood stock was only slightly positive and regarding total elms felling negative. Therefore, we believe that elms are slowly recovering from Dutch elm disease. However, other damaging agents threaten elms, e.g. ice damage and unknown agents, as felling of elms due to all reasons has risen from 2005 to 2017. It is not known if elm trees damaged by ice storm/windthrows had any injury by pathogens or insects. The reason for that is design of the database of sanitary felling used by Slovenian Forestry Service which allows stating only the primary cause of the felling.

Acknowledgements

This study was conducted within the framework of the survey performed by the Public Forestry Service, through the financed support from the Ministry of Agriculture, Forestry and Food. I thank the Slovenian Forestry Service for the data that enabled the performance of the study. The authors acknowledge the financial support from the Slovenian Research Agency (research core funding No. P4-0107). I would like to express my gratitude to two reviewers for their constructive comments which contribute to improving the manuscript in a great extent. I would like to thank R. Vasaitis for encouragement, good ideas and help with publishing the article.

References

ARSO. 2014. Sneg, žled in padavine od 30. januarja do 7. februarja 2014 [Snow, ice and precipitations from 30th January to 7th February 2014]. Ljubljana, Slovenian Environment Agency: 21 pp. Available online at: http://meteo.arso.gov.si/uploads/probase/www/climate/text/sl/weather_events/sneg-zled-padavine_30jan-7feb2014.pdf. Last accessed on 7 September 2018 (in Slovenian).

Čermáková, V., Eichmeier, A., Herrero, N. and Botella, L. 2017. HfMV1 and another putative mycovirus in Central European populations of *Hymenoscyphus fraxineus*, the causal agent of ash dieback in Europe. *Baltic Forestry* 23(1): 107-115.

Kjær, E.D., McKinney, L.V., Nielsen, L.R., Hansen, L.N. and Hansen, J.K. 2012. Adaptive potential of ash (*Fraxinus excelsior*) populations against the novel emerging pathogen *Hymenoscyphus pseudoalbidus*. *Evolutionary Applications* 5: 219-228.

Maček, J. 2008. Gozdna fitopatologija [Forest pathology]. Zavod za gozdove Slovenije, Zveza gozdarskih društev Slovenije, Gozdarska založba [Slovenian Forestry Service and Association of Forestry Societies of Slovenia], Ljubljana, 448 pp. (in Slovenian).

Marinšek, A., Celarc, B., Grah, A., Kokalj, Ž., Nagel, T.A., Ogris, N., Oštir, K., Planinšek, Š., Roženbergar, D., Veljanovski, T., Vochl, S., Železnik, P. and Kobler, A. 2015. Žledolom in njegove posledice na razvoj gozdov - pregled dosedanjih znanj [Impacts of Ice Storms on Forest Development – a Review]. *Gozdarski vestnik* 73(9): 392-405. (in Slovenian with English abstract).

McKinney, L.V., Thomsen, I.M., Kjær, E.D. and Nielsen, L.R. 2012. Genetic resistance to *Hymenoscyphus pseudoalbidus* limits fungal growth and symptom occurrence in *Fraxinus excelsior*. *Forest Pathology* 42: 69-74.

Ogris, N., Hauptman, T. and Jurc, D. 2009. *Chalara fraxinea* causing common ash dieback newly reported in Slovenia. *Plant Pathology* 58: 1173.

Pliūra, A., Marčiulynienė, D., Bakys, R. and Suchockas, V. 2014. Dynamics of genetic resistance to *Hymenoscyphus pseudoalbidus* in juvenile *Fraxinus excelsior* clones. *Baltic Forestry* 20(1): 10-27.

Stener, L.G. 2013. Clonal differences in susceptibility to the dieback of *Fraxinus excelsior*. *Scandinavian Journal of Forest Research* 28(3): 1-12.

ZGS. 2014. Načrt sanacije gozdov poškodovanih v žledolomu od 30. januarja do 10. februarja 2014 [Sanitation plan for forests damaged by ice storm from 30th January to 10th February 2014]. Ljubljana, Slovenian Forestry Service: 66 pp. Available online at: http://www.zgs.si/fileadmin/zgs/main/img/CE/varstvo/2014Ujma/Nacrt__sanacije_zled_2014.pdf. Last accessed on 7 September 2018 (in Slovenian).

ZGS. 2016. Forest funds - Database. Slovenian Forestry Service

ZGS. 2017. Timber – Database about felling of forest trees. Slovenian Forestry Service