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Trends in financial damage related to urban tree failure in the Netherlands

M.A. van Haaften[a,*], M.P.M. Meuwissen[b,*], C. Gardebroek[c], J. Kopinga[d]

[a] Agricultural Economics and Rural Policy (AEP), Wageningen University, PO Box 8130, 6700 EW Wageningen, The Netherlands
[b] Business Economics (BEC), Wageningen University, PO Box 8130, 6700 EW Wageningen, The Netherlands
[c] Agricultural Economics and Rural Policy (AEP), Wageningen University, PO Box 8130, 6700 EW Wageningen, The Netherlands
[d] Alterra Wageningen UR, PO Box 47, 6700 AA Wageningen, The Netherlands

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ABSTRACT

Risk assessments on trees in urban areas and roadside plantings have become common practice and a large body of information exists on qualitative aspects on the risks of tree failure. Quantitative analysis of financial damage due to tree failure is generally lacking. The objective of this paper is to determine the amount of tree failure related property damage and to derive possible trends in the number of cases and monetary claims and compensations. This paper presents the analysis of 1610 observations on urban tree failure in the Netherlands. The data originate from two different sources, i.e. jurisprudence (4% of the data) and 21 municipalities (96%). The data covers property damage in urban areas between the early sixties and 2010. Within municipalities, paid compensations due to tree failure are found to range from €0 to € 49,296 with an average of €2,244 per paid compensation. Results demonstrate a significant annual increase in tree failure as well as in paid compensations.

Introduction

Advantages of trees have been comprehensively described in the literature, e.g. their effect on air quality, their moderating impact on so-called heat islands, and their effect on cooling or heating costs of buildings (Beckett et al., 2001; Akbari, 2002; Arnfield, 2003; Nowak et al., 2006; Brown and Fisher, 2009; Moore, 2009a,b). The added value of urban trees to the real estate value of surrounding buildings has also been investigated (Anderson and Cordell, 1988; Luttik, 2000; Laverne and Winson-Geideman, 2003; Price, 2003). Other studies describe the calming influence on traffic speed and the increased safety for bicycles and pedestrians of trees planted near roads, road crossings, roundabouts and corners (Ewing and Dumbaugh, 2009; Ewing et al., 2011; Burbridge, 2012). Cost-benefit analyses present the financial advantages of urban trees, but give less attention to the disadvantages (McPherson et al., 2005; Soares et al., 2011). For example, the damage caused by tree roots to pavements, buildings and pipe systems. The literature on these drawbacks is generally qualitative, as e.g. in Kopinga and Meyboom (1995), Arhipova et al. (2007), Morgenroth (2008) and Lucke et al. (2011) who discuss the damage of tree roots to pavements. Only few authors have estimated damage related costs and expenditures (McPherson and Peper, 1996; McPherson, 2000; Randrup et al., 2001). Similarly, the effect of tree roots on crack formations in building walls is discussed (Roberts et al., 2006; Navarro et al., 2009a,b; Satriani et al., 2010), but not substantiated by quantitative data. The interference of tree roots with pipes (sewer pipes, drains, and water works) is discussed by many authors, e.g. Leonard and Townley (1971), Mattheck and Bethge (1999), Randrup et al. (2001), Ridgers et al. (2006) and Östberg et al. (2011), while Rolf and Stal (1994), McPherson and Peper (1996) and Randrup (2000) also provide damage related costs.

Risks of tree failure in urban areas are widely discussed in the literature without quantitative data (Henwood and Pidgeon, 2001; Adams, 2007; Ball, 2007; Ellison, 2007; Wolf and Dixon, 2007; Boddy, 2009; Brown and Fisher, 2009; Forbes-Laird, 2009; Bennett, 2010; Caltrans, 2010; Barrell, 2012). Tree risk assessment methods commonly use a mix of technical and biological approaches to assess the risks of tree failure. These methods are becoming more and more used throughout the world (Wassenaar and Richardson, 2009). Governmental organizations use these methods to develop tree risk management plans to prevent or control tree failure (Pokorny et al., 2003). Some literature addresses the risks of tree failure in quantitative terms, but generally focuses on

* Corresponding authors. Tel.: +31 317483857.
E-mail addresses: marinus.vanhaaften@inholland.nl (M.A. van Haaften), miranda.meuwissen@wur.nl (M.P.M. Meuwissen), koos.gardebroek@wur.nl (C. Gardebroek), jitze.kopinga@wur.nl (J. Kopinga).

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personal injury damage. Most of the data originate from incidents in the United Kingdom and the United States. Incident frequencies reported by the United States government and in newspaper articles show an increase in registered deaths and injuries during the period from 1965 until 2011 (Johnson, 1981; Schmidlin, 2008; Dunster, 2012). For the United Kingdom, estimates of the ratio of the annual number of deaths due to tree failure per number of inhabitants vary between 1:10,000,000 (Ball and Watt, 2009) and 1:20,000,000 (Fay, 2007). The known annual number of deaths due to tree failure in urban areas in the United Kingdom varies from five to nine during the period 1998–2009 (Adams, 2007; HSE, 2007; Ball and Watt, 2009; Dunster, 2012).

In this limited data context, the objective of this paper is to determine the annual number of cases of tree failure related property damage and to derive possible trends in the number of cases and monetary claims and compensations. For this purpose, data from municipalities and jurisprudence have been collected and analyzed.

In the Netherlands the tree owner is responsible in case of damage. As a result of jurisprudence and provisions in the Dutch Civil Code, tree owners are obliged to carry out regular maintenance of trees and checks for imminent failure and visible defects (Jiang et al., 2014). This obligation has the purpose to identify hazardous trees, limit the liability of municipalities and to prevent damage and accidents due to tree failure. This results in the risk assessments of trees by applying the international common visual tree assessment (VTA) method (Mattheck and Breloer, 1994). Based on law, absence or an incorrect performed tree risk assessment leads to a liability of the owner with its obligation to pay damages. Jurisprudence determines that tree owners like municipalities can invoke force majeure if winds of Beaufort force 11 or higher occur. Lower wind speeds are circumstances which municipalities as manager and owner of urban trees should expect and the tree risk assessment program should be adjusted to this risk.

Methods

Collection of data

The analysis focuses on urban areas in the Netherlands. Urban areas in this research are defined as built-up areas where the speed limit is 50 kilometers per hour. With officials of each participating municipality an interview was arranged. In these interviews officials were asked to provide as much detailed information as possible on tree failure and damage caused by tree failure as long as possible back in time. First, officials and municipality workers of the department of public greening were approached. When it turned out that those could not provide information, because of an absence of registration of tree failure in municipal tree inventory databases, officials of the department on claims and insurances were interviewed.

The data used in this study is based on registrations from municipalities, which represent recordings of damage caused by tree failure, without making a distinction between tree or branch failure. Tree or branch failure can be affected by biological causes (e.g. wood decay fungi, increasing age) (Zabel and Morrell, 2012; Schwarze et al., 2013), weather conditions (e.g. strong winds, snow, lightning) (Smiley et al., 2002; Pokorny et al., 2003; Guggenmoos, 2009; Schindler et al., 2012), structural defects (e.g. forks, long branches, bark included junctions) (James, 2003; Smiley et al., 2007; Slater and Ennos, 2015) or loss of roots (e.g. mechanical or due to decay) (Genet et al., 2005; Tello et al., 2005). These possible causes of tree failure are included in the data subject to the following limitations. Tree failure as a result of these causes is registered by municipalities, to fulfill their duty of care for inhabitants as owner of the trees.

In the databases of the department of claims and insurances, biological specifications of the trees involved in tree failure were not recorded (e.g. species, age, diameter at breast height). Regardless of whether there was damage, tree failure as a result of inappropriate pruning or felling activities was not listed in the municipal databases. Also there appeared to be no registration on civil maintenance activities, which made a possible link between root damage and tree failure difficult to determine. Likewise did these databases not display data which represented damage to trees (e.g. car collisions, road maintenance or digging activities), not even if this right away caused damage afterwards (indirect causal relation).

Sample description municipalities

A selection of Dutch municipalities was made. The sample size within this research is large enough to draw reasonable conclusions, it contains 3,227,444 Dutch people living in urban areas. With a confidence interval of 95% we need 3,125,601 or more inhabitants to represent the total current Dutch population of 16.77 million people, living in rural and urban areas. All municipalities with more than 100,000 inhabitants (31) and all municipalities within the province of Utrecht (26) were enquired to provide data from 2012 back as far as possible. Thirteen of the 31 municipalities with more than 100,000 inhabitants responded within the time span of this study (2012–2014). Also, five of the 26 municipalities within the province of Utrecht responded. Each municipality provided multiple observations over a reported period. Additionally, three municipalities voluntarily provided data on tree failure. An overview of the average number of inhabitants and trees for the reporting period for each municipality is shown in Table 1.

Municipalities provided data on the frequency (number of cases per year) of tree failure causing damage or not. And in case of damage, municipalities provided information on the frequency and amount of claimed and paid compensations. The figures from municipalities are used to analyze if there is (absence of) a possible trend in tree failure and a possible trend in the

Table 1
Municipalities ($n = 21$) included in analysis, period covered, and number of inhabitants per municipality.

Municipality	Reported period	No. of inhabitants[1]
>100,000 inhabitants		
Amersfoort	18/1/2007–31/12/2012	143,864
Amsterdam	7/1995–31/12/2012	741,478
Apeldoorn	2008–2012	155,866
Ede	27/10/2002–18/4/2013	107,072
Emmen	2002–2012	108,831
Groningen	26/4/2001–31/12/2012	182,188
Haarlem	25/04/1997–31/12/2012	148,205
Haarlemmermeer	2009–2012	143,037
Maastricht	11/2/2004–31/12/2012	119,821
Nijmegen	9/6/1969–31/12/2012	153,404
Rotterdam	03/04/2000–31/12/2012	595,700
's-Hertogenbosch	25/11/2006–31/08/2012	138,130
Zoetermeer	1997–2012	114,940
Province of utrecht		
Anonymous	2009–2012	28,727
Bunnik	01/01/2010–31/12/2012	14,449
De Bilt	2/8/2006–29/1/2013	42,026
Wijk bij Duurstede	13/3/2012–14/2/2013	23,050
Zeist	20/4/2011–31/12/2012	61,029
Voluntarily participating municipalities		
Alkmaar	27/10/2002–31/12/2012	93,531
Groesbeek	1/7/1988–29/8/2009	18,792
Venlo	01/01/2001–31/12/2012	93,803

[1] The average annual number of inhabitants during the reported period (*source:* CBS).