Tree-trimming impact on local government property management

Humphrey Boogaerdt
PaYUng Contracting, Perth, Australia, and
Alistair Brown
School of Accounting, Curtin University, Perth, Australia

Received 18 April 2018
Revised 29 May 2018
Accepted 6 September 2018

Abstract

Purpose – The purpose of this paper is to consider the monetary valuation implications arising from local government tree trimming, by calculating the loss of local government authority' monetary tree value arising from trimming trees under power lines.

Design/methodology/approach – A city council model of estimation of the monetary value of city trees in a sample of three streets in a suburb of the Perth Metropolitan Area in Western Australia is applied to ascertain the loss of monetary value to the local government authority arising from tree trimming.

Findings – Using a sample of 274 city trees, the results of the study show that 156 city trees did not get trimmed thus incurring no monetary loss. However, the average loss of monetary value from 118 city trees that were trimmed was AU$2,816 per tree, suggesting a substantial loss of value to the council.

Research limitations/implications – The use of monetary tree valuation should be treated with caution as there is a focus on monetary calculations rather than non-monetary evaluations of trees. Further, the analysis does not take into account increases in value of city trees resulting from their growth.

Practical implications – In trimming trees, monetary value and canopy cover of trees may be reduced. In terms of property management, it may be helpful for the city council to take into account loss of city tree value from tree trimming when considering a cost-benefit analysis of the above ground/underground trade-off of power line installation.

Social implications – With increasing populations and demand on services, local government authorities may use monetary valuation techniques of trees to provide an accountability to ratepayers.

Originality/value – The results highlight the value loss of trimming a tree. The study's originality rests in providing local government authority a valuation.

Keywords Australia, Environmental management, Local government, Asset valuation

Paper type Research paper

1. Introduction

A critical responsibility taken up by Australian local government authorities is the management of city trees, which may entail some form of accountability placed on the authority to provide feedback about the tree maintenance of city trees controlled by the authority. A city tree is one located on public land and for which the authority is responsible for ongoing maintenance. Such decision making may entail calculations of loss of city tree value arising from tree trimming. In this context, the purpose of this paper is to apply a city council model of estimation of the monetary value of city trees to ascertain the loss of monetary value arising from tree trimming.

The paper is significant in that it provides a cost estimation of tree value loss due to tree trimming for consideration by a city council or a power utility in making decisions on such matters as converting overhead power lines to underground power. Councils have alternative ways to ensure that trees do not touch the power lines. One alternative is to trim the trees, which incurs costs of trimming expenditure and loss of tree infrastructure valuation (using the Helliwell method), and another is to place the power lines underground, which incurs a capital cost. The paper utilises a monetary valuation framework to provide an alternative perspective of understanding landscapes for the benefit of planning and accountability of city trees and power lines.

Property Management
Vol. 37 No. 2, 2019
pp. 229-242

0263-7472
DOI 10.1108/PM-04-2018-0030

In approaching an explanation of an account and accountability of city tree trimming it is helpful to consider the economic, ecological and social costs and benefits of city trees. Local government property management of trees is critically important given that trees have economic value (Odudu and Iruobe, 2017), need upkeep by local government property managers, require pruning of broken branches (Holden, 1986), cause a nuisance (Lee, 2007) and make a local government authority liable for damage caused by trees under their control (Rotherham, 2014; Property Management, 1998, p. 1). To avoid city tree foliage from making contact with overhead power lines, electricity utilities trim the tree foliage on a regular basis in order to try to maintain a 2 m clearance (Ausgrid, 2016). However, in trimming trees, monetary value and canopy cover of trees may be reduced (Ling and Isaac, 1996). This construction of monetary value arises from the assumption that trees may be considered as a non-current assets generating future economic benefits through service potential (Brown and Boogaerdt, 2006). These future economic benefits may arise from the beneficial effect of city trees on property (Pandit *et al.*, 2013) and amenity values (Price, 2007).

A considerable literature has placed a dollar valuation on trees (Donovan and Butry, 2010; Giergiczny *et al.*, 2012) but such calculations may be open to question given the highly subjective nature of the variables used to frame the valuation (Helliwell, 2014). One way to overcome this issue is to consider relative monetary valuations in terms of loss or gain of monetary value using opportunity cost (Salant and Yu, 2016). If opportunity cost is understood as the next best alternative foregone, then it is possible to express monetary loss in terms of choosing one alternative over another (Brown, 2014). Opportunity costs, monetary costs and monetary valuations frame trees in terms of marginal economics and utilitarian worth. In this context, there appears a growing move by local government authorities to use costs and valuations for the management of trees under their control (Sudipto *et al.*, 2012). Thus, for example, where the City of Stirling permits city tree removal for development, developers are expected to contribute to the tree removal costs and the reinstatement tree costs (including costs of watering for two subsequent summers) (City of Stirling, 2016a). Where developers damage trees in the process of development, they are expected to compensate the city according to the amenity value of the tree loss calculated through the Helliwell valuation system (City of Stirling, 2016a).

Tree contact with power lines may be a leading cause of electric power outages (Cielewicz and Peevey, 2013). Well-managed tree trimming under power lines helps avoid equipment failure and potential high frequency of outages (Springer, 2010). However, tree trimming under power lines incurs both a direct monetary cost of use of tree-trimming services and an indirect monetary cost of loss of tree amenity (Fenrick and Getachew, 2012). For example, if an entity chooses to trim a city tree under a power line, then it foregoes an increased monetary valuation of the tree in terms of the tree's future economic benefits.

Underground power helps reduce tree operations and maintenance costs and decrease power outage durations (Fenrick and Getachew, 2012). It also enables local governments to maintain tree amenity (Plant *et al.*, 2017). However, the installation of underground power has a direct monetary cost in terms of installation of underground cables, removal of poles and maintenance costs. This suggests that a cost-benefit analysis is required in considering trade-offs between using systems of underground and above ground power (Bumby *et al.*, 2010). With this in mind, the following research question is posed:

RQ1. What is the loss of local government authority' monetary tree value arising from trimming trees under power lines?

2. Research overview

Answering this question is important because it may enable stakeholders to ascertain a benchmark of the monetary costs of tree trimming in the view of local government authorities. In this way, the study focusses on costs and monetary valuation of tree loss.

2.1 City of Stirling

Consistent with perceiving and valuing landscape in monetary ways, the City of Stirling maintains a "Street and Reserve Trees Policy" (City of Stirling, 2016a), which uses accounting calculations for tree target setting. For example:

> The City aims to plant one million trees and shrubs over a 17-year period. Over the past seven years, the City's planting average has been 55,448 trees and shrubs per year. (City of Stirling, 2016b, p. 106)

Tree canopy is desirable because it "promote[s] liveability and urban sustainability" (Plant *et al.*, 2017, p. 134). Monetary valuations provide insights of city trees for the benefit of environmentalists, city planners and managers with a remit to increase tree canopy of a particular local government area (Jim, 2006). Such valuations provide an alternative perspective in understanding landscapes for the benefit of planning and design of city trees. Last year, for example, the City of Stirling planted a total of 71,000 trees and shrubs in order to meet its long range target of "18 per cent tree canopy cover across the City by 2030" (City of Stirling, 2016b, p. 8). Its existing canopy cover is 12.9 per cent, suggesting that considerable monetary costs will need to be incurred in order to reach its canopy targets. Monetary valuations are particularly helpful for the planting, protection and management of city trees as city councils often lose trees through urban development. The City of Stirling lost 81 hectares of tree canopy because of tree removal and tree pruning (City of Stirling, 2016a). Monetary valuation may help planners and managers assess city preferences for canopy cover. The attainment of city targets for canopy cover may incur substantial costs including those of increases in tree infrastructure and tree maintenance, which require the use of accounting calculus and management for the reporting of canopy cover.

It should be borne in mind that in terms of city trees the City of Stirling follows considerable regulations and policies. The City of Stirling's "Street and Reserve Trees Policy" works under the specific enactments of the "Local Government Act 1995, Local Government (Uniform Local Provisions) Regulations 1996", Local Planning Scheme No. 3 – City of Stirling, "Planning and Development Act 2005" and "Local Government Property Local Law 2009".

2.2 Tree issues generally

A major contribution of the paper is that it quantifies the monetary loss of city tree trimming for power lines through empirical testing of local government authority city trees. The analysis of the quantification of monetary loss of city tree trimming follows the theoretical work of Brown and Boogaerdt (2006) that attempted to offer a broad spectrum of valuation models for the reporting of city trees. The current study adopts a monetised approach in calculating losses of monetary values using a database on city trees provided by a local government authority. In a past study, opportunity cost was also used to appraise the trade-off between local government authority expenditure on roads and footpaths (Brown, 2014). In contrast, the present study attempts to monetise the trimming of city trees in terms of opportunity costs in a local government setting yet at the same time keep in mind ecological and social aspects of the trimming of city trees.

The paper is structured as follows. Following the introduction and research overview, the study's methodology and limitations is explained. This is followed by study's literature review before the analysis of the three suburb comparison. Then a section outlining a discussion of the results is presented followed by a section on the study's conclusion.

3. Methodology

The City of Stirling is a metropolitan local council of Perth, Western Australia (see Figure 1).

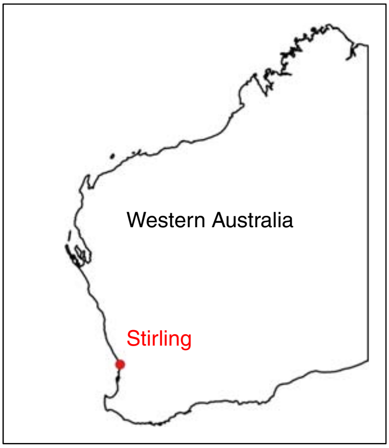


Figure 1.
City of Stirling,
Western Australia

The study examined data for three areas: Gildercliffe Street, Scarborough, between Newborough Street and St Bridget's Terrace; Grand Promenade, Scarborough, between Newborough Street and St Bridget's Terrace; and Elstree Avenue, Coolbinia, between Carnarvon Crescent and Glyde Road. This includes tree asset valuation records and "Helliwell" valuation method information. The City of Stirling defines the Helliwell method of valuation as allowing:

> […] for a monetary value to be placed on the visual amenity provided by an individual tree asset. (City of Stirling, 2016a, p. 7)

It also uses high resolution airborne multispectral imagery to keep records of significant canopy, where:

> […] "significant canopy" is defined as tree canopy cover that is taller than three metres and has a larger area than 20 m^2. Canopy loss is the result of the removal of trees from public and private land, as well as significant pruning. (City of Stirling, 2016b, p. 88)

The City of Stirling's tree asset valuation records and Helliwell condition information sets covered 338 city trees of these data for only 274 trees were analysed because others were too small or of an inappropriate type (for example Cocos palm). The City of Stirling also provided aerial imagery of the trees. The City of Stirling provided aerial images of the areas of investigation. The same areal images are used in web-based interactive mapping (Intramaps, 2017). The image was used as a backdrop for results of this investigation.

Data of each tree were also provided in spreadsheet format by the City of Stirling. The data contained location of tree, tree type and measurements and calculations in relation to the monetary tree value. The measurements of city trees taken by the City of Stirling consisted of the following information: unique tree identifier, eastings and northings of the tree, power line information related to each city tree, calculated City of Stirling monetary value expressed in dollars, category of tree size, and square metre size of tree. These data were split up and transferred into a PostgreSQL database either directly or via the QGIS. Consistent with ratio analysis, the study used the monetary values calculated by the City of Stirling in order to make comparisons of before and after tree trimming possible. Monetary values calculated by the City of Stirling were used as a basis for calculations of loss of value. Free open-source software was used. This software included Libreoffice, PostgreSQL, PostGIS and QGIS (Libreoffice, 2016; PostgreSQL, 2016; QGIS, 2016).

All the trees on both sides of the selected streets were photographed. In this way, trimmed and non-trimmed trees could be compared. An image of each city tree was imported into QGIS, then the shape of the existing crown was digitised and an estimated area of trimming loss was digitised, as illustrated in Plate 1. The digitised areas of existing canopy and lost canopy were added to get a total area. From here ratios could be calculated. These ratios in turn were applied using tree values supplied by City of Stirling. The projection of loss was calculated using ratios/percentages of loss of canopy compared to the initial existing canopy size. These ratios were then used in terms of the city tree project, and a separate QGIS project was created.

3.1 Limitations

A data confidentiality agreement were struck between the City of Stirling and the co-authors for the City of Stirling to provide details of the City of Stirling's tree asset valuation records and Helliwell condition information sets. The authors have permission to include council details of financial metrics and photographs in the study and the data was to be held by the co-authors for a period of one calendar year from the date of agreement.

For analysis only trees higher than 4 m were used to take into account the safety standards about clearance around power lines (Ausgrid, 2016). When the canopies were digitised it was recorded only if the tree had been pruned under power lines in a previous time. Part of Elstree Street was converted to underground power in 2015. No revaluation had been conducted by City of Stirling and as a consequence this data could not be used for analysis.

The paper is limited to calculating monetary loss of city tree value arising from tree trimming under power lines. It does not take into account modelling of pollution abatement, CO_2 absorption, noise reduction and cooling properties, all of which offer considerable amenity value of city trees. It also does not take into account trade-offs between underground and above ground power systems in terms of reliability, aesthetics and safety assessments (Bumby *et al.*, 2010). Nevertheless, it derives a sense of loss of tree amenity value using the City of Stirling's tree valuation method in the study's analysis.

Plate 1.
City tree (tree id 6736) not trimmed, fully grown

A further limitation of the study is that it only considers the monetary loss of city tree value of a single Western Australian local government authority, where under the "Thoroughfares and Public Places Local Law 2008", the City of Stirling defines a tree:

> […] as a woody perennial plant generally having a single stem or trunk which will grow to a height of approximately 4 metres or more. (City of Stirling, 2016a, p. 7)

Other jurisdictions may have different criteria for height of trees under their control. Future research might also consider taking a larger sample of council streets to perform a more robust analysis of the research question.

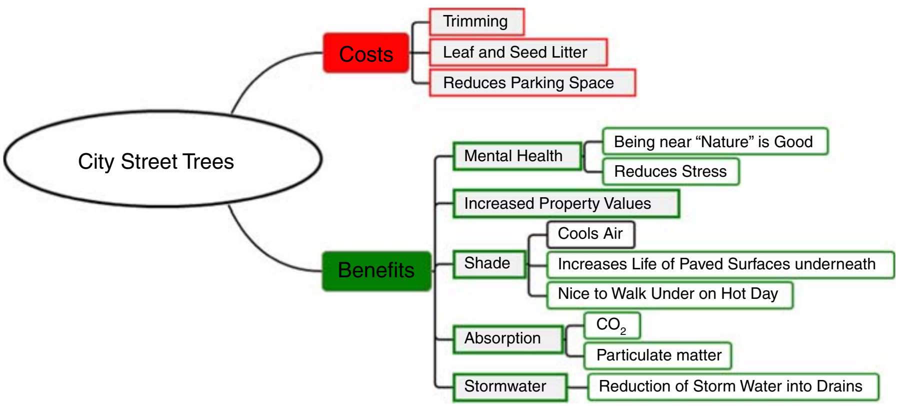
4. Literature

4.1 Accounting

The relevance of tree trimming to the field of social and environmental accounting rests on a prior accounting literature that seeks to provide financial information on issues that touch upon the natural environment. This financial information may encompass a calculation of private and external costs (Antheaume, 2004), the measurement and pricing of environmental and social externalities for improved decision making (Bebbington *et al.*, 2001), the rendering of a sustainability account (Bebbington and Gray, 2001) and the generation of full cost accounting linked to sustainability science (Bebbington and Larrinaga, 2014).

Figure 2 shows the various costs and benefits of street trees. Apart from improved mental health and increased property values, city trees provide shade, absorb carbon dioxide and reduce stormwater. Most and Weissman (2012) argue that trees also benefit society in providing carbon sequestration, street safety and electric and magnetic field shielding. The costs of trees arise from the collection of leaf and seed litter and of trimming. The issue of trimming or not trimming is pivotal to the objective of this study.

Internal stakeholders of the city council may utilise a hierarchical or individualized construction of accountability in providing a construction of environmental reality of city trees. City council ratepayers, whose rates contribute to the costs of these accounts of city street trees may gain from this individualizing form of accountability given the wide array of benefits that emanate from information sets about city trees provided by the council. For example, the information provided on the tree trimming for power lines may enable a ratepayer to assess the impact of tree trimming by a city council (ratepayers are not required to trim city trees) on property prices. Socializing forms of accountability "acknowledges the interdependence of self and other". This is particularly



Sources: Alliance for Community Trees (2011) and Beatley (2017)

Figure 2.
Costs and benefits of city trees

relevant to the interaction by a local government authority with other key stakeholders, such as utilities, environmental-interest groups, engineers and other government departments. Laffin (2009) makes the point that a local government's outcomes and initiatives, which are part of a central-local government relationship, are carried out by the local government authority as a form of accountable governance. This accountable governance includes a vertical accountability, informed by legal obligations, and a horizontal accountability, checked by co-government entities (Considine, 2002). There may also be a form of political accountability where the accountability mechanism is interpreted by various stakeholders for their own objectives (Flinders, 2011).

Together, individualising and socializing effects of accountability (Roberts, 1991a, b, 1996) encourage comprehensive reporting (Roberts, 2003; Roberts and Scapens, 1994) using a "common measurement of economic impacts of different actions and events" (Unerman and Chapman, 2014, p. 388). A reliance on monetary valuation may prove fraught in terms of emphasising the economic over the ecological and social aspects of accountability (Hines, 1991) and in reflecting the full cost accounting into practice with complete accuracy (Antheaume, 2004). Bebbington *et al.* (2001) in a review on full cost accounting in terms of the care of land noted that some measures to bring about more sustainable operations could vary across entities and that there was difficulty in estimating impacts into external costs with precision. In addition, Bebbington and Gray (2001) in an exercise constructing a sustainable cost calculation faced difficulties concerning partial information sets, incomplete cost data, and varying measurement bases. Further, Herbohn (2005) found that full cost environmental accounting was beset by a lack of appropriate measurement techniques. In this context, caution needs to be exercised in constructing estimations of monetary valuations of tree trimming.

It should be pointed out that city trees are not only trimmed for power lines. Many trees are trimmed to ensure appropriate vehicular access, or keeping branches away from buildings. In some cases, they may be trimmed for aesthetic reasons. There are also some species of trees that may need more regular maintenance trimming than others for safety reasons. However, this form of tree trimming is separate from the exercise of tree trimming for overhead power lines. As a consequence this does affect the calculation of opportunity cost presented in this study.

5. Results of discussion

The effects of appropriate tree trimming can be dramatic. Plate 1 shows an image of a non-trimmed city tree. In contrast, Plate 2 provides an image of the estimated area lost from the tree by trimming. On the left-hand side of Plate 2 is an image of a city tree that has been trimmed under a power line. The image on the right-hand side of Plate 2 shows the existing

Plate 2.
City tree (tree id 6790) trimmed for power lines

canopy digitised in green, with the estimated area lost due to the power line shown in red and the estimated area lost by shaping the tree in yellow. Estimations of loss from shaping were not used in this report.

The areas are used as ratios, which in turn are used in our calculations. The estimated areas of loss and the existing cross-sectional area for a tree are added together. The existing cross-sectional area is then divided by the just calculated total area to give a ratio that is used as a multiplier to calculate the lost dollar value. Thus, one can calculate the average value of trees under a power line and compare that with the average value of trees that are not under power line. The dollar value of each tree has been calculated by City of Stirling using the Helliwell method (Helliwell, 2008; Watson, 2002; Sarajevs, 2011).

Trees identified by the numbers 17,594–17,509 of Gildercliffe Street depicted in Plate 3 show the difference in size caused by power line cuts. The trees are of the same type (Queensland Box Tree), grow in the same natural environment and are assumed to have been planted at the same time. The shape of the canopy of the tree on the left is overlain on to the trimmed tree on the right. From this overlay, it is quite clear the substantial loss by trimming. In this example, the assumption is made that without power lines the trees would have been the same size then the power line trimming reduced 59 per cent of its potential size. A total of 16 tree pairs have been compared with an average of 58 per cent loss and a spread from 29 to 80 per cent. The average calculated loss for this street is only 30 per cent. The calculations of canopy loss in the report were based on conservative estimates. For example, the images show that many of the power-line-trimmed trees were squared off causing an additional loss of canopy, which was not used in the calculations of the analysis.

Figure 3 shows part of Gildercliffe Street. The pie charts overlaying the trees in the image are centred on the positions provided by the City of Stirling. The green of the pie is the dollar value as calculated by the City of Stirling. The red represents the calculated value loss. The size of the pie is based on the adjusted dollar values for each tree. The power lines run on the west side of the street. On both streets are little green pies without a red loss component. These represent trees that are lower than 4 m and therefore have not been trimmed.

As shown in Table I, the mean loss of tree valuation arising from trimming trees under power lines is $986 per tree. Not all trees underwent a loss in tree valuation. Indeed, 156 city trees (representing 56.93 per cent of the total sample) did not get trimmed at all, and thus did not incur a monetary valuation loss.

Table I also show the adjusted monetary valuation of the sample set of trees after taking into account the monetary loss from tree trimming. Using the valuation basis for tree valuation by City of Stirling the expected mean adjusted monetary valuation is $7,331 per tree, with a range extending from $905 to $21,718.

Table II focusses on the descriptive statistics of the 118 city trees that were trimmed. The mean monetary valuation loss of the 118 city trees was $2,186 per tree, while the mean

Plate 3.
Image Trees 17,594–17,509 in Gildercliffe Street

Figure 3. Images of tree value and tree value loss

Table I. Descriptive statistics of all trees from three streets

	Minimum	Maximum	Mean	SD
Monetary valuation loss	0	8,437	986	1,293
Adjusted monetary valuation	905	21,718	7,331	2,031

Note: $n = 274$

Table II. Descriptive statistics of the trimmed trees from three streets

	Minimum	Maximum	Mean	SD
Monetary valuation loss	483	4,767	2,186	1,293
Adjusted monetary valuation	1,690	10,893	6,522	2,949

Note: $n = 118$

adjusted valuation of these 118 city trees was $6,522 per tree. This figure of $6,522 per tree is much lower than the mean adjusted valuation of the 156 non-trimmed city trees which is $7,944 per tree. The maximum adjusted monetary valuation for trimmed trees was $10,893 while the maximum monetary valuation for non-trimmed trees was $21,718 (no adjustment needed). The maximum loss of a single tree was $4,767.

Of the sample of 118 city trees that were trimmed, the 23 trimmed trees of Elstree Street had a mean adjusted monetary value of $6,726 and a mean value loss of $2,722, whereas the

43 trimmed trees of Gildercliffe Street has a mean adjusted monetary value of $6,201 and mean value loss of $1,852. The 52 trimmed trees of Grand Promenade had a mean adjusted monetary value of $6,696 and a mean loss of $2,226.

6. Conclusion and suggestions

The City of Stirling clearly gives prominence to the monetary valuation of city trees by measuring the canopy size and carbon absorption of city trees. City trees also form a critical part of the council's socializing form of accountability, transforming trees as infrastructural assets with regular inspections on the health and condition of trees.

The findings of the study suggest that considerable information sets may be gathered from the determination of the loss of monetary tree value arising from trimming of trees under power lines. These calculations of monetary valuation losses clearly allow local government authorities to determine adjusted monetary valuation of individual and aggregate city trees. These calculations could also be used as internal records for the purposes of decision making about the retention, cost, benefit and management of city trees. In this context, calculations of monetary valuation loss may be helpful in making future decisions about possible incentives for replacing power lines with underground power and, thus, satisfy aspects of, individualising, vertical and horizontal accountability.

These calculations could also be used as external records of account of city trees. The adjusted tree valuations could be recorded as non-current assets in the City of Stirling's balance sheet. This is important given in terms of socializing accountability given that the City of Stirling intends to have in place one million trees, with tree canopy cover targeted at 18 per cent.

In the situation, where a local government authority decides not to make monetary valuations of its city trees open to the public, a particular difficulty the authority may face in storing information about potential monetary valuation losses of city trees is how to protect this information if unauthorised stakeholders of the authority gain access to it. As with the use of internal controls for the accounting of other asset classes, local government authorities may well need to put in place controls over access to information on city tree valuations to ensure its safety. However, this may become a less of an issue for a local government authority that publicly reports its adjusted monetary valuation of city trees in its annual reports.

There are a number of issues touching upon political accountability, which might affect the way in which an individual local government authority might use the study's model of determination of monetary tree valuation arising from trimming trees under power lines. First, the accuracy of the model will depend upon the specific assumptions of valuation adopted by a particular local government authority. In the case of the City of Stirling, which adopted the Helliwell valuation method, there appeared the advantage of using a relatively old system of tree valuation that has been applied in other jurisdictions over a period of time. However, other local government authorities might consider alternative models of valuation which may provide a higher degree of accuracy. The benefits of the other West Australian local government authorities in using the same valuation method is that a comparison could be made of monetary valuation loss and adjusted monetary values.

Second, no matter which model of the valuation is applied, there appears space to evaluate formally the relative loss of value in the form of opportunity cost. What is important here for local government authorities is to select a model of valuation loss that is meaningful to both authority management and authority stakeholders. The meaningfulness of the information may be demonstrated by its ability to help these managers and stakeholders make informed decisions on tree resource management based on efficient and effective collection of data. In this respect, an interesting finding from the analysis is that 56.9 per cent of the sampled trees were not trimmed at all, and thus did not incur a monetary valuation loss. By 2030, the City of Stirling may well have one million trees growing in its local government area. Given that on average 55,448 trees and shrubs are planted per year, a critical concern for city planners and managers is to consider the ratio of the population of trees that might need pruning by 2030.

Third, a local government authority might need to consider in light of the results of the study is the level of completeness of its records of monetary loss accounted for tree trimming. This study appraised a sample of 274 city trees from three streets. However, to derive more robust appraisal of the aggregate loss of monetary tree valuation, future research with might consider increasing the sample set to obtain a more accurate and comprehensive valuation figure. Given the substantial annual loss of trees in the City of Stirling and the City's substantial annual planting programmes such records of monetary valuations and losses of city trees may need to be constantly updated.

A critical matter of concern for local government authorities in determining calculations of monetary loss is how to interpret the results of calculations of loss for purposeful decision making. For example, in deciding upon the trade-off between keeping overhead power lines and putting in place underground power, the issue of monetary as against non-monetary valuations may need to be appraised. This may well depend on a City's long range tree targets. In the case of the City of Stirling, there appears a pressing need for the city to achieve substantial tree canopy cover of 18 per cent in the local government area by 2030, suggesting that the putting in place of underground power may help the city move towards that target. However, the construction of underground power requires substantial capital investment, a monetary cost which may need to be off-set against estimated monetary losses from tree trimming using the city's valuation basis as a measure of monetary worth. This suggests that the opportunity cost model presented in the study's methodology with its emphasis on trade-offs is a useful model for the City of Stirling to consider in making decisions about the above ground/underground trade-off.

In reflecting on the results, it is important to remember that the local government property managers are responsible for the upkeep of trees and the information gathered by the City of Stirling on tree trimming may extended to other parts of the city since their management inspects trees on a regular basis. It is also clear that with enhanced data on tree values, the City of Stirling could provide more information to ratepayers as part of the City of Stirling's mapping options. In this way, ratepayers may be put in a position to pressure on governments to consider underground power to improve streetscape and treescape. Such information may enable ratepayers to appreciate the financial benefits of having well-manage city trees. Monetary valuations also provide a sense of the appropriate positioning of planting new trees.

In summary, in terms of financial accountability of tree-trimming management of a local government authority, there appears merit in looking at monetary loss from tree trimming in appraising power line management. In this context, opportunity cost provides an appropriate mechanism for calculating monetary loss from tree trimming. As a consequence, many local government authorities would benefit from reappraising their tree trimming operations.

However, in framing tree trimming evaluation as a case study for a more generalizable conversation that informs lessons that can travel to other contexts, there appears space for social and environmental accountants to frame issues of overlapping ecological, social and economic aspects in terms of opportunity costs, trade-offs and alternatives foregone. The concept of amenity value, used in this study in the context of city trees, may also extend to other issues related to the natural environment, such as rivers or streams. Further, it may be fruitful for social and environmental accountants to embrace the technology of GIS to probe issues concerned with an account of the wonder of nature.

References

Alliance for Community Trees (2011), "Benefits of trees and urban forests: a research list", available at: www.ACTrees.org (accessed 6 December 2017).

Antheaume, N. (2004), "Valuing external costs – from theory to practice: implications for full cost environmental accounting", *European Accounting Review*, Vol. 13 No. 3, pp. 443-464.

Ausgrid (2016), "Network safety standard", available at: www.ausgrid.com.au (accessed 12 December 2016).

Beatley, T. (2017), *Handbook of Biophilic City Planning & Design*, Island Press, Chicago, IL.

Bebbington, J. and Gray, R. (2001), "An account of sustainability: failure, success and a reconceptualization", *Critical Perspectives on Accounting*, Vol. 12 No. 5, pp. 557-588.

Bebbington, J., Gray, R., Hibbit, C. and Kirk, E. (2001), "Full cost accounting: an agenda for action", ACCA Research Report No. 73, ACCA, London.

Bebbington, J. and Larrinaga, C. (2014), "Accounting and sustainable development: an exploration", *Accounting, Organizations and Society*, Vol. 39 No. 6, pp. 395-413.

Brown, A.M. (2014), "A monetary-valuation analysis of the footpath/road tradeoff of western Australian local government authorities", *Road and Transport Research*, Vol. 23 No. 4, pp. 3-11.

Brown, A.M. and Boogaerdt, H. (2006), "Accounting for Suburban tree information systems", *Corporate Social Responsibility and Environmental Management*, Vol. 13 No. 5, pp. 275-285.

Bumby, S., Burzhinina, E., Feraldi, R., Werthmann, D., Geyer, R. and Sahl, J. (2010), "Life cycle assessment of overhead and underground primary power distribution", *Environmental Science & Technology*, Vol. 44 No. 14, pp. 5587-5593.

Cielewicz, S.R. and Peevey, M. (2013), "Trees, power lines and FERC – an interview with FERC chairman Jon Wellinghoff", *Electric Light and Power*, Vol. 91 No. 1, pp. 18-21.

City of Stirling (2016a), "Street and reserves street policy", available at: www.stirling.wa.gov.au/development/Schemes-policies-codes-and-legislation/Planning%20and%20Development%20Policies/Street%20and%20Reserve%20Trees%20Policy.pdf (accessed 6 December 2017).

City of Stirling (2016b), "City of Stirling annual report 2015/2016", available at: www.stirling.wa.gov.au/Council/Organisational%20information/Annual%20Reports/Annual%20Report%202015%20-%202016.pdf (accessed 6 December 2017).

Considine, M. (2002), "The end of the line? Accountable governance in the age of networks, partnerships, and joined-up services", *Governance: An International Journal of Policy, Adminisration and Institutions*, Vol. 15 No. 3, pp. 21-40.

Donovan, G.H. and Butry, D.T. (2010), "Trees in the city: valuing street trees in Portland, Oregon", *Landscape and Urban Planning*, Vol. 94 No. 2, pp. 77-83.

Fenrick, S.A. and Getachew, L. (2012), "Cost and reliability comparisons of underground and overhead power lines", *Utilities Policy*, Vol. 20 No. 1, pp. 31-37.

Flinders, M. (2011), "Daring to be a Daniel: the pathology of politicized accountability in a monitory democracy", *Administration & Society*, Vol. 43 No. 5, pp. 595-619.

Giergiczny, M., Valasiuk, S., Czajkowski, M., De Salvo, M. and Signorello, G. (2012), "Including cost income ratio into utility function as a way of dealing with 'exploding' implicit prices in mixed Logit models", *Journal of Forest Economics*, Vol. 18 No. 4, pp. 370-380.

Helliwell, R. (2008), "The amenity value of trees and woodlands", *Arboricultural Journal: The International Journal of Urban Forestry*, Vol. 31 No. 3, pp. 161-168.

Helliwell, R. (2014), "Putting a value on visual amenity", *Arboricultural Journal: The International Journal of Urban Forestry*, Vol. 36 No. 3, pp. 129-139.

Herbohn, K. (2005), "A full cost environmental accounting experiment", *Accounting, Organizations and Society*, Vol. 30 No. 6, pp. 519-536.

Hines, R. (1991), "On valuing nature", *Accounting, Auditing & Accountability Journal*, Vol. 4 No. 3, pp. 27-29.

Holden, R. (1986), "The maintenance of business park landscape", *Property Management*, Vol. 4 No. 4, pp. 347-357.

Intramaps (2017), "IntraMaps", available at: www.mapsolutions.com.au/intramaps/intramaps-public.aspx (accessed 6 December 2017).

Jim, C.Y. (2006), "Formulaic expert method to integrate evaluation and valuation of heritage trees in compact city", *Environmental Monitoring and Assessment*, Vol. 116 No. 1, pp. 53-80.

Laffin, M. (2009), "Central-local relations in an era of governance: towards a new research agenda", *Local Government Studies*, Vol. 15 No. 1, pp. 21-37.

Lee, R. (2007), "Nuisance – the right to light", *Property Management*, Vol. 25 No. 3, available at: https://doi.org/10.1108/pm.2007.11325cab.003

Libreoffice (2016), "LibreOffice: the document foundation", available at: www.libreoffice.org/ (accessed 6 December 2017).

Ling, L. and Isaac, D. (1996), "Environmental management issues in China: problems and strategies", *Property Management*, Vol. 14 No. 3, pp. 17-26.

Most, W.B. and Weissman, S. (2012), "Trees and power lines: minimizing conflicts between electric power infrastructure and the urban forest", Centre of Law, Energy & the Environment, Publications, CA, available at: www.law.berkeley.edu/center-article/trees-and-power-lines-minimizing-conflicts-between-electric-power-infrastructure-and-the-urban-forest/ (accessed 6 December 2017).

Odudu, C.O. and Iruobe, P.O. (2017), "Compensation study of Boboroku, Jesse, delta state, Nigeria", *Property Management*, Vol. 35 No. 5, pp. 490-507.

Pandit, R., Polyakov, M., Tapsuwan, S. and Moran, T. (2013), "The effect of street trees on property value in Perth Western Australia", *Landscape and Urban Planning*, Vol. 110, pp. 134-142.

Plant, L., Rambaldi, A. and Sipe, N. (2017), "Evaluating revealed preferences for street tree cover targets: a business case for collaborative investment in leafier streetscapes in Brisbane, Australia", *Ecological Economics*, Vol. 134, pp. 238-249.

PostgreSQL (2016), "PostgreSQL Database", available at: www.postgresql.org/ (accessed 6 December 2017).

Price, C. (2007), "Putting a value on trees: an economist's perspective", *Arboricultural Journal*, Vol. 30 No. 1, pp. 7-19.

Property Management (1998), "Nuisance – trees", *Property Management*, Vol. 16 No. 1, available at: https://doi.org/10.1108/pm.1998.11316aab.018

QGIS (2016), "QGIS Free and open geographic information system", available at: http://qgis.org/en/site/ (accessed 1 November 2016).

Roberts, J. (1991a), "The possibilities of accountability", *Accounting, Organizations and Society*, Vol. 16 No. 4, pp. 355-368.

Roberts, J. (1991b), "Trust and control in Anglo-American system of corporate governance: the individualizing and socializing effects of processes of accountability", *Human Relations*, Vol. 54 No. 12, pp. 1547-1572.

Roberts, J. (1996), "From discipline to dialogue: individualizing and socializing forms of accountability", in Munro, R. and Mouritsen, J. (Eds), *Accountability: Power Ethos and the Technologies of Managing*, International Thompson Business Press, London, pp. 40-61.

Roberts, J. (2003), "The manufacture of corporate social responsibility: constructing corporate sensibility", *Organization*, Vol. 10 No. 2, pp. 249-265.

Roberts, J. and Scapens, R. (1994), "Accounting systems and systems of accountability – understanding accounting practices in their organisational contexts", *Accounting, Organizations and Society*, Vol. 10 No. 4, pp. 443-456.

Rotherham, I.D. (2014), "Trees remain in focus with extreme weather and local government cuts adding to the stresses", *Arboricultural Journal: The International Journal of Urban Forestry*, Vol. 36 No. 1, pp. 1-2.

Salant, S.W. and Yu, X. (2016), "Forest loss, monetary compensation, and delayed re-planting: the effects of unpredictable land tenure in China", *Journal of Environmental Economics and Management*, Vol. 78, pp. 49-66.

Sarajevs, V. (2011), "Street tree valuation systems", Forest Research, Roslin, available at: www.forestry.gov.uk/pdf/FCRN008.pdf/$FILE/FCRN008.pdf (accessed 6 December 2017).

Springer, G. (2010), "Trimming your way to a more reliable future", *Transmission & Distribution World*, Vol. 62 No. 5, pp. 38-41.

Sudipto, R., Byrne, J. and Pickering, C. (2012), "A systematic quantitative review of urban tree benefits, costs, and assessment methods across cities in different climatic zones", *Urban Forestry & Urban Greening*, Vol. 11 No. 4, pp. 351-363.

Unerman, J. and Chapman, C. (2014), "Academic contributions to enhancing accounting for sustainable development", *Accounting, Organizations and Society*, Vol. 39 No. 6, pp. 385-394.

Watson, G. (2002), "Comparing formula methods for tree appraisal", *Journal of Arboriculture*, Vol. 28 No. 1, pp. 11-18.

Further reading

Scolozzi, R., Morri, E. and Santolini, R. (2012), "Delphi-based change assessment in ecosystem service values to support strategic spatial planning in Italian landscapes", *Ecological Indicators*, Vol. 21, pp. 134-144.

Corresponding author
Alistair Brown can be contacted at: Alistair.Brown@cbs.curtin.edu.au