Supplementary Appendix S3

An assessment of the potential economic impacts of the invasive polyphagous shot hole borer (Coleoptera: Curculionidae) in South Africa

M.P. de Wit et al., Journal of Economic Entomology

This appendix contains:

1. A list of agricultural tree species affected by the PSHB
2. Benefit Transfer Method equations
3. Adjusted Total Economic Values for natural forests and selected urban trees
4. Estimated total number of urban trees affected by PSHB invasion

Table S1 Agricultural tree species affected by the Polyphagous Shot Hole Borer in global case studies

Latin name	**Common name**
Citrus limon	Lemon
Citrus sinensis	Orange
Ficus carica	Common fig
Macadamia integrifolia tetraphylla	Macadamia nut
Prunus persica	Peach
Psidium guajava	Guava
Vitis vinifera	Grapevine
Carya illinoinensis	Pecan nut

Benefit-Transfer Method Equations

The adjustment equations used for the economic value of natural forests in South Africa are represented by equations (1) (the currency conversion formula), (2) (the CPI adjustment formula), and (3) (GDP-PPP adjustment), respectively as follows:

$$A_1 i = X^0, oc. e^t tc, oc \quad (1)$$

where $A_1 i$ is the i^{th} original context value after adjustment, X^0, oc is the i^{th} initial original context value and $e^t tc, oc$ is the currency ratio of the transfer context to the original context at the base year. For Natural Forests, the total value per hectare is provided by Brenner et al. (2013), De Groot et al. (2013) and De Groot et al. (2012). For Urban Environments, total value per tree quantities provided by McPherson (2003), Soares et al. (2011) and Peper et al. (2007) are used. The quantities provided by these studies are converted from U.S dollars to Rands using the average annual exchange rates provided by Investing.com (2020), per equation 1. These values are then adjusted for CPI using the following equation:

$$A_2 i = A_1 i \ (CPI^t tc, oc / CPI^0 tc, 0) \quad (2)$$

where $A_2 i$ is the i^{th} original context value after the second adjustment is the i^{th} original context value after the first adjustment, $CPI^t tc, oc$ is the CPI of the transfer context/country for the current year and $CPI^0 tc, 0$ is the CPI of the transfer context/country for the initial year/study date. CPI, or the Consumer Price Index, measures the monthly changes in prices for a range of consumer products, with these changes recording the rate of inflation (StatsSA 2013). This adjustment allows for the values obtained by equation 1 to be represented in current prices. The CPI headline year-on-year rates are obtained from StatsSA (2020). Finally, the per tree values for Urban Environments are adjusted for the PPP-GDP using the following equation:

$$A_3 i = A_2 i \ (GDP^t tc / GDP^t oc)^{\varepsilon} \quad (3)$$

where $A_3 i$ is the i^{th} original context value after the third adjustment, $A_2 i$ is the i^{th} original context value after the second adjustment, $GDP^t tc$ is the PPP GDP of the transfer context/country for the current year, the $GDP^t oc$ is the PPP GDP of the original context/country for the current year and ε is the income elasticity of demand for environmental quality. The GDP (PPP) adjustment captures the conversion of the gross domestic product to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as a U.S. dollar has in the United States. Purchasing power parities (PPPs) are the rates of currency conversion that eliminate the differences in price levels between countries (Global Finance 2020). This allows for Equation 2's values to capture the different income levels from the original study to the local study. To prevent double-counting, this step was omitted for Natural Forests as the original studies had already adjusted the local values to the international dollar's metric. For Urban Environments, the GDP per capita (PPP) conversion values are obtained from the World Bank (2020), with the 'World' GDP per capita (PPP) equating to Int. $17 680.20 and the South African GDP per capita (PPP) equating to Int. $12 999.10. To obtain the int. $ Gross Production Values, the rand values for Avocado Trees and Black Wattle are converted using this formula with the same 'World' and South African GDP per capita (PPP) values provided by the World Bank (2020).

Table S2 Adjusted Total Economic Value (TEV) for natural forests in South Africa (2019 Int. $/ha)

Value per hectare	Original study
3 260.80	De Groot et al. (2012)
6 642.87	Brenner et al. (2010)
2 111.23	De Groot et al. (2013)

Table S3 Adjusted Total Economic Value (TEV) for selected urban trees in South Africa (2019 Int. $/tree)

Urban tree species	Value per tree	Original study
London Plane	11.52	McPherson (2003)
Modesto Ash	10.82	McPherson (2003)
Chinese Sweetgum	8.22	McPherson (2003)
Modesto Ash	10.82	McPherson (2003)
Variety of Lisbon Trees	21.21	Soares et al. (2011)
Variety of New York Trees	29.97	Peper et al. (2007)
London Plane	44.04	Peper et al. (2007)
Sweetgum	22.20	Peper et al. (2007)
Pin Oak	39.31	Peper et al. (2007)
Honey Locust	31.67	Peper et al. (2007)
Unknown Large	37.84	Peper et al. (2007)
Other	22.31	Peper et al. (2007)
Oak, northern red	32.24	Peper et al. (2007)
Maple average	28.77	Peper et al. (2007)
Mean value	25.07	Calculated

Table S4 Estimated total number of urban trees affected by a PSHB invasion

	Tree coverage		Source	Urban area (ha)	Source	Number of trees (million)	Source
Cape Town	13.4	%	Treepedia (2020)	400 300		13.8	Calculation[1]
Johannesburg	23.6	%	Treepedia (2020)	164 542	Schäffler et al. (2013)	10	JUFA (2020)
Durban	23.7	%	Treepedia (2020)	229 200		14.0	Calculation[2]
Sub-total				794 042		37.8	
Total Urban area (SA)				5 346 000		254.5	Calculation[3]

Notes:

*1) 10m trees / 164 542ha / 23.6% * 13.4% * 400 300ha*

*2) 10m trees /164 542ha / 23.6% * 23.7% * 229 200ha*

*3) 5 346 000 ha / 794 042 ha * 37.8m trees*

References

De Groot, R. S., L. Brander, S. Van der Ploeg, et al. 2012. Global estimates of the value of ecosystems and their services in monetary units. Ecosyst Serv. 1: 50–61. https://doi.org/10.1016/j.ecoser.2012.07.005

De Groot, R. S., J. N. Blignaut, S. van der Ploeg, et al. 2013. Benefits of investing in ecosystem restoration. Conserv Biol. 27: 1286–1293. https://doi.org/10.1111/cobi.12158

Global Finance. 2020. GDP-GNI-Definitions. https://www.gfmag.com/global-data/glossary/gdp-gni-definitions#:~:text=PPP%20GNI%20is%20gross%20national,has%20in%20the%20United%20States (accessed on 12 November 2020).

Investing.com. 2020. USD/ZAR Historical Data. https://za.investing.com/currencies/ (accessed on 12 November 2020).

Johannesburg Urban Forest Alliance (JUFA). 2020. Johannesburg as an urban forest. http://www.jufa.org.za/about.html (accessed on 23 November 2020).

McPherson, E. G. 2003. A benefit-cost analysis of ten tree species in Modesto, California, U.S.A. J Arboric. 29: 1–8.

Peper, P., E. G. McPherson, J. R. Simpson, et al. 2007. Municipal Forest Resource Analysis. Davis, CA, New York City, New York.

Schäffler, A., N. Christopher, K. Bobbins, et al. 2013. State of Green Infrastructure in the Gauteng City-Region. Gauteng City-Region Observatory, Johannesburg.

Soares, A. L., F. C. Rego, E. G. McPherson, et al. 2011. Benefits and costs of street trees in Lisbon, Portugal. Urban For Urban Green. 10: 69–78. https://doi.org/10.1016/j.ufug.2010.12.001

StatsSA. 2020. Consumer Price Index (CPI). http://www.statssa.gov.za/ (accessed on 12 November 2020).

Treepedia. 2020. Exploring the green canopy in cities around the world. http://senseable.mit.edu/treepedia/cities/cape%20town (accessed on 23 November 2020).

World Bank. 2020. GDP per capita, PPP (current international $) - South Africa. https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?locations=ZA&name_desc=true (accessed on 13 November 2020).