Chapter 1

Introduction

The City of Tshwane is the administrative capital of the Republic of South Africa and is located in the northwestern region of the province Gauteng. The City's municipal area covers 12% (2 199 km^2) of the total area of the province and has a population of 1.98 million, which represents 22.4 % of the total population (8 837 178) of the province (Tshwane IDP 2005. http://www.tshwane.gov.za/ accessed 09/06/2005). Since the first national democratic elections in 1994 the City has embarked on the provision of housing and grey infrastructure for previously disadvantaged communities. During the period 2001 – 2005 the City would have built 42 000 houses for these communities. There are also 81 informal settlements (formerly known as squatter camps or shanty towns) ranging in size from 300 to more than 8 000 families per settlement (Mkhatshwa 2005). Unemployment in the City of Tshwane is at a total of 31.7 % (Tshwane IDP 2005. http://www.tshwane.gov.za/ accessed 09/06/2005).

In 2004 a R1,4 billion housing project was launched for the previously disadvantaged communities of the Winterveld in the north of the City. This is one of several government-funded housing projects in the City. More than R170 million was spent on upgrading of street lighting infrastructure (Mkhatshwa 2004). However, the urban forestry budget was only R17 million for the entire city. This is 1.2 % of R1,4 billion allocated to the Winterveld housing project. Included in the

urban forestry budget were salaries, maintenance, transportation, equipment and lastly tree planting.

Since 1995 to the present the City has planted approximately 43 000 street trees (personal communication: B. Dry, Deputy Manager: Urban Forestry, Nursery and Training of the City of Tshwane Metropolitan Municipality, 09/06/2005). This equates to approximately one tree planted per house built for previously disadvantaged people during the period 2001 – 2005 and is much less than one tree planted per house built since the introduction of democracy in 1994.

Monetary budgets allocated to street tree planting in the City of Tshwane have declined since the commencement of democracy in spite of this rapid increase in housing development for the poorer previously disadvantaged population of the city (personal communication: B. Dry, Deputy Manager: Urban Forestry, Nursery and Training of the City of Tshwane Metropolitan Municipality, 2004). Urban forestry is not viewed as fundamentally essential but rather as an aesthetic aspect of the city and therefore is allocated less funding. Yet urban trees provide numerous environmental and social benefits like for example, reducing storm water runoff, improving air, soil and water quality, reducing global warming through amongst others carbon sequestration, providing wildlife habitat, increasing property values, enhancing community attractiveness, promoting human health and well-being as well as reducing crime (Hosty, 2003; MacArthur, 2003; McPherson *et al.*, 2002; Murray, 2003).

According to Mr Dry there is a need to quantify these and other benefits that urban trees hold for the City in monetary terms. When arguing for larger budgets the monetary benefits of these trees can then be used to qualify and quantify the benefits in a commonly understood "currency" and hence the importance of planting more trees could be motivated. Equations that predict tree dimensions and carbon storage enable arborists, researchers and urban foresters to model costs and benefits of urban trees (Peper *et al*., 2001) and could thus be used to model the monetary value of urban trees. The availability of data relating to the relationships between tree height and crown dimensions to stem diameter and tree age as well as data relating to the relationship between stem diameter to tree age could be used for modelling various urban forestry benefits for example: carbon sequestration, energy use reductions, air pollution uptake, rainfall interception as well as the microclimatic amelioration effects of urban trees (Peper *et al*., 2001). A literature search revealed no information pertaining either to these tree dimensional relationships or to their application in urban forest ecology modelling for a South African context. Hence this study has four main objectives:

1. to develop tree height, crown diameter, crown height, and crown base height to stem diameter relationships for indigenous street tree species,
2. to develop tree height, crown diameter, crown height, crown base height and stem diameter to tree age relationships for indigenous street tree species,
3. to determine the 30 year carbon sequestration estimate and monetary value of 115 000 street trees to be planted mainly in poorer previously disadvantaged communities during the period 2002 to 2008 and

4. to determine the monetary value of the *Jacaranda mimosifolia* street tree population of the City of Tshwane based on the quantity of carbon stored in the trees.

The above objectives have as overarching aim the establishment and commencement of urban forestry research and to initiate a South African urban forestry resource base which may be used for, and supplement future urban forestry ecosystem function modelling and cost benefit analysis in a southern African context. The meta-motivation being able to argue for more trees to be planted in the poorer urban areas of the City of Tshwane and indeed in all of South Africa's cities.

Thesis format

The thesis is written in article format with the aim of publication once confidentiality restrictions allow this. As a result of the independent nature of the articles there is some repetition between the chapters. However, Chapters 2, 8 and 9 are not aimed at publication. Appendix A consists of a South African patent written in collaboration with a local patent law firm.

Chapter sequence

The following is an introduction to the chapters to follow:

Chapter 2 describes some of the field data collection methodology. It also includes a discussion of the selection of an appropriate growth equation that was applied in Chapters 3, 4 and 6. The results presented in Chapter 5 are based on the calculations derived from the application of this equation in Chapter 3.

Chapter 3 provides a method for determining tree height, crown dimensional and stem diameter growth that can in turn be related to tree age. This chapter is important in that it provides a basis to calculate the future costs and benefits of urban trees.

Chapter 4 relates tree height and crown dimensions to tree age. The dimensional growth rates thus derived enables urban foresters, arborists, horticulturists and landscape architects to correctly position trees in relation to other spatial elements and utilities in view of future tree growth. It also enables computer aided design (CAD) applications to dynamically simulate the growth of trees over time in relation to other landscape, architectural and utility elements.

Chapter 5 presents a direct application of some of the findings in Chapter 3 to the urban forestry, horticultural, arborists and especially the landscape architectural industry. A literature search revealed no information that could be applied to the growth rate of tree stems in confined spaces. This chapter attempts to address the

issue. It is also intended for publication in a landscape architectural industry magazine so as to be of direct value to practitioners.

Chapter 6 is an application of the growth equations presented in Chapter 3. The aim of the chapter was to apply the growth rate results to derive carbon sequestration rates and this was applied to the City of Tshwane's urban forest. A carbon based monetary value for the trees to be planted by this City is projected.

Chapter 7 presents results that aim to quantify the carbon stored in the *Jacaranda mimosifolia* urban forest in the City of Tshwane and thence to derive a monetary value based on that quantity.

Chapter 8 provides a comparison between the growth rates and carbon sequestration rates determined in the previous chapters and that found in the literature for other countries. This is done to provide an international perspective on the local results.

Chapter 9 provides a perspective on urban forest carbon sequestration where it is applied to certain aspects of the Kyoto Protocol and the United Nation Framework Convention on Climate Chance (UNFCCC).

Appendix A is a commercial application of the carbon sequestration equations. This shows that the research presented in this thesis has an additional commercial application beyond those discussed in the previous chapters.

Conclusion

Urban forestry is defined as *the art, science and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economical and aesthetic benefits trees provide society* (Konijnendijk *et al*., 2005). It is hoped that this thesis will contribute to the body of knowledge as defined above so as to benefit especially the South African communities at large and on an individual basis.

References

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