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Urban green space, street tree and heritage large tree assessment in Bangkok, Thailand

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Abstract

Three inventories were conducted to quantify Bangkok's green infrastructure for future planning and improvement in the context of a seasonal monsoonal dry climate. Total green space was quantified by extracting surface cover areas from remotely sensed data in a geographical information system (GIS) environment, and this information was used to designate suitable sites for future green spaces such as parks. Street trees were inventoried for species identification and size. Trees of heritage value were identified through a public awareness campaign, and then were subsequently surveyed for species identification, height and trunk diameter. GIS green space analysis showed that per capita park space was approximately 1.8 m^2, but a master plan proposed increasing per capita park area to 4 m^2 within 25 years. The increased park area will be largely in the form of lower cost, semi-naturalized tree parks. The inventoried street tree population, approximately 200,000, was skewed somewhat towards a monoculture, as 42% were the facultative evergreen *Pterocarpus indicus* Wild. By contrast, none of the other species exceeded 7% of the total. That most of the other species consisted of smaller trunk diameters than *P. indicus*, and therefore younger, suggests that Bangkok's street tree plantings are becoming more diverse. The heritage large tree inventory was dominated by evergreen tree species, particularly exceptionally large *Ficus* species, found largely on Buddhist temple grounds, followed by *Albizia saman* (Jacq.) Merr. The slower growing evergreen heritage species are worth careful appraisal and preservation because they are less likely to be commonly planted. Careful species selection balancing drought deciduous and dry evergreen species can achieve adaptation to the monsoonal dry season with diverse aesthetic quality in both Bangkok's street tree population and in its semi-naturalized tree parks.

Keywords: GIS; Monsoonal climate; Per capita green space; Semi-naturalized forest park; Species selection; Tropics

Introduction

Urban green space that includes contiguous vegetated areas such as parks or forest stands, and isolated trees growing along streets, in street medians, or private property, is a critical foundation for both a healthy population and healthy economy in any city. Indeed, the UN-World Health Organization recommends at least 9 m^2 of urban green space per capita to mitigate a number of undesirable environmental effects and provide other benefits (Deloya, 1993). Urban greening and urban forests are particularly critical to healthy cities in developing countries that contain some of the world's largest metropolitan areas. Green space and urban trees will become increasingly important because

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the rate of urbanization is also greatest in developing countries, mostly in smaller cities of approximately 500,000 in Asia and Africa (UN-ESA, 2003).

In order to understand and plan for the benefits of urban green spaces, cities in tropical and subtropical developing countries seeking to improve their quality of life need to inventory their green infrastructure to determine existing resources, and to set targets for future improvements (Miller, 1996). Identifying appropriate areas for greening requires a careful process of identification and of assessing suitability, and feasibility (Gul et al., 2006). This process is especially important in dense developing country cities (Cy, 2004) linking local to regional green space (Li et al., 2005). Successful greening of tropical urban spaces hinges on financial and ecological sustainability (Randal et al., 2003). Financial and ecological sustainability are in turn strongly affected by green infrastructure allocation between expensive, and typically less environmentally adapted, turf-flower ornamental landscapes, versus lower cost trees that offer greater selection potential for environmental adaptation. Since most cities in developing countries are in regions of native tropical forest, a large diverse pool of adapted species is available (Cy and Liu, 2001).

Selection of tree species best suited for tropical urban conditions will depend on above and belowground space (Cy, 2001), and the actual climate of the city. For example, where a tropical city falls along the seasonality gradient of annual rainfall between a wet and a monsoonal climate, alternating dry and wet seasons in part govern foliage evergreeness versus deciduousness (Santiago et al., 2004), and will determine the importance of drought tolerance in species selection. Finally, inventorying, assessing and publicizing large, existing trees that may be of social and cultural heritage value is important for the character of a city and helps turn the general public into stakeholders in their green infrastructure (Cy, 2006).

Bangkok is the capital of Thailand and is among the larger cities in Asia, with an estimated unofficial population well in excess of 10 million people. As an economic magnet, Bangkok's population is continually increasing through in-migration from the Thai countryside. Adding to its native population, large numbers of tourists visit Bangkok as a destination or linger several days en route to other destinations. Bangkok has a monsoonal climate, and during the dry period from December through April the permanent and tourist populations are subject to sunny, hot conditions exacerbated by the heat island effect from pavement and buildings characteristic in urban monsoonal climates (Weng and Yang, 2004).

Bangkok's green areas and urban forest are critically important in improving its livability, particularly during the dry season. Since the early 1990s the city government, the Bangkok Metropolitan Authority (BMA), has engaged in an active street tree-planting campaign. By the late 1990s, the absence of an inventory of its overall green area as well as its street trees hindered the BMA's ability to manage and improve Bangkok's green spaces and urban forest for the benefit of locals and visitors. This paper reports on inventories of Bangkok's green space, street trees, and large heritage trees in terms of how information on tree diversity can influence future species selection for a city in a monsoonal tropical climate seeking to improve it green infrastructure.

Methods

Climate

Bangkok has a seasonal monsoonal climate where average daily high temperature remains relatively constant over the year, largely fluctuating within a range of 31–34 °C (Fig. 1). Like many tropical cities in the latitudinal belt between 15° and 25°, Bangkok has a 6-month monsoonal wet season from May through October that ameliorates the heat. December–April is the dry, sunny season, somewhat cooler the first 3 months, but March and April have high solar intensity and longer days and thus can become quite hot. Evapotranspiration, calculated using the Hargreaves equation (RefET version 2.01, University of Idaho), showed a narrow range of variation similar to daily high air temperature, highest in April and lowest in February, varying between 4 and 6 mm on a daily basis.

Urban greenspace analysis

In 2001, the BMA contracted with the Faculty of Forestry at Kasetsart University (KUFF), Thailand's

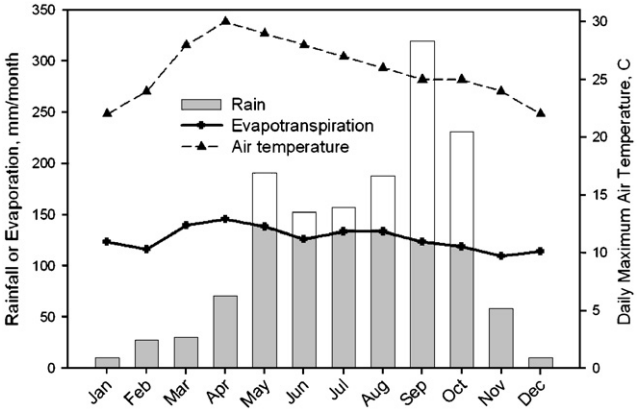

Fig. 1. Monthly rainfall, evapotranspiration (Hargreaves equation) and daily high temperature of Bangkok based on 30-year historical average data.