

Assessment of Trees Outside Forests as Potential Food Source in Second District, Makati City, Philippines

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INTRODUCTION

Urban trees provide various ecosystem services to urban areas that affect its physical environment. Ecosystem services and benefits include air quality improvement, water flow and quality, noise abatement, public health and community well-being (Nowak 2010). Urban areas do not qualify as “forest lands” and “other wooded lands” based on the Food and Agriculture Organization (FAO) definition, hence, they are considered as “other lands” (de Foresta 2013).

The trees, shrubs, and palms within other lands that are predominantly for urban use are classified as Trees Outside Forests (TOF). Trees are said to be TOF if the height is at least 5 m and other lands where TOF are found span more than 0.5 ha and have at least 5% canopy cover for trees or 10% for trees, shrubs, and palms combined. Trees and shrubs are grown in association with annual or permanent farm crops plus animal husbandry activities throughout heavily populated areas in the tropics (Bellafontaine *et.al.* 2002). These TOF are important as they present a potential contribution to food security and complement the services provided by intact forests. Studies in South African urban areas indicate that one of the top reasons for planting and retaining trees is the provision of shade and services such as food and medicines (Shackleton 2015). Urban areas such as Makati City, with a total population of 529,039 as of 2010 (National Statistics Office 2010), will benefit from the services provided by urban TOF. There is a need to establish

ABSTRACT

Urban trees provide important ecological, aesthetic, social, and economic benefits to the communities given expanding urban areas and population needing more food. The Trees Outside Forests (TOF) present potential contribution to food security and complement the services provided by intact forests. Hence, there is a need to identify them in urban areas like Makati City. The study aimed to identify and assess the TOF covered in urban areas and determine the extent of potential food sources. Google Earth Imagery was used to digitize the areas classified as “Other Lands” and assessed the TOF based on the Food and Agriculture Organization decision tree algorithm. Field assessment was done to identify the edible fruit-bearing trees and validate tree height in the TOF criteria. Following the GIS-based Assessment, Monitoring and Evaluation grid system, cells containing edible fruit-bearing TOF were marked. Results showed that the extent of cells with TOF as potential food source is scattered throughout the district. Most of the identified TOF are directly consumed by the communities. The assessment of TOF in urban areas can be used to account for the services they provide to the community. Planting of fruit-bearing trees and management of TOF in urban areas should be promoted to improve food access and security.

Keywords: decision tree algorithm, food access, Google Earth Imagery, trees outside forests, urban trees

more of these as green spaces are said to have decreased in number and area due to urbanization (Ruangrit & Sokhi 2004). As part of the urban design proposal in the city’s Comprehensive Land Use Plan (CLUP) for 2013-2023, the local government aims to increase the parks and open spaces with multiple uses. Hence, assessment of trees is needed in order to plan the green spaces in the city as well as promote the benefits of TOF for the improvement of food access. It is also now being argued that inventory of TOF should be done for its substantial role in food, wood and fuel to rural masses (Anubha *et al.* 2012). The complex spatial distribution of TOF makes it an important part of forest resources assessment. There is still the need to address the peculiarities of TOF as the assessment tools and methods are neither specific nor new (Bellafontaine *et al.* 2002).

The study aimed to assess the TOF of the second district in Makati City. Specifically, the study aimed to: (1) identify and map the urban TOF that are fruit-bearing and edible, and (2) determine the extent of the edible fruit-bearing TOF and its importance as potential food source.

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METHODOLOGY

The study area, Makati City, is located in the National Capital Region bounded by Pasig River on the north, municipality of Pateros on the east, Taguig City on the southeast, Pasay City on the south and southwest, and Manila City on the northwest (Figure 1). The total land area of Makati City is 2,735.56 ha composed of 33 barangays (villages) distributed between two legislative districts. It has the largest concentration of commercial activities in the Philippines and has a primary link to international finance, according to the Makati City CLUP for 2013-2023. The second district, with 13 barangays, has an existing land use of mixed-use zone and residential, and covers a total land area of 1,045.85 ha. Fruit consumption comprises 7% of the total estimated average one-day per capita food consumption for the island of Luzon (Food and Nutrition Research Institute 2008). Nevertheless, the national nutrition survey shows that 70% of the total estimated average one-day per capita food consumption is obtained from plant sources. Given the urban characteristics and food consumption in the region, it is therefore important to identify edible fruit bearing TOF in Makati City.

Delineation of Trees Outside Forests (TOF)

The Makati City boundary from the National Mapping and Resource Information Authority (NAMRIA) and Google Earth imagery captured on 1st April 2014 was used as reference in the delineation of TOF. Trees, palms, and shrubs within the second district of Makati City were digitized and exported in shapefile format. The identification of TOF among the digitized features was then visually interpreted using the decision tree algorithm for TOF (de Foresta 2013). Each digitized feature was subjected

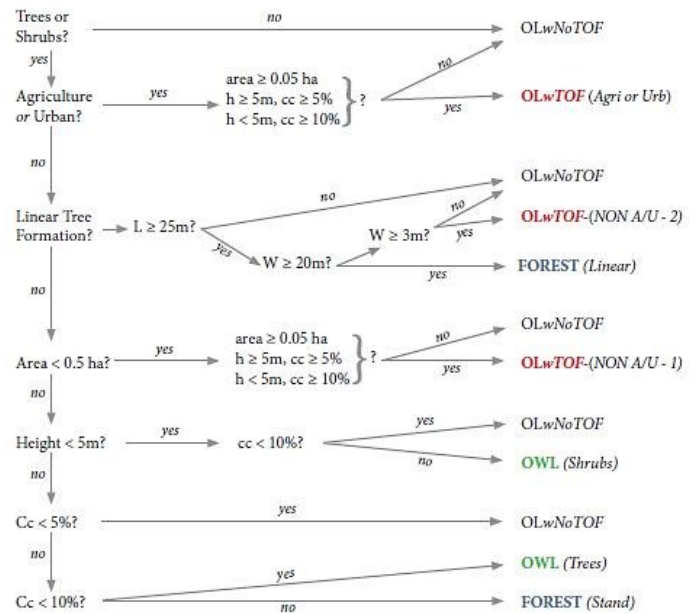


Figure 2. Decision Tree Algorithm (de Foresta 2013).

to the dichotomous criteria of the decision tree starting from the top to bottom (Figure 2). The visual assessment of each digitized feature was conducted by comparing its calculated measurements with the measurement criteria for TOF in the decision tree algorithm. The area and crown cover for the digitized features were verified using Geographic Information Systems (GIS) software measurement tools.

Assessment of TOF as Potential Food Sources

In the field assessment, the presence or absence of edible fruit-bearing trees among the identified TOF within the second district was noted. The height of the identified TOF was measured using the Abney hand level. The geographic coordinates of the TOF that passed the height criterion were captured and stored as point features in GIS geodatabase format. The edible fruit-bearing TOF point features were stored in a Grid-based Assessment, Monitoring, and Evaluation (GAME) model that follows different levels of analysis based on its area (Bantayan 2006; 2015). Using a GIS software, square-grid vector layers with standard sizes: grid (1,000,000 m²), quadrant (250,000 m²), and cell (10,000 m²) were generated for the study area (Figure 3). The generated vector layers were intersected to form a cell-level GAME model with a size of 100m x 100m and area of 10,000 m². In order to show the relative distribution of potential

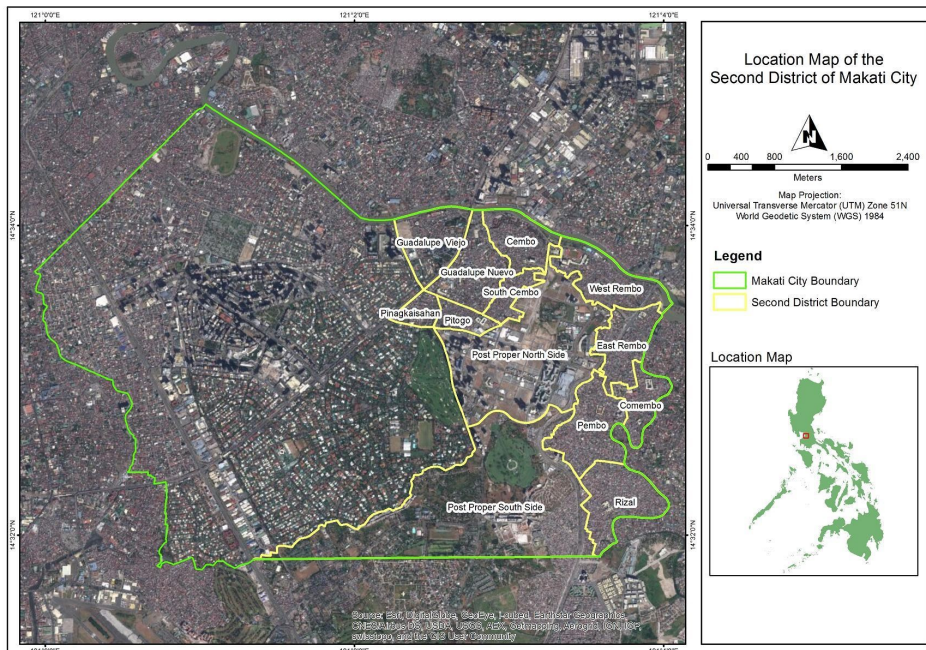


Figure 1. Location map of Second District of Makati City, Philippines.

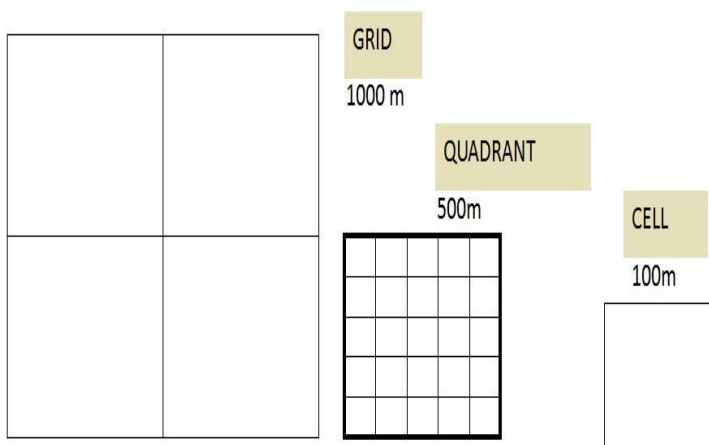


Figure 3. Grid-based Assessment, Monitoring, and Evaluation Model (Bantayan 2006; 2015).

food sources in the district, each cell that covers edible fruit-bearing TOF, regardless of the quantity, was marked and included in the cells with edible fruit-bearing TOF. The use of high-resolution images as part of the methods in the assessment of TOF needs not be different from forest assessment (de Foresta 2013).

RESULTS AND DISCUSSION

Based on the TOF delineation following the decision tree algorithm and field assessment, there are 158.91 ha of urban TOF in the second district (Figure 4). The identified TOF satisfied the criteria for minimum height and crown cover as stated in the decision tree algorithm. The minimum crown cover of 10% and area of at least 0.05 ha were also satisfied for the delineated TOF which includes a combination of trees, shrubs, and palms.

In terms of the extent of potential food sources, a total of 153 cells with an approximate area of 153 ha out of 2,000 cells were found to have edible fruit-bearing TOF (Figure 5). These cells marked as potential food sources were noted to have at least one edible fruit-bearing TOF. The most common edible fruit-bearing TOF species based on frequency in the field assessment were mango (*Mangifera indica*), coconut (*Cocos nucifera*), rambutan (*Nephelium lappaceum*), and star apple (*Chrysophyllum cainito*). As to spatial distribution, 153 cells with edible fruit-bearing TOF are scattered throughout the second district. The concentration of these TOF is mostly in areas designated as residential land use zones where they are utilized for direct consumption. The presence of edible fruit-bearing TOF is important since food scarcity is primarily caused by inadequate distribution and lack of purchasing power (Sunderland 2013).

Edible fruits, which are found in the TOF, are potential food sources as they provide additional micronutrients such as vitamin A, vitamin C, and folate to consumers. A study conducted by Ickowitz *et al.* in 2014 shows a statistically positive relationship between tree cover and consumption of vitamin A rich fruits and vegetables. In a study in Para, Brazil, fruit productivity rose from 7.3-12.2 t ha⁻¹yr⁻¹ in secondary forest to 13.7-18.2 t ha⁻¹yr⁻¹ in home gardens (Bellafontaine *et al.* 2002). From the previous studies, it is important to identify and describe the benefits of edible fruit-bearing TOF in order to gain support for urban forestry programs. These urban forestry programs which promote edible fruit-bearing trees will increase the green spaces of the city (Dwyer & Miller 1999).

The expansion of edible fruit-bearing TOF should be encouraged with the active involvement of the urban area residents. Their preferences are important in the selection of species to be planted in the area (Anubha *et al.* 2012). Government and non-government organizations also play important roles in creating awareness among the communities

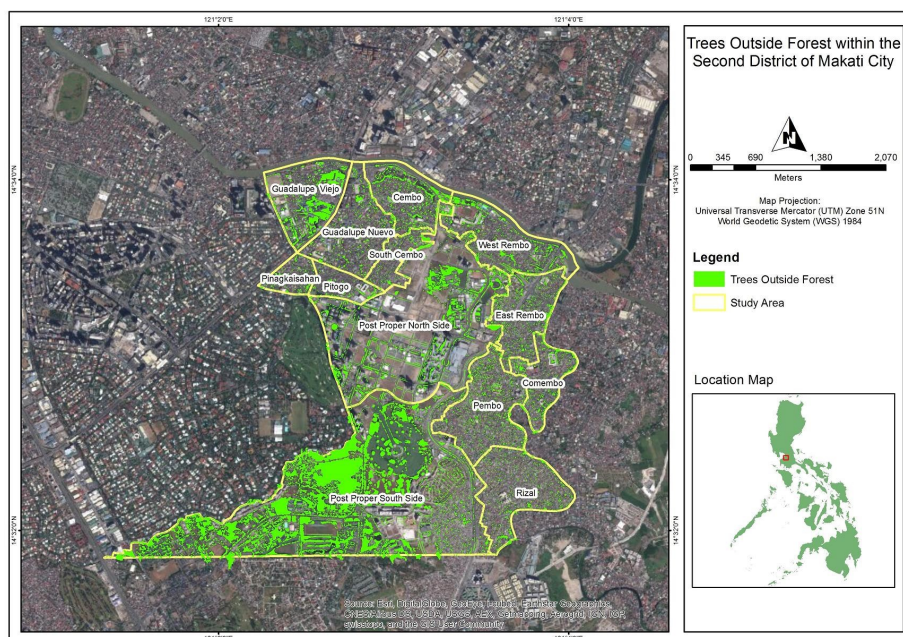


Figure 4. Urban trees outside forest in the Second District of Makati City.

to plant edible fruit-bearing tree species in their respective lands. Recent technological developments allow the accurate and comprehensive assessment of urban tree benefits (Dwyer & Miller 1999). The comprehensive assessment of urban TOF will help in further understanding its benefit to the communities.

CONCLUSION

The assessed urban TOF, covering about 153 ha, are distributed throughout the residential land use zone of the second district of Makati City. Some of these TOF are edible-fruit bearing trees mainly for consumption by the residents. The distribution of TOF in the second district residential areas enables access and potential food source to the community. The presence of urban TOF can also be used to account for the services and other benefits to the community. The edible fruits from urban TOF, according to studies,

impact the quality of life in terms of nutrition hence the need to establish and maintain them. There is no developed standard methodology yet in assessing TOF although the use of high-resolution images like Google Earth is recommended. Further studies regarding the amount of food consumption in Makati City can be made to support the potential contribution of TOF. Studies on the assessment of urban TOF should be encouraged to promote the TOF benefits and map out potential food sources in the urban areas.

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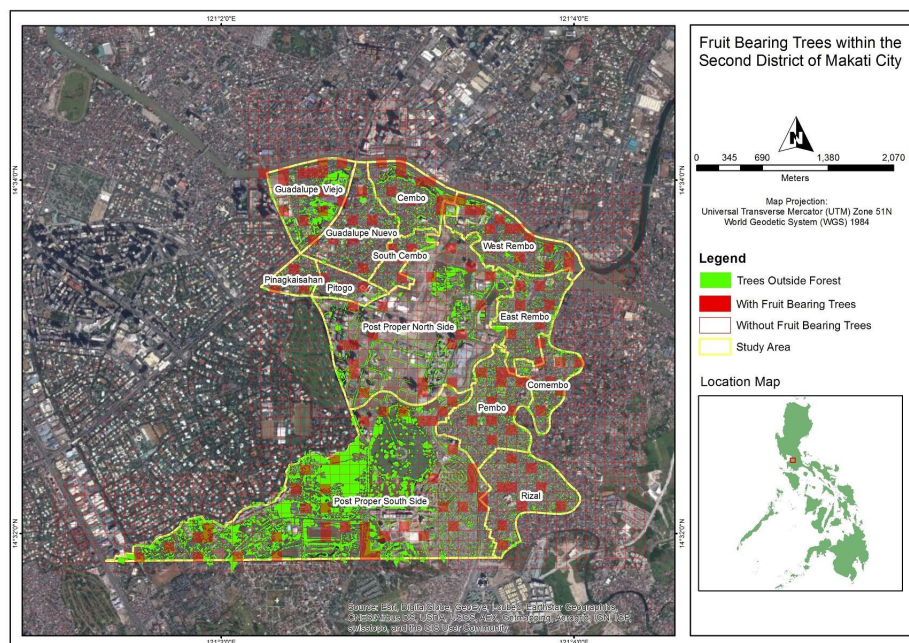


Figure 5. Distribution of edible fruit-bearing TOF in the Second District of Makati City.