Assessment of Trees Outside Forest (TOF) in Selected Makiling Subwatersheds

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Abstract: Trees outside Forest (TOF) are trees, shrubs, bushes including palms that are found in the Food and Agriculture Organization (FAO) other land classification that can be agricultural, urban, or non-agricultural/urban. TOF provide various services and functions that are neither well documented nor given enough attention, hence the need to identify and assess them in agriculture and urban areas outside Mt. Makiling. A SPOT satellite image (2010) covering the Cambantoc, Molawin-Dampalit, and Tigbi subwatersheds of Mt. Makiling was used in the supervised classification of forests, lakes, agriculture, and urban areas. Areas that qualify as other lands were extracted using the classified land types as guides in GIS vector format. Using Google Earth imagery, other lands were digitized and assessed following the FAO decision tree algorithm for TOF and field checking was conducted to validate the tree height in the TOF criteria. Based on the GIS and field assessment, Tigbi and Molawin-Dampalit were found to have TOF on urban land that are mostly fruit trees cultivated for food, landscaping while Cambantoc has TOF on agricultural land and TOF on non-agricultural/urban that are used as farm windbreaks. Findings suggested that TOF contributed to the tree canopy cover in Makiling subwatersheds. Assessment of TOF can be used to account for the ecosystem services it provides which complement those that come from forests and other wooded lands. FAO also recognizes the importance of TOF for local and national food security. TOF, especially fruit trees, are important source of food products for the people.

Keywords: Trees outside forest (TOF); other land with TOF; supervised classification; decision tree algorithm; google earth; makiling subwatershed

1. Introduction

Trees outside forests or TOF are trees present outside the forest and other wooded land classification as defined by the FAO. Aside from trees, it also includes shrubs, bamboo and palms that thrive predominantly in the other land classification or lands that are predominantly for agricultural or urban use according to FAO (2013). Trees are said to be TOF if the height is at least 5 meter and the other land where TOF are found span more than 0.5 hectare and have at least 5% canopy cover for trees or 10% for trees, shrubs, and palms combined. Trees that are not found in agricultural or urban areas but are used as windbreaks, shelterbelts, corridors and riparian tree formation that have at least 25 meter length and less than 20 meter width are also considered TOF.

TOF can be fruit trees, fodder trees, agroforestry trees, shade trees and others to include also shrubs and palms. It presents a potential contribution to food security and complements the services provided by intact forests. Food and income from cultivated, agroforestry, and naturally growing trees constitute an important component on individual household food supply (FAO, 2002). Backyard grown fruit trees provide seasonal allowance for food supply either by direct consumption or selling of harvested fruits to the market. These trees also provide additional micronutrients that staple food cannot provide adequately. Food from trees provides safety nets in times of famine, crop failure, and dry season shortages (FAO, 2002). Trees also contribute indirectly to food security because they have a major role in the sustainability of agricultural production systems.

Urban trees, for instance, impact the quality of life in urban areas through the provision of various benefits that are ecological, aesthetic, social and economic. These benefits do not have market value, and the exact information as to the type of values that people attach to them is barely recorded (Vesley, 2006). Urban tree cover provides wide range of benefits. These includes protection against soil erosion, provision of habitat for wildlife, local air quality improvements, reductions in the urban heat island effect, energy savings through building shading and insulation, carbon sequestration, and reductions in storm water runoff. Ultimately, these lead to improved quality of urban life as trees may improve the aesthetic quality of the neighborhood, provide privacy, reduce stress and shelter residents from the negative effects of undesirable land uses. The cultural benefits may also extend to neighborhoods and environmental benefits may accrue to whole urban area, like the reduction of urban heat island effect (Sander *et al.,* 2008).

However, despite the variety, importance and richness of foods from forests and trees, progress has been very slow in designing and implementing measures to increase the contribution of wild plants and animals to food production and food security through bold application of science and technology. The study generally aims to assess the Tress outside Forests of Selected Makiling subwatersheds. Specifically, the study aims to; (1) develop a map showing the TOF areas of Makiling subwatersheds, and (2) elaborate the potential economic benefits from TOF in makiling subwatersheds in the context of food security.

2. Materials and Methods

The study area is situated in three out of four subwatersheds of Mt. Makiling located on the Southern end of Laguna de Bay with a total area of some 10,000 hectare. From 100 meter altitude up to 200 meter altitude is the Makiling Forest Reserve with an area of about 4,244 hectare according to Fernando (2004) that serves as an important catchment for Laguna de Bay. The Molawin-Dampalit subwatershed is the biggest among the four with a total area of 1,491.88 hectare. It has many streams and creeks draining to the Laguna de Bay. Resident farmers are considered the major stakeholders with agricrops and forest products as some of the stakes in the area (Saplaco, 2001). Cambantoc subwatershed, which drains to Laguna de Bay through the Cambantoc River, has a total area of 1,618.30 hectare. It also has a highly diversified agroforestry systems ideal for farming and settlement dominated by perennials such as coconuts, fruit trees, and secondary forests (De Luna, 2007). The Tigbi subwatershed covers an area of 456.86 hectare. It is an important recharge for aquifers tapped by various users including the spring resorts that are the primary source of income for barangay Pansol. Areas outside of MFR are mostly agricultural and grassland with patches of urbanized areas especially in settlement areas.

Trees outside Forest (TOF) and Other Lands where TOF are technically found were delineated in GIS vector format using the high-resolution raster images as reference. The delineated Other Lands were then subjected to the FAO decision tree algorithm to identify and classify TOF followed by a field survey to verify the tree height and gather other information.

2.1 Delineation of Other Lands and TOF

Other Lands were first identified in urban and agricultural areas by doing a supervised classification of SPOT 2010 image of Mt. Makiling using ERDAS. The image is composed of four bands: Red, Green, Blue and Infrared with a resolution of 10 meter. Ten training sets for built up, agriculture, forest and water were collected and verified in the Google Earth image. A signature file was produced based on the averaged training sets containing the following RGB numbers: built up (0.933333, 0.509804, 0.933333), agriculture (1, 0.843137, 0), forest (0, 0.392157, 0), and water (0, 0, 1). Four land classes based on the signature file using maximum likelihood classifier on the SPOT image was produced and converted into GIS vector layers (Figure 1).

The classified agriculture and urban land types were extracted as a separate vector layer that will serve as reference in efficiently identifying the target areas. Other Lands were digitized based on the classified urban and agriculture land and verified with mosaicked Google Earth raster images of Mt. Makiling with one kilometer resolution. The digitized Other Lands were then classified as either Other Land with Trees Outside Forest (OLwTOF) or Other Lands without TOF and further classified into agriculture, urban, or non-agriculture/urban using the decision tree algorithm for TOF (Figure 2). The area and crown cover were assessed using the GIS measuring tools on the Google Earth Imagery.

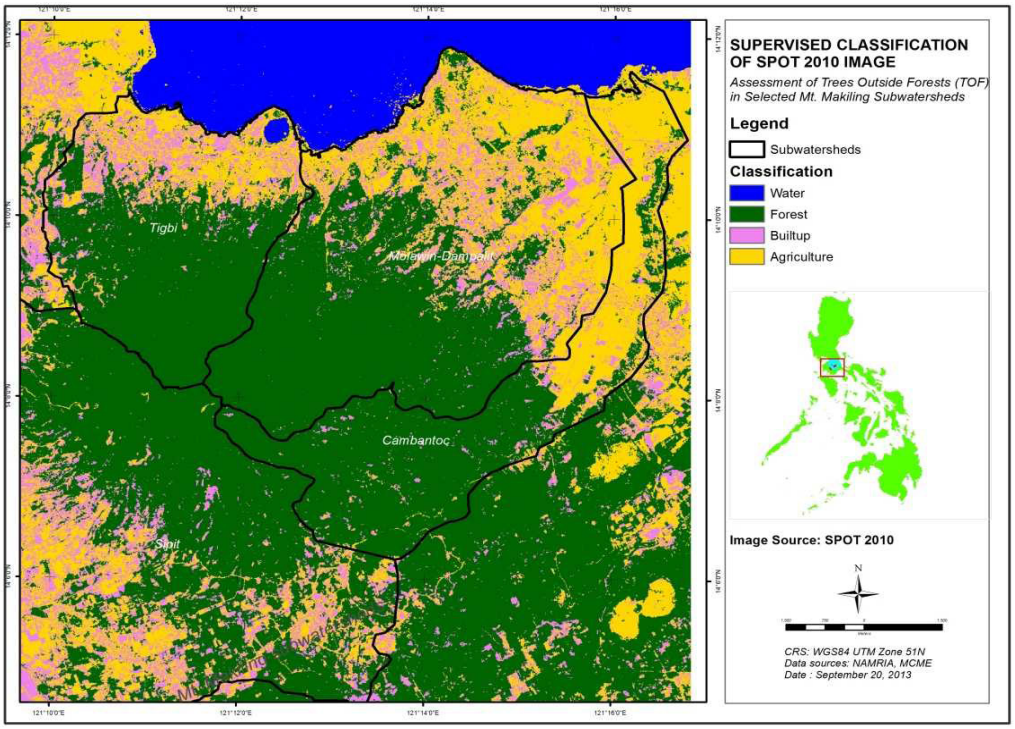

Figure 1. Land Classification of the Makiling Subwatersheds using Supervised Method

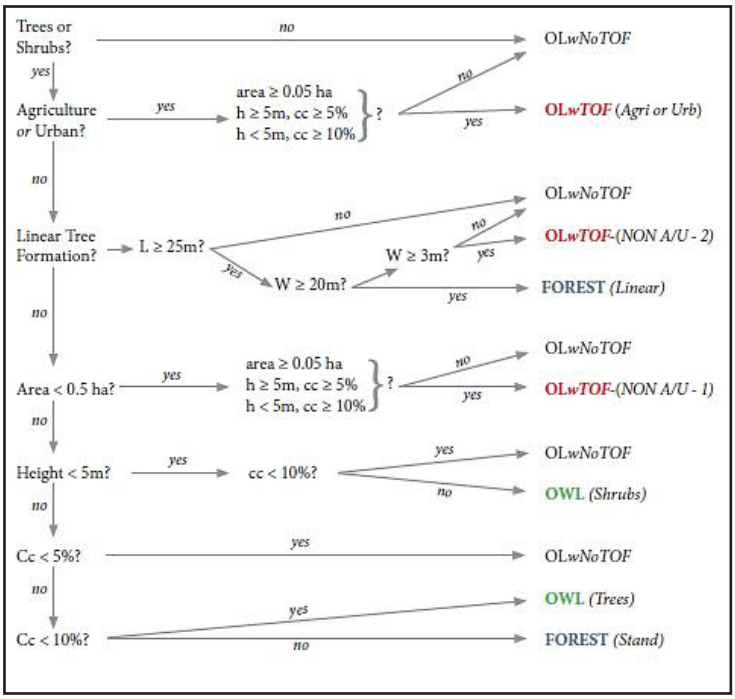

Figure 2. Decision Tree Algorithm for TOF

2.2 Assessment of Potential Benefits of TOF

A field survey was conducted to identify the species, verify the height and gather economic information on TOF. A questionnaire was used to draw information relative to the actual economic benefits derived by households from TOF. Household responses from the survey were used to validate the findings from literature review on the contribution of TOF to the economic well-being and food security of households. Obtaining reliable information on the actual impact of TOF to households is critical in establishing the relationship.

3. Results and Discussion

A total of 1389.56 hectare (17.30%) out of the 8031 hectare covered by the three (3) selected Mt. Makiling subwatersheds was identified as Other Land with Trees outside forest (OLwTOF). Tigbi subwatershed covers an OLwTOF area of about 209.78 hectare whereas Molawin Dampalit and Cambantoc have 829.83 and 349.94 hectare, respectively. OLwTOF are more concentrated in the urban areas in Molawin subwatershed (Figure 3). This is mainly attributed to fact that the downstream portion of the area is predominantly urban. Based on imagery observations, the urban landscape in Molawin-Dampalit still holds a relatively thicker crown cover.

3.1 Classification of Other Land with Trees Outside Forest

Molawin - Dampalit subwatershed has the most number of OLwTOF with 87 polygons, followed by Tigbi with 45, and Cambantoc with 18. This implies that more than half (58%) of the total number of areas delineated as OlwTOF is in Molawin-Dampalit subwatershed. 89 (59.34%) out of 150 OLwTOF were found in urban landscape. The other 38 (25.33%) and 23 (15.33%) fell within agricultural and non-agricultural/non-non-urban landscape, respectively.

Based on the actual field survey, the trees in the sampled areas were found to have an average height of more than 5 meter. Areas dominated by trees have attained the minimum crown cover of more than 5% to be classified as TOF. Palms and bamboo that contribute to the cover in the area where also tallied. A combination of trees and bamboo has attained a minimum crown cover of 10 percent. All sample areas are more than 0.05 hectare as prescribed by the FAO decision tree on TOF classification.

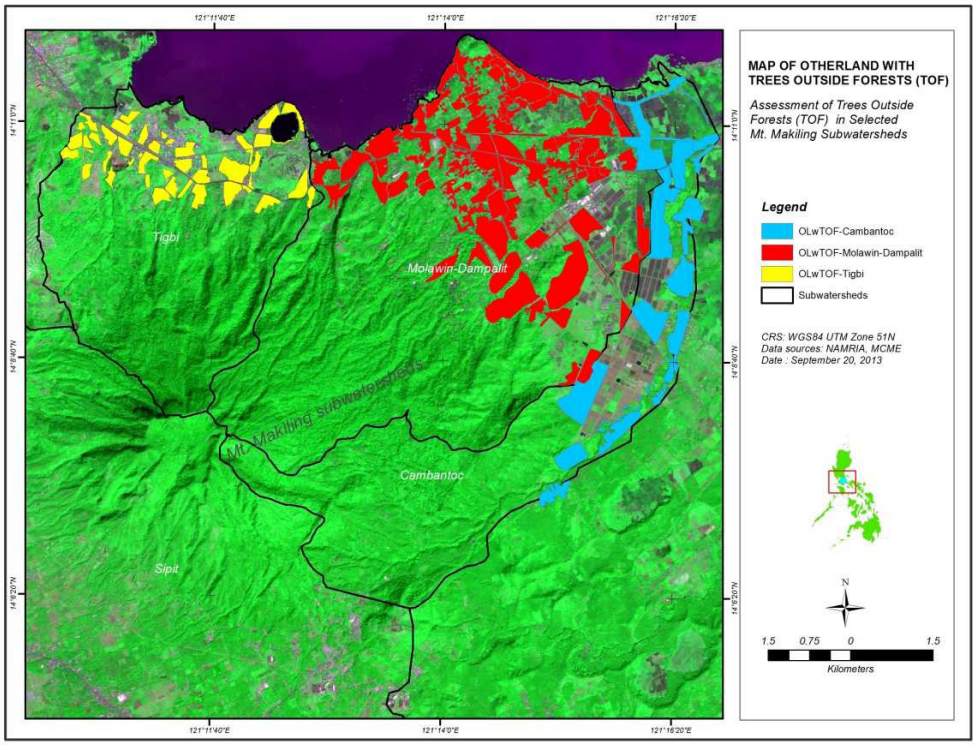

Figure 3. Delineated Other Land with Trees Outside Forest in Selected Subwatersheds

3.2 Potential Benefits of Trees Outside Forest

Niog and mangga appeared as the most frequent tree species in the selected subwatersheds. According to some of the respondents, these fruit trees are either for direct consumption or for market. In the sampled agricultural areas, other species include kakawate and kawayan which are also used other than food source. In the sampled urban areas, niog and mangga also ranked as the most frequent species found with the addition of royal palms. The fruit trees in these areas are used for direct consumption according the respondents. In the sampled areas where non-agricultural/ urban TOF are found, some of the dominant species include saging which are used for direct consumption, kawayan and paper mulberry for other uses (Figure 4).

Trees outside forests in agricultural areas are known to serve as a major source of food and feed, contribute to a balanced diet, and provide the ingredients for various remedies. Trees are used as hedgerows between rows of agricultural crops where some tree species reduce soil erosion. Trees on slopes slow down runoff rainwater and trap sediment that can help in the formation of terraces. According to FAO (2002), TOF are used in construction and crafts and shade and marking the boundaries of fields and other areas. Other functions of trees in agroforestry systems include living fences, windbreaks, and sources of fodder, fuel wood and fruits.

Studies show that the increasing tree cover increases home sale prices, although only within certain area and certain tree types (Sander *et al.*, 2008). The USDA Forest Service has found that mature trees add an average of 10 percent to a property's value. These findings suggest that trees increase the value of property. A 2004 study emphasized the correlation between business and trees.

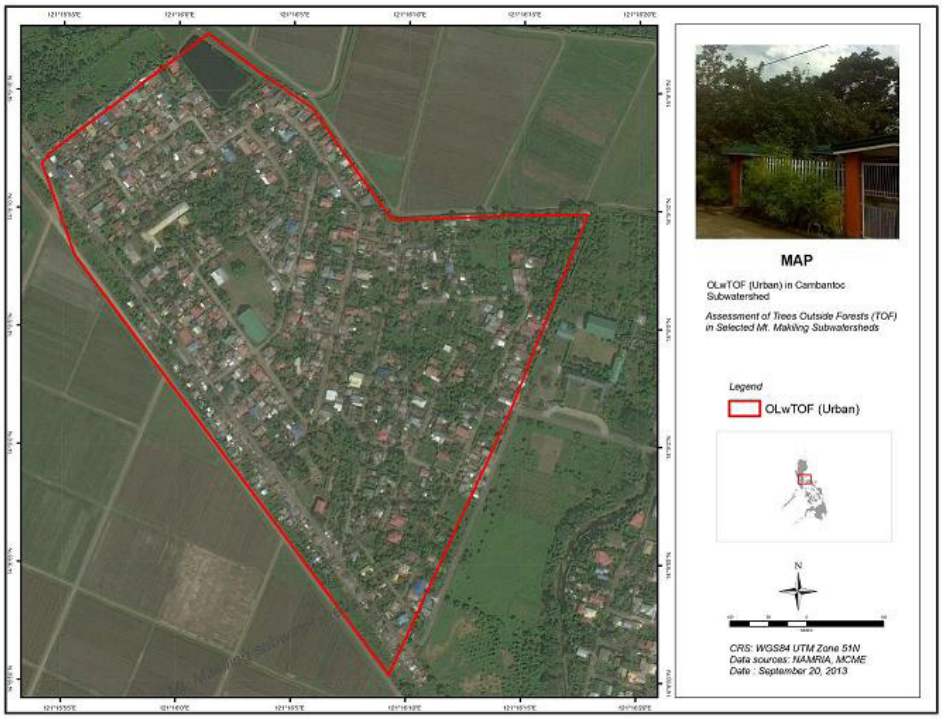

Figure 4. Sampled and verified Other Land with Trees Outside Forest (Urban) in Bay, Laguna

Consumers overwhelmingly preferred business areas with well-planted canopy-covered streets and suggest a link to the amount of time that shoppers are willing to spend in stores (Nowak, 2006). Trees in the urban landscape can also potentially reduce the fuel costs associated with heating and cooling. When placed strategically around buildings, trees can reduce cooling costs by 30 percent, and heating costs by 20-50 percent, a study revealed.

Riparian zones can be classified as non-agricultural and non-urban landscapes, wherein trees are extensively present. Riparian vegetation helps control the transport of sediments, chemicals, and other pollutants to the stream channel. Studies of agricultural watersheds showed that riparian forests are excellent nutrient sinks and buffer the nutrient discharge from the surrounding agro ecosystems (Lawrence *et al.,* 1984). Qui and Prato (1998) evaluated the economic value of riparian buffers in reducing agricultural non-point pollution source pollution in a Midwestern agricultural watershed. They calculated that the net economic value of riparian buffers in reducing a particular pollutant atrazine from a concentration of 45 to 24 ppb amounts to USD612,117 and the savings in government cost is USD631,710. The results of the study strongly suggest and encourage farmers to develop or maintain riparian buffers adjacent to streams.

Also, trees can be found in grasslands. Woody plants encroachment such as trees and shrubs in grasslands are widespread in North and South America, Australia, Africa and Southeast Asia. While this may happen because of natural succession, its impacts clearly jeopardize grassland biodiversity and threatens the sustainability of pastoral, subsistence, and commercial livestock grazing, wherein many are dependent (Noble, 1997). According to Turner *et al*. (1990), it may adversely impact approximately 20% of the world's population.

4. Conclusion

The assessed TOF contributed to the tree canopy cover in Makiling subwatersheds based on the delineation which covered at least 17% of the total area. Most of the identified trees are fruit-bearing trees that are either for direct consumption or marketing purposes. Some of the trees also have the potential of being a fodder source in agricultural areas. The integration of trees and shrubs with crops and livestock systems has strong potential in addressing problems of food insecurity in developing countries (www.theguardian.com). According to some of the respondents, these trees especially the fruit trees are important sources of food products. The assessment of TOF should be developed more so as to know the status and dynamics of other trees outside forest especially on food security.

References

1. Anubha, S., Pandey, A.K., and Ritesh, D. (2012). Assessment of important trees outside forests (TOF) in Gorakhpur district of Uttar Pradesh. Centre for Social Forestry and Eco-Rehabilitation, Allahabad (U.P.).
2. Bellefontaine, R., Petit, S., Pain-Orcet, M., Deleporte, P., and Bertault, J.G., (2002). Trees outside forests: towards better awareness, FAO Conservation

Guide, 35: 237.

3. De Luna, C.C., Visco, R.G., Carandang, W. M., Estoque, R.C., and Noriel, P.M., (2007). Landscape agroforestry dynamics in two sub-watersheds within the Makiling Forest Reserve, Laguna, Philippines, Philippine Agroforestry Development Monitor, 5:10-12.
4. Fernando, E.S., (2004). Flowering Plants and Ferns of Mt. Makiling, Seoul, South Korea, ASEAN Korean Environmental Cooperation Unit.
5. Kotwal, P.C., Horo, N.V., and Singh, A.K., (2004). Trees outside forests: alternatives for achieving sustainability of forests, C & I India Update, 2(4): 2-4.
6. Lowrance, R., Todd, R., Fail, Jr.F., Hendrickson, Jr.O., Leonard, R., and Loris, A., (1984). Riparian Forests as Nutrient Filters in Agricultural Watersheds, BioScience, 34(6): 374-377.
7. Noble, J.C., (1997), The delicate and noxious scrub: studies on native tree and shrub proliferation in semi-arid woodlands of Australia, CSIRO Division of Wildlife and Ecology, Australia, Canberra.
8. Nowak, D.J. (2006). Assessing Urban Forest Effects and Values: Minneapolis's Urban Forest, USDA Forest Service, Newtown Square, Pennsylvania.
9. Qiu, Z., and Prato, T., (1998). Economic Evaluation of Riparian Buffers in an Agricultural Watershed, JAWRA Journal of the American Water Resources Association, 34: 877-890.
10. Sander, H., Polasky, S., and Haight, R., (2008). The value of urban tree cover: A hedonic property price model in Ramsey and Dakota Counties, Minnesota, USA. Ecological Economics, 69: 1646-1656.
11. Saplaco, S.R., Bantayan, N.C., and Cruz, R.V.O., (2001). GIS-Based ATLAS of Selected Watersheds in the Philippines, Los Baños, Laguna, DOST-PCARRD-UPLB.
12. Turner, B.L. II., Clark, W.C., Kates, R.W., Richards, J.F., Mathews, J.T., and Meyers, W.B., (1990). The Earth as transformed by human action, Cambridge University Press, New York.
13. Vark, C.V., (2013). How agroforestry schemes can improve food security in developing countries, *The Guardian*, 26 February 2013, London, United Kingdom.
14. Vesely, E.T., (2006), Green for green: The perceived value of a quantitative change in the urban tree estate of New Zealand, Ecological Economics, 63: 605-615.

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