The Natural Vegetation of Mt. Makiling Forest Reserve (MFR): Potential Source of Native Planting Materials for Urban Landscaping

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Abstract

The MFR is home to more than 2000 native species of trees and plants with the potential for urban greening activities. To help promote the use of native species in urban landscapes, we used a transect method and established a total of seven 10 m x 10 m sampling plots and documented the vegetation including the existing biophysical conditions to characterize the natural mixture of trees and plants that comprise the various canopy layers at different elevations within the MFR. Cross-sectional representations were also drawn to illustrate the relative locations of large trees and concentrations of understorey vegetation. Results of the analysis on biophysical characteristics revealed an increasing temperature and light intensity with increasing elevation from 160 masl to 351 masl. Different plots have varying topographical characteristics that range from relatively flat to steep with the concentration of understorey vegetation at the lowest portions as confirmed by the drawn cross-sectional representation. We identified a total of 42, 43, and 28 species of trees and plants that comprised the dominant and co-dominant (>10 cm dbh), intermediate (<10 cm dbh), and understorey (wildlings, shrubs, vines) layers, respectively. The dominancy of Swietenia macrophylla in over 85% of sampling plots assessed was illustrated in the drawn cross-sectional representations. Apart from Swietenia macrophylla, Arenga pinnata, and Diplodiscus paniculatus were also identified as the most dominant species at the topmost canopy layer. While the dominance of Celtiz luzonica, and Arenga pinnata at the intermediate canopy layer was recorded. The understorey vegetation was found to be dominated by the species of Strombosia philippinensis and S. macrophylla. Furthermore, examples of native species of trees and palm with the potential for urban landscaping identified include bolon (Alphonsea philippinensis), kaong (Arenga pinnata), tangisang-bayawak (Ficus variegata), kalimatas (Phaeanthus ebracteolatus), balobo (Diplodiscus paniculatus), and Lamog (Planchonia spectabilis).

Keywords: MFR, native trees, urban landscaping, canopy layers.

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I. Introduction

The Makiling Forest Reserve (MFR) with about 4,244 ha is located in the southern part of Metro Manila, Luzon Island Philippines (**Figure 1**) (Combalicer et al. 2011). It has the highest peak reaching 1,090 masl (Vergara et al. 2019). The MFR, which is classified as a national park and among the critical watersheds of the country is under the jurisdiction of the University of the Philippines at Los Baños (UPLB) by virtue of the Republic Act No. 6967 in 1990 (Vallesteros 2002). In 2005, some 2,038 species of plants and trees have been reported growing naturally at MFR (Pulhin and Tapia 2005).

MFR has three major land cover classifications such as forest, agroforestry, and special use (forest buffer-zone) but now with a mosaic of land uses that include patches of residual forests, plantations, and agricultural lands (Combalicer et al. 2011). Accordingly, forests comprised high-vegetation areas such as primary, secondary, regenerating, and tree plantations. Agroforestry is areas with a mixture of forest trees, fruit trees, agricultural crops, and livestock (Nair 1993). While Special use zones or forest buffer-zone are areas outside the boundaries of the identified protected areas that need special development control (Ahmad et al. 2011). Interestingly, while a decrease in mixed vegetation is observed, an increase in forest area has been reported in MFR (Vergara et al. 2019).

Unfortunately, despite the existence of Proclamation 1257, s. 1998 which regulates human activities inside a declared protected area, researchers revealed a drastic increase of built-up areas by 117% within the buffer zone of MFR (Soriano et al. 2019). This urban sprawl expansion that gradually encroaches on the MFR is increasing the pressure and threat to the conservation and continued proliferation of the natural vegetation of the MFR. As the MFR holds a tremendous tree diversity (Malabrigo et al. 2016), conserving these species to ensure their existence is critical not only to sustain the biodiversity but a source of propagules for native species that can be used as planting materials to revegetate the deforested areas and nearby urban landscapes. Since not all tree species are suitable for urban tree planting, determining the vegetation that grows naturally in certain forest areas, particularly native trees are essential to identify some untapped native trees with the potential for urban landscape design.

As such, simple documentation of vegetation including the existing biophysical condition of selected sites within the MFR was carried out to characterize and determine the natural vegetation of this protected area.

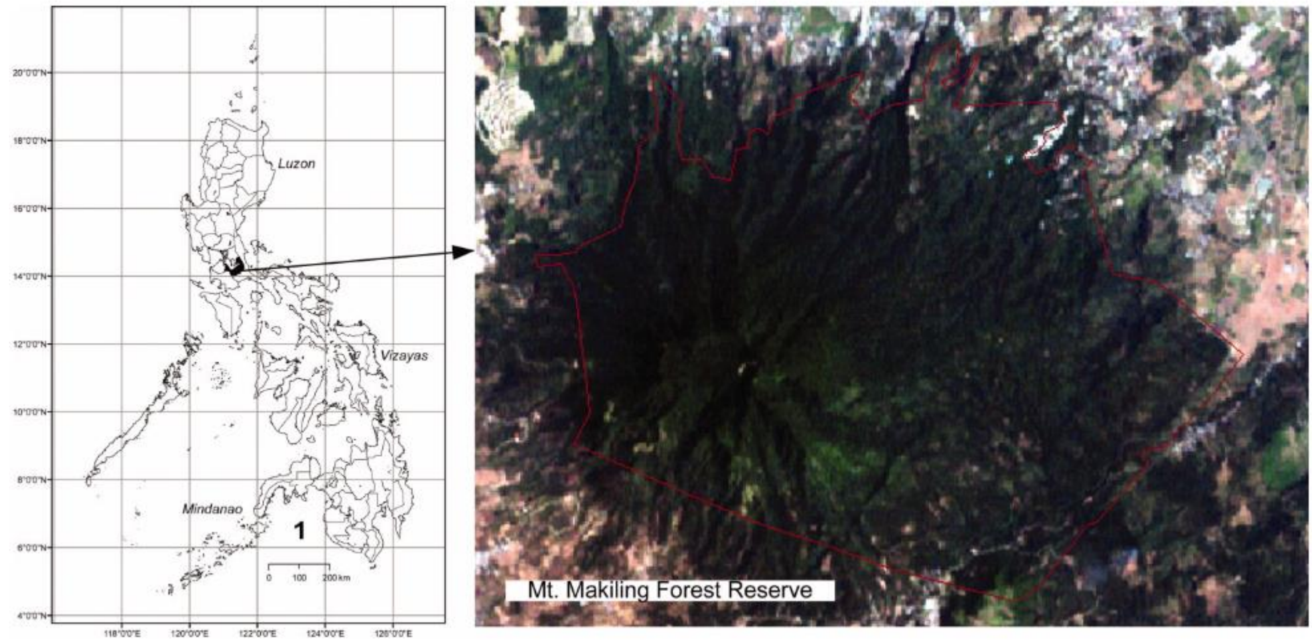


Figure 1. The Mt. Makiling Forest Reserve
Source: Combalicer et al. 2011

II. Materials and Methods

A. Study Site

To see the transition in the vegetation with increasing elevation, the study was conducted from the College of Forestry and Natural Resources campus towards station 5 going to peak 2 within the MFR. Species of trees and understorey vegetation were documented. While cross-sectional representations per plot were drawn to illustrate the relative locations of large trees and concentrations of wildlings with respect to the existing topography. Relevant information such as species identification, elevation, temperature, and light intensity was recorded.

B. Experimental Layout

We adopted the transect method using a 10 m x 10 m sampling plot with minor modifications used in evaluating the plant species diversity and assessment in Quezon Protected Landscape to come up with a representation of the existing vegetation and their biophysical characteristics in the study area, (Paclibar and Tadiosa 2020). Modifications include the non-establishment of 5 m x 5 m plots within the 10 m x 10 m plot, instead, we used a 1 m x 1 m plot that was randomly selected and established for each 10 m^2 plot to assess the understorey vegetation, particularly wildlings. The layout of the sampling plots is presented in **Figure 2**. A total of seven (7) 10 m x 10 m plots were established at quincunx design on both sides of the road at the selected area from the CFNR campus towards the mudspring of MFR. All trees (including palms) of less than (<10 cm) and greater than (>10 cm) diameter at breast height growing within each 10 m^2 plot were counted and taxonomically identified. While understory vegetation (e.g. grasses, shrubs, wildlings, and vines) growing within the randomly selected and established 1 m x 1 m plots was also counted and identified. Unfamiliar species were characterized based on the general traits that resemble the genus and family and denoted using "miscellaneous" as a temporary name. Their true identity was later confirmed using various publications (online and offline) and with the help of taxonomy experts as members of the Philippine Native Tree Enthusiasts (PNTE).

Phase factor (8.1) was used to establish the 10 m x 10 m plots with around 300 m intervals, while a tape measure was used for 1 m x 1 m plots. The establishment of a 1 m^2 plot within each of the 10 m^2 plots was conducted by tossing a ballpen randomly. All biophysical characteristics (temperature, light intensity, and elevation) were estimated using available mobile applications, while topography was characterized qualitatively. Finally, photo documentation was undertaken using mobile phones with a built-in camera.

C. Data Analysis

All data collected were encoded and organized using the Microsoft Excel 365 spreadsheet. The same computer program was used to process and analyze the data collected. While cross-sectional representations for each plot were drawn using Krita drawing applications and Microsoft PowerPoint 365. Taxonomic identifications such as scientific names and family names were determined and confirmed using the Plants of the World Online (https://powo.science.kew.org/, accessed on 15 March 2023) and Co's Digital Flora of the Philippines (CDFP) (https://www.philippineplants.org/, accessed on 15 March 2023).

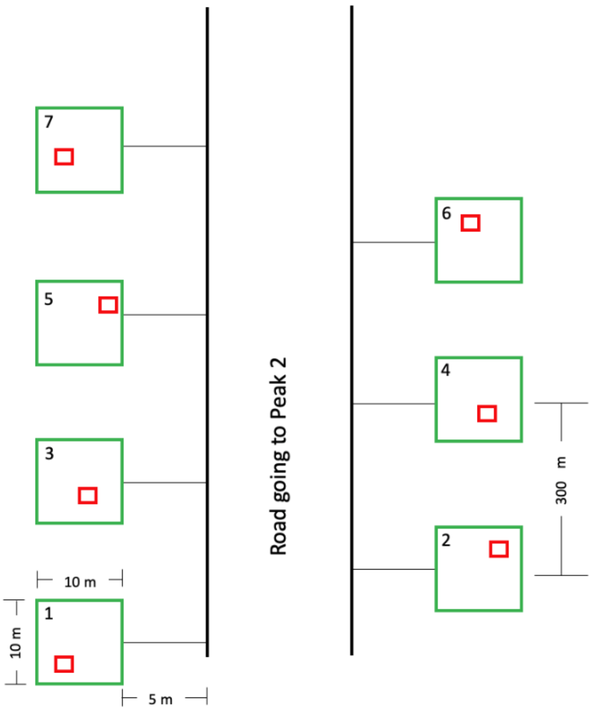


Figure 2. Sampling layout of the study plots. Big green quadrants represent the 10 m x 10 m plots, while small red quadrants denote the 1 m x 1 m plots.

III. Results and Discussion

A. Biophysical Characteristics

Data gathered on the biophysical characteristics of the site is presented in **Table 1**. Results revealed an elevation reaching 351 masl with sampling plots characterized by topography that ranges from relatively flat to steep (**Figure 3**). The average temperature within the 10 m x 10 m plots was around 27.63 °C which ranges between 23 to 29 °C. Interestingly, an increasing temperature was recorded from plots 2 to 7. Meanwhile, the overall mean light intensity was 639 lux with plot 7 recording the greatest light intensity while the lowest in plot 4. Big-leaf Mahogany (*Swietenia macrophylla*) normally is characterized by thick and dense foliage (Kriniwati et al. 2011). However, most of the towering mother trees have newly sprouted leaves with pale color (purplish to yellow-green) and a thick layer of leaves at the forest floor, which would indicate that most of this species just shed their leaves, which created some canopy openings, hence generated a relatively high light intensity measurement (884 lux) (**Figure 4**).

Table 1. Biophysical information of the study site.

Plot No.	Elev. (masl)	Temp. (Degree Celsius)	Light Intensity (Lux)	Slope
1	-	-	-	RF
2	160	23		FR
3	191	28.5	330	SS
4	274	28.5	114	S
5[a]	297	28	884	MS
6	325	28.8	637	S
7[b]	351	29	1,230	FR

NOTE: a – Mahogany plantations; b – near the intermittent creek; RF – relatively flat; FR – flat to rolling; SS – slightly sloping; S – steep; MS – moderately sloping.

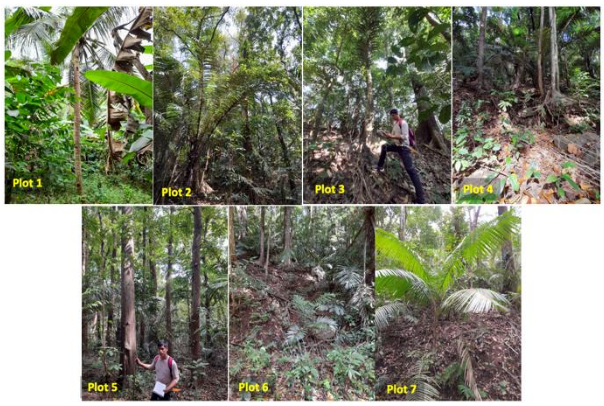


Figure 3. Portions of the plots 1 to 7 showing the topographical characteristics of the site.

Figure 4. Portion of the S. macrophylla plantation (a). Note the thick layer of the leaves accumulated at the forest floor (b) and pale color of the leaves with canopy openings (c).

B. Vegetational Characteristics

Dominant and Co-dominant

A vegetation survey in seven sampled plots showed the dominance of *S. macrophylla* of Meliaceae family among 26 species of plants and trees identified (**Figure 5 and Appendix Table 1**). It was followed by Kaong (*Arenga pinnata*) – a palm species of the family Arecaceae. While Balobo (*Diplodiscus paniculatus*) of the family Malvaceae garnered third among dominant trees across 7 sampling plots assessed. This result affirms the fast-growing ability, phenological advantage, competitiveness, and wide ecological range of the *S. macrophylla*, hence seemingly the most dominant species, particularly at the lower and middle elevation of the MFR (Krisnawati et al. 2011; Galano and Rodriguez 2021).

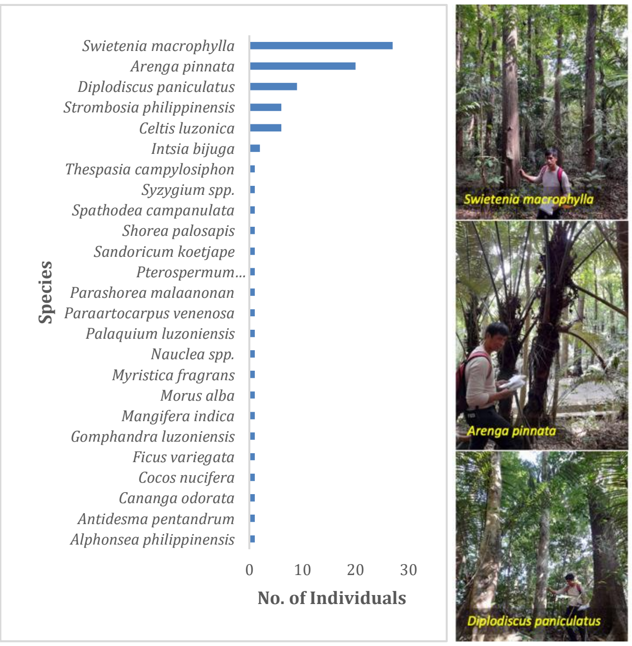


Figure 5. Species of trees and palm identified with >10 cm diameter at breast height.

Intermediate

Among 34 species of trees and plants, Magabuyo (*Celtiz luzonica*) of the Cannabaceae family dominates the intermediate canopy, followed by *Anaxagorea luzonensis*, and Kaong (*Arenga pinnata*) from the family of Arecaceae (**Figure 6 and Appendix Table 2**). These observations are consistent with the floristic survey undertaken in the permanent plots established at selected sites within the MFR (Malabrigo et al. 2016). This further suggests that the MFR is home to numerous unexplored and untapped native species of trees and plants with the potential to be used and mass-propagate for urban landscape designing purposes.

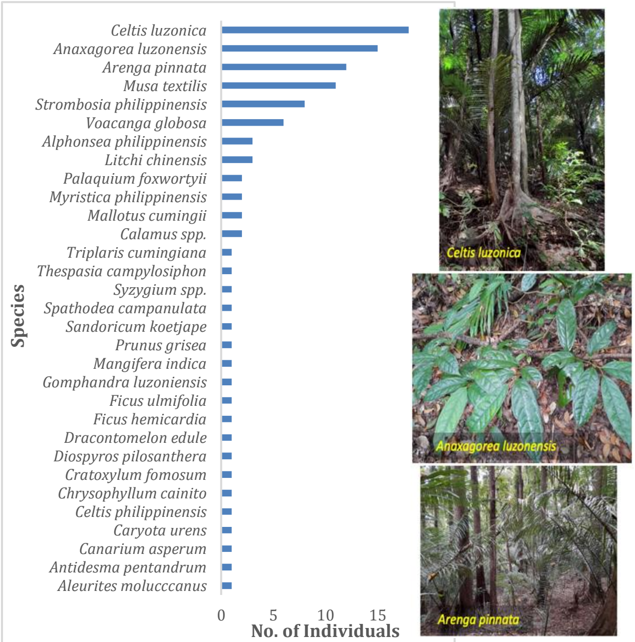


Figure 6. Species of trees and palm identified with <10 cm diameter at breast height.

Understorey

Out of 21 species identified, Tamayuan (*Strombosia philippinensis*) of the family Olacaceae was the dominant wildling the grows naturally on the forest floor of the MFR (**Figure 7 and Appendix Table 3**). Malaikmo (*Celtis philippinensis*) was found the second most dominant followed by wildlings of *S. macrophylla.* Such observations imply that these species of trees are currently at flowering and fruiting, hence they tend to dominate the understorey layer. Interestingly, we also found quite several wildlings of native species under the *S. macrophylla* plantation (**see Table 1 and Appendix Table 3**). This observation might put some claim regarding the toxicity of the leaves of Big-leaf Mahogany in question, which apparently kills the understorey vegetation. For instance, it was reported that *S. macrophylla* leaf litter is suppressing the growth of wildlings in the Philippines (Galano and Rodriguez 2021). However, in a study that analyzed the seedling recruitment of indigenous tree species within the S. *macrophylla* plantation in the MFR, they recorded a total of 44 species belonging to

20 families and 29 genera of indigenous species (Sarmiento 2019). This suggests that further studies are warranted to confirm the degree of toxicity of the S. *macrophylla* leaf litter.

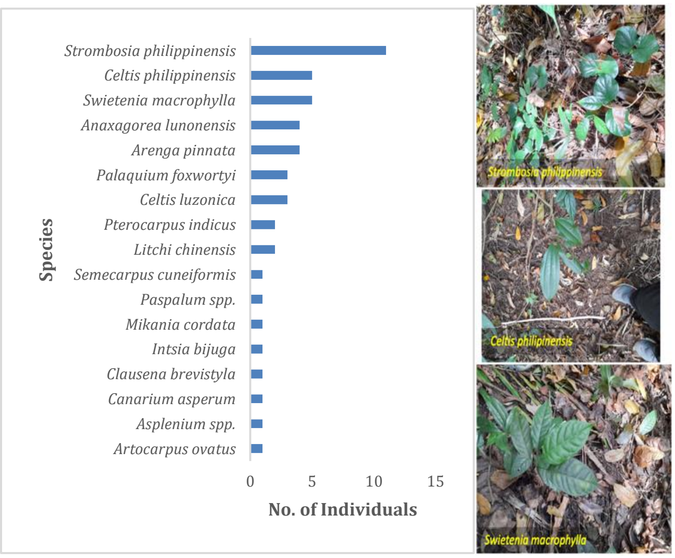
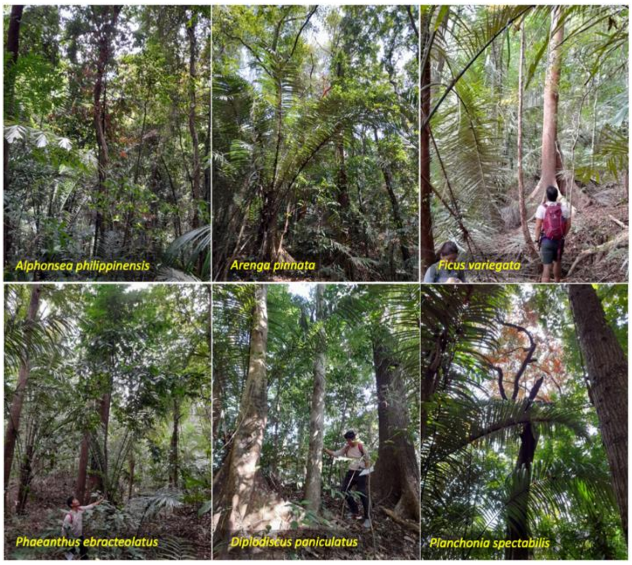


Figure 7. Species of trees and plants identified in 1 m x 1 m plots.

Some Trees with the Potential for Urban Landscaping

This fieldwork proved the huge amount of untapped native genetic reserves within the MFR not only on trees but across canopy layers. Examples of these species include bolon (*Alphonsea philippinensis*), kaong (*Arenga pinnata*), tangisang-bayawak (*Ficus variegata*), kalimatas (*Phaeanthus ebracteolatus*), balobo (Diplodiscus paniculatus), and Lamog (*Planchonia spectabilis*) (**Figure 8**). There is an increasing popularity in the use of native trees in various cities for urban green spaces worldwide (FAO 2018). Perhaps, it's high time that both *in situ* and *ex situ* conservation strategies should be considered not only to promote the use of native trees in urban areas but also to increase the knowledge and awareness of the remaining indigenous species of the Philippines.



potential for urban landscaping.

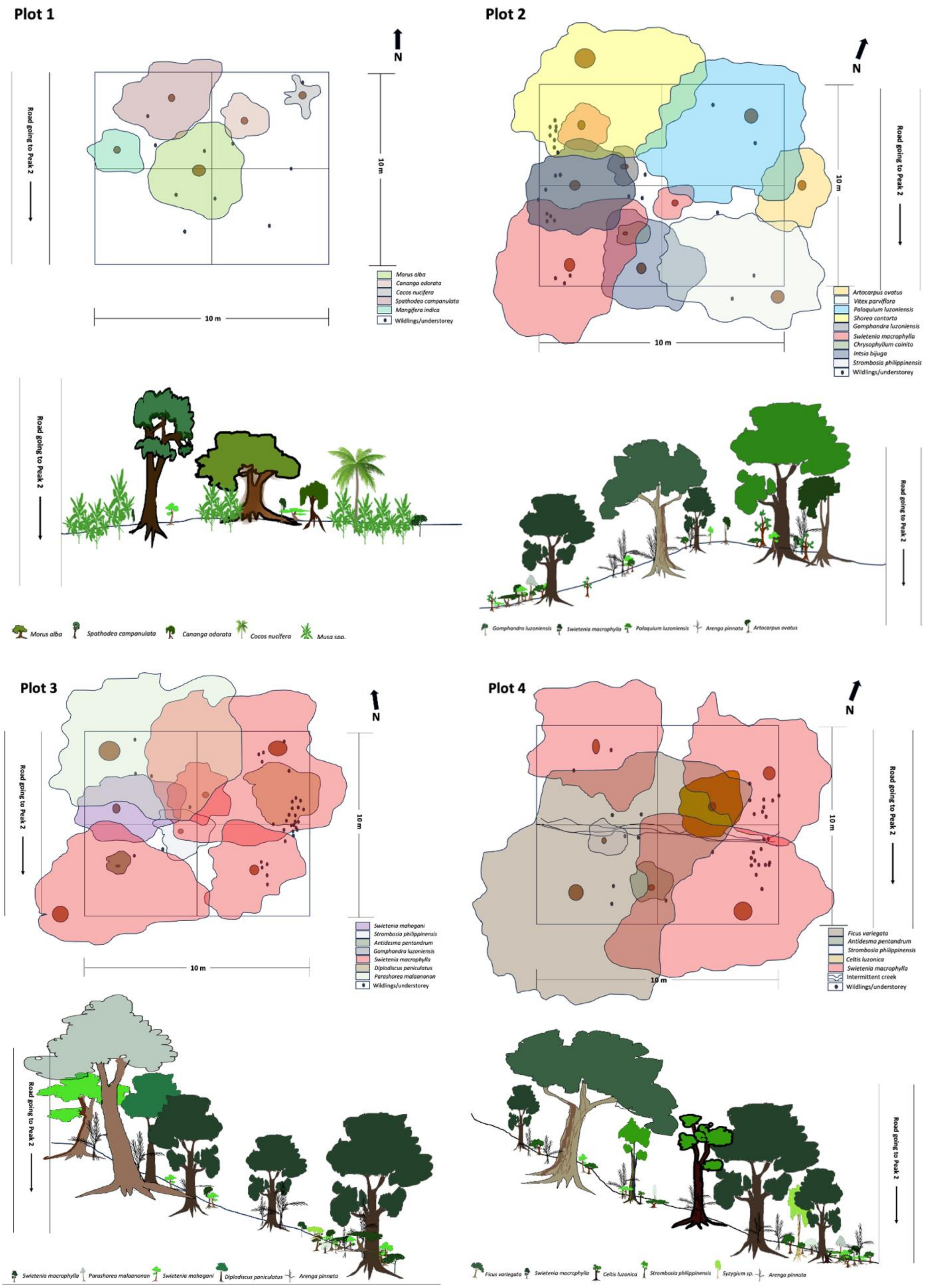
Cross-sectional Representation

Both the top and horizontal views of each sampled plot are shown in **Figure 9**. Interestingly, *S. macrophylla* was found in more than 85% of the plots assessed. This observation reaffirms the dominance of this species in lower and middle elevation areas of the MFR due to its ecological advantage, high seed viability and germination rate, and wide distribution range (Krisnawati et al. 2011; Galano and Rodriguez 2021). These representations also highlighted the relative locations of large trees in a mixture of species in a secondary forest, which can be used as a guide in setting up the urban green space with a plan to establish an aggregation of various species in one place. This is essential as large trees are considered keystone structures in urban parks as they influence the continuous existence of other associated biodiversity (e.g. birds and small mammals) and habitat (e.g. understorey plants) (Stagoll et al. 2012).

Apart from canopy and species distribution, the cross-sectional representations also show the relative location of wildlings and understorey vegetation concentration per plot. Apparently, as the degree of steepness increases, the concentrations of the seedlings or wildlings tend to increase at the lowest part of each plot. This suggests that while canopy openings usually triggered the germination of seeds stored on the forest floor, the topography may influence the concentration of seedlings within the natural forest (Raich and Khoon 1990). This information is important, particularly during the seedling collection in the wild.

IV. Conclusion and Recommendation

Results of the fieldwork, analysis, and cross-sectional representations within the MFR revealed a diverse genetic resource of indigenous trees and plants despite the dominancy of *S. macrophylla* – an exotic and apparently invasive tree species. Such high concentrations of genetic reserve in MFR could be used as potential sources of planting materials to restore the native vegetation of various urban green spaces in nearby towns and cities. A natural mixture of trees and plants found in the MFR can also be used as a guide if one is interested to mimic the natural aggregation of vegetation and forest structure in the urban landscape. Perhaps, this can be adapted to the establishment of a Miyawaki forest. This urban greening technique has long been used in various cities globally, like Japan, India, and China. As opposed to exotic and introduced species, native trees and plants could be more suitable to our local site condition, implying a greater chance of survival and less maintenance cost. Perhaps, it is high time that similar strategies should also be considered in the Philippines. Finally, further study is suggested to clearly understand the natural dynamics of various vegetation both in vertical and horizontal dimensions at various sites within the Makiling Forest Reserve.


Plot 1
N
Road going to Peak 2
10 m
10 m
Morus alba
Cananga odorata
Cocos nucifera
Spathodea campanulata
Mangifera indica
Wildlings/understorey
Morus alba
Spathodea campanulata
Cananga odorata
Cocos nucifera
Musa spp.
Plot 2
N
Road going to Peak 2
10 m
10 m
Artocarpus ovatus
Vitex parviflora
Palaquium luzoniensis
Shorea contorta
Gomphandra luzoniensis
Swietenia macrophylla
Chrysophyllum cainito
Intsia bijuga
Strombosia philippinensis
Wildlings/understorey
Gomphandra luzoniensis
Swietenia macrophylla
Palaquium luzoniensis
Arenga pinnata
Artocarpus ovatus
Plot 3
N
Road going to Peak 2
10 m
10 m
Swietenia mahogani
Strombosia philippinensis
Antidesma pentandrum
Gomphandra luzoniensis
Swietenia macrophylla
Diplodiscus paniculatus
Parashorea malaanonan
Wildlings/understorey
Swietenia macrophylla
Parashorea malaanonan
Swietenia mahogani
Diplodiscus paniculatus
Arenga pinnata
Plot 4
N
Road going to Peak 2
10 m
10 m
Ficus variegata
Antidesma pentandrum
Strombosia philippinensis
Celtis luzonica
Swietenia macrophylla
Intermittent creek
Wildlings/understorey
Ficus variegata
Swietenia macrophylla
Celtis luzonica
Strombosia philippinensis
Syzygium sp.
Arenga pinnata

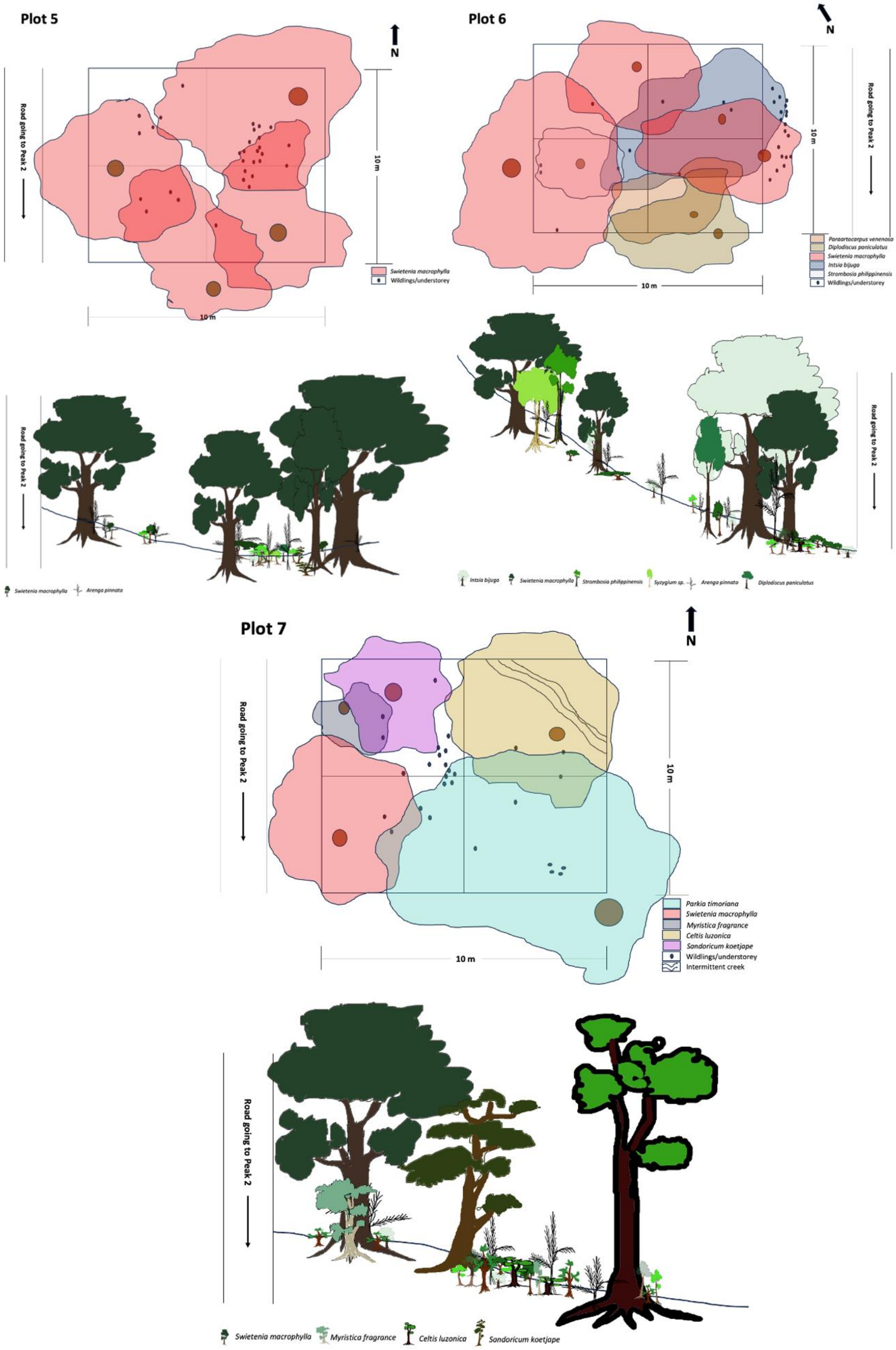


Figure 9. Cross-sectional representations of the seven sampled plots.

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