UE Research Journal
Vol. 26 (2024): pp. 141-161

Tree Species Assessment at the University of the East Tan Yan Kee Garden

[1]Mary Grace D.C. Empasis and [2]Flormay O. Manalo
[1]Technological University of the Philippines, Manila
[2]University of the East – Basic Education, Manila

Abstract

Trees are of great importance to humans and the environment. They may provide cooling, shading, and aesthetic potentials in an environment, among others. In this study, the diversity and abundance of tree species at the Tan Yan Kee Garden of the University of the East, Recto Avenue, Sampaloc, Manila, were assessed. The TYK Garden was divided into four plots. Results revealed a total of 25 plant species from the families Meliaceae, Bignoniaceae, Apocynaceae, Fabaceae, Anacardiaceae, and Lamiaceae. The Shannon-Weiner Diversity Index is 2.366169282, and the species evenness is 0.735091818. The diversity is low based on Fernando's Biodiversity Scale. Hence, it is recommended that more local species be added to make the garden more diverse and to provide more shade and cooling since the university is located in an urban area. There are also endangered and vulnerable species identified within the study site. Therefore, it is also recommended to propagate these species to promote sustainability.

Keywords: Plant diversity and conservation, Shannon-Weiner Diversity Index, Evenness, Importance Value Index

Due to an unprecedented increase in human population, trees have faced varying degrees of disturbance, including being cut down for firewood collection, charcoal production, and infrastructure improvements (Omoro *et al.*, 2010). This has had a profound impact on tree diversity, abundance, species composition, indigenous knowledge of tree flora, and overall conservation. As a response, fostering a harmonious coexistence between humans and biodiversity is crucial.

In promoting university campuses as sustainable development role models, a comprehensive understanding of tree diversity becomes essential. The Shannon Index, which measures diversity using species richness and distribution, and the Evenness Index, assessing diversity in terms of evenness in the distribution of species and individuals per quadrat (Fernando, 1998), are invaluable tools for such assessments. By incorporating these indices, campuses can inform management decisions, conduct assessments, and enhance their understanding of ecologically beneficial species (Suratman, 2012).

Moreover, recognizing the importance of local tree flora is pivotal in cultivating positive relationships between students, professors, and the trees, ultimately fostering a culture of diversity and sustainable management. Knowing the tree species present enables administrators to prioritize conservation efforts for endangered or threatened species. By identifying and documenting these species, the administration can implement measures to protect and preserve them, such as habitat restoration, controlled planting programs, or protection from human disturbances.

Promoting sustainable management involves enhancing biodiversity on campus. By identifying tree species, administrators can introduce new species to increase diversity or focus on preserving native species to maintain a balanced ecosystem. This approach fosters resilience to environmental changes and supports overall ecosystem health.

Therefore, this study aims to identify, document, and evaluate the diversity and abundance of trees in Tan Yan Kee

(TYK) Garden at the University of the East – Manila Campus. By applying the Shannon Index and Evenness Index, the research sought to not only contribute to the academic understanding of local tree populations but also to provide practical insights for sustainable management practices. This approach aligns with the broader goal of creating campuses that exemplify responsible environmental stewardship and serve as beacons for the coexistence of humans and biodiversity.

Statement of the Problem

The study was conducted to identify, document, and evaluate the diversity and abundance of trees in Tan Yan Kee Garden at the University of the East – Manila Campus.

Specifically, it aimed to find answers to the following questions:

1. What are the tree species situated at Tan Yan Kee Garden of the University of the East – Manila Campus?
2. What is the species diversity in TYK Garden in terms of the Shannon-Weiner Diversity Index and Importance Value Index?
3. What is the conservation status of the trees situated at the TYK Garden?

Significance of the study

The study served as baseline information for future researchers, about the current diversity and abundance of the tree species situated in the TYK Garden. The results of the study are intended to guide the university's administration about the condition of the trees found on the campus to promote sustainable management.

Scope and Limitation

The study is limited to evaluating and identifying the diversity of the pole and veteran tree species at the TYK Garden. A veteran tree is a tree that exhibits distinctly ancient

characteristics, regardless of chronological age, while a pole is a young tree stem between one and three meters in length that roots and sprouts when planted in the ground.

Review of Literature

Tree Diversity

Trees represent essential components of ecosystems, providing numerous benefits to both the environment and human communities. Studies such as Ogwu *et al.* (2016) underscore the significance of assessing tree diversity to understand the composition and distribution of tree species within specific areas. For instance, Ogwu *et al.* (2016) conducted research at the University of Benin main campus, Nigeria, revealing a diverse array of tree species, with a notable proportion being exotic. Similarly, Bolanle-Ojo *et al.* (2020) examined tree species diversity in urban areas, emphasizing the importance of maintaining diverse tree populations within recreation centers to preserve ecological balance.

Tree Diversity Measurement

Accurate measurement and assessment of tree diversity are crucial for effective management and conservation efforts. Studies like Babalola and Raji (2018) employed stratified sampling techniques to evaluate tree diversity within specific environments, enabling researchers to quantify species abundance and distribution patterns. Moreover, Agbelade and Akindele (2013) demonstrated innovative methods for assessing tree species diversity within forested areas, utilizing technologies like GPS to facilitate data collection and analysis.

Sustainable Management

Sustainable management practices are imperative for preserving tree diversity and promoting ecosystem health. Research by Bukar *et al.* (2021) and Jeje *et al.* (2021) highlighted the importance of conservation efforts on university campuses to prevent the loss of tree species and promote biodiversity. Babalola and Raji (2018) emphasized the necessity of raising awareness

about the benefits of trees for effective management and conservation strategies. Additionally, Agbelade and Akindele (2013) emphasized the role of accurate data in guiding sustainable forest management practices, which are essential for maintaining tree diversity over time.

In conclusion, understanding tree diversity, employing effective measurement techniques, and implementing sustainable management practices are integral components of conserving tree populations and promoting environmental sustainability.

Trees are generally known to hold great importance as they play various roles and purposes, but to be able to maintain their environmental integrity, sustainable conservation must be done to ensure their continuous existence (Ogwu *et al.*, 2016). For this reason, trees became an integral part of our forest ecosystem and are vital to conservation and management (Raji & Babalola, 2018). Some several universities and campuses try to maintain biodiversity within their environment, such as the University of Benin main campus, Benin City, Nigeria (Ogwu *et al.*, 2016), the University of Maiduguri campus (Bukar *et al.*, 2021), and the Afe Babalola University, Ado Ekiti, Nigeria (Jeje *et al.*, 2021).

On the other hand, the Permanent Site of the University of Ilorin, Nigeria, and the Federal University of Technology, Akure, both had the purpose of providing standard information about the effective management of trees and to guide the manager of the forest resources toward appropriate valuation and efficient utilization (Agbelade and Akindele, 2013; Raji and Babalola, 2018). The studies corresponding to these universities have all presented how important the abundance of trees is on their respective campuses. This study provides a similar outcome, which displays the assessment of tree species at Tan Yan Kee Garden of the University of the East, Recto Avenue, Sampaloc, Manila, in order to figure out a solution regarding the lack of diversity and management within the location in which the studies of Agbelade and Akindele in 2013 and Raji and Babalola in 2018 have suggested a beneficial suggestion. This research

ends with a similar result to Ogwu *et al.*'s study in 2016, as their campus also comprises more exotic trees than native ones. For that reason, the recommendation of adding more local trees can be applied to both campuses. Ending with a note that even with different locations, similar outcomes can be solved by suitable solutions.

Theoretical Framework

The study was anchored on biodiversity theories. According to Meyer *et al.* (2018), biodiversity theories can inform important conservation actions such as assessments of species richness and extinction or habitat loss and fragmentation. Hence, questions about conservation status, diversity indices, and importance value indices were utilized in developing this research study, and to maintain those questions, the theory was applied in the study.

Furthermore, the study will lead to a solution underlying the problem of the loss of important species in an urban environment, and sustainable management of local tree species will be promoted on campus.

Methodology

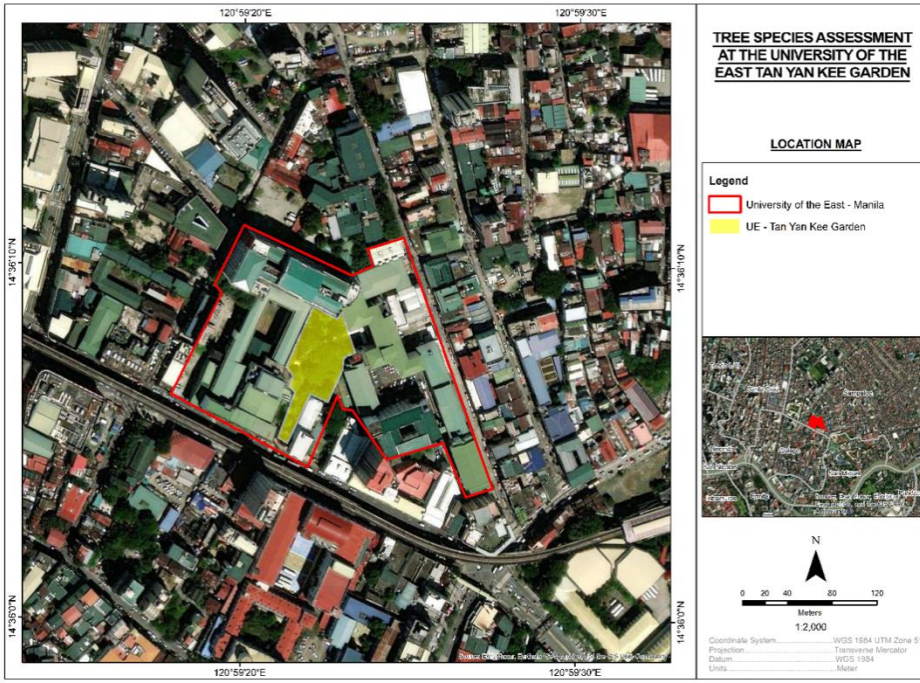
Research Design

The research design used in the study is quantitative method, and the type of quantitative research is descriptive since it aims to describe the current status of an identified variable, which is the conservation status of the tree species found in the TYK Garden. Similarly, a survey was carried out to determine the abundance of the species. As a result, a numerical analysis of the data was carried out in the study.

Study Area

The study was carried out at the Tan Yan Kee Garden of the University of the East, Recto Avenue, Sampaloc, Manila, with the coordinates of 1°36'7"N 120°59'22"E on April 15, 2023. The garden has an area of approximately 4,470 square meters.

Figure 1
Location Map of Tan Yan Kee Garden via Google Satellite



Sampling Procedure

Establishment of Quadrat Sampling

The physical and biodiversity assessments were conducted using the methodology outlined in the DENR Biodiversity Management Bureau Technical Bulletins 2016-05 and 2017-09, as well as the User Manual on Biodiversity Assessment and Monitoring System (2017). The Biodiversity Assessment and Monitoring System user guide is created for

species diversity assessment for measurements of the local flora by creating a 20m x 20m quadrat to observe the identification of the tree species.

In this study, a meter tape and plastic straw rope were used to establish the plots. Four (4) 20m x 20m plots were placed within the TYK Garden. A meter tape was also used to measure the diameter of the trees. The pole and veteran tree species that were present inside the plots were identified with the assistance of Forester Van Jasper Reblora from the University of the Philippines, Los Banos Laguna.

Figure 2
Flora Sampling Survey Map

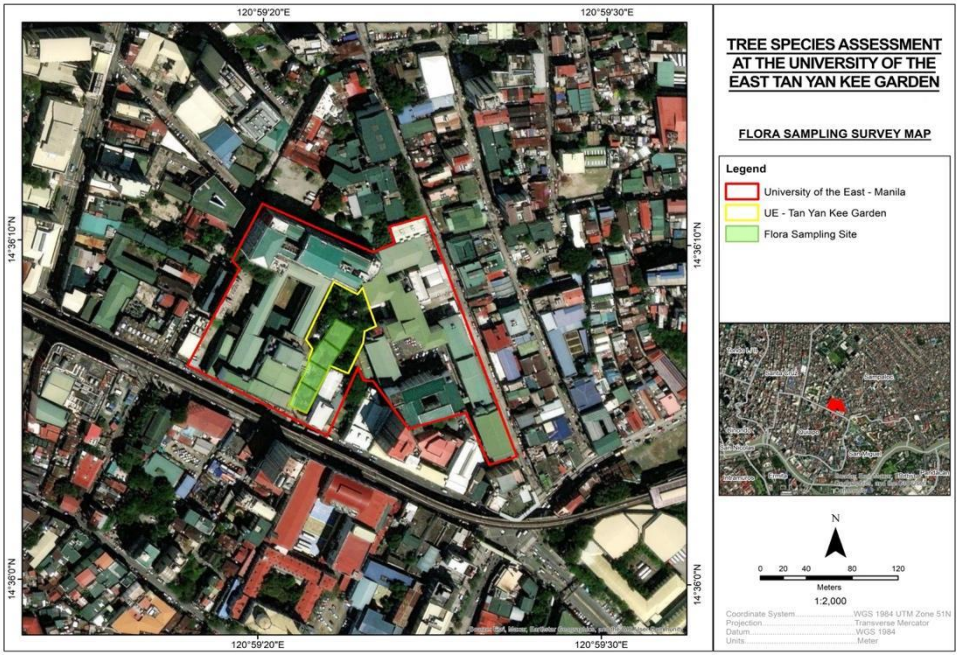


Figure 3
Measuring the diameter of a tree (left) and establishing plots (right)

Processing of Primary Data

The diversity of organisms in a community is measured using biodiversity indices (Shannon and Wiener, 1949). Shannon-Weiner, evenness, and importance value index were used in this study (Table 1). In ecology, species, genera, and families are frequently used to compute diversity indices (Supriatna, 2018). Furthermore, it includes the number of individual plants or animals, an abundance measure, and biomass, or coverage.

Table 1
Biodiversity Indices

Biodiversity Index	Description
Shannon-Weiner Diversity Index $H = -\Sigma pi * ln(pi)$	• Σ - A Greek symbol that means "sum" • *ln* - Natural log • p_i - The proportion of the entire

Biodiversity Index	Description
	community made up of species *i* ● Values range from 0-4, a value of H=0 indicates that a community has only one species
Evenness $EH = H / ln(S)$	● *H* - The Shannon Diversity Index ● *S* - The total number of unique species ● Values range from 0 to 1, where 1 indicates complete evenness
Importance Value Index *IVI = Relative Density + Relative Frequency + Relative Dominance*	● *H* - Density = number of individuals / areas sampled ● Relative density = (Density of species/total density of all species) *100 ● Frequency = Number of plots where species occur/total number of plots sampled ● Relative Frequency = (Species frequency /Total frequency for all species) *100 ● Dominance = Basal area or volume for species/Area sampled ● Basal area = (0.7854) *DBH^2 ● Relative dominance = (Species dominance/Dominance of all species) *100 ● Importance Value (IV) = Relative density + Relative Frequency + Relative dominance ● The value changes from 0-300. A high importance value indicates that **a species is well represented.**

Noteworthy species include the species endemism, indigeneity, and conservation status of identified plants were based on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species, DAO 2017-11 “Updated

National List of Threatened Philippine Plants and Their Categories", and Leonard Co's Digital Flora of the Philippines (Pelser *et al.* 2011).

Presentation and Discussion of Results

A total of 25 individual tree species from the families Meliaceae, Bignoniaceae, Apocynaceae, Fabaceae, Anacardiaceae, and Lamiaceae were identified at the study site. Moreover, in terms of conservation status based on the IUCN Red List of Threatened Species and DAO 2017-11 "Updated National List of Threatened Philippine Plants and Their Categories," as presented in Table 2,there are endangered and vulnerable species found at the study site; specifically, three individual tree species of *Vitex parviflora*, two individual tree species of *Swietenia macrophylla*, and one individual tree species of *Pterocarpus indicus* forma *indicus*. *Vitex parviflora* is an endangered species according to DAO 2017–11; *Swietenia macrophylla* is vulnerable based on the IUCN Red List; and *Pterocarpus indicus* forma *indicus* is vulnerable in accordance with DAO 2017–11 and endangered in the IUCN Red List. This classification alerts us to the fragility of certain species within the ecosystem and underscores the importance of targeted conservation strategies to protect them from further decline.

In addition, as shown in Table 3, the Shannon-Weiner Diversity Index is 2.421621057, and the species evenness is 0.75231888. The diversity is low based on Fernando's Biodiversity Scale, 1998 (Figure 4). According to BMB and GIZ (2017), the greater the value for any of the diversity indices, the greater the species diversity in the area. While the species' evenness is high due to the presence of more similar species at the study site.

The significance of these numbers lies in their reflection of the biodiversity and conservation status of the study site. The presence of endangered and vulnerable species highlights the need for proactive measures to preserve and restore habitats, prevent further habitat destruction, and mitigate threats such as

deforestation and habitat fragmentation. Without intervention, these species face an increased risk of extinction, which could disrupt ecological balance and diminish overall biodiversity. Furthermore, the calculation of diversity indices such as the Shannon-Weiner Diversity Index and species evenness provides insights into the ecological health and resilience of the ecosystem. While the diversity may be considered low based on certain scales, the high evenness suggests a relatively balanced distribution of species, which is crucial for ecosystem stability and resilience against disturbances.

Regarding the Importance Value Index, the results showed that *Spathodea campanulata* has the highest IV among the species recorded at the study site, as presented in Table 4. The importance value index is the measurement of the relative density, relative frequency, and relative dominance of one species in comparison to the other species growing in a given area. It is necessary to calculate as it will determine what species is dominant in a given area. In the case of TYK, this is vital as the dominant species may have a negative effect on other tree species.

The Importance Value Index, which identifies the dominant species within the area, sheds light on the dynamics of species interactions and their implications for ecosystem functioning. Understanding which species exert significant influence can inform management practices aimed at promoting biodiversity and minimizing negative ecological impacts.

On the other hand, one example of a negative effect is allelopathy. According to Chen *et al.* (2009) and Zhang *et al.* (2020), allelopathy (i.e., chemical interactions between plants) is known to affect individual performance and community structure, and plant invasions should be considered when adding species to an area. One of the species found at the study site, *Swietenia macrophylla*, has allelopathic potential (Mukaromah, 2017). Several studies, such as those by Grogan *et al.* (2014) and Galano *et al.* (2021), also showed that *Swietenia macrophylla* has a negative effect on Philippine native tree species and has implications for sustainable management.

In practical terms, the findings call for integrated conservation approaches that consider both the preservation of endangered species and the maintenance of ecosystem processes. This may involve habitat restoration, invasive species management, and community engagement initiatives aimed at promoting sustainable land use practices. By recognizing the significance of these numbers and understanding their implications, stakeholders can work towards safeguarding biodiversity and fostering resilient ecosystems for future generations.

Figure 4

Fernando's Biodiversity Scale

Relative values	H'	E
Very high	3.5 and above	0.75 – 1.0
High	3.0 – 3.49	0.5 – 0.74
Moderate	2.5 – 2.99	0.25 – 0.49
Low	2.0 – 2.49	0.15 – 0.24
Very low	1.9 and below	0.05 – 0.14

Table 2

Terrestrial Flora Survey - Conservation Status of the species recorded in the study site

Scientific Name	Common Name	Family Name	Distribution	IUCN Red List (ver. 2022-2)	DAO 2017-11	DBH
Azadirachta indica	Neem Tree	Meliaceae	Non-native	Least Concern	-	28.88535032
Tabebuia rosea	Pink Tabebuia	Bignoniaceae	Non-native	Least Concern	-	16.21019108
Tabebuia rosea	Pink Tabebuia	Bignoniaceae	Non-native	Least Concern	-	18.88535032
Azadirachta indica	Neem Tree	Meliaceae	Non-native	Least Concern	-	46.81528662
Tabebuia rosea	Pink Tabebuia	Bignoniaceae	Non-native	Least Concern	-	22.92993631

Scientific Name	Common Name	Family Name	Distribution	IUCN Red List (ver. 2022-2)	DAO 2017-11	DBH
Plumeria rubra	Kalachuchi	Apocynaceae	Non-native	Least Concern	-	26.75159236
Tabebuia rosea	Pink Tabebuia	Bignoniaceae	Non-native	Least Concern	-	28.98089172
Cassia fistula	Golden Shower	Fabaceae	Non-native	Least Concern	-	22.61146497
Cassia fistula	Golden Shower	Fabaceae	Non-native	Least Concern	-	38.56687898
Mangifera Indica	Mango	Anacardiaceae	Non-native	Data Deficient	-	18.28025478
Alstonia scholaris	Dita	Apocynaceae	Native	Least Concern	-	44.58598726
Vitex parviflora	Molave	Lamiaceae	Native	Least Concern	Endangered	28.66242038
Vitex parviflora	Molave	Lamiaceae	Native	Least Concern	Endangered	41.71974522
Bauhinia malabarica	Alibangbang	Fabaceae	Native	Least Concern	-	46.17834395
Vitex parviflora	Molave	Lamiaceae	Native	Least Concern	Endangered	20.73248408
Pterocarpus indicus forma *indicus*	Narra	Fabaceae	Native	Endangered	Vulnerable	100.6369427
Spathodea campanulata	African Tulip	Bignoniaceae	Non-native	Least Concern	-	50
Spathodea campanulata	African Tulip	Bignoniaceae	Non-native	Least Concern	-	18.21656051
Spathodea campanulata	African Tulip	Bignoniaceae	Non-native	Least Concern	-	39.17197452
Spathodea campanulata	African Tulip	Bignoniaceae	Non-native	Least Concern	-	52.03821656
Plumeria acuminata	Kalachuchi	Apocynaceae	Non-native	Least Concern	-	33.43949045
Thevetia peruviana	Yellow Oleander	Apocynaceae	Non-native	Data Deficient	-	20.1910828
Thevetia peruviana	Yellow Oleander	Apocynaceae	Non-native	Data Deficient	-	24.20382166
Swietenia macrophylla	Mahogany	Meliaceae	Non-native	Vulnerable	-	36.62420382
Swietenia macrophylla	Mahogany	Meliaceae	Non-native	Vulnerable	-	36.68789809

Table 3
Shannon-Weiner Diversity Index and Evenness

Common Name	Abundance	Relative Abundance	*pi*	ln(pi)	pi*lnpi
Neem tree	2	8	0.08	-2.525728644	-0.202058292
Pink Tabebuia	4	16	0.16	-1.832581464	-0.293213034
Kalachuchi	2	8	0.08	-2.525728644	-0.202058292
Golden Shower	2	8	0.08	-2.525728644	-0.202058292
Mango	1	4	0.04	-3.218875825	-0.128755033
Dita	1	4	0.04	-3.218875825	-0.128755033
Molave	3	12	0.12	-2.120263536	-0.254431624
Alibangbang	1	4	0.04	-3.218875825	-0.128755033
Narra	1	4	0.04	-3.218875825	-0.128755033
African Tulip	4	16	0.16	-1.832581464	-0.293213034
Yellow Oleander	2	8	0.08	-2.525728644	-0.202058292
Mahogany	2	8	0.08	-2.525728644	-0.202058292
	25		**1**		-2.366169282
				H'=	**2.366169282**
				E =	**0.735091818**

Table 4
Importance Value Index

Scientific Name	Basal Area (Dominance)	Density	Relative Density	Relative Dominance	Frequency	Relative Frequency	Importance Value
Alstonia scholaris	1561.304718	1	4	5.347728254	0.25	4	13.34772825
Azadirachta indica	2376.647516	2	8	8.1404129	0.5	8	24.1404129
Bauhinia malabarica	1674.817944	1	4	5.736529925	0.25	4	13.73652993
Cassia	1569.765237	2	8	5.376706938	0.5	8	21.37670694

fistula							
Mangifera Indica	262.4553231	1	4	0.898953119	0.25	4	8.898953119
Plumeria acuminata	878.233904	1	4	3.008097143	0.25	4	11.00809714
Plumeria rubra	562.0696986	1	4	1.925182171	0.25	4	9.925182171
Pterocarpus indicus forma indicus	7954.369589	1	4	27.24503839	0.25	4	35.24503839
Spathodea campanulata	5556.125883	4	16	19.03065495	1	16	51.03065495
Swietenia macrophylla	2110.632259	2	8	7.229266414	0.5	8	23.22926641
Tabebuia rosea	1559.09818	4	16	5.340170495	1	16	37.34017049
Thevetia peruviana	780.2986758	2	8	2.672652703	0.5	8	18.6726527
Vitex parviflora	2349.844056	3	12	8.048606593	0.75	12	32.04860659
	29,195.66298	**25**	**100**	**100**	**6.25**	**100**	**300**

Conclusion and Recommendation

A total of 25 individual tree species were identified in the TYK Garden. Among the species identified are three individual species of *Vitex parviflora*, classified as an endangered species according to DAO 2017–11, and one individual species of *Pterocarpus indicus* forma *indicus*, categorized as vulnerable based on DAO 2017–11 and endangered on the IUCN Red List.

Given the conservation status of the identified species, it is recommended to propagate these species to support sustainability. By propagating endangered and vulnerable species, the TYK Garden directly contributes to the preservation of biodiversity and the conservation of threatened plant species. Additionally, propagating these species can help raise awareness about their conservation status and importance in local ecosystems.

In addition to propagating endangered and vulnerable species, it is also recommended to introduce more local species to

increase the garden's diversity. Incorporating a diverse range of local species not only enhances the ecological value of the garden but also contributes to ecosystem resilience and adaptation to changing environmental conditions. Moreover, introducing more local species can provide additional benefits such as shade and cooling, especially considering that the university is located in an urban area where green spaces are limited.

However, it is essential to consider the potential negative effects of certain plants, such as the allelopathic potential of *Swietenia macrophylla*, when adding species to the area. Allelopathy, the chemical interactions between plants, can impact the growth and development of neighboring plants and influence ecosystem dynamics. Therefore, careful consideration and assessment of the potential impacts of introducing new species are necessary to ensure the overall health and sustainability of the garden ecosystem.

In summary, the recommendations to propagate endangered and vulnerable species, introduce more local species, and consider potential negative effects contribute to the sustainable management of the TYK Garden. By implementing these recommendations, the garden can serve as a model for sustainable urban ecosystems, promoting biodiversity conservation, and providing valuable ecosystem services for the university community and surrounding urban environment.

Acknowledgments

Special thanks to Dr. Alberto T. Paala Jr., Dean of UE Graduate School, and Dr. Maria Corazon Huelar, Coordinator, UE Graduate School EDSA/Research Program, for their support and for allowing us to conduct the tree species assessment at UE Tan Yan Kee Garden.

References

A. D. Agbelade and S. O. Akindele. (2013). Land Use Mapping and Tree Species Diversity of Federal University of Technology, Akure. American International Journal of Contemporary Research Vol. 3 No. 2

Agbelade, Aladesanmi,, Onyekwelu, Jonathan and Apogbona, Oluwaseun. (2016). Assessment of Urban Forest Tree Species Population and Diversity in Ibadan, Nigeria. Environment and Ecology Research. 4. 185-192. 10.13189/eer.2016.040401.

Babalola, Folaranmi and Raji, Islamiat. (2016). Perception of Urban Trees at Main Campus of University of Ilorin, Ilorin, Kwara State, Nigeria. Applied Tropical Agriculture. 21. 60-67.

Bukar, M. G., Oyebamiji, N. A. and Adeogun, P. F. (2021). Diversity and Composition of tree species in the University of Maiduguri campus. Journal of Research in Forestry, Wildlife & Environment Vol. 13(3): 22 – 28

Bolanle-Ojo, Oluwasanmi, Falana, Adepeju, Bolanle-Ojo, Oluwayomi and LeVan, Cuong. (2020). Assessment of tree species diversity and benefits in selected recreation centres for biodiversity conservation in Ibadan Metropolis, Nigeria. Notulae Scientia Biologicae. 12. 100-113. 10.15835/nsb12110561.

Chen, B.M., Peng, S.L., and Ni, G.Y. (2009). Effects of the invasive plant Mikania micrantha H.B.K. on soil nitrogen availability through allelopathy in South China. Biol Invasions 11, 1291–1299 (2009). https://doi.org/10.1007/s10530-008-9336-9

DENR-BMB (2016). Biodiversity Management Bureau Technical Bulletin 2016-05. Retrieved from: https://www.bmb.gov.ph/

DENR-BMB (2017), DAO 2017-11 “Updated National List of Threatened Philippine Plants and Their Categories” Retrieved from: https://www.bmb.gov.ph/

DENR-BMB (2017). Biodiversity Management Bureau Technical Bulletin 2017-09. Retrieved from: https://www.bmb.gov.ph/

Fernando, E.S. (1998) Forest Formations and Flora in the Philippines. College of Forestry and Natural Resources, University of the Philippines Los Banos

Galano, J. B. and Rodriguez, L. J. (2021). Exotic Mahogany Leaf Litter Hinders Growth of Philippine Native Tree Seedlings. Proceedings of the National Institute of Ecology of the Republic of Korea, 2(2), 76-81, https://doi.org/10.22920/PNIE.2021.2.2.76

Grogan, J., Landis, R.M., Free, C.M., Schulze, M.D., Lentini, M., and Ashton, M.S. (2014) Big- leaf mahogany *Swietenia macrophylla* population dynamics and implications for sustainable management. Journal of Applied Ecology, 51, 664-674.

IUCN (2022). The IUCN Red List of Threatened Species. Version 2022-2. Retrieved from https://www.iucnredlist.org/

Jeje A. A., Olanipekun M. K. and Otoide J. E. (2021). Assessment of the diversity and abundance of tree species in Afe Babalola University, Ado- Ekiti, Ekiti State, Nigeria. International Journal of Biodiversity and Conservation Vol. 13(3), pp. 144-151, July-September 2021, http://www.academicjournals.org/IJBC

Meyer KM, Sciaini M, and van Waveren C. (2018). Applications of biodiversity theories in conservation. PeerJ Preprints 6:e27054v1 https://doi.org/10.7287/peerj.preprints.27054v1

Mukaromah, A.S., Purwestri, Y.A., and Fujii, Y. (2017) Determination of allelopathic potential in mahogany (*Swietenia macrophylla* King) leaf litter using sandwich method. Indonesian Journal of Biotechnology, 21, 93.

Ogwu, M.C.1, Osawaru, M.E. and Obayuwana, O.K. (2016). Diversity and Abundance of Tree Species in the University of Benin, Benin City, Nigeria

Omoro, L.M.A., Pellikka, P.K.E. and Rogers, P.C. (2010). Tree species diversity, richness, and similarity between exotic and indigenous forests in the cloud forests of Eastern Arc Mountains, Taita Hills, Kenya. Journal of Forestry Research 21(3): 255−264

Pelser, P.B., Barcelona, J.F. and Nickrent, D.L. (2011). Leonard Co's Digital Flora of the Philippines

Raji I. A. and Babalola F. D. (2018). Assessment of Tree Diversity and Abundance in University of Ilorin Campus: Towards Conservation. Proceedings of 6th NSCB Biodiversity Conference; Uniuyo 2018 (443 - 450pp).

Shannon, C. E. and Wiener, W. (1949). The mathematical theory of communication. Urbana, University of Illinois Press. 177 p.

Supriatna, J. (2018). Biodiversity Indexes: Value and Evaluation Purposes. E3S Web of Conferences, 48, Article 01001. https://doi.org/10.1051/e3sconf/20184801001

Suratman, M. N. (2012). Tree Species Diversity and Forest Stand Structure of Pahang National Park, Malaysia.In: Biodiversity Enrichment in a Diverse World. Chapter 18. INTECH. 473-492pp

Zhang, Hao and Jim, C.Y.. (2014). Species diversity and performance assessment of trees in domestic gardens.

Landscape and Urban Planning. 128. 23–34. 10.1016/j.landurbplan.2014.04.017.

Zhang, Z., Liu, Y., Yuan, L., Weber, E., and Van Kleunen, M. (2021). Effect of allelopathy on plant performance: a meta-analysis. Ecology letters, 24(2), 348–362. https://doi.org/10.1111/ele.13627