

CONSERVATION STATUS OF PLANT DIVERSITY AT DONG NA TARD PROVINCIAL PROTECTED AREA, LAO PEOPLE' DEMOCRATIC REPUBLIC

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Abstract

The conservation status of plant diversity in Dong Na Tard Provincial Protected Area (PPA) is still relatively unknown. This paper aimed to categorize and assess the threatened plants at the local level for effective park management. The current use of plants was documented using Key Informant Interviews (KIIs). There were 70 species in 33 families that were assessed. The conservation status of plant species was perceived by local people as very high importance (14.29%), high importance (62.86%), moderate importance (20%), low importance (1.43%), and very low importance (1.42%). Based on this study, all plant species were categorized as critically endangered (5.71% - CR), endangered (32.86% - EN), vulnerable (44.29% - VU), near threatened (15.71% - NT), and least concern (1.43% - LC). Data suggested an immediate need for conservation planning. Strong support for conservation programs and strict enactment of laws are imperative to address the threats to plant diversity loss.

Keywords: Dong Na Tard; Diversity; Utilization; Conservation status; Threatened species.

Introduction

Plant diversity is fundamental to the functioning of all human societies and to the operation of all ecosystems [1, 2]. Diversity is usually observed in protected areas [3] because they are protected by laws and regulations. Despite several existing conservation policies and regulatory mechanisms, threats to plant diversity loss continue to escalate [4]. The utilization of such resource is becoming increasingly scarce and vulnerable to extinction due to improper conservation practices [5-6] and lack of information on the conservation status of plant species.

Dong Na Tard Provincial Protected Area (PPA) is a case where proper documentation of plant species, is nil to be effectively managed by laws and regulations. To date, many plant species are becoming increasingly rare and maybe vulnerable to extinction due to anthropogenic disturbances. Although International Union for the Conservation of Nature (IUCN) [3] had assessed the conservation status of threatened plant species in three districts of Savannakhet province (North-Eastern part of the province), the species were categorized at global scale. Similarly, the Ministry of Agriculture and Forestry (MAF) [7] also listed the species but only at national level. For Dong Na Tard PPA, many threatened plant species have not been assessed and/or included yet in IUCN [3] and MAF [7]. Inclusion of these species is quite important as effective conservation efforts can only be implemented if the information on the threatened plant species is available in particular areas [4, 8, 9].

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Knowing the conservation status of the plant diversity is imperative. The spatial distribution of plant species and its utilization by local people, and their conservation status, especially those under imminent threat, is vitally needed for the management. This basic information is important for the development of key forest management plans, policies and strategies. This study attempted to list the uses of plants and then determine their conservation status at the local level.

Material and methods

Study area

Dong Na Tard PPA is located in Savannakhet Province, Lao PDR covering a total area of 6,385 ha (Fig. 1). It lies between 16° 35' 20" and 16° 40' 40" N latitude and between 104° 50' 00" and 104° 57' 10" E longitude. It is influenced by the North-East and South-West monsoons causing highly uneven rainfall. The annual average temperature is 27.2°C, while the relative humidity is 74%, and rainfall is 1,445 mm·year⁻¹ [10].

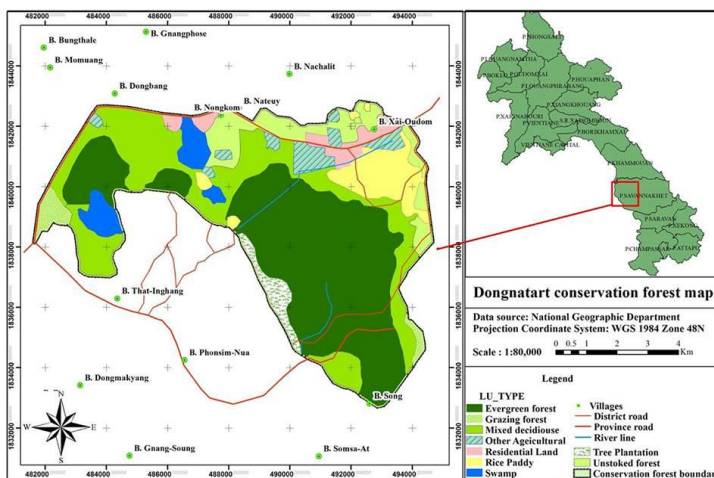


Fig. 1. Map of Dong Na Tard Provincial Protected Area (2014)

Determining plant users

Participatory field surveys and key informant interviews (KIIs) were done. The criteria in selecting KIIs were based on the knowledge and experiences using plant diversity of local people [11]. The guidelines discussed with the KIIs were adapted and modified from Feyssa [6] including name of species, life-form, utilization types, habitat, and conservation status of plant diversity. Secondary data were also taken from the Lao Flora by Inthakoun [12] and A Rapid Participatory Biodiversity Assessment [13].

Categorizing threatened plant species

The local conservation status of plant species was arrived at using weighted score method. A scoring system was devised based on global and national threatened plant assessments, perception of plant users, and values of relative frequency (RF) of each species obtained during the field surveys [10]. The criteria were adopted and modified from Sopsop and Buot [4]; Villanueva and Buot [9] and Yonzone [11] using the following: scale 1 (very low importance), scale 2 (low importance), scale 3 (moderate importance), scale 4 (high importance), and scale 5 (very high importance).

With respect to IUCN [3], we assigned scales as follows:

- Critically Endangered (CR) = 5;

- Endangered (EN) = 4;
- Vulnerable (VU) = 3;
- Near Threatened (NT) = 2 and
- Least Concern (LC) = 1.

With respect to MAF [7], we assigned scales as follows:

- Prohibition (PR) = 5;
- Special (SP) = 4;
- Management I (MA I) = 3;
- Management II (MA II) = 2 and
- Management III (MA III) = 1.

With respect to perception of plant users, we assigned scales as follows:

- Very High Importance (frequent harvesting is always disturbed) = 5;
- High Importance = 4;
- Moderate Importance = 3;
- Low Importance = 2 and
- Very Low Importance (least harvesting) = 1.

With respect to relative frequency, we assigned scales as follows:

- Very Low Frequency (0 – 20%) = 5;
- Low Frequency (21 – 40%) = 4;
- Moderate Frequency (41 – 60%) = 3;
- High Frequency (61 – 80%) = 2 and
- Very High Frequency (81 – 100%) = 1.

Conservation Status (CR, EN, VU, NT, and LC) = IUCN (2008) + MAF (2012) + perception of plant users + relative frequency. The values were classified into five categories of local threatened species as follows:

- Critically Endangered (CR): 17-20;
- Endangered (EN): 13-16;
- Vulnerable (VU): 9-12;
- Near Threatened (NT): 5-8 and
- Least Concerned (LC): 1-4.

Results and discussion

Plant utilization by local people

Majority of the 70 plant species (63.5%) identified were used for varied purposes: food, fire wood, rice field and garden fences, feeding of domestic animals, and house roofing materials. Of total number of species 12 or 17% was used for building materials and making furniture. Some 11 or 16% of the species was used for traditional medicines and 2 or 3% were commonly used for charcoal production (Fig. 2a and Table 1), while 1 or 1.5% was used for making traditional light torches (Fig. 2b and Table 1). Considering all plant uses, the local people still perceived that of the 70 plant species identified, 14.29% were very high importance, 62.86% of high importance, 20% of moderate importance, 1.43% of low importance, and 1.42% of very low importance (Table 1).

Table 1. Conservation status of plant diversity in Dong Na Tard Provincial Protected Area. Conservation status is the total value of IUCN (2008), MAF (2012, perception by plant users, and relative frequency (RF) of a species

Family Species	Local name (laos)	Plant Habit	General Uses	Perception By users	Iucn 2008	Lao maf 2012	Rf	Total Values	This Study
Anacardiaceae									
<i>Spondias pinnata</i> (Koenig & L.F.)	MakKok	Tree	Edible fruit	5	2	1	5	13	E N
Ancistrocladaceae									
<i>Ancistrocladus tectorius</i> (Lour.) Merr	Khu Hang kouy	Herb	Medicinal plant	4			5	9	V U

Apocynaceae

<i>Alstonia rostrata</i> Fisher	Mai Tin pet	Tree	Timber	4	2	1	5	12	V
<i>Wrightia arborea</i> (Dennstedt) Mabblerley	Mai Mouk	Tree	Timber	4			5	9	U
Areaceae									
<i>Cocos nucifera</i> L.	Ton Makpao	Tree	Firewood	5			5	10	V
<i>Wallichia gracilis</i> Beccari	Ton Tao	Tree	Fruit	4			5	9	U
Bignoniaceae									
<i>Fernandoa adenophylla</i> Wall ex. G. Don	Ton Kaekhon	Tree	Firewood	4			5	9	V
<i>Oroxylum indicum</i> (L.) Ventenat.	Kok Lin mai	Tree	Fruit	4			5	9	U
Bombacaceae									
<i>Bombax albidum</i> Gagnepain	NgieuPaa	Tree	Timber, decorated plant	5	2	1	5	13	E
Combretaceae									
<i>Terminalia catappa</i> L.	Ton Houkouang	Tree	Timber	4			5	9	V
<i>Terminalia corticosa</i> Pirre ex Lanessan	Mai Peuy lard	Tree	Timber	4	2	3	5	14	U
Cucurbitaceae									
<i>Lagenaria siceraria</i>	Ton Maknamtao	Tree	Timber	3			5	8	N

Dipterocarpaceae

<i>Anisoptera costata</i> Korth	Mai Bak	Tree	Good timber	5	4	3	5	17	CR
<i>Dipterocarpus obtusifolius</i> Teijsm.exMiq	Mai Sad	Tree	Good timber	4	4	3	5	17	CR
<i>Dipterocarpus spp</i> Roxburgh ex G	Mai Nhang	Tree	Timber, income	3	4	3	1	11	VU
<i>Hopea odorata</i> Roxb	Mai Khaenhua	Tree	Good timber	5	3	4	5	17	CR
<i>Hopea recopei</i> Pierre	Mai La Aen	Tree	Building materials	4	4	3	5	16	EN
<i>Shorea obtusa</i> Wall. ex Blume	Mai Chik	Tree	Building materials	4	2	3	5	14	EN
<i>Vatica odorata</i> (Griff.) Symington	Mai Jik dong	Tree	Building materials	4	2	3	5	14	EN
Ebenaceae									
<i>Diospyros filipendula</i> Pirre ex Lecomte	KokKanthong	Tree	Food	1			3	4	LC
<i>Diospyros malabarica</i> (Desr.) Kostel	Kok Lang dam	Tree	Good timber	4	2	4	4	14	EN
<i>Diospyros mollis</i> Griffith	Ton Makkuoi	Tree	Good timber	4	2	4	5	15	EN
Elaeocarpaceae									
<i>Elaeocarpus stipularis</i> Blume	Sommoun	Tree	Firewood, timber	4			5	9	VU
Euphorbiaceae									
<i>Aporosa villosa</i> (Lindl.) Baillon	Mai Maed	Tree	Firewood	4			5	9	VU
<i>Baccaurea ramiflora</i> Gagnepain	Mai Makfai	Tree	Fruits, timber	3			4	7	NT
<i>Bridelia stipularis</i> (L.) Blume	Mai Sa long khong	Tree	Firewood	4			5	9	VU
<i>Croton joufra</i> Rox burgh	KokPao	Palm	Medicinal plant	5			5	10	VU

Fabaceae

<i>Azelia xylocarpa</i> (Kurz) Craib	Mai Tae kha	Tree	Timber, firewood	3	5	4	4	16	EN
<i>Bauhinia malabarica</i> Roxburgh	Mai Somsei o	Tree	Firewood	4			5	9	VU
<i>Dalbergia cochinchinensis</i> Pierre	Mai Pa dong	Tree	Good timber	5	3	5	5	18	CR
<i>Dialium cochinchinense</i> Pierre	Mai Kheng	Tree	Timber, edible fruits	4	2	2	5	10	EN
<i>Dialium indum</i> L.	Ton Makken g	Tree	Timber, edible fruits	3			4	7	NT
<i>Peltophorum dasyrachis</i> Kurz	Mai Sa phang	Tree	Timber, firewood	3	2	2	4	11	VU
<i>Pterocarpus macrocarpus</i> Kurz	Mai Dou	Tree	Timber, firewood	4	2	4	4	14	EN
<i>Sindora siamensis</i> Teysm. ex Miquel	Mai Tae nam	Tree	Good timber	4	2	3	5	14	EN
<i>Xylia xylocarpa</i> (Roxb.) Taub	Mai Deng	Tree	Good timber	4	2	4	4	14	EN

Flacourtiaceae

<i>Hydnocarpus anthelmintica</i> Pierre	Ton Kabao	Tree	Timber	4			5	9	VU
Hypericaceae									
<i>Cratoxylum formosum</i> (Jack) Dyer	Tieu	Tree	Edible leaves	3			4	7	NT

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Irvingiaceae										
<i>Irvingia harmandiana</i> Oliv. Ex A. Benn	Mai Bok	Tree	Charcoal, firewood	2	1	2	3	8	NT	
Lythraceae										
<i>Lagerstroemia balansae</i> Koehne	Mai Peuy	Tree	Timber	4	2	3	5	14	EN	
<i>Lagerstroemia</i> spp	Mai Peuyhin	Tree	Timber	4	2	3	3	12	VU	
Meliaceae										
<i>Melia azedarach</i> L.	Ton Kadao	Tree	Edible timber leaves,	4	2	2	5	13	EN	
<i>Sandoricum koetjape</i> (Burm.f.) Merrill	Ton Tong	Tree	Edible timber fruit,	4	1	2	5	12	VU	
Moraceae										
<i>Artocarpus</i> spp	Ton Makmee	Tree	Timber, fruit, edible	3			4	7	NT	
<i>Ficus drupacea</i> Thunberg	Ton Meepea	Tree	Fruit	4	2	4	5	15	EN	
<i>Ficus septica</i> Burn.f. var. septica	Ton Makdua pong	Tree	Fruit	4	2	4	5	15	EN	
<i>Streblus asper</i> Lour	Ton Somphor	Tree	Timber	4	2	1	5	12	VU	
<i>Streblus ilicifolius</i> (Kurz.) Corn	Ton Nam khom	Tree	Firewood, fruit,	3			5	8	NT	
Myrsinaceae										
<i>Ardisia evonymifolia</i> Pitard	Kok Ta khouang	Tree	Building materials	4			5	9	VU	
Myrtaceae										
<i>Eucalyptus</i> spp	Ton vik	Tree	Medicinal plant	4			5	9	VU	
<i>Syzygium cinereum</i> (Kurz) Chant. &Parn	Ton Makva	Tree	Edible timber fruit,	3			5	8	NT	
<i>Syzygium zeylanicum</i> (L.) DC.	Ton Sa mek	Tree	Edible young leaves	4	2	3	5	14	EN	
<i>Syzygium gratum</i> (Wight) S.N. Mitra	Ton Sa mekkhao	Tree	Edible leaves	4	2	3	5	14	EN	
<i>Syzygium tinctorium</i> (Gagn.) Merr. ex Pierre	Mai Va dong	Tree	Timber	4			5	9	VU	
Pinaceae										
<i>Keteleeria evelyniana</i> Master	Mai Hing	Tree	Timber	4	2	3	5	15	EN	
Rhamnaceae										
<i>Ziziphus cambodiana</i> Pierre	Ton Makkhom	Tree	Timber	3			4	7	NT	
Rosaceae										
<i>Pyrus pashia</i> Buch. Ham. Ex D. Don	Ton Makchong	Tree	Edible fruit, timber	4			5	9	VU	
<i>Rubus multibracteatus</i> Lev. &Vaniot	Ton Maktoum	Tree	Edible fruit, timber	3			5	8	NT	
Rubiaceae										
<i>Prismatomeris tetandra</i> (Roxburgh) K. Schum	Ton Yor dong	Tree	Timber	4			5	9	VU	
Sapindaceae										
<i>Lepisanthes rubiginosa</i> (Roxburgh) Leenh	Ton MakHouad	Tree	Fruit, timber	4			5	9	VU	
Solanaceae										
<i>Solanum Torvum</i> Swartz	KhaengFaa	tree	Edible fruit	4			5	9	VU	
Sterculiaceae										
<i>Heritiera javanica</i> (Blume) Kosterm	Mai Hao	Tree	Timber	4			5	9	VU	
<i>Sterculia</i> spp	Portae	Tree	Timber	5	2	2	5	14	EN	
Stilaginaceae										
<i>Antidesma bunius</i> Sprengel	Mak Mao	Tree	Firewood, edible fruits	4			5	9	VU	
Symplocaceae										
<i>Symplocos racemosa</i> Rox burgh	Mai Muad ae	Tree	Decorated tree	3			5	8	NT	
Tiliaceae										
<i>Peltace</i>	Ton Si siet	Tree	Medicinal plant, timber	4	23	2	5	10	EN	
Verbenaceae										
<i>Tectona grandis</i> Linn	Mai Sak	Tree	Good wood	3	2	4	5	14	EN	
<i>Vitex pinnata</i> L.	Mai Tin nok	Tree	Timber	4	2	1	5	12	VU	
Zingiberaceae										
<i>Curcuma alisamatifolia</i> Gagnepain	Phak Warn	Tree	Food, edible tube	4			5	9	VU	
<i>Alpinia</i> spp.	Khapaa	Herb	Food, edible leaves	4			5	9	VU	

*Remarks: IUCN (2008): 5 = CR; 4 = EN; 3 = VU; 2 = NT; and 1 = LC. MAF (2012): 5 = PR; 4 = SP; 3 = (MA I); 2 = MA II; and 1 = MA III. RF: 5 = 0 – 20%; 4 = 21 – 40% ; 3 = 41 – 60%; 2 = 61 – 80% ; and 1 = 81 – 100%. Perception: 1(very low importance) to 5 (very high importance). Total values: 17-20 = CR; 13-16 = EN; 9-12 = VU; 5-8 = NT and 1-4 = LC.

This indicated that a number of plant species had become rare and were becoming extinct. The major threats to species loss were identified as: increasing population, prevailing poverty especially, the poor living in and around the park depending upon the forest for food, fuel wood, and timber for house materials (63.5% of total species), followed by expansion of agricultural land, local livestock's grazing or browsing, and lack of awareness on the best

collection procedures. Many local people were not carefully looking after the local species. The heavy exploitation, not only destroys the natural beauty, but also changed the status of many species from vulnerable to endangered such as *Alstonia rostrata* Fisher, *Dipterocarpus obtusifolius* Teijsm. Ex Miq, *Dipterocarpus* spp. Roxburgh ex G, *Hopea odorata* Roxb (Table 1).



Fig. 2. Process of charcoal production by local people in Dong Na Tard Provincial Protected Area (left) and Process of traditional light torch production by local people in Dong Na Tard Provincial Protected Area (right)

However, the local people had good knowledge on the use and conservation of plants. Many important woody and medicinal species were planted in their areas for present and future generation uses (Figs. 3 and 4). The top ten woody plant species planted for building materials and food are presented in figure 3. *Tectona grandis* was mostly planted by the local people (90%) due to its fast growth and rapid provision of benefit. The local people used the plant as building material. On the other hand, *Lepisanthes rubiginosa* was least planted (30%) among the ten species because it was indigenous, slow-growing and had low market value. The local people only planted it for food (*i.e.* a fruit tree) and for firewood (Fig. 3).

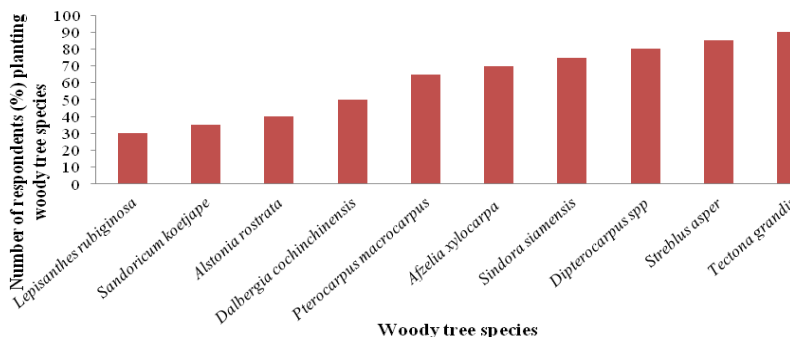


Fig. 3. Number of respondents (%) planting woody tree species in their vicinities

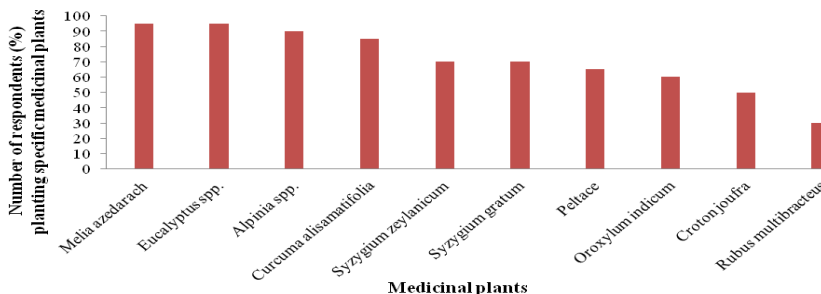


Fig. 4. Number of respondents (%) planting specific medicinal plants in their vicinities

Among the top ten medicinal plants that were used for traditional treatments (Fig. 4), *Melia azedarach* L. had the highest percent (95%) planted by the local people because of its edible leaves and flowers that can cure malaria and fever. Moreover, it was used by the local people for timber and building materials. While *Rubus multibracteatus* Lev. and *Croton jourfra* was least planted (30%) since few people were experienced in using it for disease treatments. Traditionally, people used this species for tonic needs and firewood (Fig. 4).

Interaction between plant and human was very strong and can never be separated as the dependence is necessary [14] as observed in Dong Na Tard PPA. The local people utilized plants for various purposes (Table 1). The direct users of the forest are poor local residents who have survived from plant uses including charcoal and traditional light torch production for family consumption and income (Fig. 2a-2b). The interviews on the conservation status of plant diversity as perceived by the local people indicated that most of the plant species were scarce and vulnerable to extinction such as *Anisoptera costata* Korth, *Dipterocarpus obtusifolius* Teijsm.ex Miq, *Hopea odorata* Roxb, and *Dalbergia cochinchinensis* Pierre (Table 1). These species had high biological and economic values and were also highly utilized by the local people.

Although many plant species were under circumstantial pressures, the local people have indigenous knowledge on conservation [6]. This knowledge has been handed down from generation to generation without documentation [15]. Because of its cultural and economic importance [16], the local people planted various woody and medicinal species in home gardens/backyards, edge of rice field, live fences and on small-scale tree plantation to substitute for the scarce species in the wild and to save time and costs of collections (Figs. 3 and 4). The top woody plant species of high economic value and medicinal plants were cultivated by the local people served as examples of their perception on the conservation status of plant diversity.

All these information on plant utilization by local people allowed better understanding on the conservation status of plants and in preserving traditional knowledge. Even so, the information must be interpreted carefully because all plant species identified were only those with locally important uses. This information can be applied in developing conservation plans, policies, and strategies. Thus, the priority actions should investigate the distribution patterns, population density and regeneration of plant species which could help in the planning as well as in establishing harvest regulations that will assure sustainable supply of plant materials and at the same time enhance forest management program by involving participation of the local people in the early stages of planning process.

Threatened plant species

Results of the study showed that of the plant species found in Dong Na Tard Provincial Protected Area, one was identified as Critically Threatened (CR), five plant species were categorized as Endangered (EN), two as Vulnerable (VU), 26 as Near Threatened (NT), and

two as Least Concern (LC) of the IUCN (2008); one was classified under Prohibition (PR), 9 as Special (SP), 11 under Management I (MA I), 7 under Management II (MA II), and 7 under Management III (MA III) of the MAF (2012) (Table 1). These, however, were treated on global and national scales and as such, most of the plant species in Dong Na Tard PPA were not assessed (NA). Most of the species were disturbed by human activities because they were not strictly managed and protected by Laws and regulations. This study categorized the conservation status of plant species into: Critically Endangered (4), Endangered (23), Vulnerable (31), Near Threatened (11), and Least Concern (1) based on globally and nationally threatened plant species, perception of plant users and values of relative frequency (RF) of plant species (Table 1).

Although the local people were the most knowledgeable on the conservation status of plant species in Dong Na Tard PPA, most of these plant species were becoming scare and vulnerable (Table 1) because they were not strictly managed by laws and regulations. Currently, although these species have not been listed as threatened species of IUCN and MAF, it is urgent to decide on their conservation status.

Many local species, such as: *Dalbergia cochinchinensis* Pierre, *Pterocarpus macrocarpus* Kurz, *Lagerstroemia balansae* Koehne and *Xylia xylocarpa* (Roxb.) Taub, were the scare ones in the park. They served tremendous importance in the ecology, culture and economics of the local people, yet they were not listed as threatened species in the IUCN. Similar to other plant assessment of the IUCN [3] in three districts of Savannakhet (North-East part of the province) and Salavan provinces, Lao PDR, had shown only four CR, six EN and four VU out of the 182 plant species in the said areas. Most of the plant species in Dong Na Tard PPA, though, have not been assessed or listed by the IUCN which may take time as in the declaration of the status of Philippine plants [4].

Therefore, there is an urgent need to have a listing of the conservation status of plants in the park for use in policy and decision making by the management and the local government. This study strongly supports the list identified in here for conservation by the concerned local government units, for possible policy formulation to protect Dong Na Tard PPA plants from possible extinction in the near future.

Conclusion

Plant diversity had been widely collected and utilized by local people living in and around Dong Na Tard PPA. As such, most of the woody and medicinal plants were on threatened categories as revealed in this study. The main causes were population growth, prevailing poverty, expansion of agricultural land, and lack of awareness of the best collection procedures. It is important to engage the local people in efforts of conservation and sustainable use of plants. But it is necessary to increase the income of local people and provide them with alternative sources of energy and timber in order to reduce utilization of plants in the park. It is recommended that the conservation status of plant species identified in this study be urgently looked into by the local government in order to protect them before they become extinct. To sustain the utilization and conservation of such species in the park, appropriate and socially acceptable conservation strategies should be considered for both plants and local people. The local government units (LGUs), non-government organizations (NGOs), and other stakeholders should enhance community development program to reduce the local people's dependency on plant utilization by encouraging home gardening of these forest plants or scheduled harvesting in various portions or zones of the park to prevent overutilization and excessive diversity loss.

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References

- [1] S. Jayakumar, S.S. Kim, J. Heo, *Floristic inventory and diversity assessment-A critical review*, **Proceeding of International Academy of Ecology and Environment Sciences**, 1(3-4), 2011, pp 151-168.
- [2] R. Smita, R. Sangeeta, S.S. Kumar, S. Soumya, P. Deepak, *An ethnobotanical survey of medicinal plants in Semiliguda of Koraput District, Odisha, India*, **Botany Research International**, 5(4), 2012, pp. 97-107.
- [3] * * *, **A Rapid Participatory Biodiversity Assessment: Stora Enso Eucalypt Plantation in Southern Lao PDR**, International Union for the Conservation of Nature (IUCN) in Lao PDR, 2008.
- [4] B.L. Sopsop, I.E. Buot. Jr, *The endangered plants of Palawan island, Philippines*, **Asia Life Sciences**, 18(2), 2009, pp. 251-279.
- [5] K.K. Karanth, J.D. Nichols, J.E. Hines, K.U. Karanth, N.L. Christensen, *Patterns and determinants of mammal species occurrence in India*, **Journal of Applied Ecology**, 46, 2009, pp. 1189-1200.
- [6] H.D. Feyssa, C. Abdeta, T. Berhan, M. Sharma, *Medicinal plants use and conservation practices in Jimma Zone, South West Ethiopia*, **Journal of Biodiversity and Conservation**, 7(3), 2015, pp. 202-210.
- [7] * * *, **List of tree species in Lao PDR**, Ministry of Agriculture and Forestry (MAF), Vientiane, Lao PDR, 2012.
- [8] J. Muller, R. Brandl, *Assessing biodiversity by remote sensing in mountainous terrain: The potential of LiDAR to predict forest beetle assemblages*, **Journal of Applied Ecology**, 46, 2009, pp. 897-905.
- [9] E.L.C. Villanueva, I.E. Buot. Jr, *Threatened plant species of Mindoro, Philippines*, **IAMURE International Journal of Ecology and Conservation**, 14(1), 2015, pp. 168-190, doi:http://dx.doi.org/10.7718/ijec.v14i1.901.
- [10] S. Chanthavong, I. E. Buot. Jr, *Plant diversity in Dong Na Tard Provincial Protected Area, Lao People's Democratic Republic (Lao PDR): Species and forest zonation*, **Journal of Environment Asia**, 10(1), 2017, pp. 52-62.
- [11] R. Yonzon, S. Rai, R.B. Bhujel, *Ethnomedicinal and aromatic plant diversity and resources of Darjeeling District of Eastern Himalaya in India*, **Journal of Advances in Pharmaceutical Research**, 3(4), 2012, pp. 859-871.
- [12] L. Inthakoun, C.O. Delang, **Lao Flora: A Checklist of Plants Found in Lao PDR with Scientific and Vernacular Names**, Lulu Enterprises, Inc. 860 Aviation Parkway, Suite 300, Morrisville, NC 27560, 2008.
- [13] * * *, **A Rapid Participatory Biodiversity Assessment, Stora Enso Eucalypt Plantation in Southern Lao PDR**, IUCN in Lao PDR, 2008.

- [14] S. M. Amjad, M. Arshad, *Ethnobotanical inventory and medicinal uses of some important woody plant species of Kotli, Azad Kashmir, Pakistan*, **Journal of Tropical Biomedicine**, **4**(12), 2014, pp. 952-958.
- [15] H.M. Rahman, *A study on exploration of ethnobotanical knowledge of rural community in Bangladesh: Basis for biodiversity conservation*, **ISRN Biodiversity**, **2013**, 2013, Article ID 369135.
- [16] J. Blancas, A. Casa, D. Perez-Salicrup, J. Caballero, E. Vega, *Ecological and socio-cultural factors influencing plant management in Nahuatl communities of the Tehuacan valley, Mexico*, **Journal of Ethnobiology and Ethnomedicine** **9**(1), 2013, pp. 39. DOI: 10.1186/1746-4269-9-39.
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