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LOCATION AND ASSESSMENT OF INDIVIDUAL PLUS TREES OF SOME DIPTEROCARPS AND PREMIUM INDIGENOUS TREE SPECIES IN ILOCOS NORTE

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ABSTRACT

One mechanism to conserve germplasms of threatened tree species is collection and preservation of planting materials from superior mother trees. Thus, a study was conducted to locate individual plus trees (IPTs) of dipterocarps and premium indigenous tree species; characterize and assess the phenotypic quality of these trees; and develop data base and maps on their distribution in Ilocos Norte, Philippines. Potential IPTs were assessed using the protocol for hardwood species. Candidate trees were assessed based on stem characteristics, bole form, health and branching characteristics.

A total of 237 IPTs under 13 species were identified: seven Dipterocarps species and six premium wood species. These trees were identified in the City of Batac, and in the municipalities of Dingras, Pagudpud, Pasuquin, Piddig and Nueva Era. Pagudpud had the most diverse species of IPTs, with seven species, followed by Nueva Era with five species. Selected IPTs of *Dracontomelon dao* and all the dipterocarps species were in second growth natural forests, while *Intsia bijuga*, *Vitex parviflora*, *Pterocarpus indicus* and *Sindura supa* were in plantations. Top five species in terms of number of selected IPTs were *P. indicus*, *Anisoptera thurifera*, *Shorea polysperma*, *S. contorta*, and *Hopea plagata*. Geographic Information System (GIS) generated maps, which include the location and data base of the attributes of the selected IPTs, were developed. The database is deposited in the custody of the Mariano Marcos State University Research Directorate and can be accessible to qualified

Key words: Dipterocarps, indigenous tree species, phenotypic quality, plus trees, premium tree species, GIS mapping, individual plus tree assessment

INTRODUCTION

Dipterocarps and premium indigenous timber species are the most valued tree species in the Philippines, both environmentally and economically. Dipterocarps are medium to large, resinous forest trees that belong to the family Dipterocarpaceae (Fernando, 2009). Premium tree species, on the other hand, are tree species, the wood of which has special characteristics, such as strength, durability, beauty, scarcity and rarity or is used for special purpose (DAO No. 2004-06). Dipterocarps and premium tree species comprise the major forest cover of rainforest and secondary growth forests in the country. However, many of these species are already threatened due to continuous harvesting and illegal logging activities. Moreover, since forests are sensitive to climate change, the population of these tree species is continuously declining. Thus, there is a need to conserve, regenerate and properly manage these tree species to ensure that goods and services derived from them are sustained.

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One of the recent initiatives of the government to mitigate the effects of climate change and deforestation is a nationwide, massive reforestation, *i.e.*., the National Greening Program (NGP), which advocates the use of indigenous tree species. Yet, the success of any reforestation and/or forest restoration program partly depends on the supply of good quality planting stock. Survival and growth performance of the outplanted seedlings is greatly influenced by the quality of the seedlings used. Better quality seedlings tend to have higher survival and growth rates (Wilhoit, Kutz, Fly, and South, 1993). On the other hand, O'Reilly, Keane and Morrissey (2002) mentioned that slow growth of outplanted seedlings and the high post-planting maintenance cost (e.g., weed control) are associated with the quality of planting stock used. Seedling quality also affects the length of rotation period and the volume and quality of timber that can be harvested from a plantation (Gregorio, Herbohn and Harrison, 2010).

The *International Union of Forest Research Organizations* (IUFRO (1980, cited in Hawkins, 1996) defined seedling quality as "fitness for purpose". It is an expression used to describe the extent to which a seedling may be expected to successfully survive and grow after outplanting (Duryea, 1985 cited in Wilson & Jacobs, 2004). Seedling quality is governed by two factors: the genetic make-up of the parent trees, and the physical growth of the seedling (World Agroforestry Center, 2008). Although the physical condition/quality of the seedling can be improved by good practice as it is raised in the nursery, there is no easy remedy for improving seedling genetic quality (Gregorio *et al*., 2010). Therefore, using planting materials (seeds, wildlings or cuttings) from good mother trees ensures the production of good quality planting materials. Moreover, the risk of failure due to high mortality in the field is minimized if not avoided.

Considering that the phenotype or physical quality of a tree is an expression of genetic characteristics, the physical appearance of the potential mother tree will provide an approximation of its genetic characteristics (Gregorio, Doydora, Harrison, Herbohn, and Sebual, undated). Mother trees are trees that used as sources of high quality seed. The major characteristics that determine a good mother tree are: 1) healthy and free of diseases and insects; 2) nearly mature; 3) good producers of the desired product; and 4) growing in the midst of a healthy stand of the same species (FAO, 1993).

In order to develop collection protocol and seed collection calendar, as well as to ensure the use of high quality planting materials from a wide species base, phenotypically superior trees (or individual plus trees) of dipterocarps and premium tree species must be located and assessed. Thus, this study specifically aims to: a) find and document individual plus trees (IPTs) of dipterocarps and premium indigenous tree species; b) characterize and evaluate the phenotypic quality of these potential IPTs; and c) develop data base and maps on the distribution of these trees in Ilocos Norte.

METHODOLOGY

Locale of the Study

The study was conducted in Ilocos Norte, which is geographically located between 17°48' and 18°29' north latitude and 120°25' and 120°58' east longitude. The province occupies the coastal plain at the northernmost edge of western Luzon. The province has a total land area of 3,399.34 km^2 and is sub-divided into 23 administrative units: 21 municipalities and two cities [Provincial Planning and Development Office-Province of Ilocos Norte (PPDO-PIN), 2006].

Rugged and rocky hills and mountains that run in a northwest direction to the Cordillera mountains are the distinctive features of the province. Forest lands are mainly in the northern and eastern towns such as Adams, Bangui, Burgos, Carasi, Dumalneg, Pagudpud, Pasuquin, Nueva Era, and Solsona (PPDO-PIN, 1997). Patches of second growth forests and forest plantations,

which were established through the government reforestation projects, are also found in the City of Batac, and in the municipalities of Banna, Dingras, Pasuquin and Piddig.

Based on the Coronas classification, Ilocos Norte has Type I climate, characterized by two pronounced seasons: dry season from November to April and wet season from May to October (PPDO-PIN, 2006). Mean annual rainfall in the province ranges between 1700 mm in the southwest and above 2400 mm in the eastern sections near the mountain ranges that bound the province. Tropical cyclones and storms are experienced during the southwest monsoon season, usually occurring between August and November (Roetter *et al.*, 2000). Monthly average rainfall is 143.78 mm and monthly average temperature is 27.37^{o}C.

Identification and Location of Individual Plus Trees (IPTs)

Identification, mapping, characterization and marking of potential of individual plus trees (IPTs) were done in secondary growth forest areas and forest plantations in Ilocos Norte. Preliminary data on the location of these trees was gathered through personal interviews from key informants, particularly those involved in seedling production, both from the private and government sectors. The researchers also coordinated with the DENR-Provincial Office through the Community Environment and Natural Resources Offices (CENRO Bangui and CENRO Laoag) to seek permission in the conduct of the study in their jurisdictions and for assistance in locating the potential plus trees. In addition, the researchers coordinated with the local government units (LGUs) where the potential plus trees are located.

Assessment of Candidate IPTs

Potential IPTs were selected based on phenotypic characteristics. A phenotypically superior tree has the following qualities: 1) exceptionally good growth rate (good vigor) relative to the other trees of the same species growing on the same site; 2) good bole form and branching habit; 3) high wood quality; 4) middle aged; and 5) healthy or resistant to pests (ERDB-DENR, 2010; Zobel and Talbert, 1984 as cited in Indira, 2006).

The candidate IPTs of dipterocarps and premium indigenous timber species were characterized and rated based on their vigor (stem characteristics, particularly total height diameter at breast height and apical dominance), health, bole form and branching characteristics. Physical measurements of tree parameters such as tree height and diameter at breast height (DBH) were carried out using tree caliper and clinometer. On the other hand, bole form and health were assessed through ocular inspection of the candidate trees. The parameters measured were given corresponding points based on the protocol suggested by Zabala (1994) for plus tree evaluation of hardwood species

Table 1. Criteria and corresponding parameters measured to assess the physical quality of the mother trees

CRITERION	PARAMETER	POINTS
Stem characteristics	Total height (m)	25
	Diameter at breast height (DBH, cm)	15
	Apical Dominance	10
Stem/bole form	Straightness and circularity of stem	30
	Forking	-1 for every fork
Branching characteristics	Branch angle	15
	Branch thickness or diameter	15
Health	Tree health	10
	Maximum Total Points	**120**

(Table 1). Using the criteria and parameters in Table 1 and the point system guide specified by Zabala (1994) each candidate IPT was rated.

Mapping of Selected IPTs

The geographic location of each selected IPT was determined and recorded using a handheld GPS receiver. The coordinates were used in generating maps and shape files using a GIS software. The selected IPTs were also marked with paint for easy access when collecting planting stocks.

RESULTS AND DISCUSSION

Species of Selected Individual Plus Trees (IPTs)

Table 2 shows the common and scientific names of the identified 237 potential IPTs belong to 13 species. Seven of the 13 species surveyed, namely: Apitong (*Dipterocarpus grandiflorus* Blanco), Guijo [*Shorea guiso* (Blanco) Blume], Palosapis [*Anisoptera thurifera* (Blanco) Blume spp. *thurifera*], Red lauan (*Shorea negrosensis* Foxw.), Tanguile [*Shorea polysperma* (Blanco) Merr.], White lauan (*Shorea contorta* Vidal) and Yakal saplungan [*Hopea plagata* (Blanco) Vidal], belong to the Dipterocarpaceae family. Dipterocarps species once constituted 80% of the Philippine timber resource and provide the bulk of what is sold on the market as 'Philippine mahogany' (Newman *et al.,* 1996). Three species (Ipil {*Intsia bijuga* (Colebr.) Kuntze}, Narra {*Pterocarpus indicus* Willd. *forma indicus*} and Supa {*Sindora supa* Merr.}) belong to the family Fabaceae, and one species each belongs to the families Anacardiaceae (Molave {*Vitex parviflora* Juss.}), Ebenaceae (Kamagong {*Diospyrus blancoi* A. DC }), and Lamiaceae (Molave {*Vitex parviflora* Juss.}). All the non-dipterocarp species inventoried are considered premium species based on DENR Administrative Order (DAO) No. 2003-63. Premium tree species are tree species, the wood of which has special characteristics, such as strength, durability, beauty, scarcity and rarity or is used for special purposes (DENR MC No. 2004-06). These premium tree species usually dominate Molave Forests in the country, which are found growing in areas with very distinct wet and dry seasons and in the coastal areas on shallow and excessively drained limestone

Table 2. Species of selected individual plus trees in Ilocos Norte

COMMON NAME	SCIENTIFIC NAME	FAMILY NAME
Dipterocarp Species		
Apitong	*Dipterocarpus grandiflorus* Blanco	Dipterocarpaceae
Guijo	*Shorea guiso* (Blanco) Blume)	Dipterocarpaceae
Palosapis	*Anisoptera thurifera* (Blanco) Blume spp. *thurifera*	Dipterocarpaceae
Red lauan	*Shorea negrosensis* Foxw.	Dipterocarpaceae
Tanguile	*Shorea polysperma* (Blanco) Merr.	Dipterocarpaceae
White lauan	*Shorea contorta* Vidal	Dipterocarpaceae
Yakal saplungan	*Hopea plagata* (Blanco) Vidal	Dipterocarpaceae
Premium Species		
Dao	*Dracontomelon dao* (Blanco) Merr. et Rolte	Anacardiaceae
Ipil	*Intsia bijuga* (Colebr.) Kuntze	Fabaceae
Kamagong	*Diospyrus blancoi* A. DC	Ebenaceae
Molave	*Vitex parviflora* Juss.	Lamiaceae
Narra	*Pterocarpus indicus* Willd. *forma indicus*	Fabaceae
Supa	*Sindora supa* Merr.	Fabaceae

soils (Razal *et al*., 2003). The cutting/ harvesting of premium species is regulated by the DENR and if allowed to be cut, these species have the highest forest charges, PhP 3,000 m^3 (DAO No. 2003-63).

In the National List of Philippine Plants and their Categories (DAO No. 2007-01), two species, Kamagong and Narra, were listed as critically endangered because of the observed, estimated, inferred or suspected reduction in population of at least 80% over the last 10 years due to decline in area of occupancy, extent of occurrence, and/or quality of habitat, and actual or potential level of exploitation (Table 3). The same list classified Yakal saplungan, Ipil, Supa, and Molave as Endangered, while Dao, White Lauan, Red lauan and Tanguile were classified as Vulnerable. Palosapis, Apitong and Guijo were not included in the DAO 2007 -01 list. However, Fernando (2009b) reported that the International Union for the Conservation of Nature (IUCN, 2006) classified guijo and apitong as critically endangered while palosapis was listed as vulnerable.

The result implies that the remaining secondary forests and established tree plantations in the study site had a modest number of IPTs of seven dipterocarps species and six premium tree species. However, even though the species surveyed had relatively wide natural distribution in the country, their populations are now endangered or are vulnerable because of the continuous decline in the area and quality of their natural habitat and uncontrolled exploitation.

Distribution of the Selected IPTs

The selected IPTs were found in the City of Batac and in five municipalities in Ilocos Norte, namely: Dingras, Pagudpud, Pasuquin, Piddig and Nueva Era (Fig. 1). Pagudpud had the most diverse species, with seven of the total 13 identified species, followed by Nueva Era with five species (Table 4). These two municipalities are among the few places in Ilocos Norte where considerable patches of remaining natural second growth forests are still found.

Table 3. Conservation status of the 13 identified potential plus trees

SPECIES	CONSERVATION STATUS	SOURCE
Kamagong	Critically Endangered	DENR Administrative Order No. 2007-01
Narra	Critically Endangered	DENR Administrative Order No. 2007-01
Apitong	Critically Endangered	IUCN Red List, 2006 cited in Fernando, 2009
Guijo	Critically Endangered	IUCN Red List, 2006 cited in Fernando, 2009
Yakal saplungan	Endangered	DENR Administrative Order No. 2007-01
Ipil	Endangered	DENR Administrative Order No. 2007-01
Molave	Endangered	DENR Administrative Order No. 2007-01
Red lauan	Vulnerable	DENR Administrative Order No. 2007-01
Tanguile	Vulnerable	DENR Administrative Order No. 2007-01
White lauan	Vulnerable	DENR Administrative Order No. 2007-01
Dao	Vulnerable	DENR Administrative Order No. 2007-01
Supa	Endangered	DENR Administrative Order No. 2007-01
Palosapis	Vulnerable	IUCN Red List, 2006 cited in Fernando, 2009

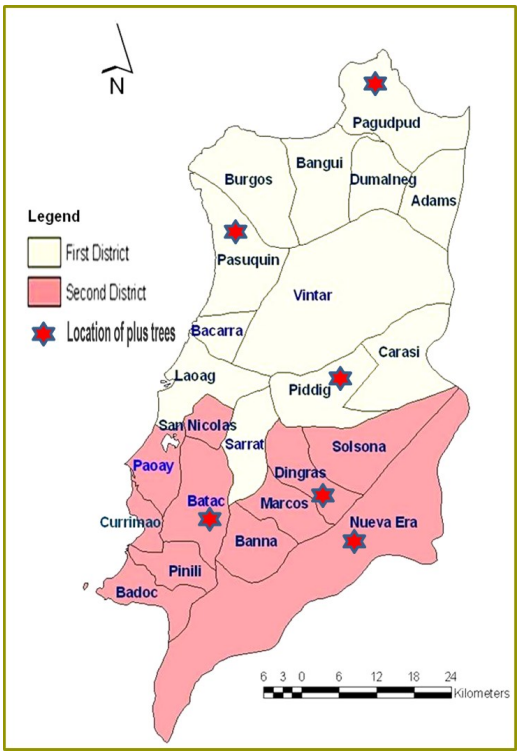

Figure 1. Map of Ilocos Norte highlighting the location of the potential individual plus.

In terms of the number of trees per species, Narra and Palosapis had the highest number of selected IPTs, each species having more than 60 individuals. Almost all of the selected IPTs of Narra (88%) were located in the City of Batac and are growing in plantations, while most of the Palosapis (66%) were growing in natural stands and found in Nueva Era (Table 4). In addition, more than one-fourth (18 IPTs) of the marked plus trees of Palosapis, were found in Dingras, mostly in abandoned kaingin areas and in open canopy forest areas. This supports the description of Ashton (1998) that palosapis is the only Dipterocarp species that readily reinvades cultivated lands.

White lauan (21 trees) and Tanguile (18 trees) also had considerable number of selected IPTs. The selected IPTs of White lauan were mostly found in second growth forests in Nueva Era, while Tanguile were found in second growth forests in Pasaleng, Pagudpud, Ilocos Norte. Palosapis, White lauan and Tanguile belong to the Dipterocarp group, of which most of the nursery operators

Table 4. Distribution and number of marked individual plus trees (IPTs) in Ilocos Norte

SPECIES	Number of IPTs						TOTAL
	City of Batac	Dingras	Pagudpud	Pasuquin	Piddig	Nueva Era	
Narra	56					8	64
Palosapis		18	3			41	62
White lauan			2			19	21
Tanguile			18				18
Yakal saplungan			1			12	13
Guijo			2	10			12
Dao			6	5			11
Red lauan						10	10
Molave	1				9		10
Kamagong	6						6
Ipil					4		4
Supa					4		4
Apitong			2				2
TOTAL	**63**	**18**	**34**	**15**	**17**	**90**	**237**

in the province have expressed difficulty in obtaining planting materials due to lack of information about the location of mother trees and the fruits/seeds collection schedules in the province.

In terms of distribution per municipality regardless of species, the highest proportion (38% or 90 IPTs) of the selected IPTs was found in Nueva Era while 27% (63 IPTs) of the selected IPTs were growing in the City of Batac (Fig. 2). This shows that while Nueva Era had less species of marked plus trees than Pagudpud, it had higher density of phenotypically superior IPTs and potentially more accessible sources of planting materials, especially for plantation establishment in the southern municipalities of the province. On the other hand, a large percentage of the selected IPTs in Batac were Narra, all of which are in plantations located inside the Forest Reserve of the Mariano Marcos State University.

Some Physical Qualities of the Selected IPTs

Table 5 shows the physical qualities (in terms of diameter at breast height and total height) of the selected IPTs of dipterocarp and indigenous premium species in Ilocos Norte. Among the dipterocarp species, IPTs of Tanguile had the biggest diameter (56.1 cm) and were also the tallest (32.0 m). Selected plus trees of Guijo and Palosapis had the second and third biggest diameter with 45.9 cm and 44.2 cm, respectively. The Yakal saplungan IPTs had the smallest diameter (28.6 cm) while the red lauan plus trees were the shortest (18.8 m). For the premium species, the biggest diameter was exhibited by the dao IPTs (51.3 cm), followed by kamagong and supa (49.8 and 49.5 cm, respectively).

The average ratings given to the marked IPTs of the different species based on their vigor (stem characteristics), health and physical characteristics are also shown in Table 5. The ratings obtained ranged from 107.0 points (for Narra) to 111.4 points (for Red lauan) out of the possible 120 points.

Data Base and Maps Developed

Maps/shape files including attribute tables showing the location and characteristics of selected plus trees of each species were developed using GIS. These shape files can be imported into Google Earth (Fig. 3). Each point on the GIS map

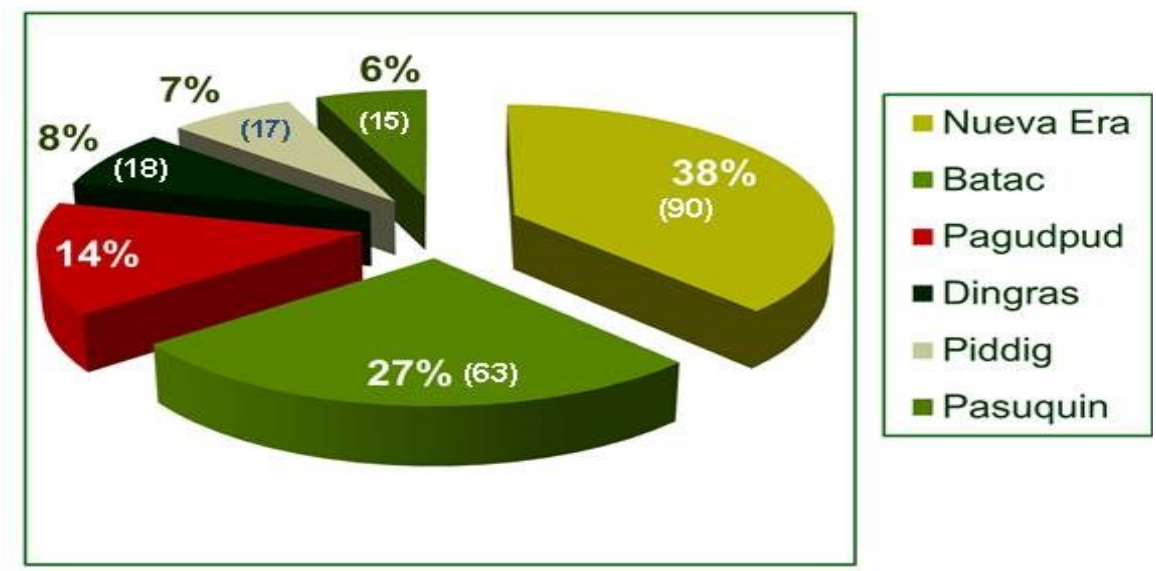

Figure 2. Distribution of selected individual plus (IPTs) in the six municipalities of Ilocos Norte. Values in parenthesis are the number of IPTs selected and marked

Table 5. Diameter at breast height (DBH), total height and ratings of the marked plus trees of dipterocarps species and indigenous premium tree species in Ilocos Norte

SPECIES	DBH (S.D), cm	TOTAL HEIGHT (SD), m	RATING* (POINTS)
Dipterocarps			
Red lauan	30.9 (9.8)	18.8 (4.1)	111.4
Tanguile	56.1 (9.6)	32.0 (2.6)	110.7
White lauan	37.3 (7.0)	24.2 (3.2)	110.2
Palosapis	44.2 (9.9)	21.5 (4.9)	110.0
Guijo	45.9 (11.4)	24.1 (1.9)	109.2
Yakal saplungan	28.6 (5.1)	21.6 (2.4)	107.2
Premium			
Supa	49.5 (8.7)	23.0 (2.2)	109.3
Kamagong	49.8 (15.2)	20.0 (1.3)	109.2
Dao	51.3 (18.7)	22.0 (2.8)	108.7
Narra	41.2 (9.5)	22.8 (4.1)	107.0
Ipil	37.5 (11.2)	18.3 (3.1)	104.8
Molave	36.3 (10.7)	17.5 (1.8)	103.2

DBH = diameter at breast height
S.D. = standard deviation
* - maximum total points is 120.

represents a plus tree and when the point is clicked, a box, containing the attributes/ characteristics of this tree including its location, will open (Fig. 4).

The study identified a total of 237 IPTs belonging to seven dipterocarp species (Apitong, Guijo, Palosapis, White Lauan, Red lauan and Yakal Saplungan),and six premium tree species three of which belong to the family Fabaceae (Ipil, Narra and Supa), and one species each from the family Anacardiaceae (Molave), Ebenaceae (Kamagong), and Lamiaceae (Molave).

The selected IPTs are distributed in six locations in Ilocos Norte, namely: in the City of Batac, and in the towns of Dingras, Pagudpud, Pasuquin, Piddig and Nueva Era. Six of the 13 species were found in Pagudpud while five species were located in Nueva Era. The two municipalities still have considerable patches of remaining natural secondary forests. However, two of the species surveyed (Kamagong and Narra) were listed as Critically Endangered by the DAO No. 2007-01. The same list classified Yakal saplungan, Ipil, Supa, and Molave as Endangered, while Dao, White Lauan, Red lauan and Tanguile were classified as Vulnerable. Although not included in the list, Apitong and Guijo were classified as Critically Endangered, while Palosapis was listed as vulnerable, by the IUCN Red List. .

In terms of tree count, the top five species with selected plus trees are Narra (64), Palosapis (62), Tanguile (21), White Lauan (18) and Yakal saplungan (13). Among the dipterocarp species, selected plus trees of Tanguile had the biggest diameter (56.1 cm) and were also the tallest (32.0 m),

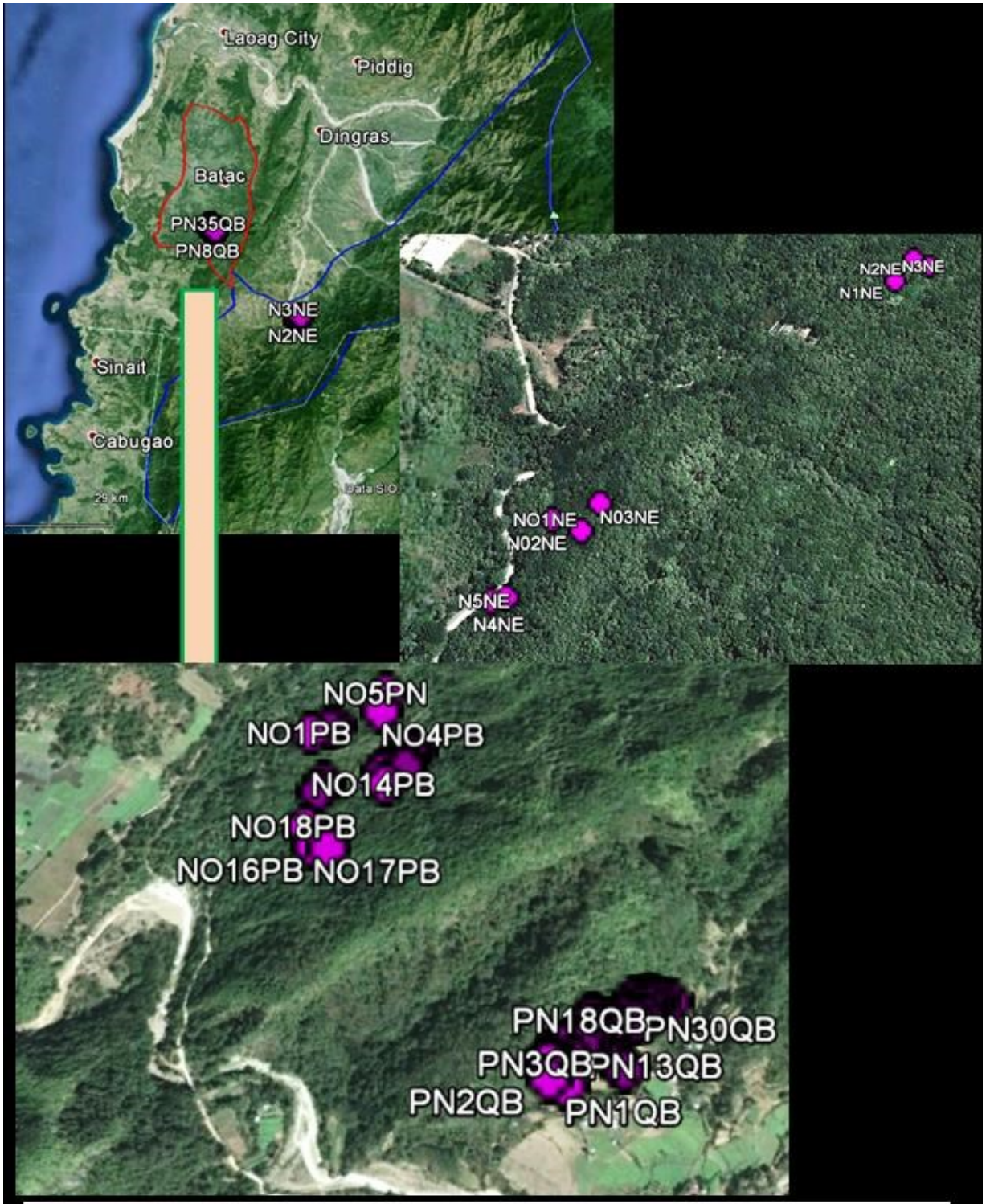

Figure 3. GIS map developed showing the location of selected IPTs of narra in Batac and Nueva Era.

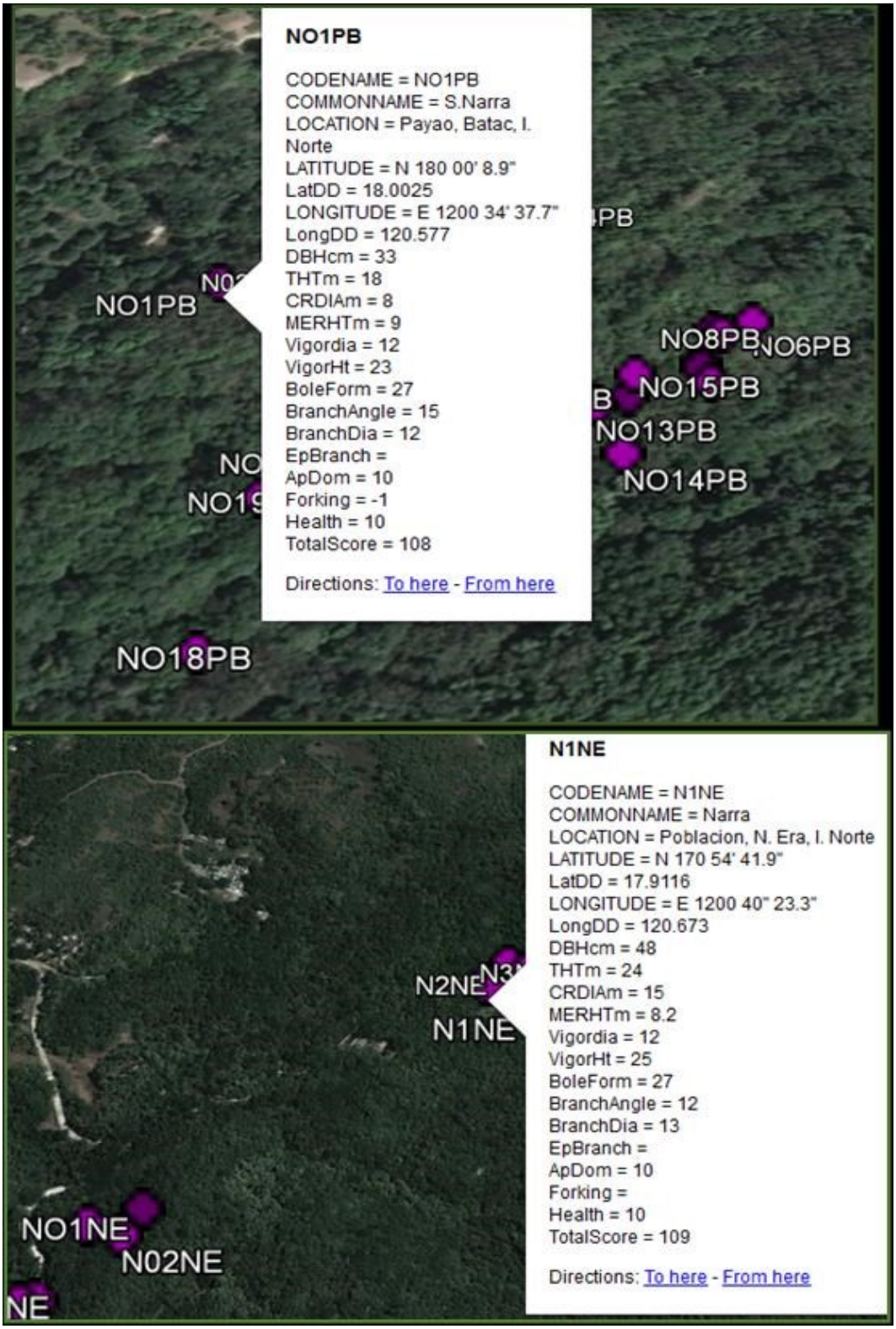

Figure 4. Screen shots showing the attributes/characteristics and location of a narra plus tree in Payao, City of Batac and in Poblacion, Nueva Era.

while the Yakal saplungan plus trees had the smallest diameter (28.6 cm) and the Red lauan plus trees were the shortest (18.8 m). For the premium species, the biggest diameter was exhibited by the Dao plus trees (51.3 cm). Maps and shape files, which include the location and data base of the attributes of the selected IPTs, were developed for each species.

CONCLUSIONS

The results indicate that the remaining secondary forests and established tree plantations in Ilocos Norte had a modest number of IPTs, seven of which are dipterocarps species and six premium tree species. It could be noted that the populations of these species including the selected IPTs are now endangered or are vulnerable because of the continuous decline in the area and quality of their natural habitat. In addition, the populations of these species are increasingly threatened by uncontrolled exploitation, mainly from timber poachers.

RECOMMENDATIONS

Based on the results of the study, the following recommendations are proposed:

1. The selected IPTs should be used as sources of quality planting materials to support the reforestation activities in the province;

2. These trees should be used in future germplasm collection and conservation activities as well as tree improvement initiatives;

3. The concerned DENR office, in coordination with the LGUs, should install appropriate signage and/or markings on the sites where these selected IPTs are located;

4. In order to further protect and manage the populations of the dipterocarps and premium tree species in the province, concerned LGUs, the PENRO/CENRO, the academe and other stakeholders should work for the declaration and/or establishment of these areas as seed production areas or individual seed sources;

5. The database generated should be deposited in the custody of the Research Directorate and made accessible to qualified clientele; and

6. The research should be expanded to cover other areas within the province and consider other native tree species with commercial value.

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