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Soil Seed Bank of Two Karst Ecosystems in Bogor, Indonesia: Similarity with the Aboveground Vegetation and Its Restoration Potential

Winda Utami Putri [1*], Ibnul Qayim [1], Abdul Qadir [2]

[1] Department of Biology, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University, Bogor, Indonesia
[2] Department of Agronomy and Horticulture, Faculty of Agriculture, Bogor Agricultural University, Bogor, Indonesia

ABSTRACT

Karst ecosystem in Bogor is currently threatened by mining activities. Restoration of the disturbed karst areas is urgently required. Seed banks are considered as an important potential seed sources for restoration. This study was conducted to quantify the composition and species diversity of the aboveground vegetation and the seed bank. The study determined the correspondence between the seed bank with the aboveground vegetation in relation with ecosystem restoration. Twenty 6 m × 6 m vegetation plots were established. A total of sixty soil samples were taken from the study sites. The seed bank was studied using germination experiment. All plant species in the vegetation plots and seedlings growing from all soil samples were identified and the number was counted to determine the composition, index of diversity, and index of similarity. There were 80 species from 41 families found in the seed bank in Mt. Nyungcung, dominated by *Clidemia hirta* (Melastomataceae), whereas 50 species from 29 families found in Mt. Kapur with *Cecropia peltata* (Urticaceae) dominated the site. Diversity index of Mt. Nyungcung and Mt. Kapur seed banks were 2.09 ± 0.21 and 1.78 ± 0.47 respectively. The similarity index between seed bank and the aboveground vegetation in the two study sites were 32.86% and 27.66% respectively. Mt. Nyungcung seed bank was more diverse than Mt. Kapur. The similarity between the seed bank with the aboveground vegetation in the two study sites were low. Further assessment is needed to determine the role of the seed bank of Mt. Nyungcung and Mt. Kapur in the restoration of the ecosystems.

Keywords: *Diversity, germination, karst, soil seed bank, vegetation*

INTRODUCTION

Karst area is natural landscape of sedimentary rock that consists primarily of calcium carbonate. Tectonic movements lifted the karst above sea level after they were formed million years ago by calcium secreted marine organism. The total of karst area in Indonesia is 145,000 km^2, 15% of which are protected [1]. Karst area possesses high ecological values especially in term of species endemicities. Karst vegetation has important role in securing water supply for the surrounding environment by absorbing and supplying water. The vegetation also supports the existence of other components of the ecosystem such as wild animals.

Soil seed bank (hereafter referred as seed bank) is a reservation of viable and ungerminated seeds either in the above or belowground of a habitat [2]. Ecologically, seed banks acts as seeds reservation that will prevent further extinctions of vulnerable local species [3]. The seed bank has also become an important part in plant regeneration process after disturbance [4].

The karst areas in Indonesia including the study sites are currently threatened by mining activities that has decreased habitat numbers, plant numbers, and species numbers as well as causing the reduction of endemic species. Restoration of the disturbed areas is urgently required for ecosystem recovery. A study on seed bank in karst ecosystem would provide information on specific plant species that can be employed for restoration. The

*Corresponding author:
Winda Utami Putri
Department of Biology, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University
Dramaga, Bogor, Indonesia 16680
E mail: winda.utami.putri@gmail.com

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study was conducted to quantify the composition and species diversity of the standing vegetation and the seed bank. The study determined the correspondence between the seed bank and the aboveground vegetation in relation with ecosystem restoration.

MATERIALS AND METHODS

This study was conducted on September 2015 until August 2016. Data were gathered from karst ecosystem in Mount (Mt.) Nyungcung (06°27'15.3" S and 106°38'45.8" E) and Mt. Kapur (06°32'59.8" S and 106°41'16.1" E), both are in Bogor Regency. Both sites were mined from around nineteen eighties. Mining activity in Mt. Nyungcung was ended around 2005 while in Mt. Kapur is still operating.

Vegetation data and soil sample collection

Twenty plots were established to collect data on vegetation composition. The size of each plot was 6 m × 6 m, which was determined by preliminary investigation on the species number plotted in a graph from previous study conducted by [5]. All plant species in the plot were identified directly in the field based on their morphological characteristics. Herbarium voucher of unidentified plants was collected for further identification at Kebun Raya Bogor. Vegetation data were used to compare the composition of the vegetation with the composition of the seed bank. A total of sixty soil samples were taken from twenty vegetation plots. The size of each plot was 1 m × 1 m with 5 – 10 cm depth. Vegetation and soil plots was placed using purposive sampling technique. The plots in Mt. Nyungcung were placed at 193 – 218 m above sea level (asl) and in Mt. Kapur at 258 – 310 m asl.

Germination experiment

Seed bank testing was conducted using the germination experiment. All soil samples from the same site were composited. The composited soil was placed in 44 cm × 35 cm × 10 cm germination plastic trays which are filled with 5 – 7 cm depth of sterilized sand. Germination experiment started by covering all the germination trays using clear plastic cover for the first two months to maintain the temperature and humidity in favorable condition for the seeds to germinate. The germination trays were then transferred to the glass house after the seeds germinated to allow them to grow into seedlings for identification purposes. Seedling identification were visually done by observing specific morphological characters of a plant.

Data analysis

Shannon's diversity index (H') [6] was determine using the following formula:

$$H' = -\sum_{i=1}^{n} pi\ Ln\ pi$$

Note:

pi: proportion of individuals belonging to the i^{th} species

Margalef species richness index (R) [7] was obtain by formula:

$$R = \frac{S-1}{Ln(N)}$$

Note:

S: Number of species

N: Total number of individual plant

Shannon's evenness index (E) [8] was calculated using formula:

$$E = \frac{H'}{ln(S)}$$

Note:

H': Shannon's diversity index

S: Number of species

The similarity of species composition in the seed bank and the aboveground vegetation on each location were analyzed using Sorensen Index of Similarity [9] formula:

$$IS = \frac{2J}{a+b} \times 100\%$$

Note:

J: Number of the same species in a and b

a: Number of Species in a

b: Number of species in b

Independent sample t-test were performed on the diversity, evenness, and species richness index. Data analysis were conducted using *Microsoft Excel* and *SPSS 22 software.*

RESULTS AND DISCUSSION

Composition of the aboveground vegetation and its diversity

The field study found 354 plants belonging to 60 plant species from 40 families in the aboveground vegetation of Mt. Nyungcung. *Coffea liberica* (Rubiaceae) dominated the site followed by *Antidesma montanum* (Phyllanthaceae) (Table 1). The aboveground vegetation in Mt. Nyungcung consisted mostly of plants belonging to Myrtaceae, Pandanaceae, Phyllanthaceae, Rubiaceae and Sapindaceae. Karst ecosystem in Mt. Kapur had

Table 1. List of top ten most abundant plant species composing the aboveground vegetation

Location	*Species*	*Total* (ind)
Mt. Nyungcung	*Coffea liberica* Hiern	47
	Antidesma montanum Blume	29
	Tristaniopsis sp.	27
	Pandanus sp.	21
	Chrysophyllum flexuosum Mart.	19
	Selaginella sp.	19
	Guioa diplopetala (Hassk.) Radlk.	18
	Microcos hirsuta (Korth.) Burret	12
	Dioscorea hispida Dennst.	9
	Dracaena elliptica Thunb. & Dalm.	9
Mt. Kapur	*Strophioblachia fimbricalyx* Boerl.	76
	Stachytarpheta indica (L.) Vahl	63
	Arytera littoralis Blume	50
	Mallotus floribundus (Blume) Müll.Arg.	46
	Alchornea rugosa (Lour.) Müll.Arg.	44
	Clausena excavate Burm.f.	37
	Calliandra calothyrsus Meisn.	33
	Bauhinia championii (Benth.) Benth.	18
	Antidesma montanum Blume	15
	Bridelia tomentosa Blume	12

more plant number but fewer number of plant species compare to that of Mt. Nyungcung. There were 528 plants belonging to 46 species from 23 families, in the site. The most abundant species were *Strophioblachia fimbricalyx* (Euphorbiaceae) followed by *Stachytarpheta indica* (Verbenaceae). In Mt. Kapur, the plants mostly belong to Anacardiaceae, Euphorbiaceae, Leguminosae, Rutaceae, Sapindaceae and Verbenaceae. The complete list of the species is given as Appendix 1.

Pioneer species such as Macaranga rhizinoides and Macaranga tanarius both Euphorbiaceae were recorded in the aboveground vegetation of the two sites indicated early successional stage of the karst ecosystem. These species can withstand hostile environment of the karst area including high light intensity, thin solum and drought. The relatively open area of karst and the high light intensity that were varied between 417 – 484 × 10 lux in Mt. Nyungcung and 1,816 – 1,823 ×10 lux in Mt. Kapur supported the growth of several species such as *Cecropia peltata* (Urticaceae) and *Melastoma malabathricum* (Melastomataceae).

The presence of several invasive species such as *Coffea liberica* (Rubiaceae) and *Piper aduncum* (Piperaceae) were also recorded in the aboveground vegetation of Mt. Nyungcung and Mt. Kapur. The invasive species may have been colonizing the two study sites after disturbance and considered to negatively impact the natural environment by replacing indigenous species [10]. Their presence at a site may be part of the condition leading to assessment that restoration is needed [11].

Diversity index of Mt. Nyungcung was higher compare to that of Mt. Kapur. The aboveground vegetation of Mt. Nyungcung had 2.65 ± 0.54 of diversity index, while Mt. Kapur had 2.51 ± 0.71. Higher value of Mt. Nyungcung diversity index showed by higher species number and more even species distribution which was indicated by higher species richness and evenness index. Value of species richness and evenness index in Mt. Nyungcung were 4.56 ± 1.21 and 0.95 ± 0.15 respectively, while in Mt. Kapur were 2.46 ± 0.84 and 1.07 ± 0.25. The species richness in the two study sites were significantly different (t = 4.515, df = 18, P = 0.00).

Seed bank characteristics: composition and species diversity

Mount Nyungcung seed bank comprised of 2602 seedlings belonging to 80 plant species from 41 families. The most abundant species were *Clidemia hirta* followed by *M. malabathricum* both Melastomataceae (Table 2). The largest family composing Mt. Nyungcung seed bank were Melastomataceae, subsequently followed by Rubiaceae, Primulaceae, Poaceae and Solanaceae.

The total number of plant species in the seed bank of Mt. Nyungcung were higher compare to that of Mt. Kapur. In Mt. Kapur seed bank, 1280 seedlings belonging to 50 plant species from 29 families were recorded. *C. peltata* (Urticaceae) was the most abundant species in Mt. Kapur. Urticaceae was the largest family composing Mt. Kapur seed bank followed by Selaginellaceae, Poaceae, Erythroxylaceae and Verbenaceae. The complete list of the species is given as Appendix 2.

Plants in Mt. Nyungcung seed bank consisted of 24.36% trees, 28.21% shrubs and 24.36% herbs while in Mt. Kapur consisted of 30.61% trees, 24.49% shrubs and 28.57% herbs. Composition of the seed bank of Mt.

Nyungcung and Mt. kapur were dominated by shrubs and herbs. The tree species in both study sites were relatively low but in Mt. Kapur the numbers were slightly higher. Forests in Karst area have relatively smaller number of tree species compared to forests with thick solum [12]. Field observation showed that the Mt. Kapur solum was a little bit thicker by approximately 5-10 cm than Mt. Nyungcung. Therefore, trees in Mt. Kapur have bigger chances to survive and store their seeds in the soil.

The studied seed bank was dominated by small-seeded species while the standing vegetation was dominated by large-seeded species. Annual species such as *Laportea aestuans* (Urticaceae), *Solanum americanum* (Solanaceae), and *Momordica charantia* (Cucurbitaceae) were recorded present in the seed bank. Short-lived annual species maintains its existence by relying their regeneration on seeds, therefore accumulates their seeds in the seed bank.

The study also recorded the presence of few long-lived dominant trees species that has seeds accumulation prevention self-mechanism which was largely due to trade-offs between seed size and seed production and between seed size and persistence. Large seeds typically produced in lower numbers than small seeds and generally accumulating in the seed bank more ineffectively [13, 14].

The seed bank had been classified into transient and persistent, depending on the seeds persistence in the soil whether less or more than a year [15]. The length of the germination experiment suggested that the studied seed banks were mostly transient. However, we also confirmed the presence of persistent seed bank. In the studied site where invasion process occurred, the seed bank had become dominated by seeds of weedy species, which typically possess large, persistent seed banks [16]. Pioneer species which were present after disturbance in the two studied sites had also formed the persistent seed bank by producing persistent seeds that remain in the seed bank [17].

The presence of invasive species such as *C. peltata* (Urticaceae) and *Piper aduncum* (Piperaceae) in the seed bank showed that the seed bank had been invaded. *C. peltata* which dominated Mt. Kapur seed bank produces large amounts of seeds which can remain fertile for years until germination occur [18]. Seed germination of the invasive species may potentially cause the rapid dominance of the species in the aboveground vegetation [19] that can lead to species loss and habitat degradation.

Species diversity index of Mt. Nyungcung seed bank were significantly different from those of Mt. Kapur ($t = 3.117$, $df = 57$, $P = 0.04$). Mt. Nyungcung had 2.09 ± 0.21 of diversity index, while Mt. Kapur had 1.78 ± 0.47. Species diversity in Mt. Nyungcung was higher than that of Mt. Kapur. The species diversity of the seed bank has positive correlation with the species diversity of the aboveground vegetation [20]. Value of the species richness index in Mt. Nyungcung and Mt. kapur were 3.97 ± 0.53 and 2.82 ± 0.64 respectively. Species richness index of Mt. Nyungcung seed bank were significantly different from those of Mt. Kapur ($t = 7.490$, $df = 57$, $P = 0.00$). Evenness index in Mt. Nyungcung and Mt. Kapur were 0.72 ± 0.09 and 0.76 ± 0.19 respectively. Number of plant species in Mt. Nyungcung seed bank was higher and more evenly distributed between the species. The species diversity of the two seed banks were in the same level with the aboveground vegetation. The species diversity was moderate based on [21] classification but the species composition was different. In the coming pe-

Table 2. List of top ten most abundant plant species composing the seed banks

Location	*Species*	*Total*
Mt. Nyungcung	*Clidemia hirta* (L.) D. Don	589
	Melastoma malabathricum L.	586
	Mussaenda acuminata Blume	323
	Embelia ribes Burm.f.	207
	Centotheca lappacea (L.) Desv.	115
	Centrosema pubescens Benth.	70
	Solanum torvum Sw.	69
	Peperomia pellucida (L.) Kunth	66
	Melicope lunu-ankenda (Gaertn.) T.G. Hartley	47
	Cecropia peltata L.	44
	Cecropia peltata L.	646
Mt. Kapur	*Selaginella* sp.	110
	Erythroxylum cuneatum (Miq.) Kurz	76
	Stachytarpheta indica (L.) Vahl	73
	Piper aduncum L.	69
	Centotheca lappacea (L.) Desv.	64
	Clidemia hirta (L.) D. Don	40
	Xanthosoma sp.	22
	Antidesma montanum Blume	17
	Mallotus floribundus (Blume) Müll.Arg.	14

riod, the seed bank will probably increase the species diversity of the standing vegetation by adding the number of species present in vegetation.

Similarity between seed bank and the aboveground vegetation

Result of germination experiment showed that there were 118 and 84 plant species in the seed bank and the aboveground vegetation of Mt. Nyungcung and Mt. Kapur. From that numbers, 49.15% were present in the seed bank but absent in the aboveground vegetation, 31.36% occurring the aboveground vegetation but absent from the seed bank of Mt. Nyungcung. In Mt. Kapur 45.24% of the species were present in the seed bank but absent in the aboveground vegetation, 39.29% present in the aboveground vegetation but absent from the seed bank. These findings were in agreement with few other studies on seed bank which showed that there were plant species recorded in the seed bank but were not part of the current standing vegetation [22,23].

The similarity index between the seed bank and the aboveground vegetation of Mt. Nyungcung was 32.86% while in Mt. Kapur was 27.66%. The species similarity was low, as found in most studies comparing the composition of established vegetation and seed bank [24]. The seed banks were poor predictors of the aboveground vegetation of Mt. Nyungcung and Mt. Kapur. Many of the plant species found in the seed bank were absent in the aboveground vegetation. Result of germination experiment was in agreement with [25, 26] finding which showed that there was no strong relationship between species composition of the seed bank with the species composition of its aboveground vegetation.

There were two factors that might explain the low similarity between the seed bank and the aboveground vegetation in the study site. The first factor was the el nino occurrence in Indonesia when the study was conducted (reported by The Indonesian Agency for Meteorology, Climatology, and Geophysics). *El nino* caused several plant species in the two study sites unable to survive, but may had stored seeds in the seed bank prior to their deaths. Second, the presence of invasive species in the aboveground vegetation may cause another plant species to disappear because of a range of mechanisms associated with an invasion [27], but their seeds might still be present in the seed bank. Thus, several plant species recorded in the seed bank were not present in the aboveground vegetation. The similarity between the seed bank and the aboveground vegetation is low at heavily invaded or long term invaded sites [28] just like Mt. Nyungcung and Mt Kapur.

Seed bank and ecosystem restoration

Seed banks play important roles in conservation of plant species. Components of species diversity in the form of seed bank are readily available to support the ecosystem restoration after disturbances. Seed banks of the two studied sites have low similarity with the aboveground vegetation, thereby affecting its ability in supporting the ecosystem restoration.

There are two possibilities that explain the low similarity between seed bank and aboveground vegetation, each has different consequences for the ecosystem restoration (if we exclude the seeds of the invasive species in the seed bank). First, the seed bank stored seeds from trees that were previously occupied the aboveground vegetation but no longer existed. The consequence of this possibility is that even if the similarity was low, the seed bank can still support the ecosystem recovery and allows natural restoration to occur. Second, the seed bank stored seeds that were carried by dispersal agents such as animals and humans from outside the ecosystem. They bring different consequences to that of the first possibility. The seed bank will have limitation in supporting the ecosystem recovery of the area. Therefore, a man managed restoration is needed. Further analysis of the aboveground vegetation composition prior to the mining activity needed to be done to determine the capacity of the current seed bank in supporting the ecosystem recovery.

The presence of invasive species in the studied seed banks may indicate a constraint in ecosystem restoration. Invasion process may change the composition of the native species seed bank, thereby affecting its restoration potential. Information on the origin of the seeds in the seed bank are required to develop an effective restoration strategy. The restoration potential of the seed bank as the total biodiversity reservoir in the site is likely to be restored if the invasive species could be controlled or eliminated.

CONCLUSION

Mt. Nyungcung vegetation and seed bank was more diverse than Mt. Kapur. The similarity between the seed bank with the aboveground vegetation in the two sites were low. The seed banks were poor predictors of the aboveground vegetation.

In term of ecosystem recovery, a further analysis of the aboveground vegetation composition prior to the mining activity needed to be done. The information

from the analysis can determine the capacity of the current seed bank in supporting the ecosystem recovery of Mt. Nyungcung and Mt. Kapur.

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Appendix 1

Table 3. List of plant species composing the aboveground vegetation of Mt. Nyungcung and Mt. Kapur

Species	*Family*	*Number of Plants*	
		Mt. Nyungcung	*Mt. Kapur*
Actinodaphne macrophylla	Lauraceae	-	5
Aglaia elliptica	Meliaceae	-	1
Alchornea rugosa	Euphorbiaceae	-	44
Allophylus cobbe	Sapindaceae	1	6
Alpinia galanga	Zingiberaceae	2	-
Alstonia scholaris	Apocynaceae	8	-
Antidesma montanum	Phyllanthaceae	29	15
Arachnis sp.	Orchidaceae	-	1
Arcangelisia flava	Menispermaceae	4	-
Artocarpus heterophyllus	Moraceae	2	-
Arytera littoralis	Sapindaceae	-	50
Bauhinia championii	Leguminosae	-	18
Bridelia tomentosa	Phyllanthaceae	-	12
Brucea javanica	Simaroubaceae	1	-
Buchanania arborescens	Anacardiaceae	4	12
Calliandra calothyrsus	Leguminosae	-	33
Calophyllum soulattri	Clusiaceae	-	1
Canthium horridum	Rubiaceae	2	-
Carallia brachiata	Rhizophoraceae	1	-
Cecropia peltata	Urticaceae	-	7
Centrosema pubescens	Leguminosae	-	7
Chrysophyllum flexuosum	Sapotaceae	19	-
Cinnamomum sintoc	Lauraceae	2	-
Clausena excavata	Rutaceae	-	37
Cleistocalyx sp.	Myrtaceae	1	-
Coffea canephora	Rubiaceae	1	-
Coffea liberica	Rubiaceae	47	-
Combretum latifolium	Combretaceae	-	2
Cratoxylum formosum	Hypericaceae	3	-
Croton tiglium	Euphorbiaceae	1	-
Cryptocarya sp.	Lauraceae	1	2
Curculigo orchioides	Hypoxidaceae	5	-
Cyperus rotundus	Cyperaceae	7	-
Daemonorops sp.	Arecaceae	3	-
Dianella sp.	Liliaceae	2	-
Dioscorea hispida	Dioscoreaceae	9	-
Dracaena angustifolia	Asparagaceae	1	-
Dracaena eliptica	Asparagaceae	9	-

Species	*Family*	*Number of Plants*	
		Mt. Nyungcung	*Mt. Kapur*
Dracaena surculosa	Asparagaceae	1	-
Elaeocarpus floribundus	Elaeocarpaceae	3	-
Erythroxylum cuneatum	Erythroxylaceae	4	-
Ficus fistulosa	Moraceae	-	6
Ficus geocarpa	Moraceae	-	5
Ficus hirta	Moraceae	1	-
Ficus montana	Moraceae	1	-
Ficus septica	Moraceae	-	5
Flacourtia rukam	Salicaceae	1	-
Flagellaria indica	Flagellariaceae	1	-
Garcinia celebica	Clusiaceae	9	-
Garcinia parviflora	Clusiaceae	2	-
Glochidion macrocarpum	Phyllanthaceae	-	1
Glochidion philippicum	Phyllanthaceae	-	2
Glochidion rubrum	Phyllanthaceae	-	1
Glycosmis pentaphylla	Rutaceae	-	1
Gnetum cuspidatum	Gnetaceae	3	-
Gnetum gnemon	Gnetaceae	2	-
Guioa diplopetala	Sapindaceae	18	-
Hiptage benghalensis	Malpighiaceae	-	4
Ixora javanica	Rubiaceae	9	12
Lantana camara	Verbenaceae	1	-
Lepisanthes rubiginosa	Sapindaceae	-	2
Litsea glutinosa	Lauraceae	-	1
Litsea umbellata	Lauraceae	-	2
Macaranga rhizinoides	Euphorbiaceae	3	8
Macaranga tanarius	Euphorbiaceae	2	-
Mallotus floribundus	Euphorbiaceae	1	46
Melastoma malabthricum	Melastomataceae	2	-
Melicope lunu-ankenda	Rutaceae	-	1
Microcos hirsuta	Malvaceae	12	-
Mucuna sp.	Leguminosae	1	-
Nauclea sp.	Rubiaceae	-	2
Pandanus sp.	Pandanaceae	21	-
Parameria laevigata	Apocynaceae	-	1
Piper aduncum	Piperaceae	-	3
Polyscias diversifolia	Araliaceae	7	-
Pothos junghuhnii	Araceae	1	-
Pterospermum javanicum	Malvaceae	-	1
Radermachera gigantea	Bignoniaceae	6	-

Species	*Family*	*Number of Plants*	
		Mt. Nyungcung	*Mt. Kapur*
Rothmannia longiflora	Rubiaceae	-	12
Sauropus androgynus	Phyllanthaceae	-	5
Selaginella sp.	Selaginellaceae	19	-
Smilax leucophylla	Smilacaceae	9	-
Stachytarpheta indica	Verbenaceae	-	63
Strophioblachia fimbricalyx	Euphorbiaceae	-	76
Syzygium acuminatissimum	Myrtaceae	9	-
Syzygium lineatum	Myrtaceae	2	2
Syzygium pycnanthum	Myrtaceae	2	-
Syzygium racemosum	Myrtaceae	2	3
Tetracera scandens	Dilleniaceae	2	1
Tristaniopsis sp.	Myrtaceae	27	-
Uncaria gambir	Rubiaceae	2	-
Uvaria concava	Annonaceae	1	2
Vitex pinnata	Lamiaceae	2	-
Voacanga grandifolia	Apocynaceae	-	5
Weinmannia fraxinea	Cunoniaceae	-	2

Appendix 2

Table 4. List of plant species in the seed bank of Mt. Nyungcung and Mt. Kapur

Species	*Family*	*Number of Plants*	
		Mt. Nyungcung	*Mt. Kapur*
Abrus precatorius	Leguminosae	1	-
Aerva javanica	Amaranthaceae	10	3
Ageratum conyzoides	Compositae	1	-
Allophylus cobbe	Sapindaceae	-	1
Alpinia galanga	Zingiberaceae	3	-
Alstonia scholaris	Apocynaceae	2	-
Amorphophallus variabilis	Araceae	1	-
Antidesma montanum	Phyllanthaceae	32	17
Axonopus compressus	Poaceae	1	2
Bridelia tomentosa	Phyllanthaceae	-	1
Brucea javanica	Simaroubaceae	2	1
Caladium sp.	Araceae	1	-
Calliandra calothyrsus	Leguminosae	-	1
Callicarpa sp.	Lamiaceae	3	-
Carallia brachiata	Rhizophoraceae	20	-
Carica papaya	Caricaceae	-	1
Cecropia peltata	Urticaceae	44	646
Centotheca lappacea	Poaceae	115	64
Centrosema pubescens	Leguminosae	70	4
Chlorophytum orchidastrum	Asparagaceae	-	1
Chromolaena odorata	Compositae	13	14
Chrysophyllum flexuosum	Sapotaceae	40	-
Clausena excavata	Rutaceae	1	-
Clidemia hirta	Melastomataceae	589	40
Coffea liberica	Rubiaceae	1	-
Combretum latifolium	Combretaceae	-	2
Costus spiralis	Costaceae	5	-
Cratoxylum formosum	Hypericaceae	22	-
Croton tiglium	Euphorbiaceae	6	-
Curculigo orchioides	Hypoxidaceae	7	-
Cyperus rotundus	Cyperaceae	6	-
Cyperus sp.	Cyperaceae	1	-
Dianella sp.	Liliaceae	2	-
Digitaria sp.	Poaceae	2	1
Dillenia obovata	Dilleniaceae	1	-
Dioscorea hispida	Dioscoreaceae	15	-
Embelia ribes	Primulaceae	207	-
Erythroxylum cuneatum	Erythroxylaceae	3	76

Species	Family	Number of Plants	
		Mt. Nyungcung	Mt. Kapur
Ficus annulata	Moraceae	5	-
Ficus coronata	Moraceae	1	-
Ficus deltoidea	Moraceae	4	-
Ficus hirta	Moraceae	3	-
Ficus palmata	Moraceae	1	2
Ficus sagitata	Moraceae	2	-
Ficus septica	Moraceae	-	1
Ficus sp.	Moraceae	1	-
Ficus uncinata	Moraceae	-	1
Galinsoga parviflora	Compositae	28	2
Gmelina arborea	Lamiaceae	2	-
Hibiscus calyphyllus	Malvaceae	-	1
Hibiscus macrophyllus	Malvaceae	11	9
Hiptage benghalensis	Malpighiaceae	1	9
Ischaemum timorense	Poaceae	11	12
Lantana camara	Verbenaceae	5	
Laportea aestuans	Urticaceae	4	6
Lepidaploa obtusifolia	Compositae	2	-
Leucaena leucocephala	Leguminosae	-	7
Macaranga rhizinoides	Euphorbiaceae	23	9
Macaranga tanarius	Euphorbiaceae	27	13
Mallotus floribundus	Euphorbiaceae	11	14
Melastoma malabathricum	Melastomataceae	586	-
Melicope lunu-ankenda	Rutaceae	47	-
Mikania micrantha	Compositae	7	6
Momordica charantia	Cucurbitaceae	1	-
Mussaenda acuminata	Rubiaceae	323	1
Oxalis barrelieri	Oxalidaceae	-	2
Oxalis corniculata	Oxalidaceae	2	2
Oxalis sp.	Oxalidaceae	-	1
Passiflora foetida	Passifloraceae	1	1
Peperomia pellucida	Piperaceae	66	3
Physalis minima	Solanaceae	-	3
Piper aduncum	Piperaceae	3	69
Rhynchospora colorata	Cyperaceae	2	-
Rostellularia sundana	Acanthaceae	2	1
Rotheca serrata	Lamiaceae	2	2
Rubus pubescens	Rosaceae	10	-
Sauropus androgynus	Phyllanthaceae	1	-
Scirpodendron ghaeri	Cyperaceae	3	-

Species	*Family*	*Number of Plants*	
		Mt. Nyungcung	*Mt. Kapur*
Scleria Sumatrensis	Cyperaceae	2	2
Selaginella sp.	Selaginella	29	110
Sida rhombifolia	Malvaceae	1	-
Solanum americanum	Solanaceae	16	6
Solanum diphyllum	Solanaceae	-	1
Solanum torvum	Solanaceae	69	6
Spermacoce laevis	Rubiaceae	13	2
Spigelia anthelmia	Loganiaceae	2	6
Stachytarpheta indica	Verbenaceae	2	73
Tetracera scandens	Dilleniaceae	2	-
Torenia violacea	Linderniaceae	10	-
Trema orientalis	Cannabaceae	19	-
Uraria lagopodoides	Leguminosae	1	-
Urochloa glumaris	Poaceae	1	-
Vitex pinnata	Lamiaceae	5	-
Xanthosoma sp.	Araceae	5	22