Table 24. Plots with very high estimated carbon densities

No.	Land use	1994			2003		
		Biomass (Kg/ha)	Biomass (Mg/ha)	Carbon density (Mg/ha)	Biomass (Kg/ha)	Biomass (Mg/ha)	Carbon density (Mg/ha)
1.	Old pine	48336.30	193.35	87.01	59124.61	236.50	106.42
2.	Pine	62915.89	251.66	113.25	72941.69	291.77	131.30
3.	Forest	50376.52	201.51	90.68	62108.81	248.44	111.80
4.	Forest	61598.65	246.39	110.88	72842.67	291.37	131.12
5.	Forest	30341.68	121.37	54.62	38550.60	154.20	69.39
6.	Agriculture	27768.31	111.07	49.98	39703.36	158.81	71.47

From these monitoring plots, one noticeable carbon value was observed in the agriculture category. In 2003, monitoring plots in agriculture areas had an average of 21.4 Mg/ha, which was more than that of forest and pines. This suggests that farmers planted more high-carbon trees outside the forest or it could be due to the sedentarisation of agriculture, which was noted by Banaticla et al. (2008) (see page 13).

5.6 Carbon emissions by land-use and land-cover change

Carbon emissions from land-use and land-cover changes between 1989 and 2001 were calculated using the derived carbon densities from this study (with addition from another study of land-cover types not sampled locally), as shown in Table 25.

Table 25. Land-cover types and carbon densities used

Land-cover type from image classification	Mean carbon densities (aboveground) Mg/ha	Sources
Agricultural land	17.61	KEF monitoring plots*
Dipterocarp/mahogany	45.0	Recent data
Fallow (swidden-fallow)	19.7	Recent data
Forest (mature)	28.9	Recent data
Grassland	4.1	Recent data
Pasture land	10.4	Recent data
Pine	17.53	KEF monitoring plots*
Old pine	16.76	KEF monitoring plots*
Rice field	8.17	KEF monitoring plots*
Secondary forest	21.74	KEF monitoring plots*
Settlement	4.1	ICRAF (Kalimantan data)

*Average of the 1994 and 2001 carbon densities (Appendix 3)

Based on our calculations (Table 26), the KFR sequestered an average of 0.30 Mg/ha of carbon less than what was emitted (average 0.82 Mg/ha) from its land-cover changes between 1989 and 2001. The carbon emission potential was 0.5 Mg/ha. Table 26 shows the estimated yearly average carbon emissions. From this, it is estimated that per year the KFR is emitting 1.4 Gg of carbon while sequestering 0.5 Gg.

Table 26. Mean carbon emissions from land-use changes, 1994–2003

	Forest	Secondary forest	Old Pine	Pine	Mahogany	Agriculture	Fallow	Rice field	Settlement	Grass	Total	
Forest	0	0	0	0.177159	-0.00595	0.123002	0.009783	0.187419	0.001925	0.011016	0.504357	
Secondary Forest	0	0	0	0.024403	-0.00645	0.009812	7.43E-05	0.023411	7.27E-05	0.001454	0.05278	
Old Pine	0	0	0	0	-0.03732	-0.0052	-0.0008	0.024051	0.000523	0.00068	-0.01806	
Pine	0	0	0.03209287	0	-0.1105	0.010798	-0.00753	0.119632	0.01068	0.005478	0.060653	
Mahogany	0	0	0	0	0	0.011365	0.000104	0.010646	0	0.000338	0.022454	
Agriculture	0	0	0	-0.01875	-0.11503	0	-0.01719	0.174666	0.041655	0.005843	0.071189	
Fallow	0	0	0	0.005687	-0.00554	0.021267	0	0.017617	6.44E-05	0.000387	0.039485	
Rice field	0	0	0	-0.07139	0	-0.13175	-0.00271	0	0.001714	0.000387	-0.20375	
Settlement	0	0	0	0	0	0	0	0	0	0	0	
Grass	0	0	0	-0.00664	0	-0.00444	-0.00483	-0.00032	0	0	-0.01623	
Total	0	0	0.03209287	0.110461	-0.28078	0.034866	-0.02311	0.557123	0.056634	0.025581	**0.512875**	**Mg/ha emission**
											0.815232	**Mg/ha emitted**
											0.302356	**Mg/ha sequestered**

Table 27. Mean carbon emissions per year, 1994–2003

	Forest	Secondary forest	Old Pine	Pine	Mahogany	Agriculture	Fallow	Rice field	Settlement	Grass	Total	
Forest	0	0	0	0.014763	-0.0005	0.01025	0.000815	0.015618	0.00016	0.000918	0.04203	
Secondary Forest	0	0	0	0.002034	-0.00054	0.000818	6.19E-06	0.001951	6.06E-06	0.000121	0.004398	
Old Pine	0	0	0	0	-0.00311	-0.00043	-6.7E-05	0.002004	4.36E-05	5.66E-05	-0.00151	
Pine	0	0	0.00267441	0	-0.00921	0.0009	-0.00063	0.009969	0.00089	0.000457	0.005054	
Mahogany	0	0	0	0	0	0.000947	8.71E-06	0.000887	0	2.81E-05	0.001871	
Agriculture	0	0	0	-0.00156	-0.00959	0	-0.00143	0.014556	0.003471	0.000487	0.005932	
Fallow	0	0	0	0.000474	-0.00046	0.001772	0	0.001468	5.37E-06	3.22E-05	0.00329	
Rice field	0	0	0	-0.00595	0	-0.01098	-0.00023	0	0.000143	3.22E-05	-0.01698	
Settlement	0	0	0	0	0	0	0	0	0	0	0	
Grass	0	0	0	-0.00055	0	-0.00037	-0.0004	-2.7E-05	0	0	-0.00135	
Total	0	0	0.00267441	0.009205	-0.0234	0.002905	-0.00193	0.046427	0.00472	0.002132	**0.04274**	**Mg/ha emission**
											0.067936	**Mg/ha emitted**
											0.025196	**Mg/ha sequestered**

5.7 Carbon-offset[6] options

1) **CDM Market**: The KEF is negotiating a CDM project. Potential sites for this project are abandoned agricultural and grassland areas. A list of participants is being prepared together with their planting strategies for the proposed CDM sites (Figure 13).

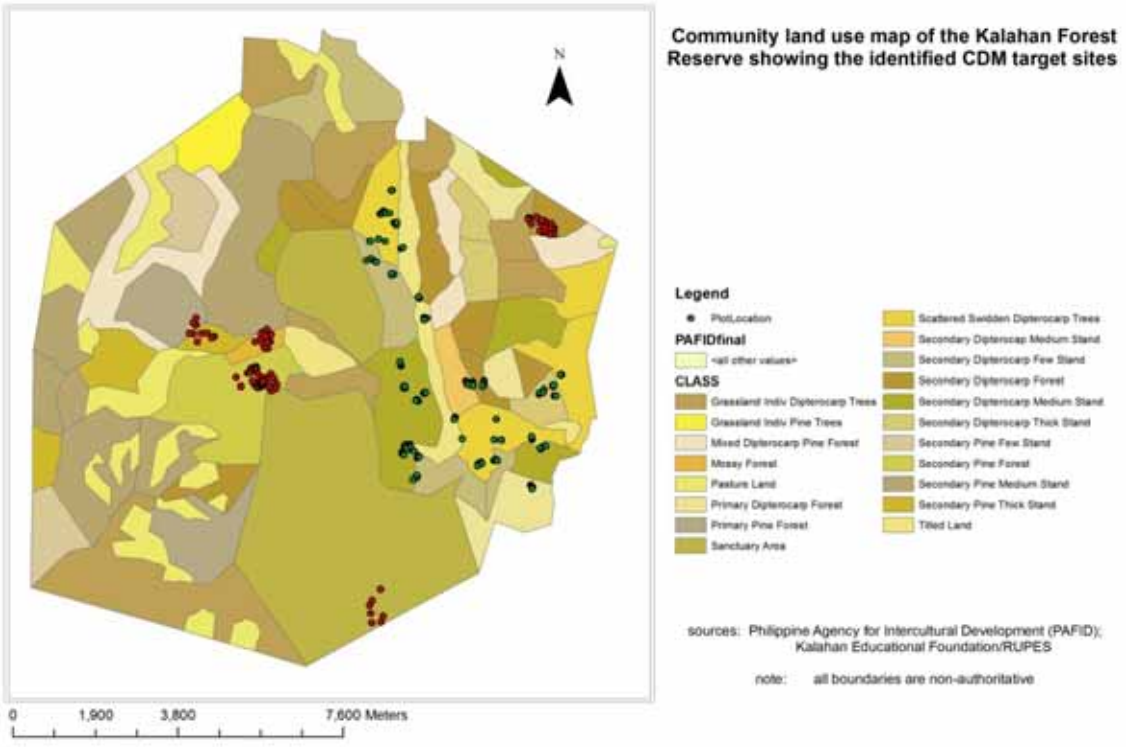

Figure 13. Target sites for CDM project (red dots).

Plant species that local farmers preferred to plant (some already have planted) were *tuai* (*Biscofia javanica*), *Alnus* (*Alnus nepalensis*) and rain tree (*Albizia saman*). Among the proposed planting schemes were reforestation with mixed tree species. Others propose to implement nurse tree to integrate climax species (for example, Benguet pine and dipterocarps). However, a possible problem under this target market is meeting the CDM requirements of forest definition, baseline, leakage and additionality[7]. Thus, the voluntary carbon market is likely to be the best for the KFR owing to its increasing carbon stock.

2) **Voluntary market**: The data and information generated from this study will be used to find voluntary carbon markets. However, the baseline should be well established. The forest improvement technology developed by the KEF could potentially enhance the carbon stock of the standing forests (Appendix 5) at the same time as maintaining the

[6] A reduction in carbon dioxide emission by a third party purchased by a heavy carbon dioxide producer as part of carbon emissions trading.
[7] CDM projects must result in 'reduction in emissions that are additional to any that would occur in the absence of the certified project activity'.

biodiversity within. The KEF is optimistic that this could be used as a management strategy to tap 'reducing emissions from deforestation and degradation' (REDD) markets.

5.8 Scenario building and future options

This section presents the results of Forest, Agroforest, Low-value Landscape Or Wasteland (FALLOW) model application in the KFR that was conducted by Suyamto et al. (2011)[8] under the Rewarding Upland Poor for the Environmental Services they provide (RUPES) project (phase 1). The FALLOW model simulates landscape dynamics and the consequences of the application of different drivers in various scenarios.

5.8.1 Baseline

Using population growth (at a rate of 1.78%) as the driver, the model predicted that within the next three decades (2001–2030), the landscape would experience a decrease in forest area of about 85 ha/yr and an increase of agricultural/grassland area of about 85 ha/yr. Depletion of biodiversity, carbon stock and sediment-filtering capacity would occur at the rate of 0.4 species/yr, 53 Gg/yr and 117 Gg/yr, respectively. Secondary expenses of the people would increase at a relatively low rate of about PHP 110 per capita per year.

5.8.2 Future options

Three options were identified based on existing livelihoods (1 and 2) and alternative land-uses (3) within the KFR, with possible future implications.

Table 28. Future options and their implications for the KFR

Options	Implications
Option 1: Improve non-timber forest products' (NTFP) productivity and markets (by increasing productivity and price 2x, 6x and 10x from the baseline)	By increasing NTFP productivity and price up to 10x from the baseline, agricultural land expansion can only be reduced at an average of about 233 ha or 8% per year
Option 2: Provide better off-farm jobs (increase incomes from off-farms jobs 2x, 6x and 10x from the baseline)	• By increasing income from off-farm jobs 2x from the baseline, agricultural land expansion could decrease at an average of 289 ha or 10% per year • By increasing income 6x, agricultural land expansion could decrease at an average of 551 ha or 17% per year and forests could increase at an average of 229 ha or 2% per year • By increasing income 10x, agricultural land expansion could decrease at an average of 1005 ha or 31% per year and forests could increase at an average of 834 ha or 8% per year

[8] Detailed information on data inputs of the model and some assumptions can be found in this working paper.

Options	Implications
Option 3: Promote tree-based systems (for example, cacao and coffee) through extension, subsidy and market improvements	Among the tree-based systems scenarios, coffee could be adopted at the fastest rate, followed by cacao and mahogany. This assumes that economically, smallholder tree-based systems are more profitable than pasture and, biophysically, pasture can be converted into tree-based systems. These efforts would replace grasslands with more valuable systems

Source: Suyanto et al. (2011) (draft working paper)

Appendix 6 shows the additionality from each scenario on biodiversity (that is, species numbers in four functional groups: pioneer, early succession, medium succession and late succession), carbon stocks, watershed functions (that is, sediment-filtering capacity) and people's welfare (that is, non-food expenses per capita).

6. Conclusion and recommendations

6.1 Conclusion

The matrix below summarises the findings of the appraisal.

Value:	**Opportunity:**
• Major land-use and land-cover types—agriculture, agroforest, grassland, secondary forest and reforestation—were assessed and their carbon stocks were calculated • KFR has its own farming practices that enhance carbon stocks in the area, such as *pang-omis*, in which *Alnus* species are integrated into swidden farming	• KEF has long-term biomass monitoring plots to support carbon-offset trading and already has skills to monitor carbon stocks within KFR (to reduce transaction cost) • KEF's own farming practices and technology can be used as a strategy to explore voluntary markets
Trust:	**Threat:**
• KEF's rules and regulations on natural resources control the cutting of trees inside KRF. It also initiates the active participation of each village in tree-planting activities	• Encroachment of outsiders owing to intermarriages (concern over changing farming practices) • Limited livelihoods' options (certificate of ancestral domain title holders might seek to sell their land)

6.2 Recommendations

- For the voluntary carbon market, further research is required to assess the potential of the KEF's forest improvement technology for REDD.
- More ground-truthing activities are need to validate the landscape-level carbon estimations.
- Process the recent satellite image of the area and use it for analysis of land-use and land-cover changes and carbon dynamics.

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Appendix 1: List of plant species and its biomass per land use

Appendix 1: Reforestation – list of plant species and biomass

No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2
1	Alagai	268.00	32	Alnus	301.62	63	Alnus	637.24	94	Amuwag	20.50
2	Alnus	6.04	33	Alnus	301.62	64	Alnus	648.34	95	Amuwag	20.50
3	Alnus	15.59	34	Alnus	312.19	65	Alnus	659.57	96	Amuwag	20.50
4	Alnus	20.50	35	Alnus	319.36	66	Alnus	665.22	97	Amuwag	24.00
5	Alnus	21.18	36	Alnus	330.30	67	Alnus	682.37	98	Amuwag	24.00
6	Alnus	27.85	37	Alnus	330.30	68	Alnus	778.40	99	Amuwag	27.85
7	Alnus	41.58	38	Alnus	349.05	69	Alnus	835.88	100	Amuwag	27.85
8	Alnus	114.46	39	Alnus	364.51	70	Alnus	951.40	101	Amuwag	27.85
9	Alnus	124.31	40	Alnus	368.44	71	Alnus	958.49	102	Amuwag	27.85
10	Alnus	242.83	41	Alnus	396.67	72	Alnus	6.04	103	Amuwag	27.85
11	Alnus	46.93	42	Alnus	396.67	73	Alnus	9.70	104	Amuwag	27.85
12	Alnus	58.84	43	Alnus	396.67	74	Alnus	20.50	105	Amuwag	27.85
13	Alnus	87.85	44	Alnus	396.67	75	Alnus	46.93	106	Amuwag	27.85
14	Alnus	87.85	45	Alnus	421.90	76	Amuwag	14.49	107	Amuwag	27.85
15	Alnus	87.85	46	Alnus	430.53	77	Amuwag	14.49	108	Amuwag	27.85
16	Alnus	168.85	47	Alnus	439.26	78	Amuwag	14.49	109	Amuwag	27.85
17	Alnus	168.85	48	Alnus	439.26	79	Amuwag	14.49	110	Amuwag	27.85
18	Alnus	194.33	49	Alnus	448.10	80	Amuwag	14.49	111	Amuwag	27.85
19	Alnus	194.33	50	Alnus	484.54	81	Amuwag	14.49	112	Amuwag	27.85
20	Alnus	205.15	51	Alnus	484.54	82	Amuwag	14.49	113	Amuwag	27.85
21	Alnus	207.91	52	Alnus	484.54	83	Amuwag	14.49	114	Amuwag	87.85
22	Alnus	222.06	53	Alnus	484.54	84	Amuwag	14.49	115	Amuwag	87.85
23	Alnus	222.06	54	Alnus	493.93	85	Amuwag	19.20	116	Antipolo	9.70
24	Alnus	222.06	55	Alnus	532.60	86	Amuwag	20.50	117	Avocado	72.45
25	Alnus	222.06	56	Alnus	532.60	87	Amuwag	20.50	118	Avocado	532.60
26	Alnus	252.09	57	Alnus	532.60	88	Amuwag	20.50	119	Avocado	753.66
27	Alnus	252.09	58	Alnus	542.54	89	Amuwag	20.50	120	Avocado	862.23
28	Alnus	258.38	59	Alnus	583.48	90	Amuwag	20.50	121	Avocado	75.38
29	Alnus	281.15	60	Alnus	609.99	91	Amuwag	20.50	122	Avocado	87.85
30	Alnus	284.50	61	Alnus	609.99	92	Amuwag	20.50	123	Avocado	284.50
31	Alnus	284.50	62	Alnus	631.73	93	Amuwag	20.50	124	Avocado	594.00

No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2
125	Ayuhip	11.02	156	Benguet Pine	1227.20	187	Coffee	8.11	218	Coffee	8.11
126	Balanti	12.93	157	Benguet Pine	1260.54	188	Coffee	8.11	219	Coffee	8.11
127	Bauang	6.04	158	Benguet Pine	1346.31	189	Coffee	8.11	220	Coffee	8.11
128	Bauang	6.04	159	Benguet Pine	1435.57	190	Coffee	8.11	221	Coffee	8.11
129	Benguet Pine	105.11	160	Benguet Pine	1881.99	191	Coffee	8.11	222	Coffee	8.11
130	Benguet Pine	145.53	161	Bilwa	9.70	192	Coffee	8.11	223	Daguay	9.70
131	Benguet Pine	171.30	162	Bilwa	13.44	193	Coffee	8.11	224	Danglin	14.49
132	Benguet Pine	194.33	163	Bilwa	46.93	194	Coffee	8.11	225	Ginnabang	17.34
133	Benguet Pine	227.88	164	Bilwa	76.88	195	Coffee	8.11	226	Gmelina	58.84
134	Benguet Pine	268.00	165	Bilwa	87.85	196	Coffee	8.11	227	Gmelina	14.49
135	Benguet Pine	330.30	166	Bilwa	199.70	197	Coffee	8.11	228	Gmelina	75.38
136	Benguet Pine	337.73	167	Bilwa	202.41	198	Coffee	8.11	229	Guava	7.03
137	Benguet Pine	337.73	168	Bini	6.04	199	Coffee	8.11	230	Guava	36.63
138	Benguet Pine	356.73	169	Bini	7.74	200	Coffee	8.11	231	Guava	8.11
139	Benguet Pine	439.26	170	Bini	14.49	201	Coffee	8.11	232	Guava	9.70
140	Benguet Pine	461.56	171	Buta buta	9.70	202	Coffee	8.11	233	Guava	27.85
141	Benguet Pine	461.56	172	Buta buta	36.63	203	Coffee	8.11	234	Guava	46.93
142	Benguet Pine	484.54	173	Buta buta	36.63	204	Coffee	8.11	235	Guava	105.11
143	Benguet Pine	484.54	174	Buta buta	114.46	205	Coffee	8.11	236	hauili	87.85
144	Benguet Pine	557.68	175	Canthum	9.70	206	Coffee	8.11	237	Hili-hili	14.49
145	Benguet Pine	604.63	176	Coffee	6.04	207	Coffee	8.11	238	Ihit	291.28
146	Benguet Pine	637.24	177	Coffee	6.04	208	Coffee	8.11	239	Ihit	20.50
147	Benguet Pine	723.43	178	Coffee	6.04	209	Coffee	8.11	240	Ihit	138.95
148	Benguet Pine	723.43	179	Coffee	8.11	210	Coffee	8.11	241	Ipil-ipil	24.00
149	Benguet Pine	753.66	180	Coffee	8.11	211	Coffee	8.11	242	Kahoy dalaga	65.43
150	Benguet Pine	753.66	181	Coffee	8.11	212	Coffee	8.11	243	Kahoy dalaga	951.40
151	Benguet Pine	784.67	182	Coffee	8.11	213	Coffee	8.11	244	Kahoy dalaga	36.63
152	Benguet Pine	916.47	183	Coffee	8.11	214	Coffee	8.11	245	Kulatingan	6.04
153	Benguet Pine	951.40	184	Coffee	8.11	215	Coffee	8.11	246	Lablaban	25.50
154	Benguet Pine	987.15	185	Coffee	8.11	216	Coffee	8.11	247	Lablabang	105.11
155	Benguet Pine	1146.24	186	Coffee	8.11	217	Coffee	8.11	248	Lablabang	430.53

Reforestation continues…

No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2
249	Ladau	87.85	280	Mangga	6.04	311	Narra	670.91			
250	Langka	27.85	281	Marang	81.47	312	Narra	882.33			
251	Langka	69.59	282	Molave	20.50	313	Padpad	14.49			
252	Langka	79.92	283	Molave	27.85	314	Padpad	79.92			
253	Lapting	87.85	284	Mussaenda setosa	20.50	315	Padpad	284.50			
254	Liwliw/Hauili	508.22	285	Narra	6.04	316	Padpad	461.56			
255	Macaranga	6.04	286	Narra	6.04	317	Palai	11.48			
256	Macaranga	6.04	287	Narra	6.04	318	Papaya	6.04			
257	Macaranga	134.66	288	Narra	9.70	319	Papaya	12.43			
258	Mahogany	14.49	289	Narra	16.74	320	Papaya	14.49			
259	Mahogany	46.93	290	Narra	20.50	321	Papaya	20.50			
260	Mahogany	1435.57	291	Narra	20.50	322	Papaya	20.50			
261	Mahogany	6.04	292	Narra	27.85	323	Papaya	24.00			
262	Manga	10.13	293	Narra	32.05	324	Pitikan	19.20			
263	Manga	20.50	294	Narra	58.84	325	Piwi	20.50			
264	Manga	24.00	295	Narra	61.42	326	Santol	36.63			
265	Manga	34.75	296	Narra	78.39	327	Sapinit	14.49			
266	Manga	62.74	297	Narra	96.24	328	Suha	6.69			
267	Manga	87.85	298	Narra	134.66	329	Suha	258.38			
268	Manga	281.15	299	Narra	168.85	330	Suha	723.43			
269	Manga	291.28	300	Narra	168.85	331	Suha	816.44			
270	Manga	330.30	301	Narra	213.50	332	Tibanglan	114.46			
271	Manga	356.73	302	Narra	222.06	333	Tuwal	58.84			
272	Manga	484.54	303	Narra	236.78	Total		73625.34			
273	Manga	532.60	304	Narra	268.00						
274	Manga	637.24	305	Narra	291.28						
275	Manga	653.94	306	Narra	330.30						
276	Manga	693.95	307	Narra	368.44						
277	Manga	723.43	308	Narra	400.81						
278	Manga	723.43	309	Narra	498.67						
279	Manga	810.02	310	Narra	642.78						

Secondary Forest

No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2
1	Adawai	26.268954	32	Benguet Pine	110.6587	63	Hagahaka	32.937682	94	Palosapis	29.487379
2	Adawai	124.3082	33	Benguet Pine	154.60227	64	Halinghing	39.551651	95	Palosapis	35.68119
3	Alagasi	11.017251	34	Benguet Pine	168.84816	65	Hauili	7.3792394	96	Palosapis	52.674717
4	Alagasi	78.389935	35	Benguet Pine	194.33328	66	Hauili	29.487379	97	Palosapis	56.322386
5	Alagau	9.7046768	36	Benguet Pine	227.87747	67	Iilog	18.563665	98	Palosapis	75.384151
6	Alagau	24.003636	37	Benguet Pine	287.87751	68	Iilog	134.66232	99	Palosapis	145.53084
7	Alagau	38.560999	38	Benguet Pine	298.14853	69	Ilo-ilog	43.670247	100	Palosapis	145.53084
8	Alagau	105.10542	39	Benguet Pine	315.76216	70	Itangan	25.499865	101	Palosapis	168.84816
9	Alagau	168.84816	40	Benguet Pine	341.4751	71	Itangan	33.837194	102	Palosapis	168.84816
10	Alagau	1178.2167	41	Benguet Pine	372.39289	72	Kamiling	16.159476	103	Palosapis	202.41227
11	Amuwag	27.849561	42	Benguet Pine	409.16755	73	Kamiling	20.503207	104	Palosapis	337.72582
12	Amuwag	32.937682	43	Benguet Pine	753.664	74	Kolalabang	15.03348	105	Palosapis	396.67228
13	Amuwag	36.62586	44	Benguet Pine	875.6026	75	kubangbang liit	14.489144	106	Palosapis	637.24009
14	Amuwag	45.824393	45	Benguet Pine	979.93283	76	La huet	15.03348	107	Palosapis	951.4035
15	Amuwag	48.042718	46	Benguet Pine	1046.0322	77	Ladao	124.3082	108	Pangnan	13.957109
16	Antipolo	76.878003	47	Benguet Pine	1083.9073	78	Ladaw	20.503207	109	Pangnan	20.503207
17	Apitong	7.7398193	48	Benguet Pine	1194.4076	79	Litan	6.3601929	110	Pangnan	36.62586
18	Ayohip	17.335929	49	Benguet Pine	1320.2104	80	Loklohong	78.389935	111	Pangnan	58.838158
19	Ayohip	36.62586	50	Benguet Pine	1745.3628	81	Luglohong	18.563665	112	Pangnan	72.450359
20	Ayohip	210.6947	51	Benguet Pine	1776.3308	82	Molave	44.739342	113	Pangnan	87.845743
21	Balete	951.4035	52	Benguet Pine	2506.3025	83	Molave	252.09138	114	Pangnan	105.10542
22	Bangat	20.503207	53	Bini	64.07435	84	Pad pad	35.68119	115	Pangnan	194.33328
23	Bangat	52.674717	54	Bini	78.389935	85	Pad pad	61.42192	116	Pangnan	1463.0459
24	Benguet Pine	16.159476	55	Binukau	219.18247	86	Pad pad	73.908297	117	Pili nut	19.8435
25	Benguet Pine	27.052154	56	Bolalog	12.433748	87	Padpad	32.053038	118	Piwi(Is-is)	15.03348
26	Benguet Pine	28.253622	57	Buta buta	10.568326	88	Palosapis	7.0291869	119	Piwi(Is-is)	17.335929
27	Benguet Pine	28.661271	58	Buta buta	147.76709	89	Palosapis	7.0291869	120	Piwi(Is-is)	19.8435
28	Benguet Pine	34.751666	59	Dagwey	20.503207	90	Palosapis	8.1110429	121	Piwi(Is-is)	31.183169
29	Benguet Pine	39.054392	60	Guijo	58.838158	91	Palosapis	15.590223	122	Piwi(Is-is)	46.925489
30	Benguet Pine	46.925489	61	Guijo	76.878003	92	Palosapis	19.8435	123	Piwi(Is-is)	51.492081
31	Benguet Pine	84.620084	62	Guijo	284.50297	93	Palosapis	20.503207	124	Salingogon	7.3792394

Secondary Forest continues…

No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2
125	Salingogon	11.477724	156	White Lauan	417.63058						
126	Salingogon	637.24009	157	White Lauan	439.25684						
127	Tabangawan	103.29329	158	White Lauan	693.95008						
128	Tabangawan	124.3082	159	White Lauan	882.33399						
129	Tibanglan	34.751666	160	White Lauan	1099.2901						
130	Tiklad	27.849561	161	White Lauan	1194.4076						
131	Tiklad	52.674717	162	White Lauan	1346.3061						
132	Tiklad	64.07435	Total		38331.918						
133	Tiklad	76.878003									
134	Tiklag	36.62586									
135	Uyok	28.661271									
136	Uyok	57.571816									
137	Uyok	261.56209									
138	White Lauan	12.433748									
139	White Lauan	14.489144									
140	White Lauan	19.197019									
141	White Lauan	36.62586									
142	White Lauan	86.223631									
143	White Lauan	87.845743									
144	White Lauan	94.521435									
145	White Lauan	105.10542									
146	White Lauan	124.3082									
147	White Lauan	124.3082									
148	White Lauan	168.84816									
149	White Lauan	168.84816									
150	White Lauan	168.84816									
151	White Lauan	258.38129									
152	White Lauan	376.37403									
153	White Lauan	392.56008									
154	White Lauan	396.67228									
155	White Lauan	396.67228									

Agroforest

No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2
8	Adawai	11.95	8	Benguet pine	6.04	34	Citrus	6.04	65	Citrus	6.04
24	Adawai	34.75	9	Benguet pine	27.85	35	Citrus	6.04	66	Citrus	6.04
58	Adawai	224.96	10	Benguet pine	27.85	36	Citrus	6.04	67	Citrus	6.04
4	Alagai	9.29	11	Benguet pine	27.85	37	Citrus	6.04	68	Citrus	6.04
1	Alnus	9.70	12	Benguet pine	27.85	38	Citrus	6.04	69	Citrus	6.04
2	Alnus	20.50	13	Benguet pine	4757.32	39	Citrus	6.04	70	Citrus	6.04
3	Alnus	9.70	29	Bini	42.62	40	Citrus	6.04	71	Citrus	6.04
47	Alnus	124.31	46	Bini	112.55	41	Citrus	6.04	72	Citrus	6.04
50	Alnus	145.53	1	Binunga	6.04	42	Citrus	6.04	73	Citrus	6.04
54	Alnus	181.32	5	Binunga	9.70	43	Citrus	6.04	74	Citrus	6.04
57	Alnus	222.06	15	Binunga	105.11	44	Citrus	6.04	75	Citrus	6.04
64	Alnus	426.20	14	Citrus	1528.40	45	Citrus	6.04	76	Citrus	6.04
65	Alnus	439.26	15	Citrus	6.04	46	Citrus	6.04	77	Citrus	6.04
67	Alnus	609.99	16	Citrus	6.04	47	Citrus	6.04	78	Citrus	6.04
69	Alnus	711.55	17	Citrus	6.04	48	Citrus	6.04	79	Citrus	6.04
28	American kapok	723.43	18	Citrus	6.04	49	Citrus	6.04	80	Citrus	6.04
17	Atsuete	130.46	19	Citrus	6.04	50	Citrus	6.04	81	Citrus	6.04
28	Avocado	41.58	20	Citrus	6.04	51	Citrus	6.04	82	Citrus	6.04
20	Avocado	216.33	21	Citrus	6.04	52	Citrus	6.04	83	Citrus	26.27
2	Bakhi	6.69	22	Citrus	6.04	53	Citrus	6.04	84	Citrus	97.97
25	Balanti	36.63	23	Citrus	6.04	54	Citrus	6.04	85	Citrus	138.95
59	Balanti	227.88	24	Citrus	6.04	55	Citrus	6.04	86	Daguey	14.49
1	Bawang	6.04	25	Citrus	6.04	56	Citrus	6.04	87	Danglin	9.70
5	Bawang	9.29	26	Citrus	6.04	57	Citrus	6.04	88	Guava	13.44
9	Bawang	13.44	27	Citrus	6.04	58	Citrus	6.04	89	Guava	58.84
42	Bawang	105.11	28	Citrus	6.04	59	Citrus	6.04	90	Guava	84.62
55	Bawang	194.33	29	Citrus	6.04	60	Citrus	6.04	91	Guba-gubai	27.85
4	Benguet pine	58.84	30	Citrus	6.04	61	Citrus	6.04	92	Hanga	105.11
5	Benguet pine	87.85	31	Citrus	6.04	62	Citrus	6.04	93	Ihit	305.12
6	Benguet pine	105.11	32	Citrus	6.04	63	Citrus	6.04	94	Ipil-ipil	11.95
7	Benguet pine	105.11	33	Citrus	6.04	64	Citrus	6.04	95	Ipil-ipil	65.43

Agroforest continues…

No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2
96	Ipil-ipil	271.25	127	Mahogany	9.70	158	Saging	2.52			
97	Ipil-ipil	994.39	128	Mahogany	36.63	159	Santol	1023.70			
98	Jacobina sp.	20.50	129	mahogany	105.11	160	Suha	41.58			
99	Jual	268.00	130	Mahogany	583.48	161	Suha	124.31			
100	Kahoy dalaga	36.63	131	Mangga	20.50	162	Suha	284.50			
101	Kamilin	8.89	132	Mangga	6.04	163	Suha	396.67			
102	Kangah	20.50	133	Mangga	9.70	164	Suha	1435.57			
103	La hwe/ La huit	45.82	134	Mangga	57.57	165	Syzygium sp. (Hangan)	105.11			
104	Lablabang	17.34	135	Mangga	79.92	166	Talanak	15.59			
105	Lablabang	52.67	136	Mangga	145.53	167	Talanak	27.05			
106	Lablabang	52.67	137	Mangga	699.79	168	Tibig	6.04			
107	Lablabang	168.85	138	Mangga	916.47	169	Tibig	9.29			
108	Ladau	20.50	139	Nangka	230.82	170	Tibig	15.59			
109	Ladau	202.41	140	Nangka	281.15	171	Tibig	252.09			
110	Ladau	356.73	141	Narra	156.92	172	Tuai	1936.24			
111	Ladau	753.66	142	Ngak ngak	24.74	173	Tubang	1023.70			
112	Ladaw	334.00	143	Nganga	51.49		Total	29890.57			
113	Langka	128.39	144	Nganga	86.22						
114	Lapting	19.84	145	Nganga	105.11						
115	Litan	36.63	146	Ngatngat	21.86						
116	Lithocarphus	6.04	147	Niog	1023.70						
117	Liwliw	36.63	148	Oak (Lithocarphus)	36.63						
118	Liwliw	57.57	149	Patat	46.93						
119	Liwliw	72.45	150	Pitikan	24.74						
120	Liwliw	159.27	151	Saging	2.52						
121	Liwliw	168.85	152	Saging	2.52						
122	Liwliw/Hauili	9.29	153	Saging	2.52						
123	Lukban/Suha	17.34	154	Saging	2.52						
124	Lukban/Suha	58.84	155	Saging	2.52						
125	Lukban/Suha	670.91	156	Saging	2.52						
126	Madlakat	46.93	157	Saging	2.52						

Agriculture

No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2
1	Saging	11.01	32	ipil ipil	58.84
2	Saging	11.01	33	Dita	951.40
3	Saging	12.53	34	Guava	1.60
4	Saging	12.53	35	Hamak	3.38
5	Saging	9.60	36	Adaway	9.70
6	Saging	11.01	37	Hamak	9.70
7	Saging	9.60	38	Hamak	9.70
8	Saging	9.60	39	Tual	9.70
9	Saging	11.01	40	Kamiling	14.49
10	Saging	11.01	41	Lablabang	20.50
11	Saging	12.53	42	Liwliw	20.50
12	Saging	12.53	43	Balanti	27.85
13	Saging	9.60	44	Pitikan	46.93
14	Saging	11.01	45	Idu-iduh	58.84
15	Saging	11.01	46	Bawang	145.53
16	Saging	12.53	Total		5399.5106
17	Saging	12.53			
18	Saging	17.71			
19	Saging	9.60			
20	Saging	12.53			
21	Saging	15.88			
22	Manga	396.67			
23	Manga	484.54			
24	Manga	532.60			
25	Manga	583.48			
26	Manga	637.24			
27	Suha	222.06			
28	Suha	356.73			
29	Suha	484.54			
30	papaya	58.84			
31	citrus	7.74			

Grassland

No.	Local name	biomass Kg/m^2	No.	Local name	biomass Kg/m^2
1	Ammowag	6.041014	32	Banana	8.2865541
2	Ammowag	6.041014	33	Banana	8.2865541
3	Ammowag	27.849561	34	Banana	9.5983291
4	Ammowag	46.925489	35	Banana	9.5983291
5	Benguet pine	72.450359	36	Banana	9.5983291
6	Kahoy dalaga	72.450359	37	Banana	11.012776
7	Ammowag	87.845743	38	Banana	11.012776
8	Benguet pine	145.53084	39	Banana	11.012776
9	Benguet pine	145.53084	40	Banana	12.530761
10	Benguet pine	194.33328	41	Banana	12.530761
11	Benguet pine	284.50297	42	Banana	12.530761
12	Benguet pine	356.72788	43	Banana	14.153104
13	Benguet pine	396.67228	44	Banana	14.153104
14	Benguet pine	1435.5749	45	Banana	14.153104
15	Benguet pine	1624.8221	46	Banana	15.880582
16	Bawang	6.041014	47	Banana	15.880582
17	Avocado	20.503207	48	Banana	15.880582
18	Avocado	20.503207	Total		5283.2753
19	Manga	20.503207			
20	Manga	20.503207			
21	Manga	20.503207			
22	Banana	5.9672923			
23	Banana	5.9672923			
24	Banana	5.9672923			
25	Banana	5.9672923			
26	Banana	5.9672923			
27	Banana	5.9672923			
28	Banana	7.076534			
29	Banana	7.076534			
30	Banana	7.076534			
31	Banana	8.2865541			

Appendix 2: List of intermediate and undergrowth

A. **Agriculture** (S5T2)

Undergrowth

Species	No. of individuals
Alatin	7
Bulak manok	178
Busikad	51
Dilang butiki	1
Euphorbia hirta	5
Habugan	7
Kamot pusa	4
Kamote	7
Kulapi	19
Kulitis	8
Leptochloa chinensis	20
Ligad-ligad	10
Makahiya	25
Mutha	5
Panibat	71
Paragis	24
Paragis like	4
Putokan putokan	9
Sampalok sampalokan	5
Tagulinaw	3
Tuhod manok	45

Intermediate

S5T2	Species	No. of individuals
3x3	Ayas-as	7
	Cogon	6
	Dilang baka	4
	Gonoy	4
	Kamot kabag	7
	Kamoteng baging	1
	Kulapi	30
	Makahiya	15
	Panibat	3
	Sapinit	3
	Uoko	4

Agriculture (S6T2)

Intermediate

S6T2S5	Species	N
3x3	Bulak manok	25
	Cogon	15
	Dilang baka	1
	Kamoteng kahoy	10 /clump
	Makahiya	1
	Panibat	3
	Uoko	2

Undergrowth

Species	N
Bulak manok	89
Camote cordate	36
Camote lobed	22
Cogon	5
Crassucephaum	10
Cupphea sp.	2
Cyperus iria	1
Digitaria sp.	5
Gabi	4
Guava	1
Kaliskis dalag	3
Kudzu	1
Ligad ligad	6
Luya	7
Makahiya	16
Okra	2
Panibat	24
Sampalokan	1
Susoloyeli sp.	5
Tabang	3
Tagulinaw liitan	1
Takip kuhol	14
Upland rice	18

Agriculture (S7T1)

Intermediate

S7T1S3	Species	N
3x3	Baka-baka	2
	Bakhi	1
	Coronitas	9
	Golon/cogon	68
	Hagonoi	4
	Lokdo	13
	Runo	22
	Suag kabayo	8
	Tambo	3
	Uoko	8

Undergrowth

Local names	N
Baka baka	4
Bakhi	2
Bulak manok	66
Centrocema pubiscens	20
Chistella dentata	8
Cogon	110
Cyperus iria	50
Dilang aso	5
Galakpak	32
Hakate	14
Higis manok	2
Kaitana	1
kandikandilaan	10
Kulapi	42
Panawal	73
Panibat	5
Pa-o	29
Paragis	2
Paspalum distichum	3
Pulat	8
Uoko	3
Walis-walisan	4

Agroforest (S1T2)

Intermediate

S1T2S2	Species	N
3x3	Alam-am (fern)	10
	Bakhi	2
	Cogon	150
	Dilang baka	6
	Guava	1
	Runo	6
	Panawal	25
	Sida/ Kulat	1

Undergrowth

Local name	N
Alam-am	9
Alinaw	1
Amuwag	9
Baka baka	12
Bakhi	2
Cogon	52
Galakgak	13
Hakati	4
Kalawag	3
Kulapi	56
Palat	3
Panawal	26
Paol	1
Wild berry	2

Agroforest (S3T1)

Intermediate

S3T1S1	Species	N
3x3	Acanthaceae	1
	Alagau	6
	Alam-am	9
	Avocado	1
	Ayusan	1
	Bagaluan	2
	Binunga	1
	Dama de noche	3
	Gnetum latifolium	1
	ground orchid	5
	Kamiring	1
	Katurog	6
	Leei sp.	3
	Marang	2
	Rattan	1
	Rubus mollucanus	1
	Salagong sibat	1
	Spaglottis sp.	1
	Subiang	1
	Tiger grass	1
	Tuai	1
	Tulibos tilos	1
	Wild Strawberry	2
	Zingiber sp.	1

Undergrowth

Local name	N
Arachis sp.	31
Baluingia	2
Bogus	4
Bulak manok	37
Busikad	10
Carabao grass	35
Christella dentata	6
Compositae	3
Dilang aso	6
Dilang Baka	17
Fimbristylis	1
Higis manok	2
Hyptis	1
Kandilaan	2
Kawad kawad	8
Kudzu	4
Kulitis	1
Ligad-ligad	2
Lubi-lubi	2
Mischanthus	1
Mutha	5
Pako	7
Panawal	20
Panibat	4
Rattan	2
Uoko	14
Zingiber	1

Agroforest (S4T2)

Intermediate

Local name	N
Achuete	2
Ayas-as	3
Hauili	1
Hyptis sp.	13
Kamote kahoy	2
Kandikandilaan	3
Kullio kulliot	2
Okra-okrahan	11
Synedrella nodiflora	2
Tambo	2
Yautia	4

Undergrowth

Local name	N
Bulak manok	14
Busikad	1
Carabao grass	130
Dilang butiki	6
Hithit	12
Ipil-pil	3
Kamra kamra	13
Kandikandilaan	14
Kulapi	57
Landrina	3
Lokdo	4
Makahiya	12
Panibat	4
Rice	139
Sampasampalukan	1
Sitsit	43
Uoko	10

Grassland (S2T3)

Intermediate

S2T3S2	Species	N
3x3	Alam-am	9
	Amorseko	60
	Amuwag	9
	Bakhi	8
	Buyot	1
	Cogon	25
	Dilang baka	17
	Giant bracken fern	5
	Kulapi	20
	Pakong alakdan	1
	Panawal	2
	Paragis	14
	Runo	17

Undergrowth

Local name	N
Alam-am	7
Amorseko	1
Apgad	1
Bakhi	6
Bigas bigasan	15
Bulak manok	12
Busikad	60
Buyot	35
Cogon	54
Cyperus iria	6
Dilang baka	31
Galakgak	28
Kamra kamra	9
Kawad kawad	19
Kilob	57
Kilob babae	7
Kollo kolliot	3
kulapi	19
Landrina	38
Leptocloa chinensis	2
Ligad-ligad	1
Lubi lubi	1
Lycopodium	7
Malatabako	1
Moss	112
Pal-ot	35
Pandan	7
Paspalidum flavidum	11
Paspalum distichum	11
Tabang	4
Takip kuhol	11
Themeda triandra	9
Wild strawberry	4

Grassland (S2T4)

Intermediate

S2T4S3	Species	N
3x3	Bakhi	13
	Cogon	8
	Giant bracken fern	6
	Golon	5
	Guava	2
	Panawal	7

Undergrowth

Localname	N
Ammowag	1
Amorseko	37
Apiit	2
Bagingay	28
Baka baka	22
Bakhi	44
Baludgangan	22
Benguet pine	4
Bulak manok	17
Chrysopogon aciculatus	8
Cyperus iria	26
Elephantopus scaber	2
Galakgak	15
Golon	50
Kaibuan	91
Kaliskis ahas	62
Kamra-kamra	17
Kilob	41
Ligad-ligad	5
Lycopodium	21
Panawel	3
Panibat	3
Paspalidum distichum	34
Paspalum conjugatum	6
Takip kuhol	22
Themeda triandra	7

Grassland (S7T2)

Intermediate

Local names	N
Baka baka	2
Hagonoy	3
Kandi-kandilaan	5
Kulapi	10
Lantana	3
Pulat	4
Tab-an	3
Talahib	12
Uoko	15

Undergrowth

Local names	N
A-apid	5
Anwad	44
Bulak manok	55
Camote	16
Christella dentata	21
Cyperus iria	11
Dioscorea flabelleflora	1
Gatas-gatas	2
Gattodan	3
Hagonoy	1
Hakati	90
Higis manok	2
Kamra-kamra	3
Kulapi	17
Paspalum distichum	4
Patpati	10
Tab-an	50
Talong-talungan	1
Tambo	5
Uoko	39
Vernonia sp.	8
Wakal	6

Reforestation (S5T1)

Intermediate

S5T1S2	Species	No. of individuals
3x3	Avocado	1
	Binunga	1
	Dilang butiki	8
	Ipil ipil	1
	Kakauate	1
	Kollo kolliot	2
	Mahogany	9
	Papaya	1
	Sapinit	11
	Talingpunay	5
	Uoko	5

Undergrowth

Local name	No. of individuals
Alikbangon	5
Avocado	5
Baging	2
Bulak manok	46
Calopogium	1
Carabao grass	60
Cyperus sp.	9
Dayang	53
Dilang baka	1
pako	1
Euphorbia hirta	4
grass	1
Kulapi	12
Kullo kuliot	11
Mahogany	4
Makahiya	2
Malvaceae	1
Panibat	1
Paragis	1
Silver fern	1
Tuhod manok	8
Tutumpak	4
Uoko	14

Reforestation (S8T1)

Intermediate

S8T1S2	Species	No. of individuals
3x3	Amuwag	4
	Buta buta	1
	Dilang baka	3
	Hagonoy	2
	Kahoy dalaga	1
	Kalulot	4
	Bakhi	5
	Wild strawberry	2

Undergrowth

Localname	No. of individuals
Akba grass	10
Bulak manok	21
Carabao grass	106
Mutha	9
Dilang baka	43
Kaliskis dulog	200
Kulapi	88
Kuliot	6
Lobi lobi	2
Makahiya	8
Myrtaceae	1
Padpad	2
Panawal	16
Sun flower	10
Tuhod manok	7
Uoko	13
Wedelia sp.	6
Wild strawberry	2

Reforestation (S8T3)

Intermediate

S8T3S1	Species	No. of individuals
3x3	Balbas pusa	1
	Hagonoy	1
	Kape	2
	Kulliot	5
	Lubi lubi	6
	Panawal	22
	Pneumatopteris levis	5
	Uoko	2

Undergrowth

Species	No. of individuals
Asak	8
Balbas pusa	15
Baludgangan	20
Christella dentata	27
Dilang baka	6
Hagonoy	8
Hyptis sp.	23
Kape	12
Kulapi	66
Langkuas	1
Lokdo	7
Malvaceae (Gummamela)	5
Panawal	20
Paspalidum flavidum	22
Rubus sp.	2
Uoko	21
Uyot	3
Wild strawberry	6

Secondary Forest (S1T1)

Intermediate

S1T1S3	Species	No. of individuals
3x3	Alam-am	2
	Cogon	12
	Dilang baka/Baka baka	2
	Kaibuan	30
	Panawal	6
	Tagulinau	1

Undergrowth

Local name	No. of individuals
Alam-am	12
Ayusan	3
Baka baka	2
Cogon	33
Guava	1
Kaibuan	95
kaliskis ahas	1
Kulapi	2
Pal-ot	2
Panawal	4
Pulat	1
Tagulinau	7
Tan-al	1

Secondary Forest (S2T1)

Intermediate

S2T1S5	Species	No. of individuals
	Alam-am	1
	Iilog	2
	Kahoy dalaga	1
	Lemon tree	2
	Syzidium sp.	2
	Wild Strawberry	2

Undergrowth

Local name	No. of individuals
Alam-am	9
Baka Baka	8
Bakhi	2
Blechnum	4
Cogon	63
Galakgak	1
Kilob	12
Panawal	50
Runo	9
Sabung-sabung	1
Wild Strawberry	2

Secondary Forest (S4T1)

Intermediate

S4T1S2	Species	No. of individuals
3x3	Alambrillong gubat	1
	Binukaw	1
	Guijo	4
	Ligas	3
	Mayapis	2
	Mutha	1
	Palosapis	1
	Pangnan	2
	White lauan	2

Undergrowth

Local name	No. of individuals
Ayas-as	1
Baka baka	2
Bayabas	1
Cogon	18
Hauili	1
Kandikandilaan	1
Kasupangil	1
Kubamba	1
Kulapi	1
Makahiya	10
Palosapis	1
Santol	1
Siver fern	1
Tutumbak	3
Uoko	1

Appendix 3: List of biomass monitoring plots

Appendix 3: KEF Monitoring plots per landuse

A. Agriculture

Block #	Plot #	1994			2003		
		Biomass (Kg/ha)	Biomass (Mg/ha)	C (Mg/ha)	Biomass (Kg/ha)	Biomass (Mg/ha)	C (Mg/ha)
28	2	3078.40	12.31	5.54	1814.68	7.26	3.27
28	4	5497.46	21.99	9.90	9120.05	36.48	16.42
30	2	9388.91	37.56	16.90	13982.93	55.93	25.17
30	3	11129.47	44.52	20.03	15308.42	61.23	27.56
30	4	12172.38	48.69	21.91	17058.03	68.23	30.70
31	1	11429.49	45.72	20.57	14133.02	56.53	25.44
31	2	4460.36	17.84	8.03	5206.40	20.83	9.37
31	3	5710.47	22.84	10.28	9502.75	38.01	17.10
31	4	12639.93	50.56	22.75	18186.43	72.75	32.74
33	1	6069.49	24.28	10.93	7122.50	28.49	12.82
33	3	5456.07	21.82	9.82	8347.99	33.39	15.03
33	4	4662.13	18.65	8.39	7808.80	31.24	14.06
34	1	11013.75	44.05	19.82	15706.90	62.83	28.27
34	2	15035.80	60.14	27.06	20002.51	80.01	36.00
36	1	10294.75	41.18	18.53	15152.17	60.61	27.27
36	2	9899.49	39.60	17.82	15657.72	62.63	28.18
40	1	10965.71	43.86	19.74	14652.10	58.61	26.37
40	4	3209.10	12.84	5.78	5778.51	23.11	10.40
41	1	1699.00	6.80	3.06	3657.09	14.63	6.58
41	2	6133.84	24.54	11.04	8912.22	35.65	16.04
41	3	12957.73	51.83	23.32	19406.49	77.63	34.93
42	2	8291.43	33.17	14.92	15879.53	63.52	28.58
42	3	14015.91	56.06	25.23	20465.11	81.86	36.84
47	2	8960.75	35.84	16.13	12842.17	51.37	23.12
48	3	1228.06	4.91	2.21	3051.25	12.20	5.49
58	2	1922.93	7.69	3.46	3346.62	13.39	6.02
59	1	5926.25	23.71	10.67	6916.20	27.66	12.45
59	2	10033.32	40.13	18.06	13483.81	53.94	24.27
59	3	9458.03	37.83	17.02	13741.02	54.96	24.73
59	4	7608.13	30.43	13.69	10303.55	41.21	18.55
Average		8181.73	32.73	14.73	11887.32	47.55	21.40

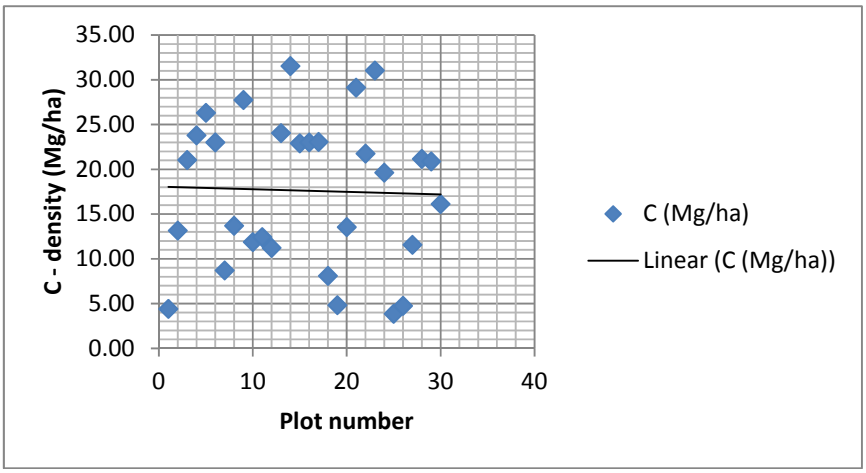

Figure 1. Average C-densities in agriculture areas.

B. Rice field

Block #	Plot #	1994			2003		
		Biomass (Kg/ha)	Biomass (Mg/ha)	C (Mg/ha)	Biomass (Kg/ha)	Biomass (Mg/ha)	C (Mg/ha)
14	1	3345.261	13.38	6.02	5224.299	20.90	9.40
14	2	5576.314	22.31	10.04	7630.863	30.52	13.74
24	4	5747.104	22.99	10.34	7353.663	29.41	13.24
26	1	4970.109	19.88	8.95	6658.986	26.64	11.99
45	3	1789.096	7.16	3.22	2788.914	11.16	5.02
Average		4285.58	17.14	7.71	5931.35	23.73	10.68

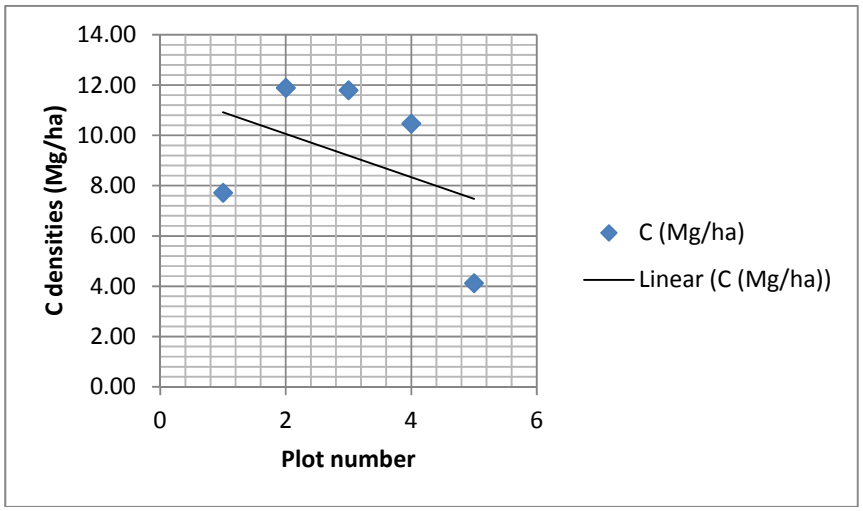

Figure 2. Average C-densities in rice fiels areas.

C. Forest

Block #	Plot #	1994			2003		
		Biomass (Kg/ha)	Biomass (Mg/ha)	C (Mg/ha)	Biomass (Kg/ha)	Biomass (Mg/ha)	C (Mg/ha)
1	2	11763.25	47.05	21.17386	14178.56	56.71	25.52142
1	3	16709.57	66.84	30.07723	20946.36	83.79	37.70344
1	4	2080.026	8.32	3.744048	2992.232	11.97	5.386017
4	1	674.2393	2.70	1.213631	1384.778	5.54	2.492601
4	2	1685.045	6.74	3.033081	2713.238	10.85	4.883829
4	4	1263.151	5.05	2.273673	2406.447	9.63	4.331604
20	1	3738.924	14.96	6.730064	5847.02	23.39	10.52464
20	2	3917.678	15.67	7.05182	6722.766	26.89	12.10098
24	1	4093.377	16.37	7.368079	5994.237	23.98	10.78963
24	2	4241.263	16.97	7.634274	6691.106	26.76	12.04399
24	3	5887.197	23.55	10.59695	6975.474	27.90	12.55585
52	1	4245.595	16.98	7.642072	5834.626	23.34	10.50233
52	2	4396.309	17.59	7.913356	5948.26	23.79	10.70687
52	3	10734.26	42.94	19.32166	15789.91	63.16	28.42184
56	1	552.0802	2.21	0.993744	1004.158	4.02	1.807484
56	2	6233.833	24.94	11.2209	8597.786	34.39	15.47601
56	3	6031.132	24.12	10.85604	7747.869	30.99	13.94616
Average		5190.996	20.76	9.343793	7163.225	28.65	12.89381

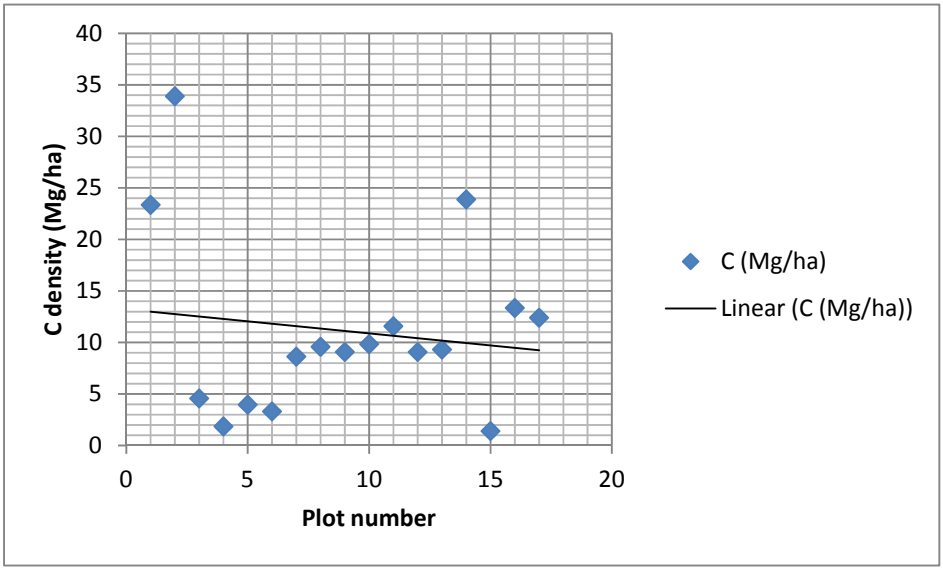

Figure 3. Average C-density in forest areas.

D. Old Pine

Block #	Plot #	1994			2003		
		Biomass (Kg/ha)	Biomass (Mg/ha)	C (Mg/ha)	Biomass (Kg/ha)	Biomass (Mg/ha)	C (Mg/ha)
15	1	3906.49	15.63	7.63	4580.40	18.32	8.94
28	3	2692.93	10.77	5.26	8116.41	32.47	15.84
29	3	8343.79	33.38	16.29	11253.64	45.01	21.97
34	3	8537.13	34.15	16.66	12404.76	49.62	24.21
34	4	7748.78	31.00	15.13	11602.79	46.41	22.65
35	1	6775.14	27.10	13.23	9062.74	36.25	17.69
35	2	12660.14	50.64	24.71	17332.27	69.33	33.83
37	1	14150.60	56.60	27.62	20214.78	80.86	39.46
39	3	10118.99	40.48	19.75	14759.74	59.04	28.81
39	4	10220.22	40.88	19.95	15065.34	60.26	29.41
40	2	9028.43	36.11	17.62	11047.04	44.19	21.56
40	3	3994.58	15.98	7.80	7953.81	31.82	15.53
48	2	1191.48	4.77	2.33	3068.35	12.27	5.99
55	1	594.87	2.38	1.16	1088.47	4.35	2.12
55	4	4594.43	18.38	8.97	6230.41	24.92	12.16
57	1	1882.36	7.53	3.67	3219.83	12.88	6.29
57	3	6257.61	25.03	12.21	10500.25	42.00	20.50
58	1	12141.11	48.56	23.70	15888.20	63.55	31.01
62	1	8139.27	32.56	15.89	9999.37	40.00	19.52
Average		6998.86	28.00	13.66	10178.35	40.71	19.87

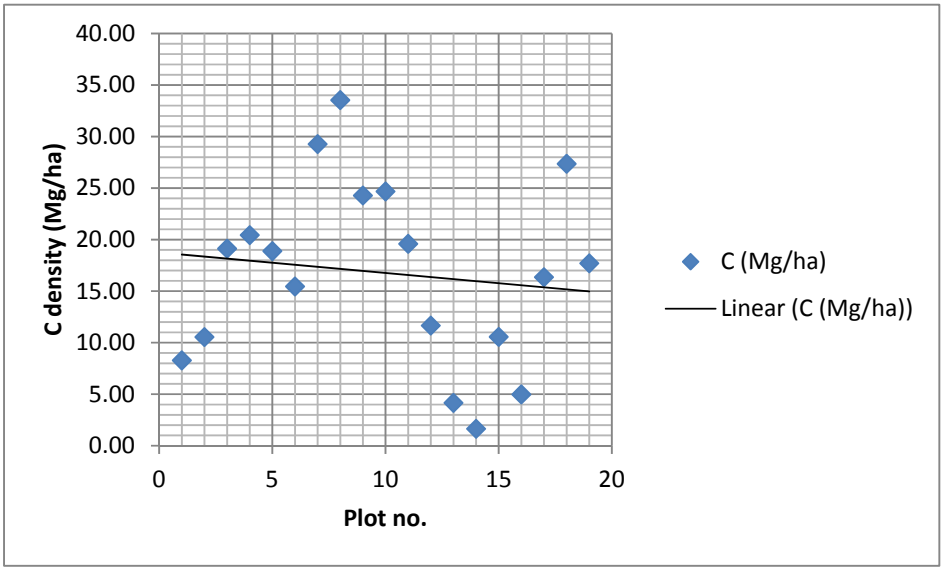

Figure 4. Average C-density in old pine areas.

E. Pine dominated

Block #	Plot #	1994			2003		
		Biomass (Kg/ha)	Biomass (Mg/ha)	C (Mg/ha)	Biomass (Kg/ha)	Biomass (Mg/ha)	C (Mg/ha)
14	3	4147.16	16.59	8.10	6311.48	25.25	12.32
15	2	3465.97	13.86	6.77	5520.39	22.08	10.78
15	3	2054.86	8.22	4.01	3367.21	13.47	6.57
15	4	1579.28	6.32	3.08	2775.82	11.10	5.42
26	2	4857.36	19.43	9.48	6519.10	26.08	12.73
26	3	4864.56	19.46	9.50	6519.10	26.08	12.73
28	1	2335.94	9.34	4.56	4430.88	17.72	8.65
29	1	8317.63	33.27	16.24	10976.87	43.91	21.43
29	2	10026.75	40.11	19.57	12742.78	50.97	24.87
30	1	10519.46	42.08	20.53	14651.07	58.60	28.60
35	3	16977.68	67.91	33.14	22044.44	88.18	43.03
35	4	9691.50	38.77	18.92	5755.52	23.02	11.23
39	1	17695.88	70.78	34.54	26378.33	105.51	51.49
39	2	16676.13	66.70	32.55	25499.69	102.00	49.78
45	2	5559.16	22.24	10.85	10183.62	40.73	19.88
47	1	11596.02	46.38	22.64	15792.35	63.17	30.83
48	1	953.22	3.81	1.86	748.76	3.00	1.46
55	3	2722.74	10.89	5.31	4663.60	18.65	9.10
57	2	3767.62	15.07	7.35	5844.26	23.38	11.41
58	3	1922.93	7.69	3.75	3346.62	13.39	6.53
60	1	11353.82	45.42	22.16	14813.59	59.25	28.92
60	2	15251.12	61.00	29.77	18125.65	72.50	35.38
62	2	8181.58	32.73	15.97	11474.69	45.90	22.40
Average		7587.75	30.35	14.81	10368.95	41.48	20.24

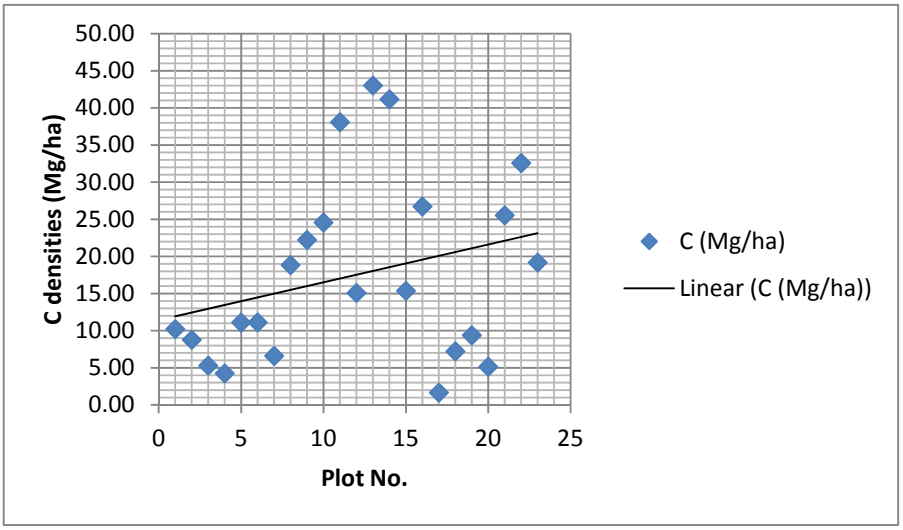

Figure 5. Average C-density in pine areas.

F. Secondary Forest

Block #	Plot #	1994			2003		
		Biomass (Kg/ha)	Biomass (Mg/ha)	C (Mg/ha)	Biomass (Kg/ha)	Biomass (Mg/ha)	C (Mg/ha)
11	1	13875	55.50	24.97	16498.87	66.00	29.70
11	2	18330.01	73.32	32.99	23784.55	95.14	42.81
11	3	7928.554	31.71	14.27	11721.84	46.89	21.10
11	4	8704.358	34.82	15.67	15829.79	63.32	28.49
16	1	6674.291	26.70	12.01	9590.779	38.36	17.26
16	2	9276.825	37.11	16.70	12599.29	50.40	22.68
16	3	5680.229	22.72	10.22	8351.617	33.41	15.03
20		9319.37	37.28	16.77	15044.32	60.18	27.08
Average		9973.58	39.89	17.95244	14177.63	56.71	25.51974

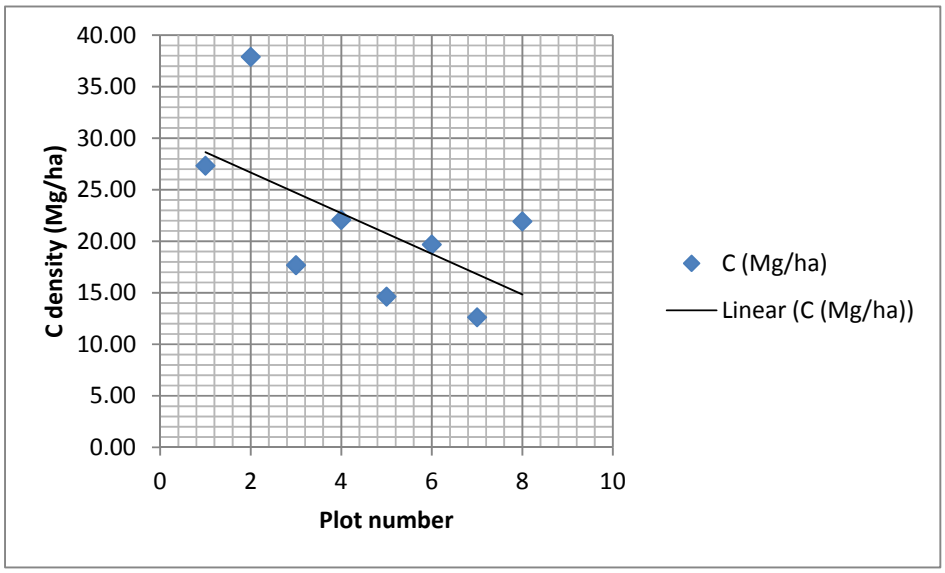

Figure 6. Average C-density in secondary forest.

Appendix 4: Rules and Regulations

Appendix Rules and regulations

Natural resources development program and agro-forestry rules and regulations

I. SWIDDEN FARMING PERMIT

A. Any person who wants to prepare a new farm clearing (uma) must get a permit from the Agro-forestry Office. A fee of five (5.00) pesos shall be collected for the permit.
B. Only residents of the Kalahan Reserve shall be granted a swidden farming permit.
C. Any person who wants to cultivate land outside his/her own claim must obtain a written permission from the claimant. This practice shall be discouraged.
D. Whenever a newly cleared area is to be burned, the owner must maintain a fireline with a width of 10 meters. This should be inspected first by a forest guard before the clearing is burned. Violation of this regulation shall be penalized for causing forest fires.
E. Clearing in reserved areas, parks, watersheds, sanctuaries, research sites shall not be allowed.
F. Forest guards neglecting their duties with regards to these policies shall be subjected to administrative sanctions.
G. Penalties
    1. Anybody clearing or extending clearings in restricted areas shall be fined PhP500 and will be required to repair the damage or shoulder the equivalent cost of said repair.
    2. Anybody clearing without a permit shall be fined 250 pesos. Clearing any area other than the inspected site is considered clearing without a permit.

II. TREE CUTTING PERMIT

A. Any person who wants to cut any tree must first get a permit from the Agro-forestry office.
B. The permit shall identify the tree to be cut and the time frame within which the tree should be cut and removed from the forest.
C. A “minute” of the lumber needed shall be required from the applicants. This must be approved by the Barangay Captain of the area where the tree is to be used.
D. Tree cutting permits shall only be issued upon approval of the Agro-Forestry office and upon payment of the corresponding permit fee as to the following purposes:
E. Profit sharing from the permit fees to be collected shall be implemented based on a 40-60% scheme between the barangay and the KEF respectively.
F. No tree shall be cut without the proper mark of the Forester responsible for the Forest Improvement Technology (FIT) activities under the Natural Resources Development Program. No permit shall be issued to cut any tree not so marked. This includes salvage trees or sanitation cutting. The mark will indicate the direction to fell. The foresters shall avoid issuing permits to be implemented during the rainy season when forest damage may be severe.
G. Penalties
    1. First offense: any person violating these regulations shall be fined 400 pesos fore every tree cut. Any lumber, slab or other products obtained will be confiscated.

2. Second offense: Violators shall be fined 400 pesos and shall be denied a cutting permit in the future. Any lumber, slab, or other products obtained shall be confiscated.

III. CHAINSAW REGISTRATION AND OPERATIONS

A. All chainsaws operating within the Kalahan Reserve must be registered annually with the Agro-forestry Office. A copy of the registration will be furnished to the CENRO. A charge of 200 pesos registration will be paid by the owner/operator per year.
B. A maximum of 14 chainsaws shall only be allowed to operate within the Kalahan Reserve. Replacements or new chainsaws shall not be allowed.
C. The entry or operations of unregistered chainsaws in the Kalahan Reserve is absolutely forbidden.
D. A forest charge will be collected from the chainsaw owners/operators equivalent to 15% of the lumber price generated purposely for forest improvement.
E. No lumber shall be brought outside the Kalahan Reserve. Accepting orders, selling, or donating lumbers to any person, group, or institution outside the Reserve is prohibited.
F. PENALTIES: Any person found violating any of these regulations will be fined as follows:
    1. First offense: Any person who accepts lumber orders to donate or sell to persons outside of the Kalahan Reserve will be fined 500 pesos.
    2. Second offense: Permanent cancellation of chainsaw registration.
    3. Any chainsaw owner or operator who fails to pay the proper forest charges within 90 days shall be suspended from the operation of his chainsaw until his obligation is paid in full.
    4. Operations of unregistered chainsaws shall be fined 500 pesos and an additional fine of 400 pesos for every tree cut.
    5. Failure to renew chainsaw registration in 2 months after the expiration of its registration shall be a ground for cancellation of the permit to operate.

IV. FISHING

A. Residents of the Kalahan Reserve are free to do fishing by traditional means but chemicals and electricity shall not be allowed under any circumstances. Non-residents are strictly forbidden to fish within the Kalahan Reserve.
B. Penalties: Violators of this policy shall be fined as follows:

    1. Use of illegal fishing methods will be fined 400 pesos per violator and all fishing supplies and/or equipment will be confiscated.
    2. Non-residents who fish within the Kalahan Reserve shall be charged with illegal entry in addition to being punished for illegal fishing.

C. Use of “natural tuba” in halap may be allowed provided that the waterflow be returned immediately after fishing.

V. FOREST FIRES

A. Limited prescribed burning in grazing lands may be allowed provided that the interested party obtains a permit describing the specific area to be burned and the date and time of

burning. Only a forester shall be allowed to issue this permit. A charge of five pesos will be paid.

Any fire which occurs which is not covered by a swidden permit or grazing land burning permit shall be considered as a forest fire.

B. Penalties
   1. Any person who causes a forest fire shall pay the proper remuneration for all persons involved in putting out the fire.
   2. The guilty party must pay or repair all damages to houses, fruit trees, forest trees, etc.
   3. The guilty party must reforest the burned area.
   4. The guilty party must pay a fine of 500 pesos.

VI. QUARRYING

A. Quarrying in the riverbeds shall be supervised by the Barangay concerned in cooperation with the Agro-Forestry Office.
B. Clearing stone from the road shall not be considered quarrying.

VII. ILLEGAL ENTRY

A. Persons who are not bonafide residents of the Kalahan Reserve are not entitled to harvest or utilize the natural resources within the Kalahan Reserve.
B. Penalties: Any person violating this regulation shall be fined a minimum of 500 pesos or a maximum of 5,000 pesos and any and all harvested forest products shall be confiscated. Said violation may also be reported to the DENR or PNP with a request that violators be prosecuted according to law.

VIII. SANCTUARIES AND WATERSHEDS

A. The KEF has designated two Watershed-Sanctuaries within the Kalahan Reserve. All plant and animal resources found therein are under protection. Hunting, catching animals and harvesting plants are prohibited. Gathering of limited samples for research purposes may be permitted subject to permission from the KEF and Barangay authorities.
B. Barangays are encouraged to identify additional watersheds within their jurisdiction. FIT may be practiced inside unless the watershed is also declared to be a sanctuary.
C. Penalties
   1. Violations of this regulation shall be punished with a fine of at least 1,000 pesos but not more than 10,000 pesos depending on the severity of the violation. Any and all products or resources obtained by the violator shall be confiscated.
   2. Attempts to violate this regulation shall be considered as consummated violations.

IX. HUNTING

A. Seasonal hunting is allowed outside the sanctuaries during the following periods:
   Animals: July to August

   Birds: November to December

The night bird catching “Akik” has not regulation provided to cover this issue. A larger body should reconsider this to resolve issues.

B. Penalties

Any person found violating this regulation shall be fined 500 pesos plus confiscation of harvest and hunting equipment.

X. LAND CLAIMS

A. Each bonafide resident family may claim a maximum of ten (10) hectares of private land within the Kalahan Reserve. Each claimant must make and implement a land use plan of which 25% shall be dedicated to environmental protection and register the same with the Agro-forestry Office. Each claimant shall be issued a copy his/her claim.
B. Any claimant who does not begin implementation of his/her land use plan within a period of five (5) years from its registration may have his/her claim reduced in size.
C. Sale, mortgage or transfer of possession of any land claim to other bonafide residents of the Kalahan Reserve shall require the approval of the Board of Trustees (BOT) through the NRDP Agro-forestry Office which shall maintain an up-to-date record of all such claims.
D. Sale, mortgage or transfer of possession of any land claim to any person who is not a bonafide resident of th4e Kalahan reserve shall not be allowed and the KEF will not recognize such transactions.
E. All surveys, including relocation and subdivision, shall be done by the Agro-forestry Office of the KEF. The Agro-forestry office shall charge the amount of 800 pesos for the first day and 600 pesos for each succeeding day needed for the resurvey to cover costs of labor in the field, equipment, transportation, materials and registration. Disputes over boundaries must be discussed first among the concerned claimants and referred to the Tribal Elders and Barangay officials. Failure of the accomplishment of the survey due to unclarified boundary disputes shall be charged against the claimant requesting resurvey.

XI. MISCELLANEOUS POLICIES

A. *Tree planting*: All barangays covered by the Kalahan Reserve are encouraged to initiate and actively participate to the regular tree planting activities in their respective barangays.
B. *Banned Species*: Cutting and or gathering of the banned or endangered plant or animal species inside the Kalahan Reserve is strictly prohibited.
C. *Certification of lumber origin*: A Certification of Lumber Origin may be issued by the Agro-Forestry Office to individuals who wish to move lumber from a house within the Reserve to some location outside of the Reserve provided that the lumber are originally sourced from within the Kalahan Reserve with proper permits.
D. *Ban of chemical pesticides*: In Keeping with the KEF policy of environmental cooperation in all undertakings that involve the natural resources, no chemical pesticides be used within the Reserve. It was understood that use of these will have adverse effects on the soil, biodiversity, and human health.

The effects of thrown pesticides in the river, the guilty party is obliged to pay the damage on lives and properties.

E. *Collection of fines and fees*: All fines must be collected within three (3) months from the date they were promulgated. Fines not paid within three months shall be charged an interest of 3% per month. For the share of the barangays from all fines and fees, it shall be given every 12th month of the year.
F. *Disposition of fines*: Fines shall be shared by KEF and the Barangay concerned. The 75% shall go to the apprehending party and 25% shall be given to the other party. When an individual apprehends the violator, he/she shall receive 50% of the fine and the KEF and the concerned barangay shall be entitled to 25% each
G. *Other actions*: Violations may be referred to higher authorities for action if violators fail to comply.
H. *Lumber price*: P6.00 per board foot
I. *Orchid gathering moratorium*: Moratorium on gathering orchids in all parts of the Reserve shall be imposed on January 1, 2002. Training on orchid production shall also be conducted.
J. *Effectivity*: February 1, 2001.

Approved this day of December 5, 2000 at Imugan, Sta. Fe, Nueva Vizcaya.

Appendix 5: Forest Improvement Technology (FIT)

Appendix 5: Forest Improvement Technology (FIT) Source: Rice (2000)

The goal of FIT is to improve the forest, rather than simply improve the short-term income of the forest farmer. In the long run this will lead to more sustainable increases in income. Trees are cut continuously in small amounts rather than all together every thirty years. In this way the forest ecosystem can be maintained.

Each year the forest farmer makes a selection of trees to be cut. He checks the forest for crooked, damaged or crowded trees that need to be removed to improve the forest. When these have been removed, they are sawn into lumber. It may not be first-class wood but it can be used or sold. Simple equipment is used and the sawdust, tops and branches are left to rot because they restore fertility to the forest soil and help maintain biodiversity. The forest farmer does not separate the potential crop trees from the other trees because he knows that all trees have a role to play in the forest.

In natural forests there is a continuous process of rejuvenation. Trees die or are felled by storms. In this way the canopy is opened and, because the microclimate is not damaged, young seedlings get a chance to develop. FIT follows this natural process. Mature trees that have stopped growing are removed to create favourable conditions for forest rejuvenation. If this is done every year, the forest will continue to develop and improve. The removal of individual trees does not hurt the forest or its environment and provides first class lumber. If there are large open spaces, a forest pioneer species will be planted first. Agricultural crops are not planted between the trees because they would bother the other plants that need to grow to make a good forest. The population of one or two species of large or small plants can be increased by enrichment planting. This can be very favourable as long as the forest is not turned into a plantation.

As the forest grows, biodiversity will continue to improve and many species of insects, small animals, grasses and other plants will move in. This is good because all of these species help each other and the improved biodiversity will encourage the forest to grow faster and become healthier. The forest farmer will only cut a small amount of growth allowing the forest to improve each year.

The growth-rate presently expected in Philippine forests is about 4.5 cubic meters per hectare per year. Under proper management, using FIT, the forest can produce as much as 15 - 20 cubic meters per hectare per year. Such an analogue forest still retains the characteristics of a natural forest. It is not a plantation. It still has high bio-diversity and is an effective watershed with a high percolation rate. It will also provide a sanctuary for many kinds of wild orchids, animals, birds and insects.

If each forest farmer cares for 5 hectares of good forest, he may harvest up to 80 cubic meters of first class lumber every year without damaging the forest. That would provide him with higher cash income than many professionals and he would still have plenty of time to produce his own food on the farm. Once the forest has developed, it can be sustained indefinitely.

Appendix 6: FALLOW Model results on biodiversity, carbon stocks and sediment filtering capacity

Appendix 6: Predicted time-averaged relative additionality on ecosystem services and community welfare in Kalahan 2001-2030 perdio under some scenarios (in %).

No.	Scenario	Species number (%)				Carbon stocks (%)	Sediment filtering capacity (%)	Non-food expense per capita (%)
		Pioneer	Early	Medium	Late			
A.	**Improving NTFP productivity and market**							
1.	Increasing NTFP productivity and price 2x from the baseline	4.35	1.22	-0.10	0.06	-1.88	-1.49	13.60
2.	Increasing NTFP productivity and price 6x from the baseline	5.49	1.61	0.74	1.20	-0.82	5.94	75.19
3.	Increasing NTFP productivity and price 10x from the baseline	4.18	1.72	1.24	1.70	0.51	16.71	136.76
B.	**Providing better off farm jobs**							
4.	Increasing payoffs from off farm jobs 2x from the baseline	4.26	1.50	0.59	-0.90	0.70	17.49	56.31
5.	Increasing payoffs from off farm jobs 6x from the baseline	1.25	1.40	2.62	1.66	6.58	32.82	375.57
6.	Increasing payoffs from off farm jobs 10x from the baseline	0.20	3.07	6.80	8.63	12.39	36.93	756.38
C.	**Promoting small-holder tree-based systems through extension, subsidy, market improvement and giving legal tenure rights to farmers to access grasslands for tree-based systems practices**							
7.	Promoting cacao-based systems	-40.87	-17.45	1.08	7.89	7.57	26.59	710.21
8.	Promoting coffee-based systems	-45.03	-19.66	0.72	8.56	-0.78	26.06	656.17
9.	Promoting mahogany-based systems	-36.37	-22.35	-5.10	6.88	16.74	39.60	-41.28

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The World Agroforestry Centre is the international leader in the science and practice of integrating 'working trees' on small farms and in rural landscapes. We have invigorated the ancient practice of growing trees on farms, using innovative science for development to transform lives and landscapes.

Our vision

Our Vision is an 'Agroforestry Transformation' in the developing world resulting in a massive increase in the use of working trees on working landscapes by smallholder rural households that helps ensure security in food, nutrition, income, health, shelter and energy and a regenerated environment.

Our mission

Our mission is to advance the science and practice of agroforestry to help realize an 'Agroforestry Transformation' throughout the developing world.

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