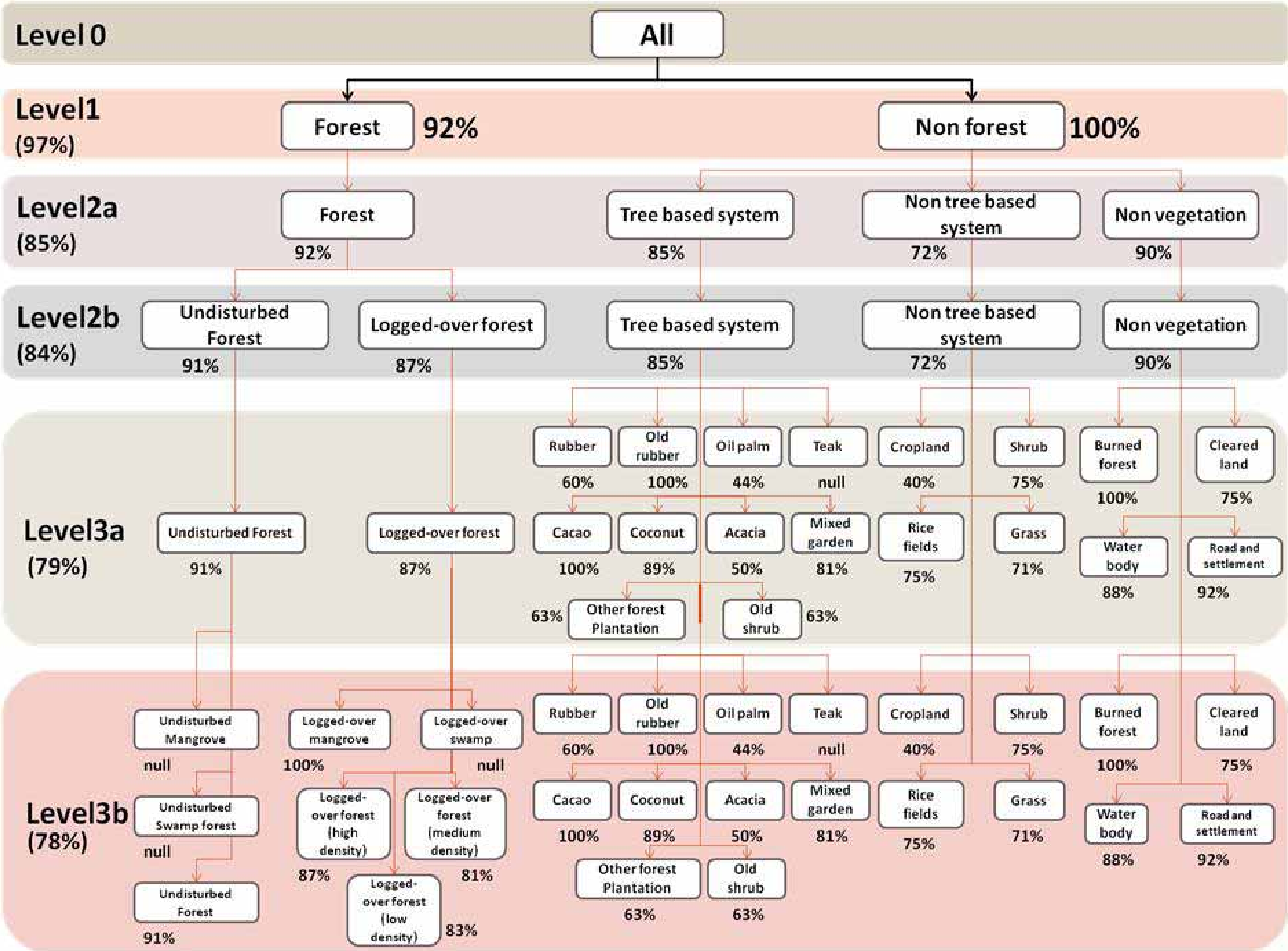

Figure 1.10. Accuracy of classification results for each level (overall and each land use/cover types)

Quantification of area of changes in land use/cover for the whole district area and zone-specific areas within the district

Overall changes in area of each land use/cover types in the district are presented in Table 1.5. Ideally and technically we should apply the common no-data mask across the time series, however considering the extent and distribution of cloud cover across the time series we do not do it to avoid losing a huge part of the dataset in the analysis. Due to the no-data problems caused by cloud cover, which in known to have some spatial correlations with the occurrence of extensive tropical humid forests, we can only draw some asymmetric conclusions. Those patterns that do not concern forests and those of continuous increases over time have larger probability to be real patterns, disregard of the cloud cover. In the table, we highlighted those patterns which we are more confident about relatively to others in yellow. We cannot say with confidence how much in areas these particular land use/cover types increase but we can say that, e.g., acacia plantation expanded *at least* 16 times in areas in 2008 from 1990, and the areas in 2008 is *at least* 82,088 ha; similarly with oil palm, in 2008, the extent is *at least* 44,117 ha. Teak is small in area but definitely increases, showing the trends of increasing highly profitable tree-based systems, for timber, fiber and crops.

The extent of annual crop land also increases steadily, along with cleared land and road and settlement areas. This can be explained from the increases of population both from natural growth and from in-migration as found by DriLUC analysis.

Another trend is the increases in the extent of logged-over mangrove which is quite significant, shows the increasing activities in the mangrove area, mostly due to logging. The areas of shrub and old shrub land increases continuously, due to the abandonment of some activities in the shrub land that causes natural regrowth to take place, perhaps due to more locally-focused, intensified agricultures, instead of traditional shifting cultivation (increasing economic return per unit of land), or the availability of labour market that pulls people away from activities with lower economic return per unit of labour.

With less certainty, due to the no-data areas that might be correlated spatially with forest cover; we can see the tendencies of decreasing undisturbed forest area, logged-forest areas both in dry and wet land. Mixed garden rubber, other forest plantation, coconut and grass land tend to increase sharply in the earlier period of study and then stabilize during the more recent period.

Figure 1.11. shows the major trends of area changes of each land use/cover types over the period of study. Undisturbed and logged-over forest classes are not shown in the figure, purely because of practical reason; the large area of the extent will overrides the graph such that the trends of others cannot be seen. This analysis, while showing the changes in total areas of each of the land use/cover types across the study period, does not provide us with information of the trajectories, i.e., what were the original land use/cover types of most of the currently existing acacia plantation.

Table 1.5. Overall changes in total area for each land use/cover types from 1990 to 2008

No	Land use/cover types	1990 (ha)	2000 (ha)	2005 (ha)	2008 (ha)
1	Undisturbed forest	1219641.93	840703.95	755158.68	431890.65
2	Logged-over forest	712084.32	799114.23	949698.36	576580.86
3	Undisturbed mangrove	25193.43	23593.41	21159.63	14434.38
4	Logged-over mangrove	40.05	1944	5577.84	12473.01
5	Undisturbed swamp forest	16487.46	10023.57	6650.37	2157.39
6	Logged-over swamp	2224.62	3807.09	6220.17	3555.36
7	Old shrub	116.28	12574.62	10305.09	24881.49
8	Mixed garden	8089.11	23691.24	21081.24	27099.45
9	Old rubber	124.38	2217.6	517.86	1517.22
10	Teak	56.34	1093.86	1992.24	2523.6
11	Acacia	4998.69	37090.17	62397.27	82087.83
12	Other forest plantation	1906.92	6196.32	8275.23	3163.86
13	Rubber	306.72	2256.84	2792.88	958.05
14	Oil palm	2391.48	16978.05	30764.7	44117.28
15	Coconut	38.16	2095.11	3270.78	1101.69
16	Shrub	6184.8	18954.18	27655.56	9733.23
17	Cacao	1568.07	328.32	10417.77	3539.52
18	Cropland	1070.37	3536.73	5181.12	11268
19	Ricefield	1098.27	1855.98	4778.64	2539.08
20	Grass land	2947.86	9926.91	15820.47	12655.53
21	Cleared land	1244.43	4723.29	7235.73	8695.89
22	Burned forest	156.96	56.07	830.16	141.66
23	Road and settlement	6801.39	18033.03	33458.22	35402.94
24	Water body	23436.36	23436.36	23436.36	23436.36
25	No data	160014.78	333992.25	183546.81	862268.85
	TOTAL	2198223.18	2198223.18	2198223.18	2198223.18

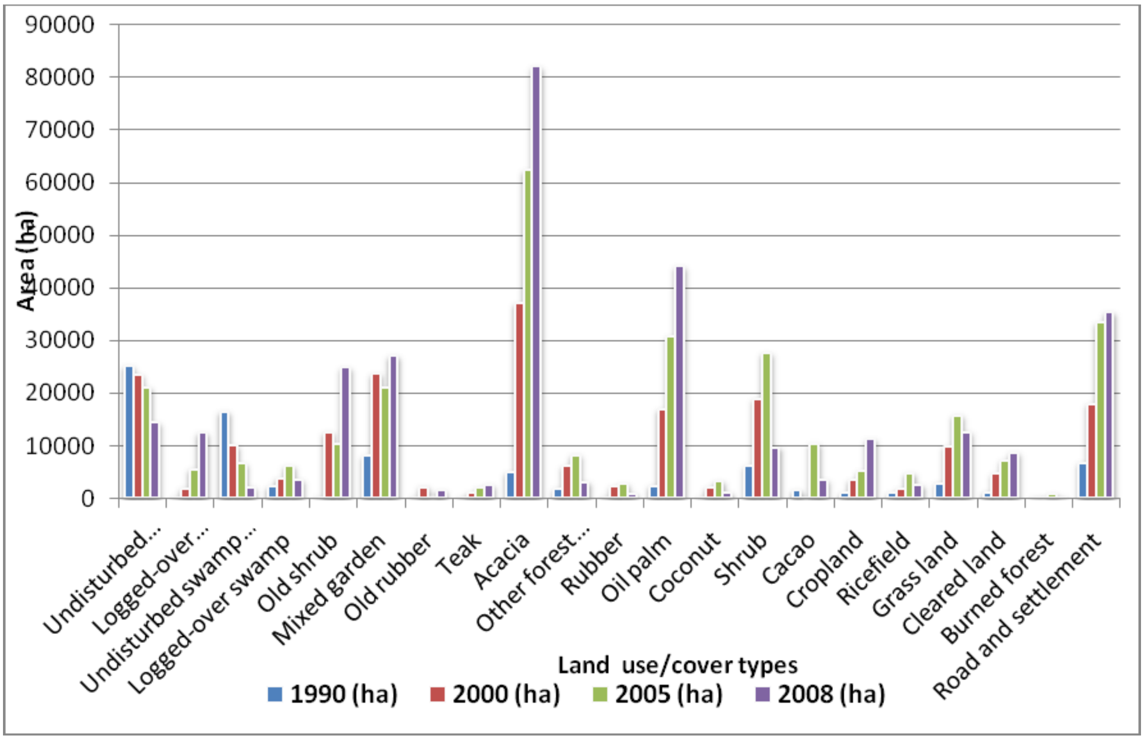

Figure 1.11. Total areas of each land use/cover type (except undisturbed forest) in Berau from 1990 to 2008

For policy recommendation in forestry and any related land use sectors, including discussion on mitigation action strategy, it is important to know where within the allocated zones for specific uses some particular land use/cover types are dominant and how they change in area with time.

Land use/cover trajectories during the period of analysis

For the trajectory analysis, we will keep the no-data area constant by removing all data from the maps in the area covered by cloud in at least one of the maps. The reason for this is that we focus on extracting information of the evolution, so to speak, of land use/cover types in particular location, and then summing them up to see the typical trajectories in Berau. Missing information in some of the steps along the trajectory will lead to ambiguity, except for the two cases: areas identified as tree crop and forest plantation in 2005 will most likely remain the same in 2008. In these cases, in order to salvage some data we fill the 2008 with the same land use/cover types of 2005. In this analysis we address two different nature of changes: (i) changes only concerning forest, (ii) changes beyond deforestation and forest degradation and look at the overall land transformation in Berau.

For changes concerning forest cover only, we use terminologies that are defined specifically for our communications here, without meaning to jump in into any debates on the definition. We use the term "deforestation" as changes of natural forest cover to other land use/cover types other than natural forest and "forest degradation" as changes of density within natural forest cover. As we warn earlier this study find a serious obstacle in drawing firm conclusions with regards to forest cover changes due to extensive cloud cover of the imageries, especially the most recent one, and therefore these particular results are weak in terms of the data the analysis based on. This problem is exacerbated by the fact that cloud over forest is more commonly found than others, i.e., the no-data area is non-randomly located.

Figure 1.12. shows that within protected forest zone, deforestation is minimum but forest degradation is noticeable and tends to increase more recently. Area of deforestation is comparable between forest cultivation (Kawasan Budidaya Kehutanan/KBK) and non-forest cultivation zones (Kawasan Budidaya Non Kehutanan/KBNK) in 1990 – 2005, but more recently deforestation in non-forest cultivation zone is higher. Forest degradation has been consistently higher under forest cultivation zone compared to those in non-forest zone, due to logging activities. The annual forest degradation seems highest in the period of 2000 - 2005. Forest degradation declines in non-forest cultivation zone, perhaps due to the limited extent of natural forest with commercial standing stock left that are in accessible areas. This is being said, we would like to put front once more the caveat of data gaps due to cloud cover.

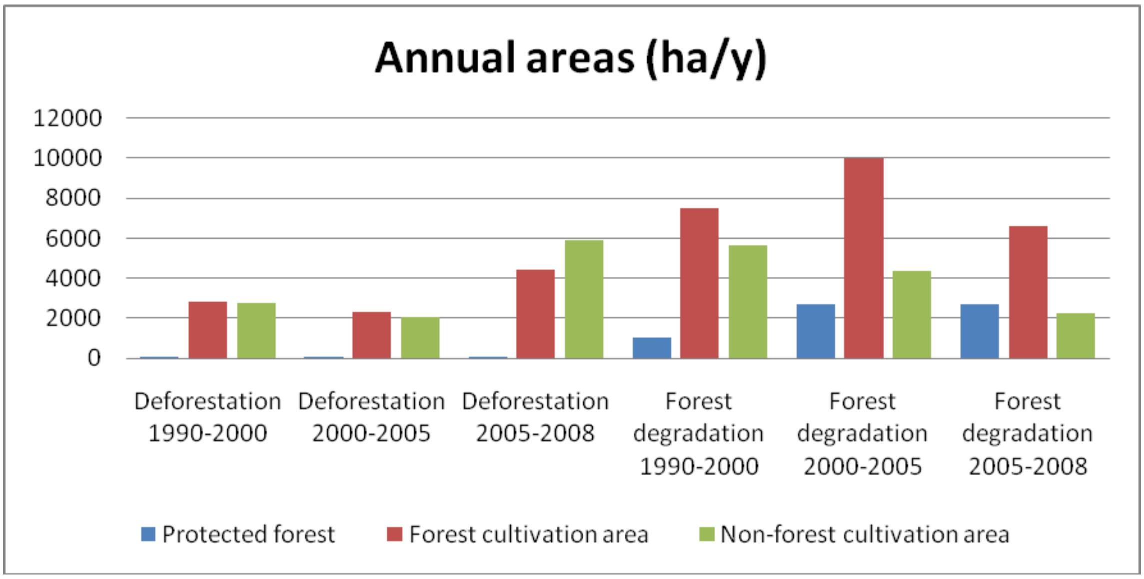

Figure 1.12. Changes in natural forest cover area within each zones of land use plan/allocation

In addition to changes in natural forest, we formulate major trajectories of land use/cover types in Berau during 1990 to 2008, and referring these as trajectory I to IV from this point onward, to address overall land use/cover changes and land transformation that undergoes in Berau. Four main types of trajectories are identifies as the following:

1. Natural forest conversion to:
    a. Forest plantation
    b. Agroforest

c. Tree crop

d. Shrubland

e. Traditional shifting cultivation

f. Permanent cropland

2. Natural forest degradation, i.e., from higher stocked C natural forests to lower stocked
3. Agricultural intensification, including:
   a. From tree-based systems to annual crop or others
   b. From shrubland to permanent crop land
4. Conversion from land based activities to non-land based activities, i.e., changes to settlement, road, etc.

Figure 1.13. shows the proportion of each of the trajectory to overall land in Berau. The area of no-data across 1990 to 2008 is about 20% of the total areas. This trajectory analysis is intended to provide a semi-qualitative summary of trend of land use and cover changes during the 18 years period. It does not have a consequence to the emission estimation and therefore in order to minimize the lost of data we try to salvage some data by rationalizing plausible trajectories using the intermediate time step as a supplementary information. We developed the following rules:

1. If a pixel has no data in 1990 and is classified as undisturbed forest in 2000, then label the pixel as undisturbed forest in 1990. The assumption we make is that if a piece of land is covered by undisturbed natural forest in 2000, then it was in 1990;
2. If a pixel has no data in 2008 and is classified as land uses other than natural forest in 2005, then label the pixel correspondingly to those in 2005 for 2008. Here we take the assumption that in 2-3 years (2005/6 to 2008) period those non-natural forest areas tend to stabilize.

Trajectory II (natural forest degradation) dominates the overall land transformation in the whole Berau over the 18 years periods (47.1%). The stable undisturbed forest comprises of 20.4% of the total land areas. Natural forest conversion to various uses (trajectory I) is 7.4 %, dominated by conversion to forest plantation and tree crops. Agricultural intensification (trajectory III) is quite low (less than 1%) whilst changes to non-land based cultivation (trajectory IV) is the only notified transformation (1.6%).

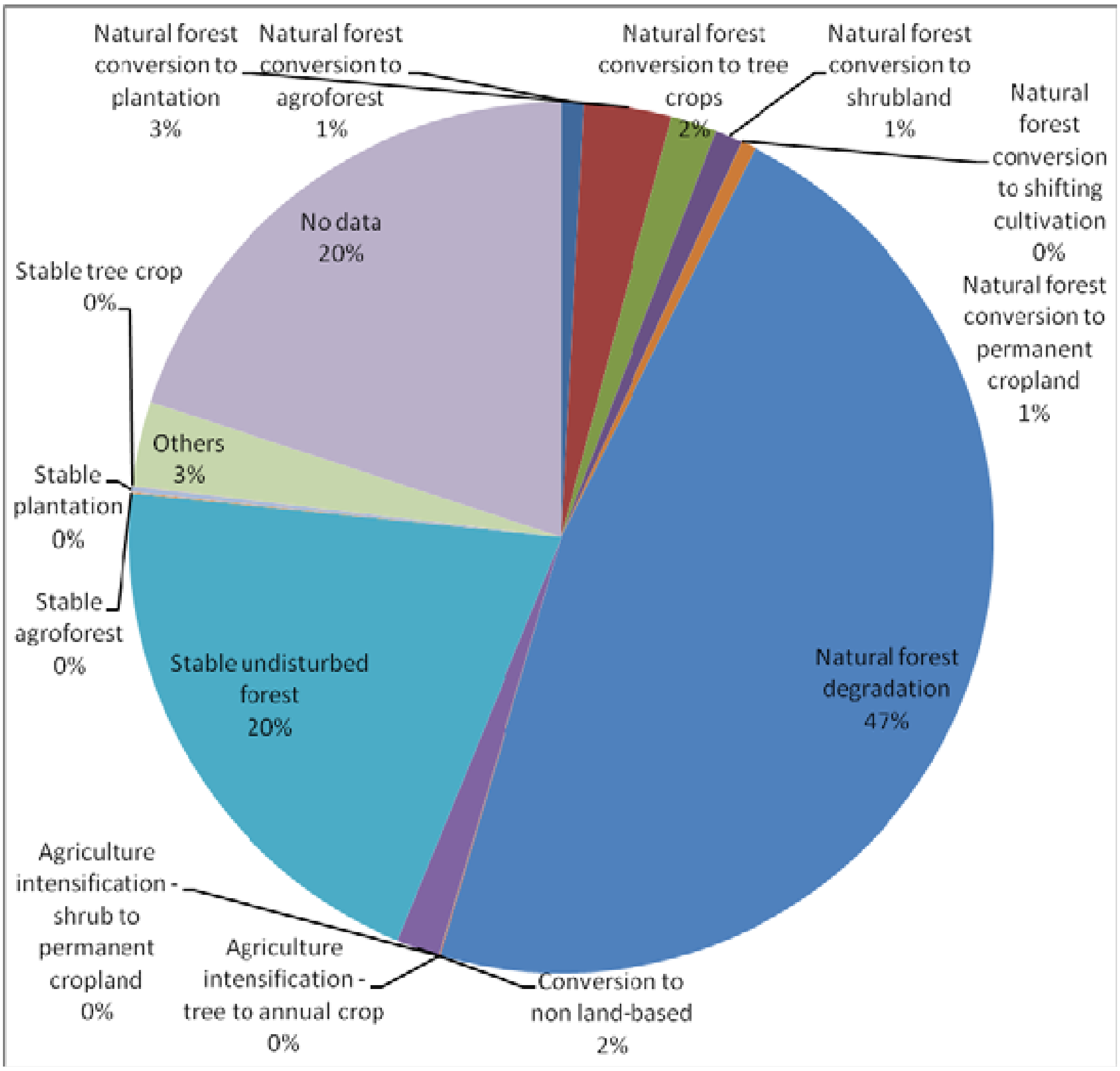

Figure 1.13. Various land use/cover trajectories in Berau and their proportion in land area for the period of 1990 to 2008

Disaggregating the results further by the zones of provincial land use planning (RTRWK) (Figure 1.14.), we found that the extent of area of natural forest conversion is comparable between those under forest cultivation zone (Kawasan Budidaya Kehutanan) and non-forest cultivation zone (Kawasan Budidaya Non-kehutanan); those under forest cultivation zone is mostly to forest plantation and those in the non-forest zone is to others. Natural forest degradation occurred in all three zones, including protected forest zone, but most prominently can be found in the forest cultivation zone. As expected, most protected areas will be at the stage of stable undisturbed forest, however, there are considerable areas (at least 289,000 ha) of stable undisturbed forest can be found in forest cultivation zones, mostly in areas of low access and rough topography, and some areas (72,400 ha) of stable undisturbed forest under non-forest cultivation zones, mostly in areas of low access, with rough topography and low population density–far from the settlement, river and road.

Trajectories toward agricultural intensification and mixed tree based systems/agroforestry, which are managed by smallholder farmers, mostly take place under non-forest cultivation zones. However, conversions to non-land based uses (cleared land, road and settlement) are comparable in areas between forest cultivation zone and non-forest cultivation zone. This can be explained by the development of road infrastructure, settlement and other facilities to support the operation of forest plantation and logging activities. Figure 1.15. presents maps of land use/cover trajectories in Berau and the RTRWP.

The area captured as cleared land in more recent maps might not be cleared land permanently but was in the process of planting. This is an artifact of the study rather than a real on the ground process, which, with extensive and intensive groundtruthing and more accurate, up-to-date and comprehensive, thematic maps of forest plantation boundaries can be addressed better.

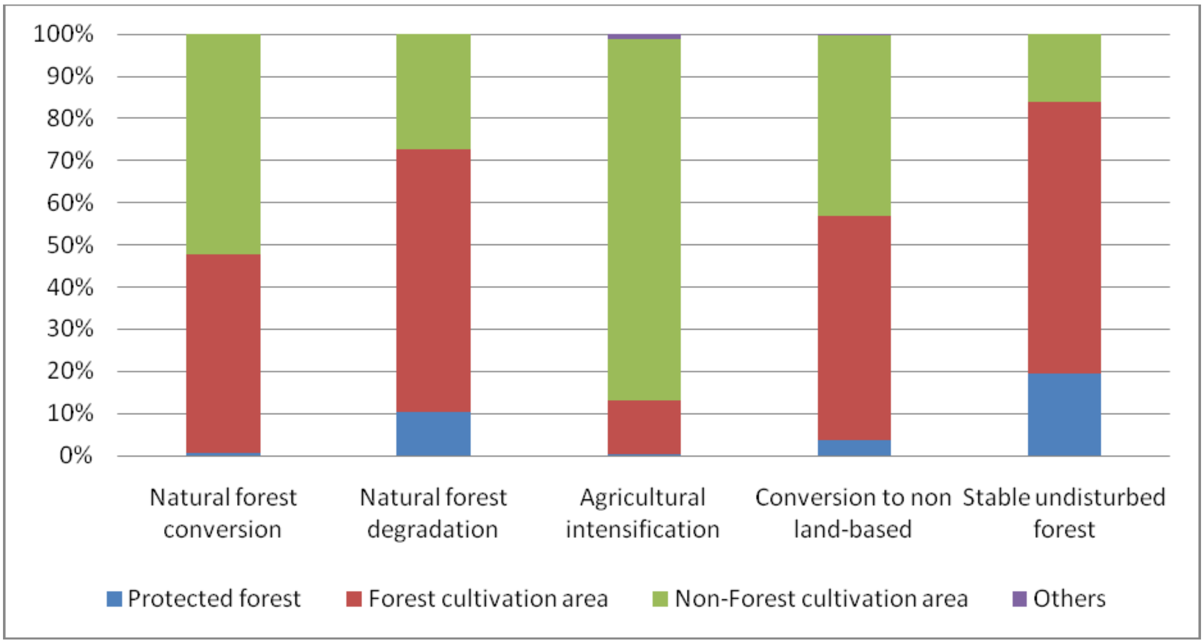

Figure 1.14. Proportions of each trajectories of land use/cover in Berau between 1990 and 2008 under various zones of land use plan/allocation

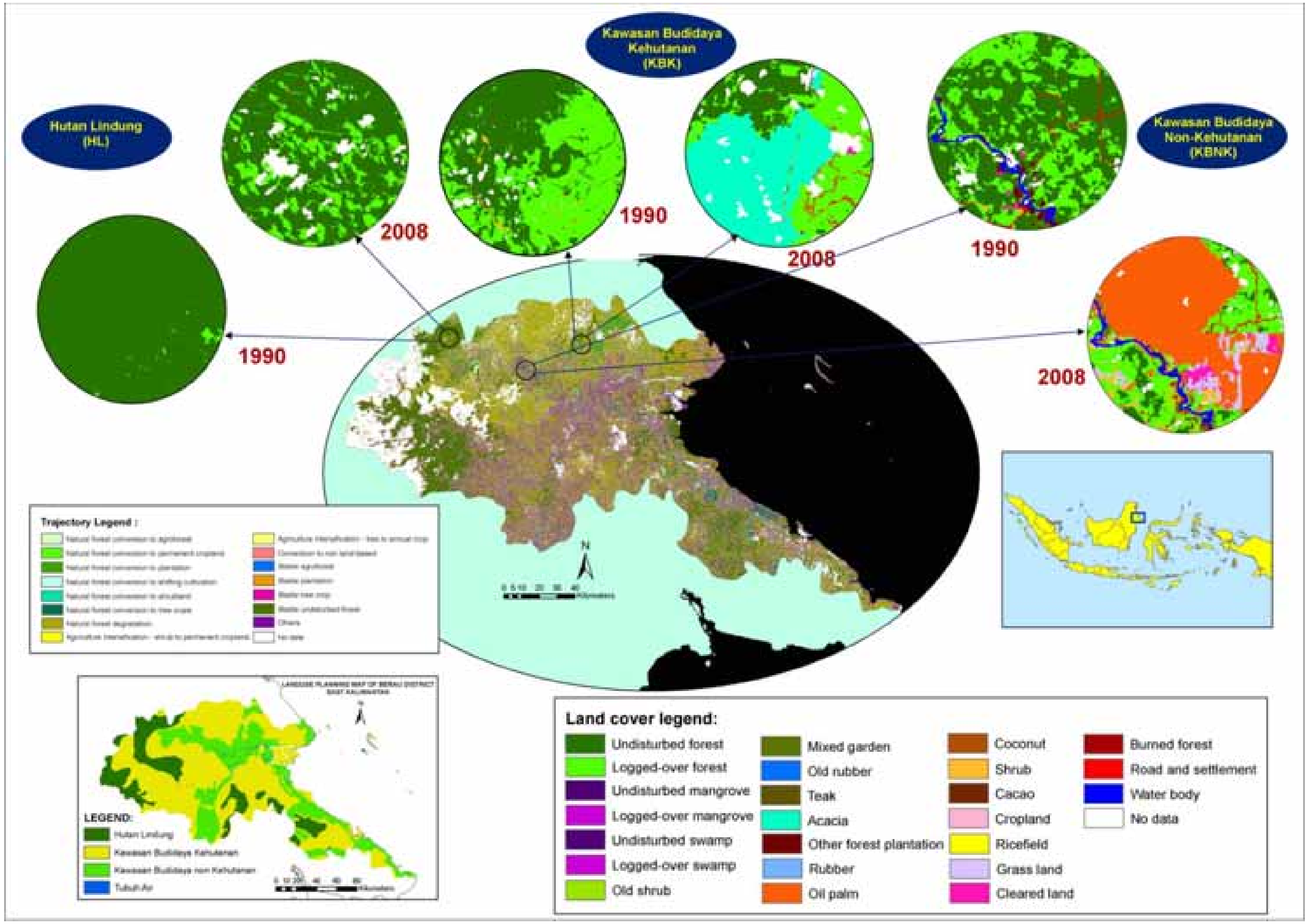

Figure 1.15. Land use/cover trajectories in Berau during 1990 and 2008. The rectangular inset shows land use plan/allocation (RTRWP) and the circular insets zoom in to some example areas of changes under different zones

Emission estimate at the landscape level

In this section we present the results of combining the activity data and the emission factors. The activity data is expressed in terms of transition matrices from pairwise of land cover maps of the defined periods, e.g., 1990 – 2000 (period I), 2000 – 2005 (period II), 2005 – 2008 (period III). The transition matrices summarize the proportion of land areas of Berau (excluding the no-data areas) of each transition of land use/cover classes. Further in the analysis we also disaggregate the landscape of Berau into the 3 zones of RTRWK, namely protection forest, forest cultivation and non-forest cultivation zones. All transition matrices are provided along with other electronic data as a companion of this report.

The overall annual emissions in ton CO_2-eq/ha within each period is presented in Figure 1.16. The no-data areas are common within each pairwise of analysis period. Tables 1.6a. and 1.6b. summarize the results in annual per unit area, annual per total area and total ender each specific land allocation, concessions and land-based activities. Please note that those calculations of per total area include extrapolation from area with data to the overall area. If the assumption that no-data area is similar in proportion to the area with data, i.e., there are no correlation between cloud cover with particular trends of trajectories, then there will not be any bias resulted from the extrapolation.

Within Berau area of 2.2 million hectares, a quarter is allocated for non-forest cultivation areas, 16.4% for protection forest and the rest (58.3%) for forest cultivation area. If we look at annual emissions per unit area, the emissions in Berau have steadily increase from period I to period III with much sharper increases recently. The annual emission per unit area is highest in non-forest cultivation zone, as expected and lowest in the protection forest zone, while that in forest cultivation zone and overall Berau district are in the middle of the two numbers.

As for the annual sequestration per unit area, even though it is quite small compared to the emissions, show quite an intriguing pattern. Non-forest zone shows high and sharply increasing sequestrations over time, while in forest cultivation zone, the sequestrations are low and is declining in more recent period.

More than half (51%) of the emissions in the earliest period (period I) occurred in forest cultivation zone, 46% in non-forest cultivation zone. In period II, the proportion of emissions occurred in forest zones increases (53% from forest cultivation and 41% from protection forest). In most recent period the proportion is almost the same. In terms of sequestrations, most of them occurred in non-forest zone in period I, but become more distributed recently, with the increase of sequestration that occurred in forest cultivation zone.

Table 1.6a. Emissions and sequestrations throughout Berau during 1990-2008 under specific zones under land use plan and concessions

	90-'00	00-'05	05-'08	90-'08	00-'08
OVERALL BERAU					
Average Emission(Mg CO_2-eq/Ha.Year)	6.57	7.9	11.65	9.2	8.71
Total Emission(Mg CO_2-eq/Year)	14,390,171.73	17,316,980.72	25,537,545.04	20,165,036.23	19,089,523.16
Average sequestration (Mg CO2-eq/Ha.Year)	-0.02	-0.13	-0.35	-0.02	-0.11
Total sequestration (Mg CO_2-eq/Year)	-50,101.15	-295,041.87	-762,227.05	-39,416.79	-242,273.88
Average Net Emission(Mg CO_2-eq/Ha.Year)	6.55	7.77	11.3	9.18	8.6
Total Net Emission(Mg CO_2-eq/Year)	14,340,070.58	17,021,938.85	24,775,317.99	20,125,619.44	18,847,249.28
HUTAN LINDUNG					
Average Emission(Mg CO_2-eq/Ha.Year)	0.43	1.08	0.94	1.03	1.04
Total Emission(Mg CO2-eq/Year)	937,929.18	2,367,687.36	2,068,552.99	2,246,814.20	2,270,258.60
Average sequestration (Mg CO_2-eq/Ha.Year)	0	-0.01	-0.01	0	-0.01
Total sequestration (Mg CO_2-eq/Year)	-4,482.48	-27,655.17	-11,407.63	-5,018.54	-18,925.04
Average Net Emission(Mg CO_2-eq/Ha.Year)	0.43	1.07	0.93	1.03	1.03
Total Net Emission(Mg CO_2-eq/Year)	933,446.70	2,340,032.19	2,057,145.36	2,241,795.66	2,251,333.56
KAWASAN BUDIDAYA KEHUTANAN					
Average Emission(Mg CO_2-eq/Ha.Year)	3.03	3.36	4.73	3.87	3.58
Total Emission(Mg CO2-eq/Year)	6,651,280.72	7,360,485.47	10,359,273.06	8,491,556.16	7,840,360.05
Average sequestration (Mg CO_2-eq/Ha.Year)	0	-0.05	-0.06	0	-0.04
Total sequestration (Mg CO_2-eq/Year)	-9,041.78	-104,867.02	-132,660.62	-3,811.99	-89,763.64
Average Net Emission(Mg CO_2-eq/Ha.Year)	3.03	3.31	4.67	3.87	3.54
Total Net Emission(Mg CO_2-eq/Year)	6,642,238.94	7,255,618.45	10,226,612.44	8,487,744.17	7,750,596.41

Table 1.6a. (Continuation)

KAWASAN BUDIDAYA NON-KEHUTANAN					
Average Emission(Mg CO_2-eq/Ha.Year)	3.37	3.66	6.13	4.47	4.31
Total Emission(Mg CO2-eq/Year)	7,394,094.08	8,027,787.80	13,440,026.33	9,791,625.12	9,444,867.19
Average sequestration (Mg CO_2-eq/Ha.Year)	-0.02	-0.08	-0.29	-0.01	-0.06
Total sequestration (Mg CO_2-eq/Year)	-46,690.58	-173,946.70	-632,014.75	-31,902.45	-141,646.42
Average Net Emission(Mg CO_2-eq/Ha.Year)	3.35	3.58	5.84	4.46	4.25
Total Net Emission(Mg CO_2-eq/Year)	7,347,403.50	7,853,841.10	12,808,011.58	9,759,722.67	9,303,220.77
HPH					
Average Emission(Mg CO_2-eq/Ha.Year)	1.22	2.59	2.28	1.96	2.29
Total Emission(Mg CO_2-eq/Year)	2,682,394.35	5,674,866.32	4,994,653.79	4,301,648.59	5,025,095.54
Average sequestration (Mg CO_2-eq/Ha.Year)	0	-0.01	-0.03	0	-0.01
Total sequestration (Mg CO_2-eq/Year)	-2,425.25	-27,428.46	-75,739.72	-1,663.34	-23,850.78
Average Net Emission(Mg CO_2-eq/Ha.Year)	1.22	2.58	2.25	1.96	2.28
Total Net Emission(Mg CO_2-eq/Year)	2,679,969.10	5,647,437.86	4,918,914.07	4,299,985.25	5,001,244.76
HTI					
Average Emission(Mg CO_2-eq/Ha.Year)	0.56	0.28	0.65	0.49	0.39
Total Emission(Mg CO_2-eq/Year)	1,229,594.52	614,558.88	1,427,636.85	1,076,279.33	865,271.26
Average sequestration (Mg CO_2-eq/Ha.Year)	0	-0.01	-0.01	0	-0.01
Total sequestration (Mg CO_2-eq/Year)	-536.54	-28,680.27	-15,900.73	-392.99	-23,154.76
Average Net Emission(Mg CO_2-eq/Ha.Year)	0.56	0.27	0.64	0.49	0.38
Total Net Emission(Mg CO_2-eq/Year)	1,229,057.98	585,878.61	1,411,736.12	1,075,886.34	842,116.50

Table 1.6b. Emissions and sequestrations in Berau during 1990-2008 for the dominant land-based activities throughout Berau

Overall Land-based activities	Net emissions (t CO2-eq)	Area of changes (ha)	Emission factor (t CO2-eq/ha)	Percent Emissions
Total degradation	7,264,449.71	21,050.27	345.10	36.10
HPH	4,299,985.25	6,884.63	624.58	21.37
HL	1,616,716.40	4,666.16	346.48	8.03
Conversion to Forest Plantation under HTI	3,961,058.16	5,803.66	682.51	19.68
Conversion to Shrubs	3,191,469.39	4,536.21	703.55	15.86
Conversion to Oil Palm	1,953,560.26	2,872.21	680.16	9.71
Conversion to Mixed garden	848,451.86	1,434.67	591.39	4.22
Conversion to road, settlement, annual crop, grassland	2,470,368.08	3,550.08	695.86	12.27
Sub-total	19,689,357.44	39,247.10	501.68	97.83
Others	436,262.00	82,506.83	5.29	2.17
Total	20,125,619.44	121,753.94	165.30	100.00

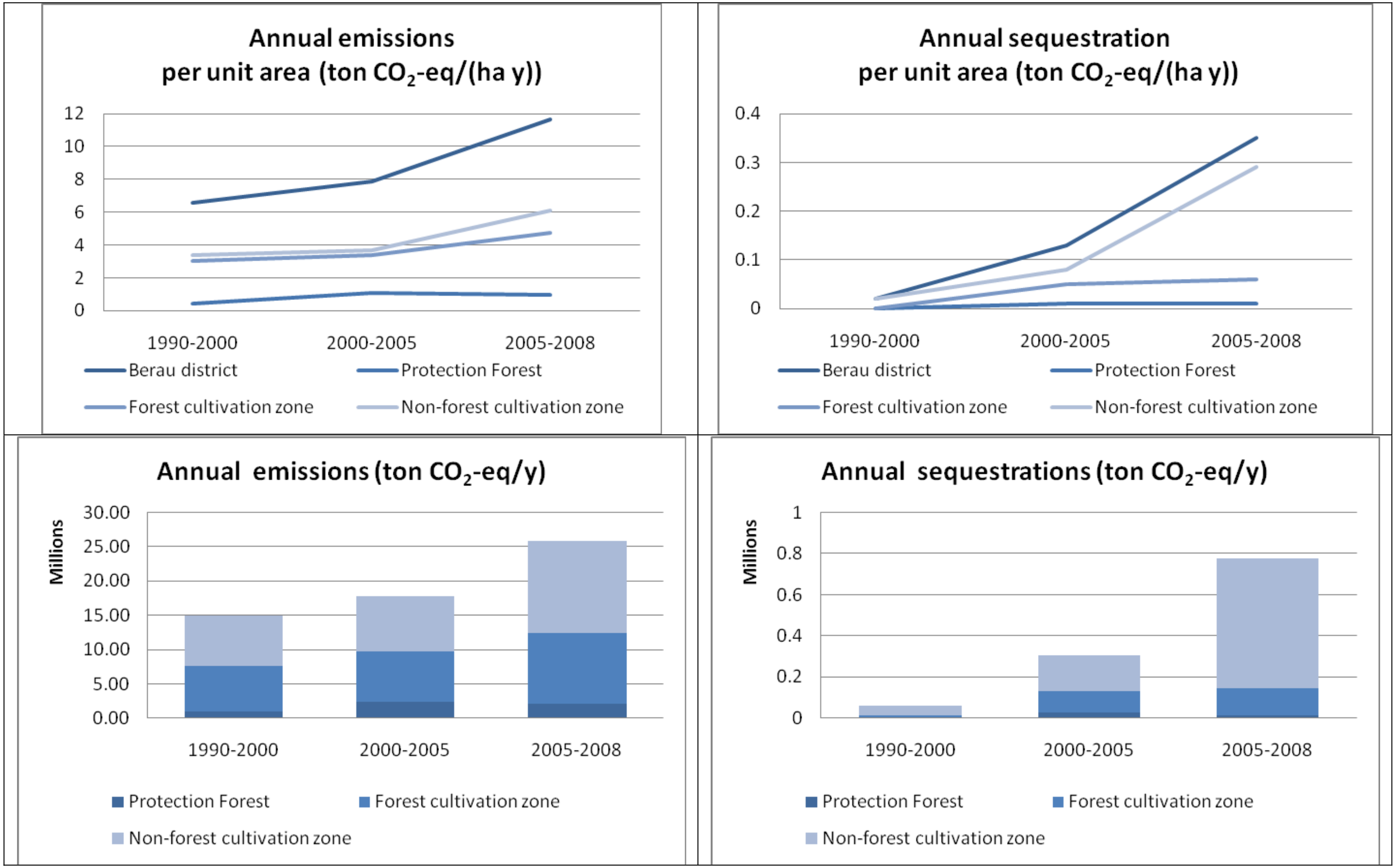

Figure 1.16. Annual emissions and sequestration in each land use plan zone for each three period per unit area (top row) and entire area (bottom row)

These findings can be used to identify options of effective mitigation actions in different ways. Combining these with the intermediate drivers can results with some models of land use/cover changes to project the future emissions and run the scenario analysis. Identification of location with high C-stock and intermediate threat level is doable. For setting a REL, breakdowns of historical emissions based on spatial plan is one key input. Integrating the data with profitability analysis, we can produce rough estimates of opportunity costs for reducing emissions. With the results of DriLUC, fair and efficient attribution, payment distribution and institutional arrangement for climate change mitigations can be negotiated and designed.

Research gaps

- Peatland, mangrove and swamp C-stock data do not widely exist. Measuring and incorporating below ground biomass from peat will improve the accuracy of the estimation, especially because there have been some changes in the peat area. However, considering the resources and the technical complexities of measuring C-stock and emissions in peat land, and considering the limited extend of peat area in Berau and its depth, filling data gap particularly for this should not be the top most priority;
- Reducing plot level error to targeted level (see IPCC) especially with time-averaged and in undisturbed forests area which is non-accessible and need a lot of resources and time;
- Time-averaged C-stock as a basis to determine emission factors from LULUCF are suitable in estimating past level of emissions and therefore can serve as a primary data to set the Reference Emission Level;
- For a monitoring system of performance-based reward mechanism for climate change mitigation action, including REDD+, the time scale assumed by time-averaged C-stock (one rotation of the shortest land use systems, say forest plantation is 7 years) might be fine enough for a program which is interested in monitoring performance every 5 year or shorter;
- Medium resolution satellite image interpretation to land cover maps are feasible for district level, however to achieve higher accuracy in discriminating land cover of very similar reflectance experiments using higher resolution imageries to derive calibration factors for medium resolution once might be fruitful. Otherwise, the algorithms such as those developed by Asner (2000) for sub-pixel level analysis could be the answers;
- Overall uncertainties between activity data and emission factor using the hierarchical classification, with specific legends to address variation in C-stock among land cover types, and the differences in time-averaged C-stock as the emission factor, are reasonable. However, these could be reduced when the data are more rigorous;
- Modelling drivers of land use/cover changes and projecting emissions from LULUCF using different scenarios are important in negotiating REL and anticipating challenges in the implementation of particular actions/programs;
- Technical Local capacity development should be a priority for different reasons: (i) it is important institutionally (in terms of buy-in and accountability) for local people to be able to

have technical capacity in monitoring C-stock, especially when any programs will be applied in the area, (ii) it is most cost-effective to have local institution to conduct the study;

- The database and analysis conducted up to this point is only a initial step; some continuous improvement and iterations will be required to reduce the uncertainties; therefore it is crucial for the database to be maintained properly since most likely it will grow and be modified especially if and when a performance-based program is to be operational. Technical, institutional and financial capacity and stability are needed to support such database management.

Section 2

Identification of drivers of land use/cover changes in Berau District (East Kalimantan)

Mustofa Agung Sardjono and Ibe Ibrahim

Introduction

Land use is dynamic. It is the resultant of decisions and choices made by many actors and agents, and the consequences of the change on many stakeholders. At an early stage of involvement in Integrated Natural Resource Management of a certain landscape, the key features of the resultant 'system' need to be mapped and understood. Looking at a dynamic landscape as a system implies a concept of 'internal' (endogenous) and 'external' (exogenous) drivers of change (even though the system boundary is fluid). The system is subject to 'pressure', has 'response options', 'time lags' and 'feedback mechanisms' that allow learning and internal adjustment. Yet, we shouldn't lose sight of the disconnected, conflicting interests and sometimes open conflicts between the various stakeholders and actors. A 'political ecology' view on the multiple interests and stakes in the landscape can help to form a platform for discussions and negotiations among stakeholders.

In the context of REDD especially concerning Berau Forest Carbon Program (BFCP) of The Nature Conservancy (TNC), driver analysis of land use changes is essential in order to identify cause-effect relations of emissions from deforestation and degradation and relevant actors and potential activities to reduce these threats in that selected district.

Objectives

This component of study aims at a clear understanding of the way local drivers of land use change in a relatively broad landscape (district) relate to external conditions and the types of local/regional/national feedback that currently relate impacts on livelihoods and the provision of goods and services in Berau.

Methodology

A rapid assessment tool, namely Rapid Appraisal of Drivers of Land Use Change (DriLUC), developed by ICRAF, has been employed in this analysis. Since the tool was just explaining the possible 7 (seven) key steps for identifying drivers of land use/forest cover changes in certain areas, detailed instruments of the study e.g., objectives, outputs, data collection and analysis methods were developed independently by the team.

Table 2.1. Detailed methodology used for implementation of DriLUC in Berau District

DriLUC Steps	Objectives	Outputs	Key Data	Methods
Step 1. Document changes in land cover, demographics, eco-nomic indicators, road/river access and analyze `condition and trends`	To make rough identification of land use changes based on biophysical and sociocultural dynamics for certain period in the region	Data and views of biophy-sical and sociocultural changes in the target re-gion are collected, iden-tified and understood	• Administration • Demography • Sociocultural aspects • Socio-economy • Land/Resource use • Infrastructure/road map, etc [For the last 20 years]	• Existing data approach • Maps observ-ation • Key informant approach • Diagrammatic Illustration
Step 2. Discuss with key stakeholders the way choices are made about land uses	To collect information based on experiences of identified key stakeholders concerning land use/forest changes (focus on process)	Information about situation developed which may affect land use development/ changes in the region (based on experiences of key stakeholders) are collected and integrated with the first step results	• Stakeholders • Role and function • Economic de-velopment pro-grams • Structural or-ganization	• Stakeholders analysis • Key informants approach • Attitude survey approach • Focus Groups interview • Diagrammatic illustration
Step 3. Identify Local-National linkage of the `five capitals` of sustainable live-lihood	To identify five capital situations at local level, their interactions and external factors affecting the situation	Situation and condition of five capitals (solitarily or collectively) at local, re-gional and national levels (incl. their interactions) are identified	• Five capitals situations and development • Regional deve-lopment plan • National poli-cies	• Existing data approach • Attitude survey approach • Key informant approach • Diagrammatic illustration
Step 4. Determine position on agroforest transition baseline	To observe (directly /indirectly) develop-ment of landcovers of utilized areas in the region	Position of agriculture, for-estry and agroforests/ agroforestry land uses is well understood and iden-tified	• Agriculture and forestry land uses • Land use policy • Land use dyna-mics	• Maps observ-ation • Key informant approach • Diagrammatic illustration
Step 5. Identify dynamics along the segregate-integrate axis	To identify spatial pattern of the various land cover types and their `negative/ positive` integration drivers	Spatial pattern of forest cover types (incl. drivers of deforestation/reforestation as well as functional inte-gration drivers) is clearly identified	• Land use situa-tion and dynamics • Regional eco-nomic develop-ment plan	• Maps observ-ation • Key informant approach • Diagrammatic illustration

Table 2.1. (Continuation)

DriLUC Steps	Objectives	Outputs	Key Data	Methods
Step 6. Recognize stages of conflicts and collective action	To identify and reconstruct social capital within local communities and networks among stake-holders (dissociation and association interactions)	Internal structure within community and engage-ment with outside world are identified and even reconstructed	• Land status and land tenure • Capitals within local community • Historical rela-tionship among land users • Map of conflicts	• Key informants approach • Attitude survey approach • Focus Group Interview • Diagrammatic illustration
Step 7. Understand agents of land-use change and stakeholders' views on the goods versus services tradeoff	To understand ele-ments and associa-ted drivers of land use changes and views of key stakeholders	Agents of land use change and stakeholders' views on the goods versus service trade off are understood	• Demand and supply of goods • Ecological/envi-ronmental services • Historical trends of natural disas-ters • Socio-Economy trends	• Key informants approach • Attitude survey approach • Focus Group Interview • Diagrammatic illustration

Based on the process of DriLUCs implementation it can be illustrated as the following diagram (Figure 2.1.).

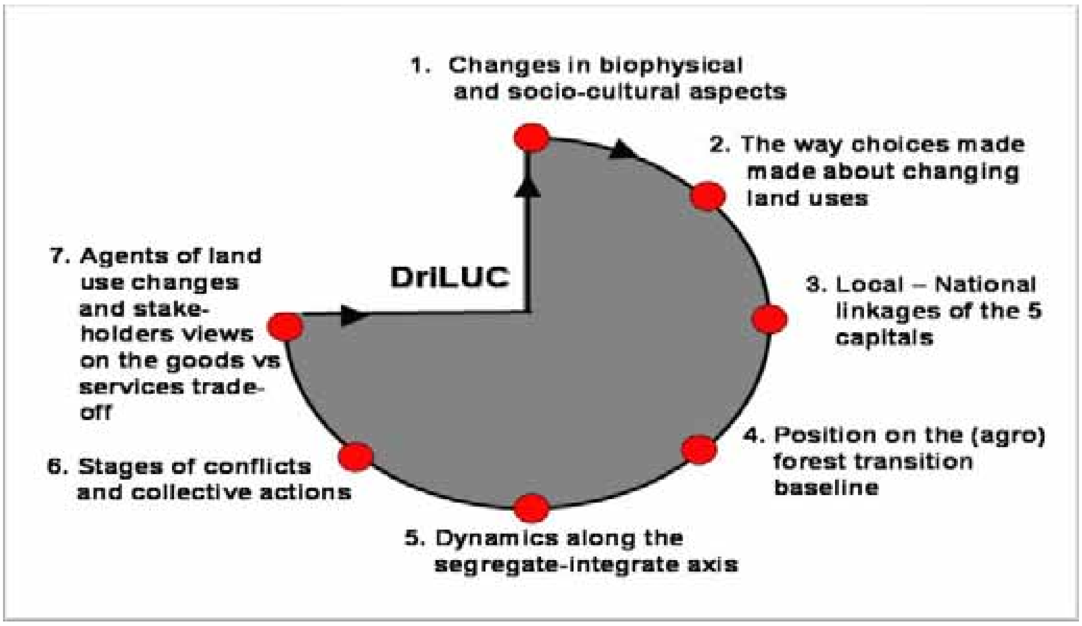

Figure 2.1. The Seven steps of DriLUCs method of ICRAF used for Berau District

Additionally, because the method was developed by ICRAF without any detailed and more complete technical information, there were some subjective (but logical) understandings referred in this study: (1) the seven steps are not reflecting a sequence and should not be implemented completely; (2) the whole story of DriLUCs through the 7 steps is to understand the drivers of land use changes from different perspectives or approaches based on the necessity; (3) Although all data and information have been collected from reliable sources and with reliable techniques, the result of analysis can be varied from one to another researcher.

Results and discussion

Berau is one of the initial six districts/cities of East Kalimantan[3] and because of the existing old Kingdoms in the area (namely Sembaliung and Gunung Tabur) Berau has even also been acknowledged as the oldest region. Following its specific geographical position 116 ° BT - 119 ° BT and 1 ° LU - 2 ° 33' LU) the district with the total territory of 34,127km^2[4] has a unique bio-physical condition as well as specific socio-economic dynamics. Berau is located just in the middle of the province, and therefore when recently there is a discourse of possible development[5] of a new province separated from East Kalimantan (with the name North Kalimantan) Berau has been competed to be included in both provinces.

Furthermore, from bio-physical aspect, Berau covers different ecosystems from coastal zone to remote areas or from accessible mangrove and low-land vegetation to relatively inaccessible forests. In addition to that, some small islands with high biodiversity administratively also belong to the district. In other words, Berau is not only ecologically important but from economical point of view it is also a promising region.

Talking about demographic aspects (and also influenced by bio-physical condition), Berau has two ethnic groups: the traditional native community (or widely known as indigenous people) and migrants. The native community consists of Berau (in coastal zone) and Dayaks (with more than five sub-ethnic groups – mainly in remote areas), while the migrants are dominated by Bajau, Buginese (both come from Sulawesi), Javanese (especially East Java) and also Banjarese (from South Kalimantan). Recently following better accessibility Timorese tend to increase from day to day.

The presence of immigrants is also closely related with the economic development of the district. They come to Berau especially to look for work and different business opportunities. As it has been mentioned previously the district is rich in natural resources and like many other regions those resources have been used since the last four decades to gain more revenue, not only for Berau but surely for national interest.

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[3] *The other districts/cities were Samarinda, Balikpapan, Kutai, Paser, and Bulungan.*

[4] *The Berau district territory has gradually extended from 22.528,3 (1988); 24.201,4 (1998); 34.127 (2003-2009);*

[5] *In Bahasa Indonesia we call it `pemekaran`*

Under such situations, possible changes on forest cover and land uses caused by different internal and/or external factors and with multiple ecological as well as social impacts are unarguable for Berau. Those all situations will be analyzed in more details using DriLUC approach as follows:

Changes in land cover, demographics, economic indicators, road/river access and `conditions and trends` analyses

Although the economic development in Berau has been started since the beginning of the 70`s, based on the statistical data collected for the last two decades (1988-2008) (see Appendixes) changes in land cover (incl. forestry) have drastically increased just in the last one decade (after the reformation). The changes in land cover has certainly a close relation with many different aspects such as administration, demography and especially socio-economy which are also very dynamics in the same period. Therefore it is considered necessary to observe them one by one in order to get a better idea about the drivers of changes.

From administrative aspects it is necessary to note that the district that in 1988 had only 7 sub-districts and 45 villages twenty years later (2008) expanded to double (13 sub-districts and 97 villages). Undoubtedly this comes from the fact that demographically Berau has also significantly multiplied. Although its population growth especially from immigration for jobs is fluctuated, the number of population, households and density in the district are going up (see Table 1)[6].

Those above demographic growths have been influenced by better socio-economic facilities in the area, especially physical and transportation infrastructures as well as wider fulfillment of community basic needs e.g., education and health. For example, in 1988 there was only 147.87 km of asphalted roads, but in 2008 it already reached 586.59 km. Similar situation, in 1988 Berau had only 5 units of high-school, but twenty years later they increased to 13 units (see Appendix VII).

One factor that affecting changes in demography and socio-economy are intensive utilization of the existing natural resources, firstly forests (started in the beginning of the 70`s and decreased in the end of the 90`s) and later (after the 80`s until nowadays) coal mining and lands for crop-estate development (especially oil-palm). Particularly for crop-estates, their development in line with the increase of population in the last half decade has not only focused on large- but also on small-scale agricultural business. Statistical data which have been mentioned in Appendixes VIII-XI show more detailed information.

[6] Actually Berau has also received official transmigrants since the beginning of the 80`s, but after the year 2000 (implementation of regional autonomy) the number of participants tended to decrease.

Table 2.2. Demographic situation during period of 1998-2008 in Berau District

No.	Description	1988	1998	2003	2008
1.	Population (people)	55,859	107,188	136,628	164,501
	Male (people)	29,372	59,384	74,901	90,419
	Female (people)	26,487	47,804	61,728	74,082
2.	House Hold (HHs)	11,852	23,187	29,677	37,417
3.	Population Density (people/km^2)	2.48	4.42	4.01	4.82
4.	Population Growth Rate (%)	0.86	6.73	6.81	2.56
5.	Mortality (people)	1,017	1,203	2,017	1,979
6.	Natality (people)	210	261	430	379
7.	Imigration (people)	1,438	5,079	13,277	3,271
8.	Move (people)	1,768	3,440	8,781	769
9.	Job-Seekers (people)	1,023	4,066	4,816	3,383

Source: Statistical Book of the Berau District (2009; 1999; 2004; 2009)

All above situation can be illustrated through a diagrammatical flow of land use and forest cover changes as follows:

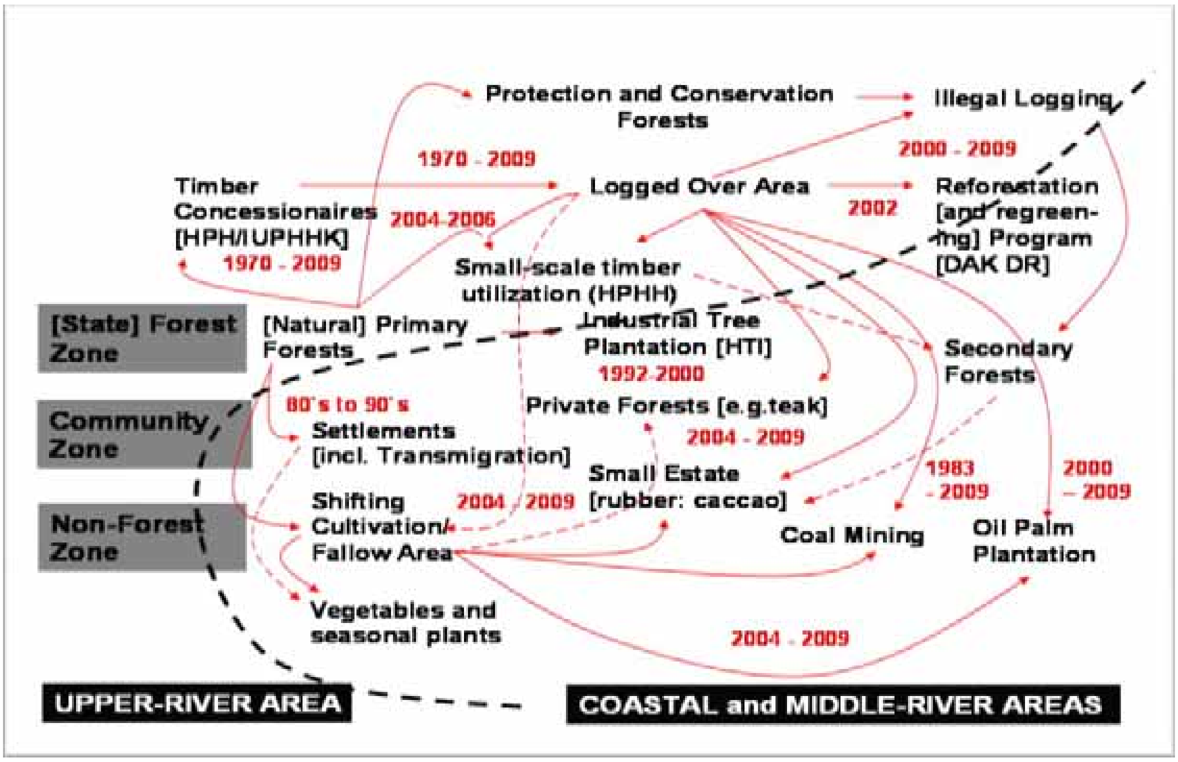

Figure 2.2. Land-use dynamics and forest cover changes in Berau District (1970-2009)

The way choices are made by key stakeholders about changing land uses

Land use changes in Berau especially in the last four decades were generally not affected by natural disasters such as earthquakes, floods or land-slides. Even forest fire threats which are widely known to be periodically faced by East Kalimantan[7] during long drought, have reportedly covered only very minimum areas of the district. Nevertheless, most land use changes have been driven initially by internal and external economic factors, and in a further development they are being combined by political alterations and social dynamics. It means that anthropogenic causes especially related to different stakeholders' interests and decisions are clearly becoming main factors of the changes.

From different conditioning factors there are some key factors which are considered dominant, such as intensification of natural resource industrialization (to commercialize the utilization of forest and other natural resources); rapid regional development with the main reason to optimize poverty alleviation and to do local community empowerment. Actually, those activities also have interrelationship with the political escalation following the implementation of regional autonomy policies.

Those above (mostly external) situations have brought about local assumptions that there will be more new actors (especially from other regions) present in Berau, which are followed by changes in rights to resources (since the new settlers/job seekers mean more demands for living space); competition on space and resources will potentially influence the relationships among actors, and consequently require equal distribution of power and authorities. All of the mentioned factors can encourage development of new sub-districts, which are actually directed to increase economic gains for the community welfare (see Figure 2.3. below)

[7] Large forest fires have been found especially in Middle Mahakam (District of Kutai Kartanegara). Only in 1997/1998 fires destroyed more than 5.0 million hectares of the province forest areas.

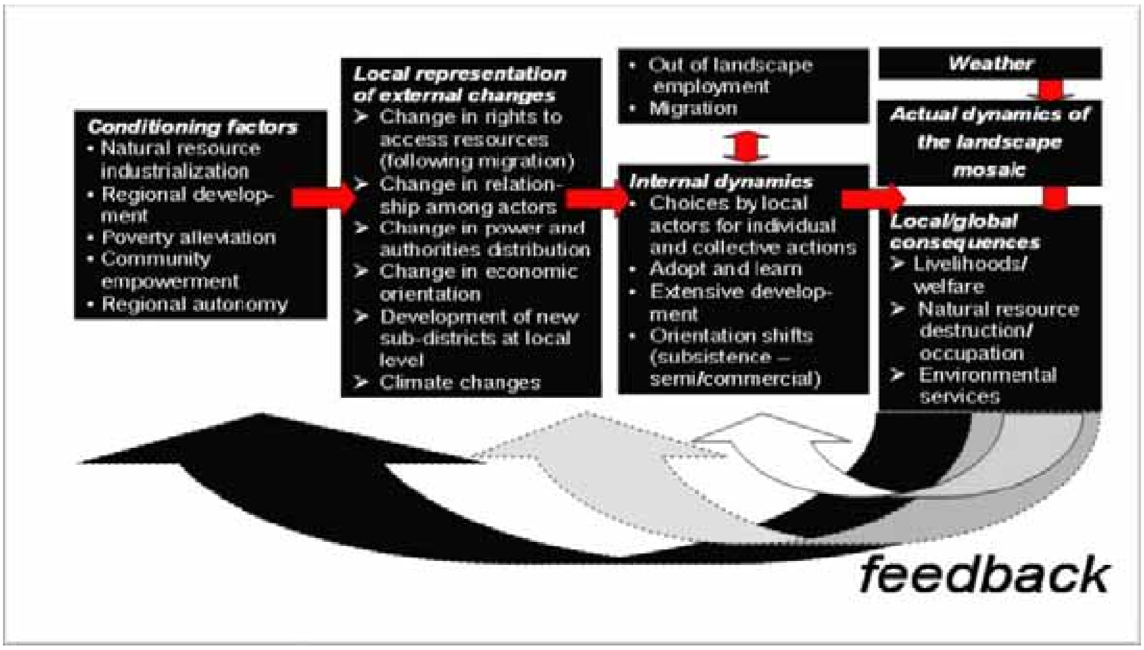

Figure 2.3. Different factors affecting land-use changes in Berau District

From the above table it is clear to say that responses or perception of the external changes has influenced local dynamics, such as opportunities for local actors to develop strategies in land or resource use: adopt and learn possible new technologies or introduced innovations and; extensively developing the choices (such as development of oil-palm, which has grown up incredibly in the last half decade). Those developments are socially reflecting the economic orientation shifts of taking profits, not only by large-scale actors but also among small-scale business. However, for many of peasants in the remote areas who feel not satisfy with their traditional subsistence agricultural activities, they are trying to change their jobs for becoming labors or employments. In the same time the number of migration increases further.

Such situation which is indeed additionally influenced by unpredictable weather that has been experienced by local communities since last two decades has created dynamic mosaics of land use and landscape changes. The final impacts that might also give feedbacks to previous issues and already existed in Berau is a perception about the improvement (although probably just temporary) of community welfare (especially in coastal zone) which is in line with ecological and environmental destructions and finally has started to shift the understanding among actors about necessity of environmental services.

Local – National linkage of the `five capitals` of sustainable livelihoods

Land or resource use and therefore also its changes as well as subsequent impacts in general cannot be separated from five main capitals or assets, namely financial (F), physical (P), human (H), social (S incl. political) and indeed natural (N) capitals, since those capitals are dynamically interacted to each other. Certainly dynamic interactions can be considered in (and also depend on) internal and external circumstances. In the context of region (in this case Berau) internal and external mean local and national spheres.

In that context and in the local Berau case, five dominant dimensions of rural poverty can be identified: (1) lack of legal access to state forests or natural resources for local communities (both traditional groups and migrants) (natural and social capital); (2) unbalanced distribution of physical infrastructure following given geographical condition between coastal zone and remote areas e.g., causing significant economic disparity and different access to basic needs fulfillment between communities in those two areas (natural and physical capitals; interacting with social and financial capital)and social capitals); (3) lack of investment funds for clean development or ecologically friendly business has led to under-estimation of natural resources (financial and natural capital, modified by social and human capital); (4) lack of income opportunities following rapid and high immigration and critical competition, especially between traditional community and migrants (human and financial capital combined with social capital) and (5) lack of efforts to obtain optimum good governance and dominant roles of `local elites`, being primary issues that causes environmental degradation and demand for establishment of new sub-districts or even new villages (in which actually under recent situation potentially brings negative feedback to higher natural resource destruction) (social and natural capitals, combined with human capital).

In a broader context (where those capitals are considered at broader scale), five major policy domains link the local representation of the primary constraints to land use to the national level: (1) creation and access to knowledge and skills through responsive research programs and extension as well as training systems; (2) policies of (forest) land classification and access rules/mechanisms to land/resource in the frame of `healthier` regional autonomy and decentralization process; (3) overall economic development and creation of jobs out of the primary agricultural production sector; (4) price policies, subsidies and regulation of market access especially for relatively remote areas; and (5) development (or expanding) and maintenance of regional infrastructure for transport, communication and other social-economy facilities especially relating to primary needs of the community.

All these five policy domains are embedded in the overall context of governance and indeed poverty reduction strategies (incl. forestry policies involvement as element of economic sectors).

Figure 2.4. Five major policy domains link the local representation of primary constraints to land use in Berau DIstrict

Positions on agro – forest transition baseline

The changes on land use and forest cover in Berau, as it has been widely described above, are affected mainly by increasing efforts to gain more national economic revenues since the beginning of the 70`s (which also influenced different aspects within the district) and have rapidly extended since the last ten years following reformation and regional autonomy. If this situation continually grows without careful control, it will bring to the development of poverty, especially among the inferior (say less capitalistic) groups.

From the theoretical basis, under the environmental condition of tropical region like in Berau, changes of forestry land use to become financially more productive but mono-cultural agriculture are [for most parts of the district] considered too risky. It is because such a model sooner or later can bring into unfriendly (non-sustainable) use. Agroforestry, which is actually combining agriculture and forestry activities in the same management units of plot or landscape will be expected to give simultaneous benefits, both e.g., poverty alleviation and sustaining forest benefits incl. environmental services.

The following curves of `agro-forest transition frameworks` (Figure 2.5.) under local Berau condition will represent the status of the landscape, especially concerning with different forms of poverty (actual and potential) as well as their different effects of environmental services:

As it has been previously discussed (see Step 1.) the forest resources of Berau have been intensively exploited by large scale timber concessionaires since the beginning of the 70`s. This activity has reduced the living space of the local communities and practically there was very limited economical share to the surrounding inhabitants. Beside that, such exploitative forest use has given negative ecological impacts including environmental services (e.g., changes in water balance). This situation ran until the end of the 90`s and just slowing downed following reformation (1998). In line with political instability during transition from centralized to decentralized governance (1998-2001) including in forestry sectors, illegal logging (or illicit felling) has drastically increased. From the perspectives of poverty and environmental service indicators the landscape changes have brought to the following dynamics:

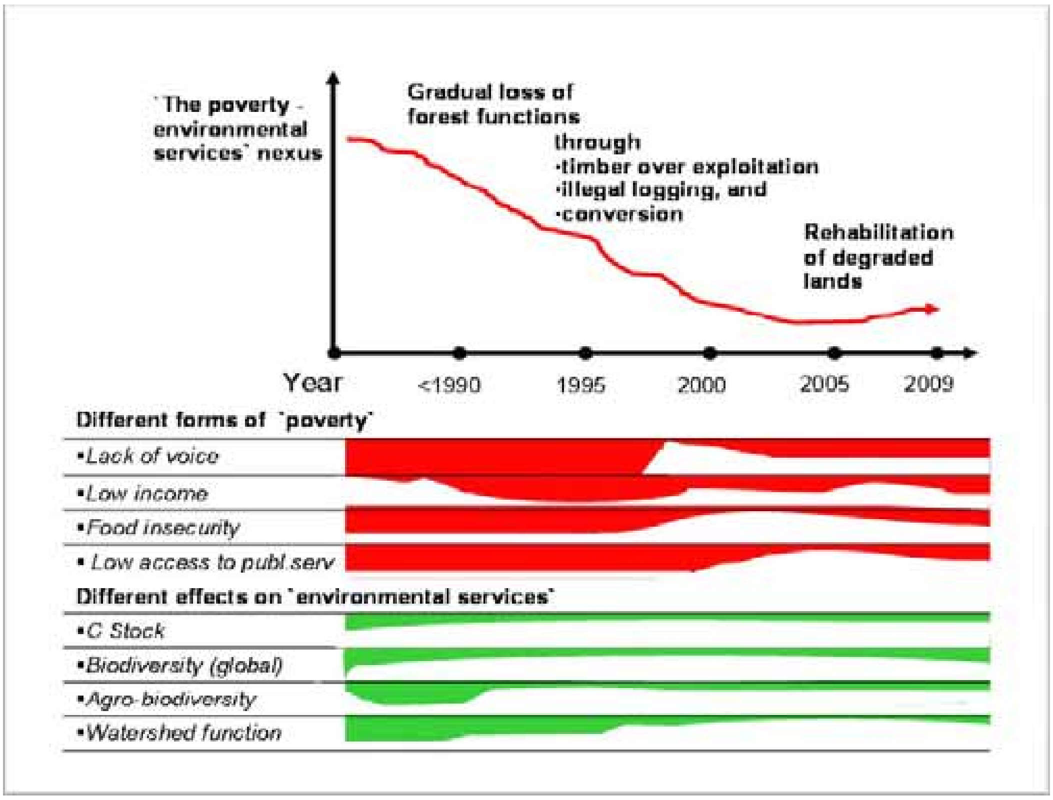

Figure 2.5. Position of different forms of poverty and different effects on environmental services on agro-forest transition in Berau District

In discussing poverty dynamics in the last one and a half decades relating to increased deforestation and forest degradation in Berau, it can be seen from different key indicators reflected clearly in the above diagram (Figure 2.5.), as follows:

- **Lack of voice**. Practically before reformation movement (1998) following very repressive (central) government, not only did local community lose the forests as their living space but also they were very afraid to protest or to claim their rights on the resources. After reformation and then followed by regional autonomy (2001) the local community started to articulate their aspirations incl. in local resource utilization and/or sharing of benefits.

- **Low income**. Concerning cash income from resources, it has to be said that there was a tendency of decreasing average income of the local community due to the domination of large scale investors in line with resource scarcity. After reformation and regional autonomy the average income of that population has increased because of opportunities for occupation of local resources based on historical rights esp. among traditional communities and therefore existing production fees. However, following forest over-exploitation the average income temporarily decreased (2003-2005) before starting forest conversion into mining industries (especially coal) and crop-estate extensive development (dominantly oil-palm).
- **Food insecurity**. The food especially rice was relatively secured during the decades of the 80-90`s, because most of the people in remote and rural areas sufficiently produced and supplied for urban people consumption. However following long drought in the 1997/1998 (in line with economic crisis) there was a shortage of rice, while other alternatives (e.g., food from the forest) were getting more difficult to find. Supply of rice during transition from reformation to regional autonomy was even worse, because many farmers changed their jobs to be loggers, which offered better cash income than from farming-fields. However after regional autonomy and development of better irrigation for wet-land rice, further economic infrastructures (especially roads and markets) as well as more local political stability, food insecurity started to decrease.
- **Low access to public services**. During centralized New Order regime economic development in Berau (incl. in Tanjung Redeb as capital of the district) was relatively slow and therefore public facilities were limited in remote and rural regions. Facilities were built only in economic centers (e.g., forest base-camps) and directed mainly for limited target groups (e.g., labors of the private companies). However after regional autonomy local government has rapidly developed social and economic facilities in those areas (including the demanded human resources), which enable more poor rural or remote people to use those public services.

Deforestation and forest degradation in Berau especially with increasing threats on resources such as illegal logging, forest encroachment and indeed land conversion into non-forest utilization under socio-economic and political circumstances especially in the last decade have influenced not only in the dynamics of people poverty but certainly also their implications to environmental services. Some key indicators related with dynamics of the environmental services are used as follows:

- **C Stock**. Although carbon accounting is still being conducted in line with this study, its availability especially in the last decades can be logically estimated from the existing forest/tree stands in the district. Because of relatively short period of observation (only about two decades) it can be said that exploitative large scale periods from the 70`s to the 90`s have been replaced by extensive small-scale illegal logging activities after reformation and regional autonomy era. However, in the same time farmers, occupants and even land speculators have planted more trees and/or different tree-crop species for land marking and/or investments. Therefore, it is considered that there is only a slightl different in carbon-stock in the district during the observed period.

- **Biodiversity (global)**. Deforestation, forest degradation and also forest conversion into other different land-uses in Berau have contributed to the biodiversity. In many places especially in primary forests such dynamics have reduced richness and evenness of the existing flora and fauna, but conversion has factually also increased diversity of biological components. Therefore during the last two decades there has been considered only slight development in biodiversity in Berau District following land use changes
- **Agro-biodiversity**. Since the beginning of the 90`s when village development program especially among local community surrounding the forests had been obligated for timber concessionaires by the government, different agricultural commodities have been planted. In addition to that, parallel transmigration schemes were intensified (at least until late of the decade –see Appendix 3). Because of that the agro-biodiversity considerably increased in Berau District.
- **Watershed function**. Tree stands and indeed vegetation coverage in Berau play significant role in protected water balance and erosion control especially within watershed areas of two main rivers Kelay and Segah. Over exploitation especially during the new order regime (before 2001) or even conversion of primary forests into different land uses especially extensive seasonal agricultures can definitely reduce ecological carrying capacity of the forest ecosystem. On the other hand, if land users have converted secondary forests into agro-forests forms, where more useful and cultivated tree species have been planted in combination with short-lived agricultural plants, the watershed function can relatively be maintained. Unfortunately in the last five years in line with extensive development of oil palm plantation and higher interest in coal mining industries there has been more forest areas encroached, trees illegally logged and strategic lands occupied, leaving unproductive bare lands behind and consequently reducing the watershed function.

Dynamics along the segregate-integrate axis

Rapid economic development of Berau District characterized not only by intensive utilization of natural resources especially forest and land but also by increasing number of population through immigration since the 70`s resulted mosaic of agricultural fields, fallow areas and residual primary as well as secondary forests. Those land uses located side by side with settlements and areas used for public facilities e.g., roads, bridges, buildings etc. For fallow areas and secondary forests which have been no longer disturbed e.g., because of relatively not accessible or far away from public facilities, they are in succession process and some of them achieved an old secondary forests stage. However, population increase and more large scale land uses have made fallow areas and secondary forests especially surrounding settlements or villages intensively reused for food production through slash and burn agriculture, which led to bare lands and grass lands (see also Figure 2.6. below).

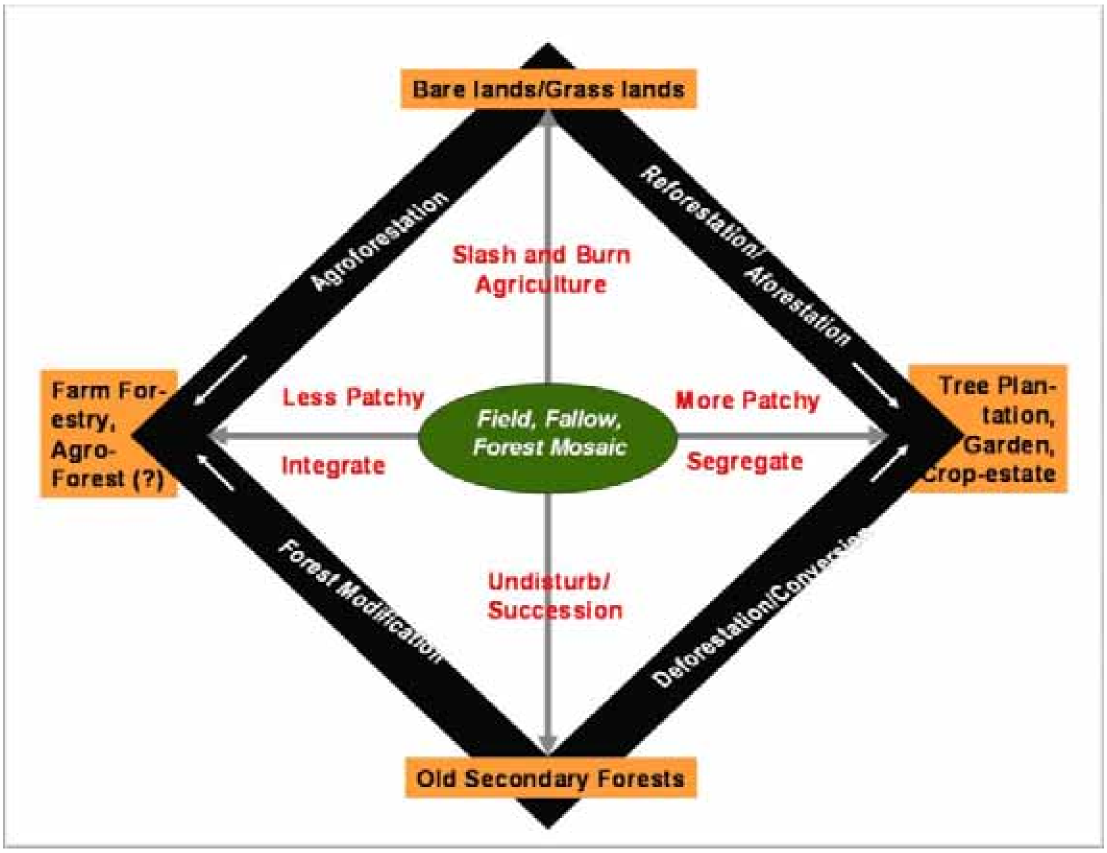

Figure 2.6. Land use dynamics along segregate – integrate axis in Berau District

In some areas especially within settlements/villages or around agricultural areas in remote areas, home- and forest-gardens are found. Those mixed gardens can be categorized as farm-forestry and/or traditional agroforestry, which are as integral part of agroecosystem. Particularly forets-gardens are also widely known as modification of old secondary forests, where the natural vegetations specifically useful trees have been deliberately maintained or enriched with more marketable commodities, either tree- or cash-crops.

In some places, especially in coastal and middle-river areas, industrial tree plantation or commercial tree plantation in monoculture forms have been widely developed. The largest industrial tree plantation belongs to private company (PT. TRH), and the remaining smaller ones are generally owned by individual farmers/land occupants or as results of reforestation program (2002-2003). In the last decade some of old secondary vegetations were also converted into crop-estate commodities (mainly oil palms, but in smaller scales included rubber, cacao, coffee, etc) as alternative income sources.

Stages of conflicts and collective action

Economic development in Berau which was characterized by intensive natural (esp. forest) resource industrialization and started in the 70`s has brought not only tens of large-scale investors to the districts, but also thousands of migrants from other provinces or regions of Indonesia. They came to Berau in the frame of (particularly spontaneous) transmigration program due to possible labor and (in parallel of it) various job opportunities. Different socio- economic motivation and technical capacity between local native community and migrants have led to unequal competition. Limited labors that can be recruited by industries in comparison with the number of job seekers have finally made them back to primary jobs in agriculture. Since then not only competition related to labor opportunities but also land occupation as well as production between both groups has started.

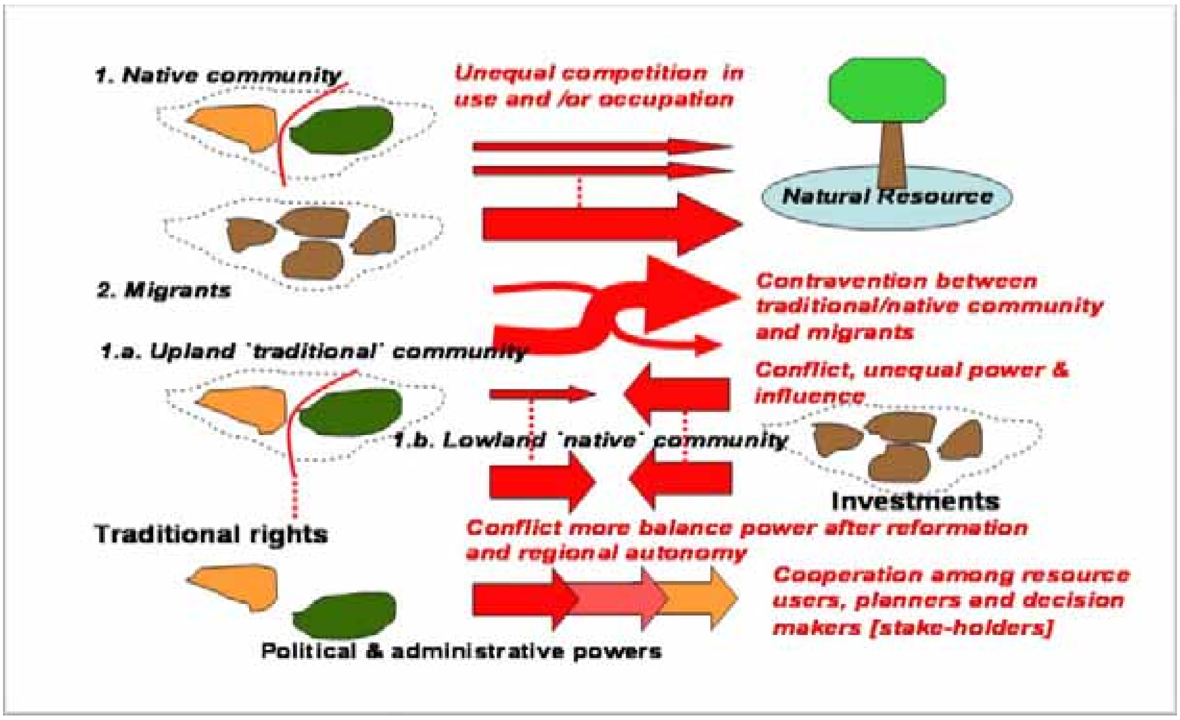

Figure 2.7. Social interaction dynamics among community groups in Berau District

The situation was becoming worst with stereotype of most investors directed to local native community especially whom stay in remote areas such as indiscipline and lack of initiatives. Under such situation there were reluctances for employing local native people and consequently assimilation process between those migrants and the natives was getting more difficult. That minimum social interaction in term of limited contact and communication has implicated of shifting from competition to contravention in many places. This contravention was clearly not coming up to the surface but it could be seen by facts that practically none of the community development programs of timber enterprises could be categorized as success.

Such social dissociation process was actually considered as the beginning or initial steps of conflicts, although during the very repressive New Order regime they were latent or underlying. However after reformation those latent social conflicts broke up and were reflected by oppositions of many local native communities especially against large scale enterprises, who were mostly from outside of Berau. Localism and even ethnocentrism have started ton develop and native communities significantly increased their power since they had occupied larger natural capital based on historical tradition or customary law and (in case of native people in remote areas especially Dayak) and also stronger institutional capital (which is dominated by native coastal community Berau, who are dominantly work as government employee or bureaucrats). Therefore with consideration that financial capital are still dominated by investors or migrants there is more balance or equal powers distribution among community groups in the district. Today, instead of conflicts there are more initiatives in Berau to do more cooperation in form of more participative processes and collaborative works or partnerships schemes among community or different interest groups or key stakeholders in achieving targets of natural resource utilization/management.

Agents of land use change and stakeholders views on the goods versus services tradeoff

Two aspects which cannot be separated to each other in relating to every economic development are maximum profit (in term of financial revenue and/or goods) and sustainable resources (which means not only yields but also carrying capacity of its environment to serve people). This is also valid for Berau District since the last decade, where in a spirit of community`s welfare the local government has decided to accelerate regional development through e.g., intensifying natural resource utilization such as forest, dry- and wet-lands for different agricultural purposes, and last but not least mining industry.

How each economical agent reflected by their different resource/land utilization activities has taken attention to those (in many cases) conflicting targets are becoming interested subject to observe. It is particularly important to see a tendency of their impacts in forms of land use and forest cover changes in the region. In order to observe that situation, two ranges used in this study, the first range in form of horizontal line representing the economic aspect (from zero profitability at the left side to intensification at right – horizontal line/abscissa) and the second range (vertical line/ordinate) stands for ecological aspects (shifting from no environmental service at the lowest position to conservation at the top).

Four quadrants have been resulted from the crossing-over of both abscissa and ordinate (see Figure 2.8.). The estimated position of each land use/agent of change in Berau District depends on the stake-holders` views and their interests in relation with economic and ecological focuses as it has been previously discussed.

a. **Land-use with a less profit (partly subsistence oriented), and (incl. for their sustainability) relatively considering conservation**, e.g.; traditional shifting (slash and burn with long fallow period allowing soils to regenerate); reforestations (especially in the frame of official program); protected areas (both protection and conservation forests, where ecotourism and other commercial programs have not taken place yet); traditional tree gardening (collection of different useful plants/trees esp. fruits on fallow areas, mostly for subsistence purposes);
b. **Land use with a more commercial mission, but from different reasons considering the importance of conservation**, e.g.; home gardens (domestication of different wild , semi-cultivated and cultivated but mostly semi- and commercial plants/trees in the vicinity of houses); forest concessionaires (large scale timber companies or IUPHHK); Industrial Tree Plantation (or HTI, purposes to supply raw material for local existing pulp/paper industry); large-scale oil palm industries; private forests (trees planted on occupied or private lands,

mostly small-scale); and mangrove fish-ponds (conversion of mangrove with removing all/part of mangrove vegetation for fish-culture);

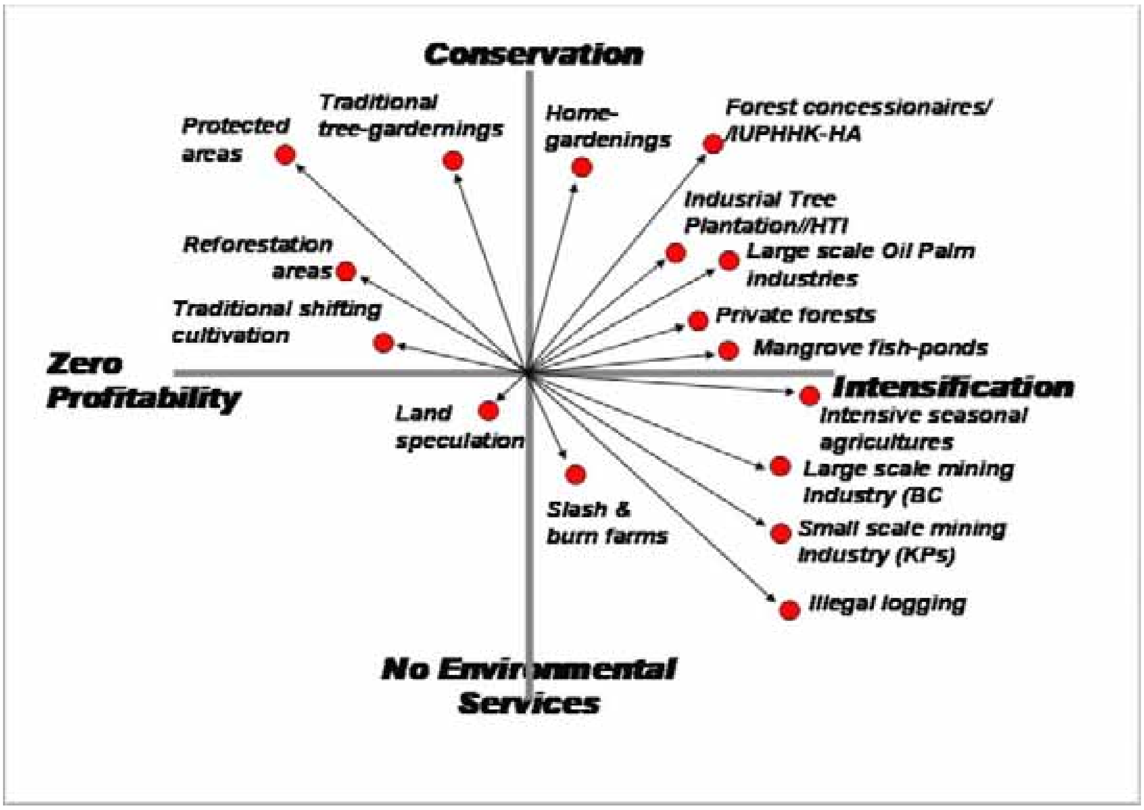

Figure 2.8. Stakeholders` views on the goods versus services tradeoff in Berau District

c. **Land use with commercial orientation based on maximum goods, but less (or even without) attention to conservation especially environmental services**, e.g.; slash and burn agriculture (or widely known as mining-agriculture, because it intensifies land utilization through burning without adequate production inputs); illegal logging (or illicit felling of forest); small-scale (coal) mining industry (or locally known as KP/*Kuasa Pertambangan*); large scale (coal) mining industry (especially those who do not implement environmental management and monitoring properly); and intensive seasonal agriculture (especially those located in unsuitable slopes);

d. **Land use without conservation or environmental services objectives, but also indefinite gaining of profitability**: land speculation (occupying land/forest area for unlimited duration without/or with minimum cultivation because of economic expectation).

However it has to be noted that in each quadrant the precise position of each activity considering ecological and economic aspects is different (see more detailed in above Figure 2.8.). Furthermore, looking at the concentration of activities in the four quadrants it can be concluded that most of them are profit oriented and partly give limited orientation on environment or are not interested to optimize environmental services.

Analysis of the land use change drivers in Berau

From above long discussion related to results of the implementation of seven DriLUCs steps in the Berau District, it can be derived understanding that drivers of land use as well as forest cover changes are not solely single simple factor but in generally long complicated factors. They are probably directly as sources of changes, but frequently as effects or impacts of different causes. It does mean decision of various agents to utilize existing natural resources in the districts has not solely economic background but in many cases also politically, economically and/or socially embedded.

Beside internal drivers (which mean all factors affecting land use and forest cover changes found within Berau) there are actually also some external forces, which are also covering political, economical and social issues. Some of them are resulted directly to the changes, but there are also some of them accumulated with internal drivers. The following table (Table 2.3.) shows internal and external drivers, which are principally as a synthesis of seven steps DriLUCs identification:

Table 2.3. Identification of drivers of land use and forest cover changes in Berau Districts

Aspects	Drivers			Land Use or Forest Changes
	Sources	Effects	Impacts	
Internal	**Politics**			
	• Implementation regional autonomy • Development of new sub-districts and villages • Regional Head elections	• More local authorities • Existing new elites among people • More groups of interests	• More competition e.g., among ethnical groups • Resource occu-pations and claims • Horizontal con-flicts	• Land use and forest cover fragmentation
	Economy			
	• Regional Development Programs • Demand for higher local revenue • Increasing resource based industry	• Local resource utilization • Seeking large-scale investors • More jobs and immigration	• Development of new economic centers • More consump-tions • Change in eco-nomic orientation	• Increasing forest conversion into economically more productive land uses

Table 2.3. (continuation)

Aspects	Drivers			Land Use or Forest Changes
	Sources	Effects	Impacts	
	Social			
	• Low population density • [Relatively] Tolerant local community characters • Low capitals of local people [except. Natural resource]	• Lack of local workers • Domination of migrants [incl. economy]	• Unequal demo-graphical distribution • Unequal resource distribution	• **Residual primary forest in remote areas** • **Commercial farmlands in coastal zone** • **Settlements in development centers [esp. in coastal zone]**
External	**Politics**			
	• State sovereignty [relatively] Centralized forestry	• Unharmonious Central -Local relation • `Careless` on forest area [?]	• Proposal for spatial plan changes • Intensive deve-lopment of non-forest area • Forest area encroachment	• **Reducing total forested areas** • **Enlarging occupied and converted forest areas**
	Economy			
	• National development plan • Introduction of `modern con-sumptive live styles • Global socio-political changes	• National invest-ment/-tors in the region • Development of economic faci-lties • Locally acts for global necessi-ties	• Competition on resource use among actors • Land use con-versions for commodities of global and modern markets	• **Higher pressures on natural resources** • **Enlarger frag-mentation of intact resources** • **Mosaic of diff-erent land uses (mostly poorly biodiversity or monoculture)**
	Social			
	• Transmigration program • Settlement and other social infrastructures programs	• More migration flows to Berau • Development of intensive agri-culture esp for food production • More limited tree	• Unbalanced assimilation and acculturation among ethnic groups • Better economics but lower	• Lost of traditional wisdom and sustainable resource management practices

		stands	environment quality	• Micro environ-mental changes

Surely it is very difficult to predict which factor (internal and external) is more dominant in changing face of the district. However logically external factors are mostly influenced by national interests and development programs. Meanwhile internal dynamics are partly as unavoidable implications of those external factors and the remains have been created by local initiatives, particularly from the motivation to gain rapid economic progress. Indeed Berau belongs to older districts, but sufficient space for decision making in development plan has just been obtained in the last decade. However, it is also necessary to say that although according to the authority distribution in the frame of regional autonomy forest area is under responsibility of Central Government, dynamics within that ecosystem are clearly interrelated with surrounding environment incl. non-forest area.

From long discussion, which has been synthesized in the above table it can also be con-cluded that drivers of land use and forest cover changes are actually exist in all level of social structure and therefore strategy or programs of mitigation is closely related with tasks, responsibilities and interests of the key actors found within the structure, as follows:

- **Government (Central and Local levels):** decision/policy makers (executive and legislative) and development planners;
- **Private/Economic Sector**: business owners/investors, field managers of timber/crop-estate/mining industries and traders;
- **Community**: land users (farmers, plant cultivators and fisher-men) and land occupants/settlers;
- **Other Agents**: land speculators.

Closing remarks: research gaps

Research on drivers of land use and forest cover changes needs series of socio-political and economic data of the area. Documentation and updated data/information especially related to small-scale activities are practically very weak and therefore unavailable in the district. Beside that most of the written development policies could not be totally utilized as references, since in the reality has not been used by planners or decision makers in the program implementation. Interviews with many resource persons showed that information which have been gathered from resource persons were more factual and even more useful than what can be found in the document. That situation is in general similar in every place and therefore should be carefully taken into account for the implementation of DriLUCs method.

Section 3

Profitability analysis of Berau main land use systems

Suseno Budidarsono, Meine van Noordwijk, Arif Rahmanulloh, M. Sofiyuddin

Introduction

This section concerns with the third objective of the assessment of Carbon Emissions from Land Use and Land Use Change in Berau District, East Kalimantan, as part of TNC- Lead Berau Forest Carbon Program in Indonesia, i.e., to carry out Profitability Analysis of major land use system as a basis for Opportunity Cost calculation of REDD in the program site. Profitability analysis of major land use systems that is conducted using Policy Analysis Matrix methodology (e.g., Monke and Pearson, 1995), aiming at the clarification of the following three aspects: firstly, profitability of the main land use systems; hence, is the land use system profitable for the operators? In other words, does it pay the operators to invest in the systems compared to other options? Secondly, factor input of each land use systems, emphasizing on the labor requirements. The concern here is labor constraints. Thirdly, policy related issues in land use changes.

Methodology

The Policy analysis matrix (PAM) is a matrix of information about agricultural and natural resources policies and factor market imperfection, that is created by comparing multi years land use system budget calculated at financial prices (reflecting actual market) and economics prices (reflecting efficiency). The matrix is designed to analyze the pattern of incentives at the microeconomic level and to provide quantitative estimates of the impact of polices on those incentives. Understanding the economic and financial incentives faced by land use operator is an important aspect of the decision to convert land uses. The PAM is a partial equilibrium static framework which provides a consistent framework to analyze firm or household information regarding land use activities and relate these direct financial and economic incentives to relevant government policy which influences these incentives. The basic structure of the PAM is shown in Figure 3.1. below.

As shown in Figure 3.1., PAM structure is composed of two set of identities – one set defining *profitability*, and the other defining the difference between private price and social values, measuring the *effect of divergence*; as the difference between observed parameters and parameters that would exist if the divergence were removed (Monke and Pearson, 1995, pp.: 16 – 19).

Profitability as the first identity of the accounting matrix is measured horizontally, across the columns of the matrix as demonstrated in Figure 3.1. Profits, shown in the right hand column, are found by subtraction of cost, given in two middle columns, from revenue, indicated in the left-hand column. This column constitutes *profitability identities.* There are two profitability calculations: private profitability and social profitability.

Private profitability calculation is provided in the first row. The term of *private* refers to observe revenues and cost reflecting market prices received or paid by farmers, merchant, or processors in the agricultural system. Private profitability calculations show the competitiveness of agricultural systems at given current technologies, output values, import cost and policy transfer. Private profits are the difference between revenues (A) and cost of input (tradable input B, and domestic factors C); all measured in actual market price: D = A-B-C.

Social profitability calculation, as indicated in the second row of Figure 3.1., is the accounting matrix utilized social prices. These valuations measure comparative advantages or efficiency in the agricultural commodity system. Social profits H, are efficiency measures, because output E (revenues) and input (E + F) are valued in prices that reflect scarcity or social opportunity cost. Social valuation of output (E) and input (F) that internationally tradable, are given by world price: c.i.f. prices for goods and services that are imported or f.o.b. export prices for exportable. Social valuation for domestic factor (G) is found by estimation of net income forgone because the factor is not employed its best alternative use or its opportunity cost (Monke and Person, 1995 p.21). In practice the valuation begins with a distinction between mobile (capital, labor and services that can move from agriculture to other sector of economy) and fixed factors (mostly land). For mobile factors, aggregate supply and demand forces determine prices. For fixed or immobile factors of production, such as land, are determined within particular sector of the economy. The value of agricultural land, for example, is usually determined only by land's worth in growing alternative crops.

	Revenues	Cost		Profits
		Tradable inputs	Domestic Factor	
Private prices	A	B	C	D[1]
Social prices	E	F	G	H[2]
Effect of divergences	I[3]	J[4]	K[5]	L[6]

Note :

[1] Private profit, D, equal A minus B minus C
[2] Social profits, H, equal E minus F minus G
[3] Output transfer, I, equal A minus E
[4] Input transfer, J, equal B minus F
[5] Factor transfer, K, equal C minus G
[6] Net transfer, L, equal D minus H, they also equal I minus J minus K

Ratio Indicators for Comparison of Unlike Outputs

Private cost ratio (PCR): C / (A – B)
Domestic resource cost ratio (DRC): G / (E – F)
Nominal protection coefficient (NPC)
on tradable outputs (NPCO): A / E
on tradable inputs (NPCI): B / F
Effective protection coefficient (EPC): (A – B) / (E – F)
Profitability coefficient (PC): (A – B – C) / (E – F – G) or D / H
Subsidy ratio to producers (SRP): L / E or (D – H) / E

Source: Monke and Pearson (1995, p.19)

Figure 3.1. Policy Analysis Matrix

The second identity of the accounting matrix is ***effect of divergences***, indicated in the third row. Although this row mainly concerns the difference between private and social valuation of revenues, costs and profits, and is measured vertically. This row constitutes the main point of the PAM approach. Any divergence between the observed private prices and the estimated social prices must be explained by the effect of policy or by the existence of market failure. *Output transfer* (I = A-E) and *input transfer* (J = B-F), arise from two kinds of policy that cause divergence between observed market prices and world product prices. Those two kind of policies are commodity-specific policies include a wide range of taxes and subsidies and trade policies, and exchanged rate policy. *Factor transfer* (K = C-G) shows how policies on factors of production and the factor market imperfection had been taking place that create a divergence between private cost (C) and social cost (G). Finally the *net transfer* (L) caused by policy and market failure is the sum of the separate effect from product and factor market (L = I-J-K). Positive entries in two cost categories J and K represent negative transfer because they reduce private profit, whereas negative entries in J and K represent positive transfer.

Profitability calculation

Many of the land use systems in Berau involve perennials and thus constitute long term investment. The appropriate measure of **profitability** is the **net present value** (NPV, present discounted value) of revenues less costs of tradable inputs (fertilizer, fuel, etc) and of domestic factors of production (land, labor, management) over the full 25 year period considered in the analysis. Because it can account for input and factor costs as well as outputs and can handle time by discounting future values, this measure of total factor productivity is superior to partial measures of productivity (e.g., yield or output per unit labor). Referring to Gittinger (1992), the NPV, *i.e.,* the present worth of benefit (revenues) less the present worth of the cost of tradable inputs and domestic factors of productions, mathematically it is as:

$$NPV = \sum_{t=0}^{t=n} \frac{B_t - C_t}{(1+i)^t}$$

where B_t is benefit at year t, C_t cost at year t, *t* is time denoting year and *i* is discount rate.

An investment in land use activity unit over 25 years since its establishment is appraised as profitable if NPV is greater than 0. In reverse, an activity with NPV less than zero is 'unprofitable' by definition. This does not necessarily mean that there are no positive cash flows. Instead, it means that it would be more profitable to do other things with the land, labor and capital than to devote them to this activity.

Tomich et al (1998, p 64) argues that in areas where land is scarce, the NPV calculation over the 25-year period can be interpreted as the 'returns to land' for the selected land use activity unit under study, because they are the 'surplus' remaining after accounting for costs of labor (including imputed value of family labor), capital (through discounting), and purchased inputs. Although land abundance and labor scarcity historically prevailed in many areas of outer island of Java, I this regard is Kalimantan Island, making it an attractive focus of government sponsored transmigration programs or even spontaneous in-migration due to the large scale investments, this relationship seems to be shifting. Much of this abundance land has been subsequently granted to industrial plantations or has been settled by spontaneous migrants as it's been taking place in Berau region since the past two decades. East Kalimantan area, where Berau District is located, has been an attractive destination for many spontaneous migrants.

On the other hand the study also look at a measure of 'return to labor' that is the wage rate that sets the NPV equal to zero. Adjusting the wage rate until NPV goes to zero can be used as a proxy for 'returns to labor' since this calculation converts the surplus to a wage rate (Vosti et al. 2000). Returns to labor that exceed the average daily wage rate, indicate that individuals with their own land will prefer this activity to off-farm activities and it also justifies hiring non-family labor. Returns to labor valued at private prices can thus be viewed as the primary of indicator of profitability for smallholder's production incentives. Graphical presentation in Figure 3.2. summarizes step by step of profitability assessment is accomplished. Green broken line box is the area where data collection is carried out, and another red broken light box is the analysis part. The light blue box with dark blue broken line is the parameters used of focus points of this study. Basically this is an iterative process from data collection to the analysis.

Data requirement

The approach and technique require set of essential data on agricultural activities, the market prices of any agricultural inputs as well as its output and its comparable social prices, and also the related land use systems.

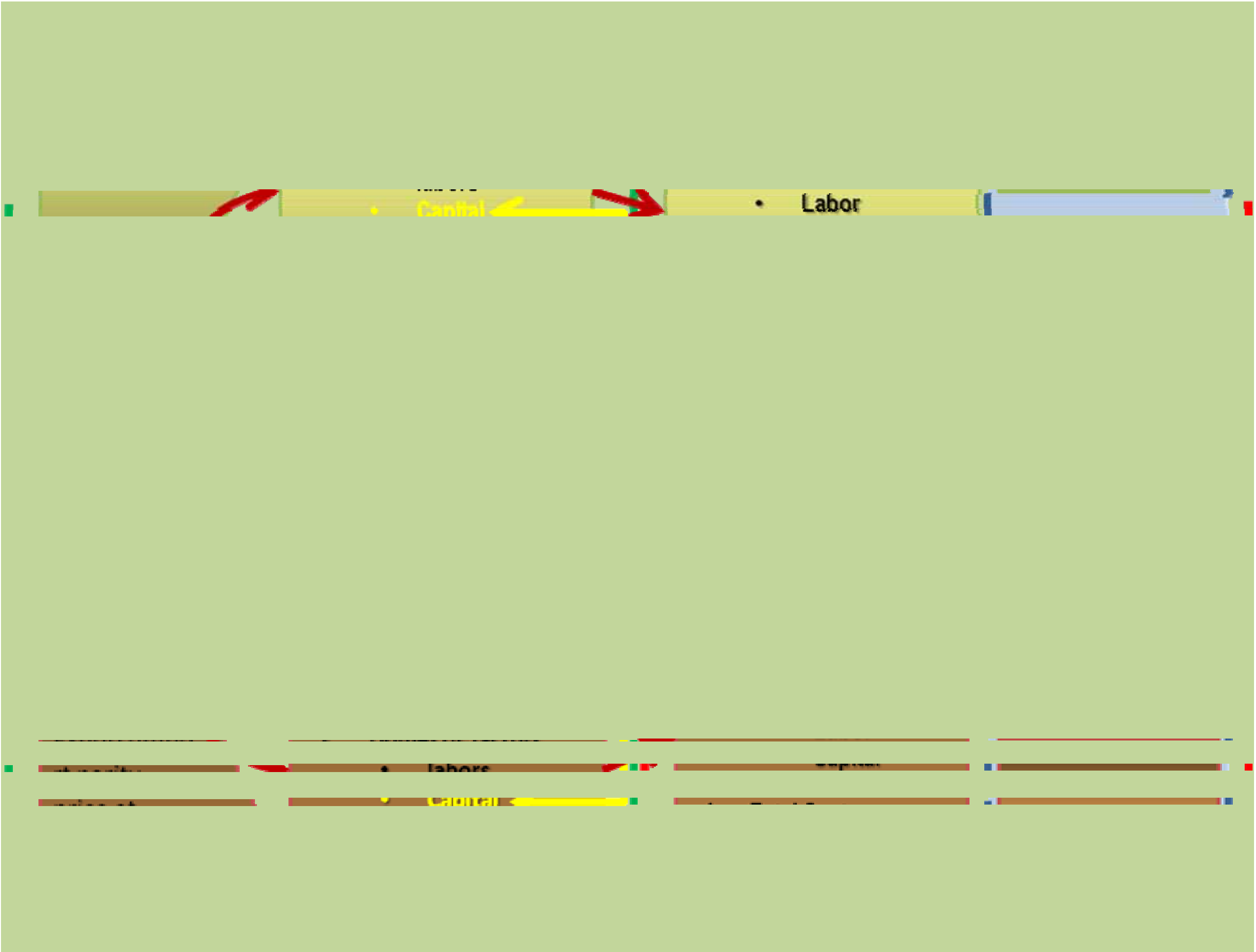

Figure 3.2. Steps by steps profitability assessment applying PAM methodology

Farm budget, inputs and outputs

The determination of profit that actually received by farmers/households or operators is straightforward and important initial result of the analysis. It shows which operators are currently competitive and how their profit might change if price policies were changed. Therefore farm budget components of the principal land uses systems, such as farm output or revenues and input cost, are the main necessary data and information. All of these are measured in actual market price. Regarding the second row of the matrix, hence social profitability that measures comparative advantages or efficiency in the agricultural commodity system, the valuation is given in world price. Therefore f.o.b. prices data of exportable items and c.i.f. prices of importable items in farm budget are the necessary data that should be collected.

There are two components that also need to be thought over in farm budget calculation is the value of land and the value of land use activity unit after year 25, hence the salvage value. With regard to the value of land, it is assumed that the price of land is zero for all land use systems under study. The reason is that the value of land is basically a function of its profitability, and the cost components of land acquisition, such as land permits and land tax already included in the farm budget calculation. With regard to salvage value, the assessment will not include this value in the farm budget calculation. Firstly because of that whatever the discounted value of land use systems at year 25 will be very little proportion to the overall returns.

Pricing and macroeconomic assumptions

Profitability assessment needs a detail-farm budget calculation. It is necessary to clarify the proper prices for calculating the cost and return and the macroeconomic assumption used in this assessment.

In determining the prices, ideally the study should use annual average prices of eight to ten years' time series data of all tradable farm inputs and farm commodities that are cast in the respective constant prices. Hence, local market prices as the basis of calculation of farm budget valued at private prices. Whereas for the comparable farm budget at social prices, it should apply export or import parity prices at farm gate as the basis of calculation. The purpose is to reduce the price volatility bias. However, due to the time constraint and lack of reliable time series data, especially for local market prices, the study uses single year price data, that is 2008 prices, for both private and social profitability calculation.

Profitability assessment of land use system in Berau uses macroeconomic parameters of 2009 as tabulated in Table 3.1. It closely linked to the time when data collection was carried out. Hence, the exchange rate was about Rp 9,680 / US dollar. By most assessments of economic fundamentals (e.g., purchasing power parity), the Indonesian Rupiah was not greatly overvalued at that time.

For agricultural wage rate, the study uses the same wage rate in both set (private and social profitability) calculations; IDR 44,000/ps-day. It is assumed that there are no imperfections in the market for unskilled labor. Probably this is not completely true. However, it seems that these imperfections do not have a significant effect in the unskilled labor market.

Real interest rates (that is interest rate net of inflation) are the discount factors used to value future cash flows in current term. A private discount rate of 10% and a social rate of 5% were chosen as the initials values to facilitate comparison with PAM results of different land use activities. It is argued that a private discount rate of 10% is a lower bound for the actual cost of capital for smallholder due to imperfections in capital markets in the area under study. The real social interest rate is less than the private rate and 5% is probably too low. So, somewhat arbitrarily, a rate of 5% has been used for the real social cost of capital, which are both the interest rate and the discount rate for calculating NPV at social prices.

Table 3.1. Macroeconomic parameters used in the study

Parameters	**July 2009**
Exchange rate	IDR 9,680/ US$ 1
Wage rate in Kalimantan	IDR 44,000 / ps-day
Real interest rates (net of inflation):	
Private:	10 % per year
Social:	5 % per year

Data collection

As the study is basically part of the assessment of Carbon Emissions from Land Use and Land Use Change in Berau District, data collection for carbon stock measurement was prioritized, meaning that the land use systems being assessed (its profitability) should be closely related to the land use data identified in the Carbon Emission Study. In identifying the main land use systems to be assessed, the study relies on the spatial data analyses of Carbon Emission Study (Section 1). Data collection for profitability analysis was done using Rapid Rural Appraisal (RRA) technique[8] in which the 'triangulation principles' in collecting particular data from various sources to assure the reliability of the data collected was also applied. It began with secondary data collections then followed by field observation and in-depth interview with the relevance key informants.

Results of the assessment

Land use systems in Berau

Land use system identification to be analyzed in this profitability assessment were selected based on land cover data identified in the carbon measurement study (Section 1 Report) plus intensive groundtruthing. There are eight land use systems, excluding mining, identified to be assessed in this section, as presented Table 3.2.

However, there are two remarks in selecting land use systems from land cover data. Land cover by definition is distinct from land use despite the two terms often being used interchangeably. Land use is a description of how people *utilize* the land. Or it is human modification of natural environment or wilderness into planned or built environment such as agricultural fields, pastures, and settlements. Whilst land cover is the physical material at the surface of the earth that grass, asphalt, tree cover, bare ground, water, etc. (See, Fisher et al. 2005 and Comber et al. 2005). For example, forest is a land cover. But it is also type of land use if there is a human activity involved; say to conserve this type of land cover.

Another problem is to determine which land cover types considered as land use systems that can be accounted for profitability analysis, especially land cover data derived from satellite imagery. Some land use systems look similar in the satellite imagery data, such as cleared land, pepper cultivation and early stage of dry land paddy. With extensive and intensive groundtruthing we gained more accurate and up-to-date information. For this reason, pepper cultivation was included in this profitability assessment, although it is not listed in the land cover data. And from four forest categories, this study considered two type logging: logging on low density forest and logging on high density forest.

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[8] RRA consist of short, intensive and informal field surveys that focuses on people own views of their problem (Khon Kaen University 1985; Chambers et al, 1989). Generally, the method involves open-ended exploration of important issues and more focused understanding on important themes from key informants' perspectives. Two data collection techniques were applied i.e., field observation and in-depth interview with key informants using semi structured interview guide.

The eight main selected land use systems of Berau that is listed in the Table 3.2., were identified through field work carried out in June - July 2009, followed by in-depth study (observation and in-depth interview) to collect more data to construct the farm budget as the basis for profitability analysis. Figure 3.3. presents the spatial distribution of the selected land uses systems, from which in-depth interview with key informants and observations were carried out.

Table 3.2. Land cover of Berau and the selected main land use systems

Land cover type	Selected Land use system	Scale of operation
Forest (undisturbed) **Forest (high density)** **Forest (medium density)** **Forest (low density)**	**Forest extraction** (36,360 ha) • Logging high density (40 m3/ha) • Logging low density (17 m3/ha)	Large scale enterprise
Acacia mangium ***Gmelina*** ***Paraserianthes*** **Teak**	**Timber plantation** • Industrial Timber Plantation • Acacia mangium	Large scale enterprise
Oil palm	• Oil Palm (8,140 ha)	Large scale enterprise and some smallholder
Cacao (2-5 ha) **Rubber (2 – 5 ha)** **Coconut (2- 5 ha** **Coffee (2-5 ha)** **Paddy (1 – 3 ha)** **Old shrub**	• Cocoa based mix garden • Cocoa Monoculture • Rubber Monoculture • Coconut Monoculture • Pepper • Upland Paddy, bush fallow rotation	Smallholder

The study noted 11 forest concessions covering 780,000 ha in 2009. However, some of them have been inactive for sometimes or its concession had been expired. In this assessment, two production scenarios were developed for logging: (1) logging on low density forest with production level of 17 cubic-meter/ha and (2) logging in high density forest with 40 cubic-meter of timber production. There were also large scale operated industrial timber plantation (*Hutan Tanaman Industri /HTI*) under three holding companies, covering 230,000 ha concession area. Four main species indentified in the timber estate: teak (for lumber), *Gmelina, Paraserianthes* and *Acacia mangium* for pulp. One plantation temporarily stopped its operation, while the others were not operated optimally. This circumstance strongly related to the current timber market that forced them to reduce its activity. The study selected *Acacia mangium* plantation to be assessed, as the most data available during the field work.

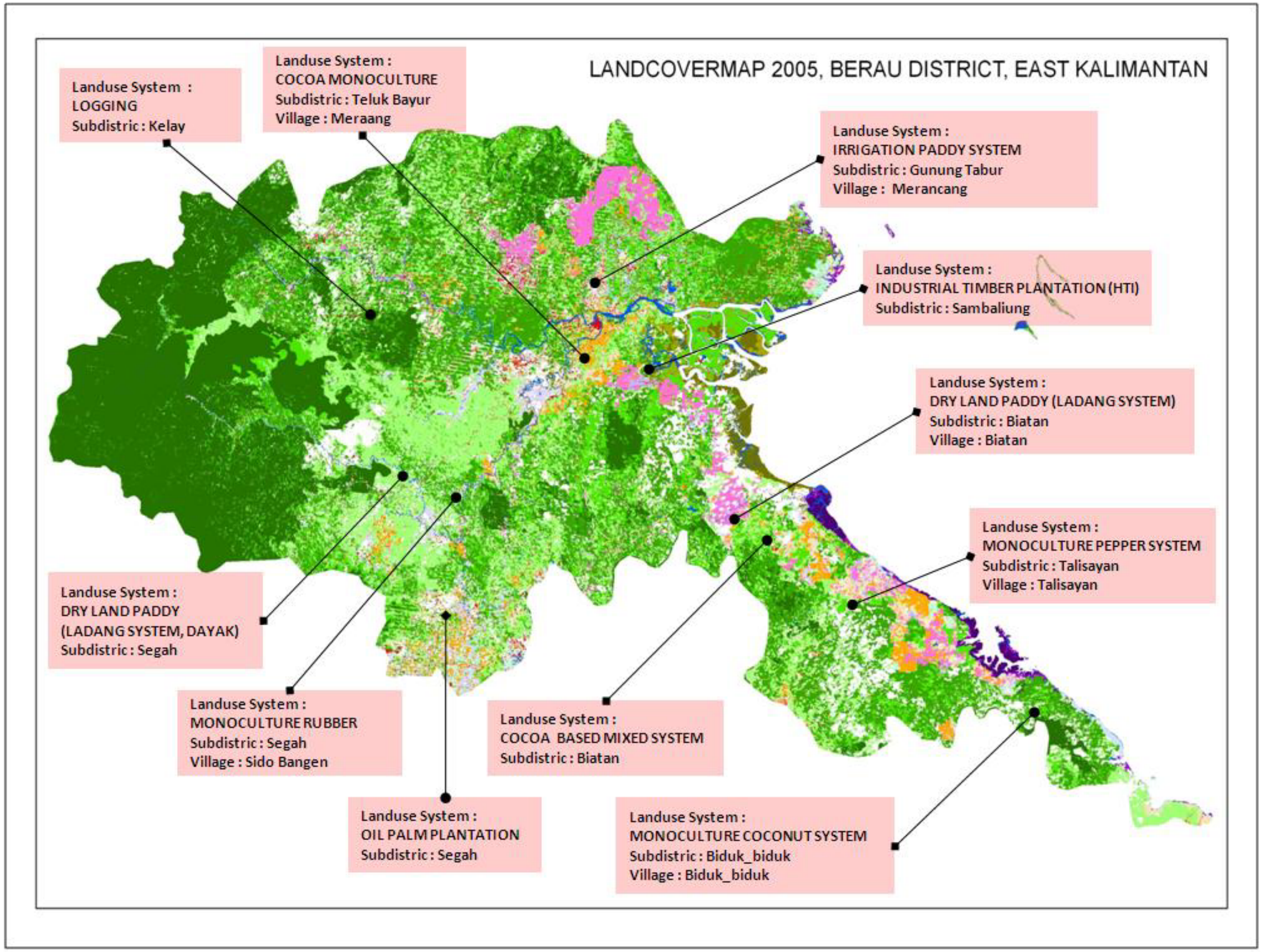

Figure 3.3. Spatial distribution of the selected land uses system under study

The newly emerged oil palm plantation has been growing significantly since the past five years. Until 2000, only two large scale oil palm plantations were established in Berau, with total area of 20,806 ha. The first large scale operated oil palm plantation was established in 1996. Since 2004, the area allocated for oil palm plantation had increased significantly. Plantation Statistic of Berau notes, until July 2009 there were 191,385 ha already allocated for oil palm plantation with 28 companies involved. However, the realization has been slow; only less than 30,000 ha were planted in July 2009. Quite recently a CPO processing unit has been operated in Berau with 45 ton FFB/hour installed capacity. However, due to the low supply of FFB, this CPO processing unit has been operated under its optimal capacity.

For smallholder operated land use system, the study selected cocoa (monoculture and mixed systems), pepper, rubber, coconut, and dry land paddy as the main systems to be assessed. Those systems are dominant agricultural practices of many villagers in Berau, and also strategic commodities to be developed by local government. In 2009 budget year, for example, Berau District Government allocated IDR 1.6 billion for Cocoa development, 54,850 clonal rubber seedling (approximately equivalent to IDR 515 million) were distributed to farmers, and provide pepper piling machine that worth IDR 234 million. While in the coconut producing area of Biduk-biduk, there is Coconut Biodiesel Processing Unit with the production capacity of 1000 liter/day that was established quite recently. Dry land paddy is selected because the system is mostly practiced in the form of shifting cultivation, and in subsistence mode of production. Area coverage in 2007 was 7,414ha.

There were some land use systems identified during the survey, but were not selected to be assessed. They are food crop systems that were scattered in small patches throughout the district (producing soybean, maize, cassava, sweet potato, and some vegetables). The study, within the time given, was not able to cover these food crop systems.

Profitability

Two indicators are accounted to assess land use profitability. They are ***returns to land*** that is defined as the 'surplus' remaining after accounting for cost of labor, capital, and purchased inputs (NPV), and ***returns to labor*** - that is the wage rate that sets the NPV equal to zero (Vosti et al., 2000). The calculation of return to labor converts the 'surplus' to a wage after accounting for purchased inputs and the discounting for the cost of capital. Both are derived from farm budget calculation and discounted cash flow analysis of the main land uses systems, which were calculated at private prices (for financial profitability) and at social prices (for social profitability). Estimates of returns to land and returns to labor, each evaluated at private and at social prices, are presented in Table 3.3.

Table 3.3. Profitability matrix

Selected land use	RETURN TO LAND*) (NPV, IDR 000/ha)			RETURN TO LABOUR* (IDR/ps-day)	
	at private prices	*at social prices*	*Divergences*	*at private prices*	*at social prices*
Logging					
low density (17 m3/ha)	3,851	9,074	(5,222)	97,851	129,514
high density (40 m3/ha)	17,086	39,611	(22,525)	281,057	417,314
HTI Acacia mangium	5,566	12,603	(7,037)	34,057	50,205
Oil Palm	33,146	137,699	(104.553)	127,976	222,395
Paddy					
Dry (Dayak)	(30,768)	(65,769)	35,001	17,302	8,917
Dry (Coastal)	(24,809)	(35,978)	11,169	18,722	8,963
Cocoa based Mix Garden	2,920	13,029	(10,109)	50,011	65,766
Cocoa Monoculture	13,038	32,551	(19,513)	61,200	62,384
Coconut Monoculture	3,404	15,863	(12,458)	53,476	79,313
Pepper Monoculture	28,069	64,503	(36,433)	61,253	69,243
Rubber Monoculture	12,199	68,902	(56,703)	59,996	96,029

*) Prices are based on 2009 average prices and express in July 2009 IDR (IDR 9,680/ US$ 1)

Sources: Authors' calculation

The upland paddy/ bush fallow rotation (three year cycle) stands out as being 'unprofitable', either in terms of potential profitability (returns to land at social prices) or smallholder production incentives (returns to labor at private prices). An activity with NPV less than zero is 'unprofitable' by definition. This does not necessarily mean that there are no positive cash flows. Instead, it means that it would be more profitable to do other things with the land, labor and capital than to devote them to this activity. Although paddy productivity is relatively low (maximum 1 ton per ha), and return to labor estimate is also less than agricultural wage rate (IDR. 44,000./ps-day) the farmers keep practicing the systems to secure their staple food. For many Dayak communities and other upland communities, planting paddy is intended for their food security; which is relatively important than working for wages.

Other smallholder operated land use systems, such as cocoa, rubber, pepper, and coconut gain positive NPV; being profitable in terms of potential profitability (returns to land at social prices), and also yielded higher return to labor than daily agricultural wage rate, varies between IDR 50,000 and 60,000/ps-day at private prices. In relatively labor-scarce environment like in Berau (2.7 person /km^2), higher return to labor would be expected to outweigh return to land in farmers perspectives.

Profitability estimates for smallholder rubber monoculture system shows positive returns to land and relatively higher return to labor as compared to daily wage. The smallholder rubber plantations in Sidobangen were previously part of NES –transmigration for industrial timber plantation (*PIR Trans HTI*). Farmer managed rubber plantation (2 ha per farmer) in Sidobangen was initially planted as a transmigration package to support they livelihood, while the farmers (transmigrant) also work as laborer for the large scale operated industrial timber plantation (HTI). During the field survey, the new planted rubber to rejuvenate the old rubber or conversion from other food crop systems were identified in many part of Sidobangen area. It seems that better price of rubber (up to IDR 9,000 per kg) attract farmers to plant this commodity. Of the two cocoa systems, cocoa monoculture is better than the mix systems. It generates return to land more than double of the mix system, and 10% higher return to labor. The cocoa mix systems were basically combination cocoa cultivation with other tree crops (five or more other tree species) seems not as intensive as the monoculture systems. Pepper cultivation that mostly cultivate by migrant from Sulawesi and also Javanese yield highest profitability among the smallholder operated land use systems.

Oil palm plantation, the new emerging land use system in the last ten years, and is mostly operated by large scale investor, stands out as the most profitable systems in Berau District. Estimate return to land (NPV at social prices) reach IDR 138 million per hectare (25 years production scenario at 5% discount rate). Oil palm is widely viewed as the most profitable land use system Kalimantan, and Indonesia's oil palm producers have the lowest unit costs in the world. Thus, it is not surprising that large-scale oil palm monoculture is among the most profitable, either in terms of returns to land valued at social prices or in terms of returns to labor valued at private prices. The lowest unit cost probably relate to the official wage rate for plantation workers are far below the estimate return to labor. Besides, the study also found some oil palm plots of 2-5 ha planted by independent smallholders began to appear scattered in the region, mostly located closed to the large scale plantation. Another interesting result is the divergence figures; oil palm plantation has the biggest divergence for any land uses in Berau. This is because of policies related to the oil palm plantation and also the CPO trade, such as expenditure to be incurred by the investor to establish the plantation, CPO export tax, etc.

The results for commercial logging show that this land use system has been profitable for both low and high density forest, but still lower than oil palm system. Industrial timber even lower than logging operation, and its return to labor is even lower daily labor wage. It is not very attractive for investor and farmers. It partly relates to the timber market in Indonesia that has been affected by the timber from illegal logging and probably international market in relation to the environmental issues. Although not very common any longer as compared to the previous decade, timbers from illegal logging still exist in the market. As , the major cost item for logging concessions, establishing and maintaining logging roads, is not incurred by illegal loggers. If one can get access to timber without having to invest in infrastructure (and at the same time circumventing various fees), logging can be very profitable.

Labor requirements and cost of establishment

Returns are not the only issue governing the feasibility to practice such land use systems. There are specific conditions to be met to achieve those returns at different production cycles. These conditions may relate to land, especially in relation to agronomic profile, and more critical in relation to labor, especially in the relatively labor-scarce environment like in Berau, and in relation to capital. For this, Table 3.4. presents three different indicators of labor requirements. First, total person-days required to establish a system, where 'establishment' refers to the period before positive cash flows begin. The two other indicators of labor requirements in are closely related;

labor requirements for the operational phase (defined as the period after positive cash flow begins) and total labor. Both measures are averaged over time and the units are person-days per hectare per year.

Industrial timber plantation stands as very the highest labor requirements for establishment phase followed by logging with high production scenario, and then large scale oil palm plantation. The different lie on the return they can make. Profitability of industrial timber plantation is far lower than oil palm plantation, and estimate return to labor from industrial timber plantation (measured in private price) is not very attractive; it cannot pay the daily wage rate. And positive cash flow for industrial timber plantation happen 10 years after its establishment, which is not very feasible for stallholder farmer. As already noted earlier that returns to labor valued at private prices, which was selected above as an indicator of smallholders' production incentives is a good indicator for smallholders' concerns with labor constraints if combined with assessments of institutional barriers in markets for labor and capital.

Table 3.4. Labor requirements matrix of Berau Land use system, July 2009 (total labor inputs for establishment and averages over time for operations and total labor)

No	Coffee farming system	Year to positive cash flow	Labor requirement for Establishment *ps-day/ha*	Labor requirement for Operation *ps-day/ ha/year*
1	Logging			
	low density (17 m3/ha)	1	248	48
	high density (40 m3/ha)	1	459	153
2	HTI Acacia mangium	10	782	84
3	Oil Palm	9	321	77
4	Cocoa based Mix Garden	5	100	39
5	Cocoa Monoculture	5	268	75
6	Coconut Monoculture	11	484	69
7	Pepper Monoculture	4/3	407	164
8	Rubber Monoculture	5	347	102
9	Paddy			
	Upland paddy (Dayak)	na	na	142
	Upland paddy (Coastal)	na	na	122

Source: Authors' calculation

Looking at the time averaged labor requirements pepper cultivation and logging on high density forest are being the highest employer; 164 and 153 ps-day per ha per year. From the perspective of policymakers concerned with employment generation, total time-averaged labor requirements are a good indicator that is related to equity and stability criteria; employment generation in rural area. Note, however, that while labor-intensive land use systems should be attractive for policymakers who are concerned with job creation, these alternatives will only be attractive to households if they provide attractive returns to labor, the indicator discussed above.

Another aspect to look at in the assessment is cost of establishment. Because perennials are so important land uses in Berau, the analysis of cash flow constraints focused on multi-year (rather than seasonal) cash flow constraints in order to assess whether the investments required by these systems are barriers to adoption by smallholders. Table 3.5. presents two perspectives on multi-year cash flow constraints: years to positive cash flow and the NPV of establishment costs, which is defined as costs prior to positive cash flow. The imputed value of family labor is included in these establishment costs because these labor inputs presumably represent foregone earnings in other activities even if they do not require cash outlay.

Table 3.5. Cost of establishment (per ha)

	Year to positive cash flow	Establishment cost (IDR 000)	
		In private prices	**In social prices**
Logging			
low density (17 m3/ha)	1	2,853	3,643
high density (40 m3/ha)	1	4,988	3,863
HTI Acacia mangium	10	10,150	12,158
Oil Palm	9	22,765	20,543
Cocoa based Mix Garden	5	4,920	5,353
Cocoa Monoculture	5	9,441	10,149
Coconut Monoculture	11	11,769	11,043
Pepper Monoculture	4/3	24,620	20,861
Rubber Monoculture	5	7.152	8,084
Paddy			
Upland paddy (Dayak)	na	na	na
Upland paddy (Coastal)	na	na	na

Sources: Authors' calculation.

By either measure, logging concession is a profitable system with smallest establishment cost per hectare. This figure needs to understand with care. Logging concession is indeed can provide positive cash flow at the first year of its operation. But it has long list of condition that regulated by government to be met especially in relation to the extent of the area and the location. With such regulations, access to this logging concession is not very easy, and some cases create space for the possibility higher cost of establishment to happen. For the other systems, years to positive cash flow range from three years for pepper cultivation, five years for rubber and cocoa cultivation, and nine years for oil palm plantation, ten years for industrial plantation and 11 years for coconut cultivation. It seems that time is not a constraint by itself, as evidenced by almost three thousand hectare of coconut cultivation that have been planted by smallholders without any formal credit.

The NPV of establishment costs at private prices, which is derived directly from the PAM cash flows, probably is the best indicator of cash flow constraints for smallholders. At IDR 22 million per ha, investment costs for large-scale oil palm plantations are the highest of all. Such investments of this magnitude would be difficult for many smallholders. That is why the NES is encouraged to enable small-scale take part in this profitable land use systems. The second biggest investment is pepper cultivation. It requires IDR 24 million per hectare to establish to cultivate pepper. It seems that the pepper system remains attractive and affordable for farmer to enter. In relation to the extent of the area pepper cultivation is flexible; farmers with land less than 1 hectare can grow pepper.

Human population and sustainable land use systems

From the labour requirement data presented above, we can take the analysis a few steps further by considering the 'sustainable land use system' equivalents of the land use studied, essentially by estimating the relative length of 'resting period' needed in between production cycles. This applies specifically to the logging and paddy rice cultivation, but probably also to the pepper production. By specifying the number of ps-days/year and the fraction of the human population that can potentially engage in the land use activities (economically active population), we can derive a 'equilibrium sustainable human population density' for each land use type. By considering the relative proportion of local jobs in the value chain downstream of the farm gate, we can use a constant fraction for working part of the population. Table 3.6. presents the equilibrium sustainable human population density of each land uses studied.

The calculation basically converts the lifecycle average labour absorption of a land use system to an 'equilibrium human population density'. It is assume that average number of effective working days per year is 250 person-day per year, and the proportion of economically active population is 67%.