Modeling the Dynamics of Landscapes and Livelihoods in Malinau District, Indonesia

[1]Suwarno, A. and [2]B. Campbell

[1]Centre for International Forestry Research (CIFOR), [2]CIFOR and Charles Darwin University, E-Mail: a.suwarno@cgiar.org

Key words: *participatory model, district revenue, landscape dynamics, livelihoods, plantations*

EXTENDED ABSTRACT

The complex dynamic interactions between land resources and society have to be taken into account when planning land use and managing land resources. Simulation models and participatory modeling can be ideal tools to improve our understanding of these complex interactions.

For several decades, land use in Malinau district was dictated by the central government through the allocation of land to agriculture, timber concessions and mining companies. Now, with a policy of decentralization in place, district governments have a greater say in the allocation of land use. As a part of the district government development programs to increase district revenue, several forest areas are likely to be allocated for plantation production, but the proposed creation of a "conservation district" will require some level of forest protection. Using a combination of empirical data and stakeholder's participation, a computer model using STELLA software was developed to investigate long term land use, district revenue and livelihood dynamics.

Indonesian forests are globally important biodiversity hotspots. However, we hypothesize that land use changes, in which forests are converted to plantation and other intensive land uses, are to the benefit of most key stakeholders that can drive these changes. .

The modeling results show that the imperative for large-scale development (i.e. plantation and other intensive land use systems) is enormous, as such systems will yield significant benefits to local authorities and local people. While there will undoubtedly be losers with such development (e.g. hunter-gatherers relying on non-timber forest products; those who are displaced by plantation expansion; the conservation lobby), the current incentives are likely to drive forest conversion.

1. INTRODUCTION

Landscapes and livelihoods have strong relationships and multiple interactions. A landscape is here defined as a heterogeneous area made up of a cluster of interacting ecosystems/habitats (Forman, 1995). A livelihood comprises the capabilities, assets and activities required for a means of living (Carney, 1999). The dynamics of landscapes and livelihoods are closely connected, and for that reason, must be jointly considered by land use planners, development practitioners and policy makers.

Modeling in livelihood studies has a long history, with its roots in peasant studies by Chayanov, as well as other Soviet pioneers of development planning such as Bukhiran (Soussan *et al*, 2001). There are many aspects that influence the dynamics of livelihoods, as the access to land and natural resources as the important one.

Malinau is one of the new districts in East Kalimantan Province, Indonesia (Figure 1). Most of the district is forest area (98 %), including production forest, conversion forest and protected areas. Only 2% of the area is classified as agriculture, mining and other use areas. With the coming of decentralization and political reform, the district government has taken increasing control over land use decisions but not without conflict with central government.

As part of a strategy to show leadership in land use planning, the local government established district regulation No.12/2003 concerning land allocation and natural resources management. Based on that regulation, local government administration tried to re-evaluate land use allocation in the district. The head (*Bupati*) of Malinau has proposed reallocating some conversion forest areas to plantation areas in order to increase local revenues for the district and improve household livelihoods. He planned to release permits for acacia and oil palm plantations for about 30,000 hectares come from both primary (unlogged) and secondary (logged) forest. *Bupati* has also proposed to declare Malinau as a "District Conservation" zone. However, those objectives will face big challenges, especially balancing the economic and conservation aspects.

The aim of this paper is to simulate landscape dynamics in Malinau District, an area of 42,620 km², in order to understand the conservation and development trade-offs and synergies from the perspectives of different stakeholders. The model illustrates possible future land use and livelihoods. The model was designed to be of use in developing policies for Malinau District.

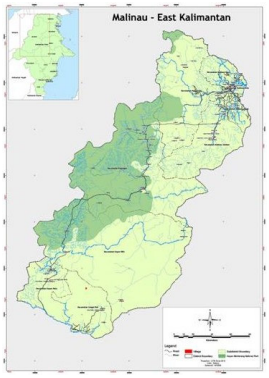

Figure 1. Geographical features of Malinau District (Topography Kodam, 2004 and Bappeda, 2002). The inset shows the location of Malinau District in the province of East Kalimantan.

Forests in Malinau are considered to be one of the world's 15 tropical rain forest hotspots (Mittermeier and Bowles, 1993). We hypothesize that land use changes, in which forests are converted to plantations and other intensive land uses, are to the benefit of most stakeholders, and these stakeholders have the power to drive this conversion process. There decisions are likely to determine the landscape and livelihood dynamics in Malinau district.

The model that is presented in this paper is a participatory model. Model development is initiated by sharing ideas with local stakeholders to obtain a general picture of what is happening in the landscape and the influences of landscape use on livelihoods. The purpose is to recognize observable land-use components and to identify the type and rate of change. Since the actual land-use dynamic is a result of the complex interaction of biological, social, economic and political factors, any ideal form of land-use change model should take these factors into account.

2. METHODS AND APPROACH

The simulation model was built using the dynamics modeling software STELLA v.8. The model included variables and information on land-use, human populations, employment, forest and plantation economics, and district income. STELLA v.8 is user friendly, incorporating equation-building and simulation functions. To identify the current status of livelihoods in Malinau district, we used data from BPS-Statistics of Malinau and from CIFOR researchers working in Malinau. Data used for the model included bio-physical, economic and institutional collected

between 2000 and 2005. All monetary values are reported in Indonesian rupee (Rp), where c. US$1 = Rp 10,000. Initially, the idea for a model was shared with CIFOR researchers and a "throw-away" model (Sayer and Campbell, 2004; Lynam et al., 2003) was produced that simulated land-use change. The results of simulations were discussed to researchers and staff of the district, including the *Bupati* and gave the modelers the opportunity to get feedback on priority issues, sources of data and key variables and drivers of change. A workshop was then convened with twelve persons from the district agencies where available information and data were shared and discussed followed the detailed model preparation, largely undertaken by one of us (AS). Various drafts of the model were shared with stakeholders in subsequent meetings to explore simulations, identify problems with the model and clarify the methodology. After the above process, a modeling course was conducted to enhance the capability of some of the district staff (twelve participants from eight agencies).

3. LAND-USE IN MALINAU

3.1. Main Land Use Types

During the centralisation policy era prior to 1998, land use in the Malinau district was under the control of the central government and the area was allocated to forest use, mining concessions and other uses, and distributed these under private and state concessions. In the decentralisation policy era, land use allocation has come increasingly under the control of the district government, though some allocation is still under central government.

Table 1. Land-use in Malinau in 2004 (hectares)

Years	2004 (hectares)
Total Area Malinau District	4,262,070
Permanent Agriculture Area	4,197
Shifting Cultivation Area	6,880
Tree Crops	4,622
Forest Area	4,205,000
a. Protected area	1,890,000
d. Production and Conversion Forest	2,315,000
Total Mining Area	19,919
Other Uses (for settlement)	22,839

Source: BPS-Statistics of Malinau Regency, 2002; LANDSAT TM 7, 2002; and RTRWP 2004

Land use in Malinau District in 2004, as recognised in offical statistics, is presented in Table 1. Forests are a major component of the landscape and it can be divided into primary and secondary forest. The term secondary forest is used to cover all those forest areas that have been logged in the past, so roughly 25% of the landscape was logged by 2004. Previously, during the centralization era, few of the forest areas in Malinau district were allocated to agriculture, mining, or plantation. Likely land-use changes are summarized in Figure 2.

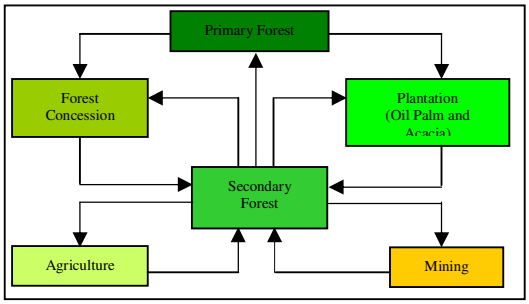

Figure 2. Major land-use changes in Malinau district

3.2. Timber Utilization

In the 1980's the Indonesian government established a forest policy entitled 'Agreed Forest Use Categories' (TGHK). This policy classifies all state forestland into the following categories: conservation and protected forest, limited production and production forest; and conversion forest. Conservation and protection forest form a large part of this district with a large portion is being found in Kayan Mentarang National Park. The logging that occurs in Malinau largely takes place in the production, limited production and conversion forest areas, though some area designated as protection forest has also been allocated for logging by local authorities.

Logging activity mainly carried out by concession holders both HPH (large scale forest concessions) and IUPHHK (small-scale forest concessions), typically takes place in primary forest or regenerated logged-over areas (secondary forest) and drive the conversion from primary forest to secondary forest. The timber market will certainly affect the rate of conversion but it is government that primarily regulates the rate.

Another type of forest concession is IPK (permit for land clearing) that supposed to be a precursor for forest conversion, usually for plantation development. The total area released for IPK activity is based on the permits released for plantation development and it usually done for three years at the initiation of the plantation development process. However, some IPK concession holders do the logging but have no intention of converting the area to plantations.

3.3. Agriculture

A population sub-model drives the rate of increase in farming households, and this feeds through to area farmed. Included in the population model is in-migration that is driven by major economic development (e.g. plantations, mining). Expert opinion suggests that if plantation development occurs, 60% of outsiders coming to Malinau will work on plantations or mines, 30% will work in the service sector and 10% will undertake farming.

Permanent agriculture is defined as the system that uses fixed areas for intensive crop and production. Many residents close to the major town of Malinau practice intensive agriculture as they are close to the market for their produce. In addition about one-fifth of households further from Malinau town have a small area for intensive production (about 0.5 ha).

Shifting cultivation is prevalent in the area. The shifting cultivation system starts with the conversion of secondary forest to dryland rice cultivation. After about 5 years when the crop yields become very low, farmers will abandon this area and will be back to the area after an average of about 10 years.

3.4. Plantations

In order to increase the revenues of the district and community, the local government has proposed the development of oil palm and acacia plantations. These plantations will be allocated in a number of primary and secondary forest zones and it is proposed that companies should develop the plantations collaboratively with local people, e.g. through outgrower schemes.

Permits for plantation production are usually given for a 25-30 year period and after that they can be extended or halted. In this paper, we have used four scenarios for plantation development: (a) No plantation development; (b) Acacia plantation development—Two concessions with maximum area of 100,000 hectare each; (c) Oil palm plantation development—Two oil palm concessions with maximum area of 100,000 hectare each; and, (d) Full plantation development—here there are both oil palm and acacia plantations together forming an area of 400,000 hectares.

Some have argued that plantations are not sustainable in Malinau because of the poor soils and distance from markets. Oil palm may be able to establish and grow locally, however it is not a good indication of economic viability, as the seasonal availability of moisture is vital to good fruit initiation and production. Downstream plantations may be viable but any further upstream are likely to struggle (Basuki and Sheil, 2005). The road network in the district is rapidly expanding with new roads that now link Malinau to Nunukan district, so markets are effectively getting closer. Even if soils are poor it is likely that plantation development will go ahead – perhaps the resulting plantations will not be as profitable as those in other areas of Indonesia and Malaysia, but the evidence from elsewhere is that poor soils do not necessarily halt economic development (e.g. *Acacia mangium* plantations are being developed on poor sandy soils in northern Australia for export to Indonesia).

3.5. Mining

A small area of the landscape is allocated to coal mining (Table 1), but of that only 20-30% is currently being mined. We assume that this mined area mostly comes from secondary forest. Recently, further small areas for mining concessions were released by the central government.

3.6 Land use changes

Figure 3 shows the land-use simulation for the 'full development' scenario with oil palm and acacia plantations. The simulation suggests that the area of primary and secondary forest will decrease over the next 40 years due to logging, plantation development and agriculture, with the remaining primary forest area mostly being that in Kayan Mentarang National Park. This scenario is driven by the plans and aspirations of local government to increase economic activity by stimulating oil palm and acacia plantations, thus at the end of the 40-year scenario a good portion of the landscape is plantation.

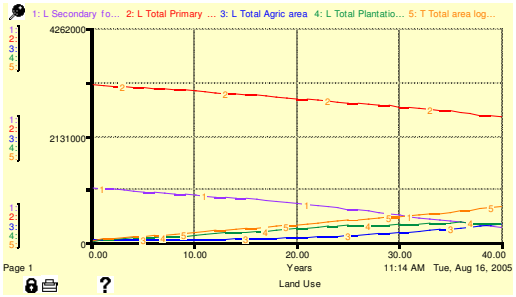

Figure 3. A 40-year simulation of land use in Malinau district (full plantation development).

The amount of forest area cut in any one year is based on annual permit (about 13,000 ha per year)

and this number can be change annually, influenced by policy and regulation from central government. A plantation development program will increase the amount of forest area cut, since area for plantation is derived from primary and/or secondary forest.

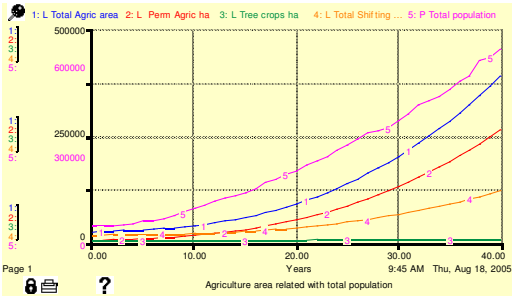

Figure 4. A 40-year simulation of agriculture area and total population in Malinau district, assuming full plantation development

Agriculture makes up a very small part of the landscape initially due to the low population numbers, but with the full plantation development scenario it becomes increasingly important over the 40-year period as farmers are attracted into the district to supply the expanding population of workers (Figure 4).

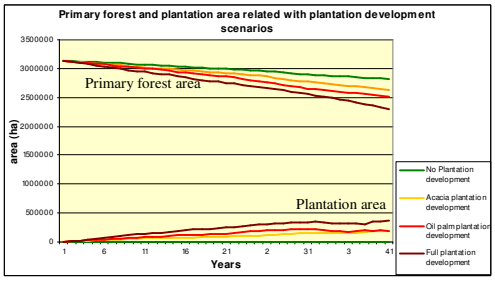

Figure 5. Total primary forest and plantation area, in relation to different plantation development scenarios

The degree to which plantation area is increased is greater than the decreased of primary forest, because much expansion in plantation is catered for by reduced secondary forest (Figure 5). Agriculture and plantation together make up 16% of the landscape at the end of the 40-year simulation for the full development scenario, while primary forest is still 58%.

4. ECONOMIC DEVELOPMENT

4.1 Population numbers

The total population in Malinau district, based on 2003 data was 44,316 with 80% living in the remote areas. The model differentiated between farming and non-farming households, with the former currently making up 75-80% of total households (the 'farming' sector included the largely hunter-gatherer population which has very small areas devoted to agriculture). In-migration is relatively high, related to the new opportunities in the District largely in the mining and the service sectors, and potentially in the plantation sector. The model simulates natural growth and in-migration. Plantation development, especially for oil palm, is likely to attract large numbers of people to the district (Table 2). The population rises sharply with the full development scenario (Figure 4).

4.2 Employment and Livelihoods

For many years, livelihoods in Malinau district have been dominated by agriculture and forestry. People in rural area largely depend on forest and on forest product for their livelihoods, and they practice shifting cultivation, the collection of non-timber forest products (NTFPs) and most have a small home garden for permanent agriculture (Levang et al., 2005). The smaller numbers of people that stay in Malinau town work in the service sector, undertake trading, have some permanent agriculture areas supplying the town with produce, or are employees in private companies (mining, forest concession, plantation, etc). Employees of extractive industries are also found in forest camps and in a few of the remote settlements.

Table 2 shows the numbers of households involved in different sectors in 2004 and as simulated under the different scenarios for 2044. With plantation development, after 40 years a greater proportion of households will be involved in the plantation sector with a reduction in the proportion in the timber, mining and agricultural sectors. Under the no development scenario agriculture accounts for 82% of jobs, while in the full plantation development option agriculture only accounts for 67% of jobs, with plantation and services jobs together reaching 31% of jobs.

Figure 6 shows the average cash income per household in relation to the different development scenarios. The plantation development scenarios give higher incomes than the no development scenario. After 30 years of the acacia and oil palm development scenario, the amount of land allocated to these reaches the maximum that we set for this scenario and as no further expansion takes place there are fewer jobs in plantation development and thus annual incomes decline as no new planting area is opened up.

Table 2. Employment in different sectors, and total population in Malinau district (2004 data and simulation results)

Primary activities of households	No of Households				
	2004[2]	Simulated results – 2044			
		No development	Acacia	Oil Palm	Full Development
Agriculture (Permanent, shifting cultivation and NTFP[1])	8,244	9,375	11,911	41,661	50,245
Mining	206	1,024	1,246	1,246	1,098
Timber Concession	618	5,242	2,244	3,029	2,850
Gov officer, trading & service	1,236	7,114	8,364	29,639	35,763
Plantation	0	0	8,364	21,762	34,692
Total households	10,306	22,756	33,038.	97,506	124,650
Total population	44,310	97,851	142,064	419,279	535,997

[1] These households also have some areas of permanent agriculture (20% of these households were assumed to have an average of 0.5 ha each)
[2] Source: Census 2004 and Malinau Regency in Figures, 2003

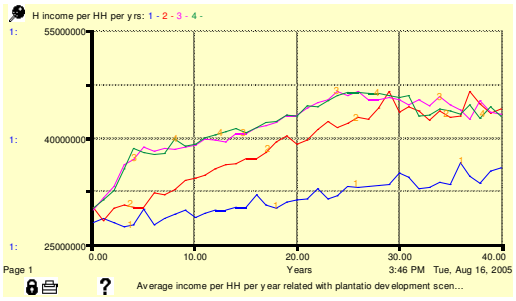

Figure 6. Average cash income per household, in relation to different plantation development scenarios.

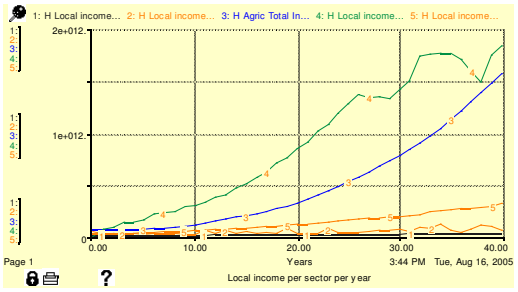

Figure 7. Total income for all households per sector per year, assuming full plantation development

4.3 District Development

Since Malinau was declared as a new district in year 1999, the local government has explored ways of increasing their income. In 2004, the budget for Malinau district was Rp. 408 billion with 98% of that coming from central government and only 2% coming from local income. Of this budget 36% was for the annual budget and maintenance, and 65% for development activities. From this latter proportion, the government officer and monitoring section took 39% for developing non-transport infrastructure, infrastructure for transportation took 29% and capital expenditure for education took 6%.

Increased economic activity, rising per capita incomes and rising populations will have a major impact on district budgets. Figure 7 shows the cash incomes to all households for different sectors over the 40-year simulation with the full plantation development scenario. Figure 8 shows the relationship between various development scenarios and the total jobs generated while Figure 9 shows total district revenue. Plantation development is likely to attract large numbers of people to the district (Table 2).

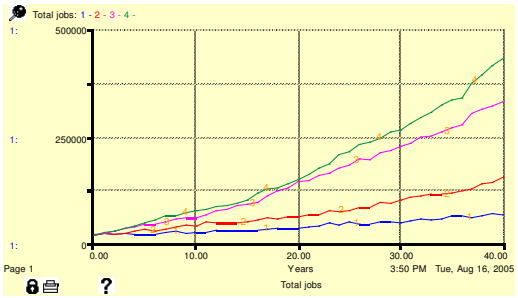

Figure 8. Total jobs generated in relation to different plantation development scenarios.

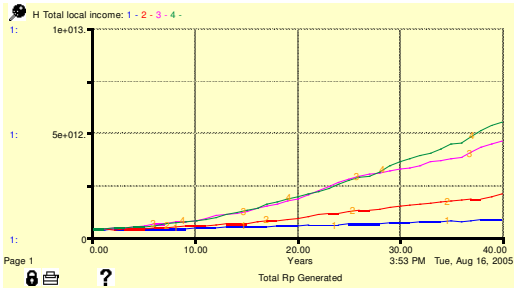

Figure 9. Total district revenue (Rp) in relation to different plantation development scenarios.

Based on a full plantation development scenario, household income for plantations becomes the biggest source of income, in line with the increasing the number of jobs. Household income

from agriculture rises substantially as farmer numbers increase and demand for the growing population is met. The full development scenario will also deliver more income to district government. This outcome has a strong bearing on current government aspirations. If the government decides to release two permits for acacia plantations and two permits for oil palm plantations, job opportunities will increase, populations will rise and the regional economy will expand. Total income to all households from the timber sector declines relative to other income sources over time related to total annual cut. The simulation results showed that local income from mining is increasing by small amounts, related to the scale of activity and the number of jobs in this sector which were both relatively constant.

5. CONCLUDING REMARKS

There is a strong relationship between landscape dynamics, livelihood outcomes and district development. Land-use change is likely to be widespread and accelerating, largely driven by decisions made in the district capital in terms of concessions for plantation development. Allocating primary and secondary forest to plantations and other intensive land uses, will be to the benefit of most stakeholders. Local people see the promise of jobs with higher cash incomes. District officials see greater economic activity, more in-migrants and larger district budgets. At the national level some of the income gets back to the national coffers and the nations politicians and officials see development occurring, which is a major aspiration.

Most conservation-based stakeholders do not see plantation development as a positive way forward for Malinau district, given that it opens up the district and is likely to bring more pressures on forests. But the conservation lobby is not to any significant extent party to the forums where the decisions on the future of Malinau will be made. Much is made of direct payments for environmental services (PES) provided, and one could argue that the global community interested in biodiversity could change the incentive structure for local and district stakeholders so that they selected more conservation-based land uses PES to communities can increase conservation awareness and improve incentives for conservation (Ferraro and Kiss, 2002). However, the area is vast and the size of payments will be well beyond most budgets for conservation. Indeed, an attempt was made to facilitate a payment for one village in Malinau but this has to date been unsuccessful, with lack of buyers for biodiversity being notable (Wunder et al. in press, 2004).

But even with our full-development scenario with 400,000 ha of plantations, the major part of the district remains under forest at the end of the 40-year simulation period. If this indeed can be conserved, then a full development scenario is not, in our minds, at odd with the proposal to develop Malinau as a conservation district. As a supporting tool, the model of land use change and livelihood dynamics will make a contribution to decision making process at district level. As this has been built in a participatory manner local officials are easily able to maneuver around within the model and change variables.

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